by B. F. A. Basnayake, C. Chiemchaisri and C. Visvanathan

Wastelands

Clearing up after the tsunami in Sri Lanka and Thailand

Efforts to clear the massive quantities of wastes accumulated along the tsunami-affected areas of Sri Lanka and Thailand continue. A particular challenge lies in how to handle large amounts of demolition waste without appropriate equipment.

Over one year on, derelict and destroyed landscapes remain in the wake of the tsunami disaster of 26 December 2004. The tsunami struck first at provinces such as Phuket, Krabi and Phangnga in Thailand. A few hours later, the east coast of Sri Lanka suffered a direct hit before the tsunami ravaged the country's Southern Province and, to a lesser degree, the west coast. In Thailand, some of the solid wastes were swept into the sea with a huge receding force. A notable difference in the east coast of Sri Lanka was the presence of sludge washed ashore from the sea.

In broad terms, the devastation produced three categories of waste, defined according to their disposal requirements:

- municipal solid waste (MSW) generated by the people living in the area
- infectious waste from dead bodies (human and animal) and medical activities
- debris from demolished buildings and civil structures (including roads).

It is a tribute to those faced with bringing order back to the affected areas is that they have cleared around 0.5 million tonnes of wastes in Sri Lanka and over 0.8 million tonnes in Thailand.

Management of MSW and construction debris after the tsunami

The wastes created by the disaster presented new collection problems in many of the affected areas as communities were compelled to discard materials had once been useful to them. Colossal volumes of unusual wastes weighed down the waste management capacity and capability of the local authorities and government agencies, especially in Sri Lanka. The burden was less for most Thai authorities since they had a better infrastructure in place for managing waste before the tragedy struck.

Some of the local authorities received valuable support in managing their wastes.

After the tsunami struck in the sub-district of Kamala, Phuket Island, Thailand.
PHOTO: KAMALA SUB-DISTRICT ADMINISTRATIVE ORGANIZATION

Others, which lacked financial resources and did not receive external support, are still suffering from the accumulation of these wastes. As a result, demolition wastes remain by the roadside in some places in both Thailand and Sri Lanka.

Thailand

In many places in Thailand, the demolition waste produced by the tsunami consisted of a mixture of materials such as building debris, wood, metals and plant residues. These were managed in different ways depending on the capability of the respective local authorities.

Phuket, Phangnga and Krabi Provinces have their own centralized facilities for landfilling MSW. Phuket also operates an incinerator and a waste separation plant with a daily capacity of 300 tonnes. The latter is designed specifically as a pre-treatment unit prior to waste incineration and employs both manual and mechanical separation. However, the amount of waste requiring handling exceeded the plant's processing capacity.

Some of the local authorities (such as Pathong Municipality in Phuket Province and PP Island in Krabi Province) brought the private sector into action. This meant that wastes could be disposed of at private sites and not just local authority ones.

Approximately 23,000 and 20,000 tonnes of debris were generated by the tsunami in the Phatong and Kamala municipalities of Phuket Province respectively. Both municipalities hired private companies to transport and dispose of untreated debris by landfilling it on private land at a total cost of 4.4 and 1.5 million Baht respectively ($US1 = Bt40).

The most affected area in Krabi Province was PP Island, where about 32,000 tonnes of debris were generated. This waste was transported by boats from the island to the mainland for disposal on private land at total cost of 105 million Baht. This cost was supported by funding from the Thai Ministry of the Interior. Remarkably, in the Bang Muang district of the Phangnga Province, one private company (Waste Management Siam Co. Ltd) helped to transport about 1250 tonnes of waste to the Chonburi Province for disposal in a non-hazardous industrial waste landfill free of charge.

Some local authorities are still suffering from the accumulation of their wastes

Sri Lanka

In the case of Sri Lanka, the action of the tsunami and the earth-excavating machinery for clear the affected areas mixed together greater quantities of woody materials,

BELOW LEFT Large amount of seabed sludge disposed of in a playground on the eastern coast of Sri Lanka **BELOW** Tsunami waste on the Costal Beach of Khao Lak, Phangnga, Thailand

ABOVE A playground in Kalmunai in eastern Sri Lanka is used as a dumpsite for the disposal of tsunami waste **FACING PAGE** Solid waste and debris were transported and disposed of at a sanitary landfill in Chonburi Province managed by Waste Management Siam Co. Ltd

asbestos, waste dislodged from former dumpsites, 'seabed sludge' caused by destructive wave action, grit, sand and salt.

In densely populated regions on the east coast, it has so far been impossible to carry out proper collection and disposal operations. Those in the wealthier Baticaloa municipality, for example, where around 42,000 tonnes of debris was generated, have used an existing dumpsite on the side of a lagoon to dispose of tsunami wastes. But regrettably, this site was already polluting the environment before the tsunami.

Some of the debris has also been disposed in other 'convenient areas' or, in some cases, burnt. For instance, in Kalmunai on the east coast of Sri Lanka, a playground was used as a temporary disposal site. But because this playground is in a low-lying area, dumping has resulted in leachate emissions polluting the wells not only near the playground but a considerable distance from it.

In southern and south-western parts of the country, notably in the Galle and Matara districts, the huge volume of woody materials and construction debris and the lack of proper disposal facilities are posing considerable problems. Although most of these wastes have been removed from the affected areas, a substantial amount remains in heaps in the sites themselves, and the destroyed foundations of some of buildings are still there.

The Galle Municipal Council has collected and dumped such wastes in five sites closer to Galle City while Matara Municipal Council used its MSW dumpsite alongside the Nilwala River to dispose of the wastes from the tsunami.

Some of the debris was disposed in 'convenient areas' or, in some cases, burnt

Telwatte (Hikkaduwa), the most affected area in Southern Province, generated a total of 36,800 tonnes of debris; sadly, the Central Environmental Authority of Sri Lanka has given permission to fill 10 coral mining areas with construction debris.

Dumpsite versus landfill

Dumpsite and landfill are two means of waste disposal used in both Thailand and Sri Lanka. The main difference between them is that, a dumpsite is an area where the waste is unloaded in a pile without proper site preparation while a landfill (normally referred to as a sanitary landfill) is designed to minimize the potential for groundwater contamination.

A dumpsite is normally an open or excavated area where the waste is disposed of and left uncovered without any surface liner or protective measures. Such sites allow free access to waste pickers and often produce unpleasant odours and aesthetic nuisance. Landfills, on the other hand, consist of an area of excavated land covered with a protective, impervious liner to shield the surface from direct contact with disposed waste. Sanitary landfills have covers and leachate collection/treatment systems.

TABLE 1. Amount of MSW and debris before and after the tsunami disaster

Province	MSW before tsunami (tonnes/day)	MSW after tsunami (tonnes/day)	Debris (tonnes)	Management
Southern Province (Sri Lanka)				
Balapitiya PS	3.5	3.8	2000	Disposal in MSW dumpsite
Galle MC	46	50	34,559	Disposal in temporary MSW dumpsite
Hikkaduwa UC	7.5	4.5–6.0	36,865	Filling coral/mined land with construction debris
Matara (MC)	16–18	20	13,048	Disposal in MSW dumpsite on river bank
Devinuwara PS	01	01	5683	Disposal in low-lying areas
Dikwella PS	10	11–12	–	Disposal in low-lying areas
Tangalle UC	7	6	3905	Disposal in low-lying areas
Eastern Province (Sri Lanka)				
Kalmunai MC	25	75	19,908	Dumping on sea side, paddy fields and vacant land
Batticloa MC	75–80	–	42,713	Burning and disposal on any convenient land, road sides, etc.
Phuket (Thailand)				
Phuket Municipality	108–110	100–105	–	–
Pathong Municipality	65–66	45–50	23,000	Landfilling on private land
Kamala District	7–8	5–6	20,000	Landfilling on private land
Total	*395–400*	*350*	–	
Phangnga (Thailand)				
Ta Kua Pa Municipality	12–13	12–13	–	–
Bang Muang District	5–3	3–4	1250	Transfer to private-sector sanitary landfill in Chonburi
Kuk Kug District	15	6–7	NA	Left on road side
Lam Kean District	95–100	80–90	NA	Sent to MSW landfill
Krabi (Thailand)				
Krabi Municipality	30–35	30–35	–	–
Ao Nang District (PP Island)	19–20	10–12	32,000	Landfilling on private land

Local administrative units in Sri Lanka: MC = Municipal Council; UC = Urban Council; PS = Pradeshiya Sabha

– = no information available

NA = not applicable

Capacity problems and waste amounts

Most of the wastes from the tsunami in Thailand have been disposed of in existing landfill facilities. However, these wastes have occupied most of the remaining landfill space. Similarly in Sri Lanka, the existing sites can no longer handle the incoming wastes.

In order to cope, the local authorities therefore need to find new landfill sites or to expand existing ones. Table 1 shows the quantities of MSW generated before and after the tsunami and the amount of debris from affected provinces in Sri Lanka and Thailand. The information was obtained from a field survey carried out by the University of Peradeniya, Sri Lanka, and a questionnaire sent to local authorities in Thailand.

As expected, there was a fall in the amount of MSW in some affected areas in both countries due to fewer tourists visiting holiday resorts in the coastal belts.

Recycling of demolition wastes

The debris contained various types of recyclable materials. Scavengers have been able to separate and sell recyclables such as metals, wood, cardboard and plastics at junk shops. Although this informal sector has not received official encouragement, it is the only one to have had a real impact on reducing waste loads.

Recycling of construction and demolition wastes including trees and branches is not widely practised in Thailand and Sri Lanka, mainly due to the lack of heavy crushing machines to reduce the size of waste materials for ease of transport and eventual reuse. A huge demand was perceived for the materials in question, but as well as reducing the size of the material, the recyclables also need to be separated from the total wastes as much as possible. Manual separation has only helped to reduce the volume of debris by a only small amount.

The waste still has to be transported to a plant for crushing. The need for heavy equipment remains

It was found later on in Thailand that heavy crushing equipment was available at some industrial sites such as those belonging to the cement industry. However, the waste still has to be transported to the plant for crushing. The need for heavy equipment remains.

Cleaning up after Katrina

In the aftermath of Hurricane Katrina, members of the Solid Waste Association of North America (SWANA) expressed a desire to help those charged with clear-up by offering to put together knowledge acquired through prior experience. Following a request for assistance from the State of Louisiana Department of Environmental Quality, SWANA approached its eight technical divisions for support.

SWANA published a report on the management of disaster debris in September 2005 and revised this report in December 2005, with updates particularly relating to the handling of household hazardous waste (HHW) and other hazardous materials.

Typically, there are two major phases to a debris management strategy. The first is the removal of debris that could cause an immediate threat to public safety (such as highly unstable structures and clearing of roadways). Opportunities for diversion and recycling during this phase will generally be limited. The second phase is long-term debris removal associated with recovery. This phase provides the greatest opportunity for diversion and recovery.

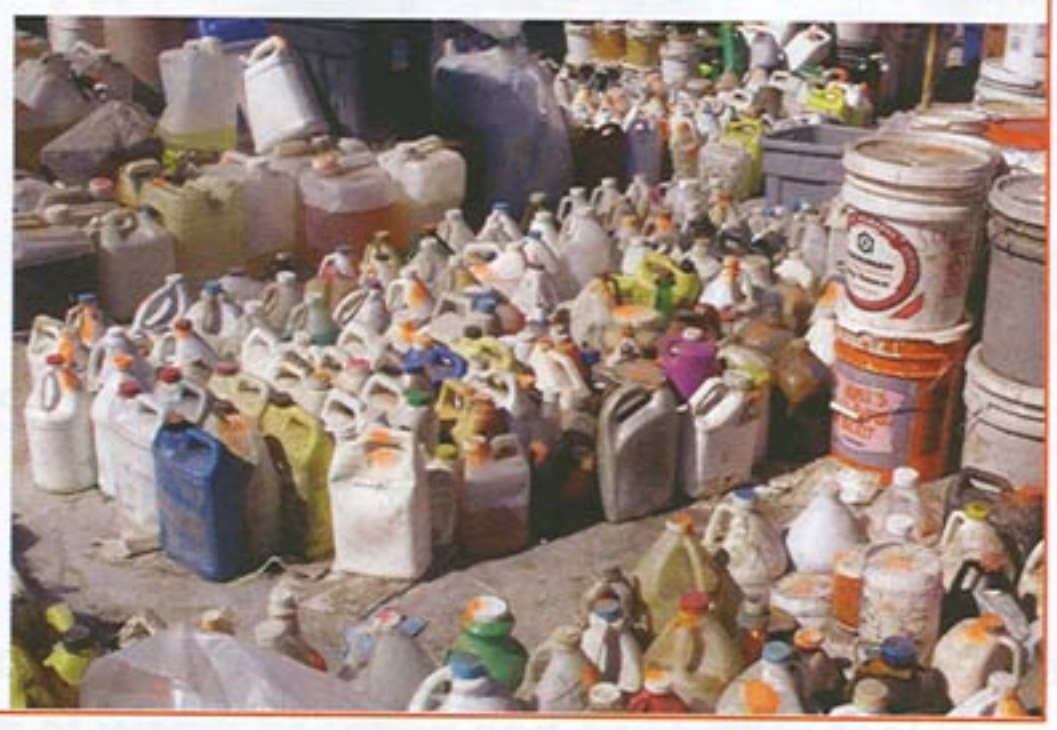
A critical component in the management of disaster debris is the establishment of strategically located staging areas to which debris can be moved quickly and stored on a temporary basis for subsequent separation, processing and/or transfer to ultimate disposal. A goal in many communities is to re-establish normal and regular MSW collection services as soon as possible to limit the build-up of debris and waste following the disaster.

The SWANA report offers a broad range of insights, recommendations and tools. Its aim is to provide practical, experience-based advice to those communities that have never faced the problems and issues associated with disaster debris management. It is hoped that this report will enable communities to manage disaster debris more effectively based on the experiences and the lessons learnt by other jurisdictions that have responded successfully to past disasters.

For more information, visit the SWANA website (www.swana.org).

– Jeremy O'Brien, Director of Applied Research, SWANA, US

Household hazardous waste to be disposed after Katrina



Cost of the collection and disposal of tsunami waste

In Thailand, operations along the coast recovered 102 tonnes of materials including plastics, paper, rubber, wood, metal and electrical appliances. In addition, a staggering 150 tonnes of wrecked boats were brought up from the seabed. The cost of coastal recovery operations totalled 9 million Baht (US$230,000). However, this amount was dwarfed by the 110 million Baht ($2.8 million) incurred in handling and disposing of construction debris in Thailand.

In Thailand, 150 tonnes of wrecked boats were brought up from the seabed

There is little information about the costs incurred in Sri Lanka, but direct losses may already amount to 500–600 million rupees (US$1 = SLRs 100) for managing the wastes. This is only the direct cost to the Sri Lankan government.

Recommendations to improve the situation

Some of the dumpsites in Sri Lanka and landfill sites in Thailand could be possibly mined to recover building debris for construction activities. But how much would it cost to mine and process these wastes? Would it be better to find suitable sites for sanitary landfills to dispose the incoming MSW?

It may be possible to find landfills to receive the waste generated by the tsunami in Thailand but it seems impossible for most of the local authorities in the coastal belts of Sri Lanka. The only alternative is to envisage the use of low-lying marshlands, lagoons or paddy fields. The authorities are in a dilemma about whether or not to allow waste disposal in such areas, but wastes have already been dumped in these low-lying lands and a solution is required.

One option could be to design an 'engineered low-lying landfill' (ELLL). The concept involves having a constructed wetland surrounding the landfill to take up the diffusing flux of leachate and using vertical geomembranes to prevent advective flow below the landfill.

But are such ELLLs applicable for managing debris materials? The most appropriate solution for managing demolition wastes is to crush them into smaller materials using heavy machinery. The crushed materials can then be reused as a constituent for road reconstruction or applied as landfill cover and for other suitable purposes. The co-operation of owners of such machines in the private sector should be encouraged to help in clearing the colossal amount of demolition waste in the affected areas.

In addition, technical and financial feasibility studies should be undertaken to safeguard the fragile social conditions in devastated coastal belts. The long-term planning of solid waste management in these areas is under discussion at a national level in both Thailand and Sri Lanka.

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