

Planning Centralised Building Waste Management Programmes in Response to Large Disasters

shelter centre

ProAct network
environmental partnerships
for community resilience

Disaster
Waste
Recovery



“*...the re-use of materials salvaged from damaged buildings should be promoted where feasible, either as primary construction materials (bricks or stone masonry, roof timber, roof tiles, etc.) or as secondary material (rubble for foundations or levelling roads, etc.).*”

SPHERE Handbook, Shelter and Settlement, Standard 5: Construction, Guidance note 1, 2004

“*...the production and supply of construction material and the building process minimises the long-term depletion of natural resources.*”

SPHERE Handbook, Shelter and Settlement Standard 6: Environmental Impact, Key Indicator 3, 2004

“*The eventual discontinuation of [...] temporary settlements should be managed to ensure the satisfactory removal and re-use of all material or waste that cannot be re-used or that could have an adverse effect on the environment.*”

SPHERE Handbook, Shelter and Settlement Standard 6, Guidance note 5, 2004

AIM

This booklet is a short guide for shelter practitioners with little experience of centralised disaster waste settings, mainly in response to large disasters. It highlights key issues and priorities of disaster waste management in different settings. It provides simple examples of re-use and recycling of building waste materials in temporary and permanent shelter programmes. Further reading and other sources of more in-depth information are provided.

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“Waste created in a disaster poses significant challenges to relief and recovery operations and a rapid return to a normal situation.”

1. INTRODUCTION

After a disaster or conflict, the first priority is to meet the urgent survival needs of the affected population. Often this includes the provision of emergency food, water and sanitation, as well as shelter and medical care. However, the timely and appropriate management of waste generated during a disaster can also quickly become a major concern, often adding to problems already faced by affected populations.

Waste created in a disaster poses significant challenges to relief and recovery operations and a rapid return to a normal situation. Disaster debris needs to be removed from roads, homes and public facilities before survivors can begin to rebuild their lives and livelihoods. Left uncollected and unmanaged, such waste can hinder emergency response operations and create additional public health and environmental risks.

This booklet outlines the basic principles of centralised building waste management programmes, including some key issues that shelter practitioners may encounter. It also identifies potential for the re-use of certain building waste materials in emergency, temporary or permanent shelter construction programmes for affected populations.

The booklet offers a range of practical, proven advice and guidance and outlines possible content for a waste management plan (Appendix 3) to help practitioners respond in the first instance.

1.1 DISASTERS AND WASTE

Debris created in a large scale disaster poses significant challenges to relief and recovery operations. Lack of waste management after a disaster can have the following negative impacts on affected populations and the environment:

- hindering access, reconstruction and rehabilitation activities;
- encouraging uncontrolled dumping;
- public health risks; and
- hazardous waste risks to peoples' health and the environment.

Yet, if in the haste to recover, disaster debris is disposed of improperly, it will cause future hardships for the disaster-affected population.

Waste from demolition, reconstruction and rehabilitation of damaged buildings is one of the most voluminous types of waste generated by a disaster. Building waste, however, has the potential to be a valuable resource. Its use in emergency shelter and reconstruction efforts can contribute to a reduction in natural resource extraction. Labour intensive public works clean-up programmes can assist affected communities in their post-disaster recovery.

At the same time, disaster debris is one of the first sources of emergency shelter and energy. In addition, most disaster debris has intrinsic value to the owner and considerable use in the recovery effort. Simply collecting and disposing of all debris without taking these factors into account will make the recovery process more costly and more difficult than if the debris is transformed into a positive contribution to recovery.

“ Disaster debris is one of the first sources of emergency shelter and energy. ”

“ In most cases, shelter practitioners will be involved in supporting the activities of the affected populations. ”

“ The composition of building waste varies according to location, local building practices, context and type of disaster. ”

CASE STUDIES

Case Study 1 Japan, 1995

The Hanshin-Awaji earthquake on 17 January 1995 in Kobe destroyed more than 192,000 buildings as well as roads and railways. The quantity of demolition waste generated from the site clearing works was estimated at more than 15,000,000m³.

The majority of the waste was removed to landfill or used for land reclamation in Osaka bay. Only a minor proportion was recycled. This resulted in the demolition waste taking up valuable municipal and household waste landfill space, with resulting negative impacts on the city's solid waste management systems.



Case Study 2 Mexico, 2007

The State of Tabasco, Mexico, was hit by flooding in October 2007. Over 920,000 people were displaced and over 245,000 homes were affected. A large percentage of the generated waste was demolition waste.

Existing waste management services were not able to deal with the disaster waste arising from the flood event and subsequent recovery phase. A majority of the waste was removed to uncontrolled temporary storage areas causing environmental and public health risks.



Case Study 3 The Maldives, 2004

Following the Indian Ocean tsunami in 2004, approximately 290,000m³ of demolition waste, combined with an estimated 50,000m³ of household and other waste, was generated in the Maldives.

The waste was disposed of in uncontrolled dump sites and in shallow coastal waters off beaches. This led to increased health risks through contact with decomposing wastes. There was also a risk of groundwater contamination through heavy metals leaching through soils.



Case Study 4 Kosovo, 1999

During the 1999 war in Kosovo, considerable damage was caused to buildings and structures across the country. More than 120,000 housing units were damaged in 29 municipalities. It was roughly estimated that the waste from damaged buildings and structures reached a magnitude of 10 million tonnes.

Through a DANIDA funded environmental programme, the recycling of building waste was integrated into the reconstruction work, with recycled materials being used in new roads and buildings.



2. NATURE OF DISASTERS AND SCALE OF OPERATIONS

The type and composition of waste varies according to the location, type and scale of disaster, as illustrated below.

Shelter practitioners may be expected to contribute to operations on different levels. In rare, but welcome, cases they may be involved in the design of a waste management plan with government ministries or local and international specialists.

In most cases, however, they will be directly involved in supporting the activities of the affected populations.

Conflict

Post-conflict building waste often contains reduced amounts of timber, furnishings and personal possessions since the buildings will often have been burned. In post-conflict situations there is, however, a risk of unexploded ordnances (UXO), mines and booby traps being present in the building waste. In such instances, access should be restricted until professionals have first cleared the area.



Banda Aceh

Disasters

The nature and scale of waste following a disaster varies considerably from one situation to another. In post-tsunami situations, for instance, the majority of solid building waste could be washed out to sea by the receding waves. What may remain, however, is a large volume of mud into which other materials may be mixed, which may prove difficult for sorting.

In contrast, post-earthquake debris will often have all of the materials from the buildings still present at the footprint of the building.



Pakistan



Sri Lanka

3. BUILDING WASTE GENERATION

In a disaster there are four phases where building waste is likely to be generated.

Disaster

Waste generated by buildings and infrastructure destroyed by the disaster itself.

Search and Rescue

Partial demolition of buildings to improve access and safety for emergency response efforts.

Demolition

Demolition of buildings and infrastructure to facilitate reconstruction.

Temporary or Permanent Shelter Construction

Waste generated during reconstruction.

Building waste occurs in every type of disaster and often represents a large percentage of the total waste.

The types of waste generated depend on the nature and location of the disaster, however they can broadly be categorised as follows:

- vegetation, soils and sediment, ash and charred wood;
- building waste;
- domestic waste;
- damaged household goods;
- hazardous waste;
- industrial waste; and
- waste from the emergency response, e.g. packaging materials.

Table 1: Major categories of waste in selected events

	Hurricane	Earthquake	Tornado	Flood	Fire	Tsunami	Conflict	Camp closure
Vegetation	✓	✓	✓	✓		✓		✓
Soil and Sediment	✓	✓					✓	✓
Ash and charred wood		✓						
Building waste	✓	✓	✓	✓	✓	✓	✓	✓
Domestic waste	✓	✓	✓	✓		✓	✓	✓
Damaged household goods	✓	✓	✓	✓	✓	✓	✓	
Hazardous waste	✓	✓	✓	✓		✓	✓	
Industrial waste	✓	✓	✓	✓		✓	✓	
Relief waste	✓	✓	✓	✓	✓	✓	✓	✓

4. COMPOSITION OF BUILDING WASTE MATERIALS

The composition of building waste varies according to the location, local building practices, and the context and type of disaster.

In rural Africa, local construction can be simple, with grass roofs, a wood framework and mud brick walls.



Côte d'Ivoire

More complex structures can include breeze blocks, iron sheeting, roofing tiles, rebar and timber.



The Maldives

In large cities, disaster waste may include a mix of building materials, white goods, personal belongings and hazardous waste.

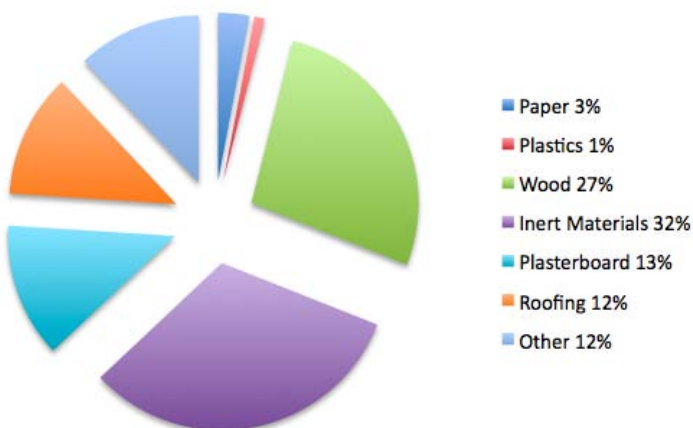


Mexico

It is currently estimated that approximately 50 per cent of the world's population live in cities. UN Habitat forecasts that this percentage will increase in the coming years. This means that a majority of waste from future disasters will occur in cities and will have a typically urban waste composition.

The average composition of building waste in cities in developed countries is shown below. In developing countries, the percentage of inert materials can reach up to 90 per cent of all building waste.

Estimated average composition of construction and demolition debris in urban settings



“An adequately planned long-term waste disposal plan can provide economic benefits through re-use, recycling and/or sale of materials, according to local needs.”

“Recycling options depend on local technology and practices and the market value for the recycled material.”

“Direct re-use or resale of building materials may happen spontaneously with local scavengers salvaging any usable parts.”

5. PRIORITIES

A timely and well planned long-term waste disposal plan (see Appendix 3 for an example outline) can not only protect health and safety, but also provide economic benefits through re-use, recycling and/or sale of materials, according to local needs. It may also:

- improve access for immediate relief efforts;
- reduce health and environmental risks;
- reduce land and landfill space taken for dumping;
- provide materials for rehabilitation and reconstruction;
- help with income generation through recycling and re-use;
- be a positive action through community recycling; and
- reduce the need for double handling of wastes.

A sound and co-ordinated waste management plan should assess all possible options for each type of waste. Choose the most viable one on the basis of the time, practical options, public health, as well as legal, financial and environmental considerations.

The management of disaster building waste should be considered, from day one, as part of an integral disaster waste management plan for the affected area.

The following typical priorities are often selected for building waste in a post-disaster situation, with additional comments with regards the handling of building waste.

Table 2: Typical priorities for building waste in the post-disaster phases

	DESCRIPTION	Building Waste Comment
Priority 1	To remove the building waste (debris) which is impeding search and rescue operations as well as the immediate, emergency relief operations (i.e. the providence of first aid, food, shelter and water).	The site for dumping of the waste should be selected with consideration to future use of the waste and future use of the land on which dumped (i.e. not to dump building waste on someone's agricultural land).
Priority 2	The removal of damaged buildings and infrastructure which could cause an immediate threat to public safety such as unstable structures and large piles of unstable rubble in urban, residential areas.	Handling requires attention to Health and Safety for the workers. It also requires attention to potential legal issues such as access and ownership of the waste. Site for dumping of the building waste as above.
Priority 3	To remove uncontrolled dumped building waste from urban areas since if left to lie will often attract dumping of general wastes (which will reduce the opportunity to recycle the building waste), which in turn can lead to public health and environmental risks.	Handling requires attention to Health and Safety for the workers. It also requires attention to potential legal issues such as access and ownership of the waste. Site for dumping of the building waste as above.
Priority 4	To remove building waste of damaged buildings from private and public plots of land to enable reconstruction.	Handling requires attention to Health and Safety for the workers and there may be an opportunity to sort the wastes into recyclables before transport. It also requires attention to potential legal issues such as access and ownership of the waste. Site for dumping of the building waste as for Priority 1.

6. RE-USE, RECYCLING AND DISPOSAL

A successful waste management plan aims to maximise the re-use of recovered materials, minimise the volume of waste requiring ultimate disposal and improve waste management in the longer term.

Where useful materials are recovered, the volume of the waste requiring disposal is reduced while the impact of rebuilding and recovery is diminished through substituting raw materials with the recycled materials.

A simplified flowchart in Appendix 1 presents the typical steps in handling, treating and processing disaster waste in an urban setting. Appendix 2 highlights some re-use and recycling options for common materials.

Some options for disaster building waste are described below.

RE-USE

Direct re-use or resale of building materials is a desirable solution. The quality of the materials should always be checked, while options will depend on local practices and market value. This often happens spontaneously.

RECYCLING

Recycling of building waste materials (for example, crushing concrete to re-use as gravel) avoids using landfill space, reduces the need to quarry rocks and/or cut trees, can bring economic benefits and is generally good environmental practice. Recycling options depend on local technologies and practices and the market value for recycled materials.

DISPOSAL TO LAND

Uncontrolled disposal can lead to public health and environmental risks, as well as a potential need to move the waste again once the relief phase has been completed. Disposing of large volumes of building waste directly to landfill or dumpsites can use up space better suited for non-recyclable wastes and reduce the capacity of existing municipal solid waste management, if such a system exists.

REDUCE

Volume reduction of waste at source is the most desirable long-term option and should be an integral part of every waste management plan. For disaster building wastes, this may involve reduced packaging for the (re) construction materials.

Re-use or recycling of building waste will depend on the situation, context and demand for materials.

The most common post-disaster operation is the recycling of concrete and bricks into a gravel or aggregates material, where these can be used in low strength concrete, as a sub-base for roads, as an aggregate for building blocks and as fill under foundations or on general reconstruction works. In many cases, this can be an economically and environmentally viable option after a disaster as there may be an increased demand for aggregate in reconstruction and rehabilitation works.

Many countries have established quality standards for the recycling of inert building waste into aggregates or gravel for road base. Check local standards and specifications to ensure that they are met, or refer to relevant national standards, if they exist.

The value of aggregates and the economic viability of using recycled concrete, bricks or other building waste materials depends on local demand, availability and proximity of natural sources, the availability and cost of sorting, crushing and grading recycled materials and the cost of landfill disposal.

6.1 ECONOMICS OF WASTE RECYCLING

Recycling will only be feasible if it is economically viable. This will depend largely on the market value of the material, once produced. In addition, other factors may also have an influence, such as:

- enforcement of stopping illegal quarrying since this would otherwise produce a “competitive” material to that produced through recycling;
- how easy it is to dump building waste as regards costs and legality of dumping, i.e. if it is easier to dump waste and buy cheap quarry materials then it may be difficult to support recycling from an economic viewpoint;

“The most common post-disaster operation is the recycling of concrete and bricks into a gravel or aggregates material.”

“Recycling of a material will only be a feasible option if it is economically viable.”



Stacked cleaned bricks ready for re-use at the Oxfam GB re-use/recycling yard in Banda Aceh.



Building blocks for reconstruction purposes which can be produced from recycled building waste, Pakistan.



Recycled aggregate from crushed building waste in Kosovo, as used for road construction or low strength concrete foundations.

- the ease with which the material can be recycled, i.e. has it been mixed with household waste and would the removal of non-recyclables be too expensive and high risk to complete; and
- the level of acceptance for the recycled material into the (re)construction market, i.e. will engineers accept to use recycled materials compared with natural quarry materials that they may be more familiar with?

Post-disaster reconstruction work normally places a huge demand on quarry materials so there are typically good economic grounds for recycling building waste. An exception might be in rural areas with good access to unlimited quarries.

A long-term waste management plan (see Appendix 3) arising from the post-disaster waste management work may include a focus on developing a market for recycled materials where it does not exist. This can be developed over time in collaboration with the relevant authorities.

7. ACCESS AND TRANSPORT

Transporting waste is an important economic and logistical factor to be considered, given the large volumes that may need to be dealt with (see also Section 11). Following a disaster, there is commonly a shortage of vehicles and the road infrastructure may have been damaged. This will have a considerable impact on the selection of temporary waste storage sites.

There are two main mechanisms for moving building waste from its source to the treatment site for recycling, re-use or disposal:

- **push** which entails paying an organisation – i.e. contractor or through cash-for-work – to bring the building waste to the treatment site; or
- **pull** which entails paying a fixed sum of money for every load of building waste brought to the treatment site, e.g. US\$1 per wheelbarrow of bricks.

One positive advantage of the pull mechanism is that it allows for the local community to participate in the building waste clean-up work and thus spreads the economic benefits of building waste work deeper into the community.

An example of this was the Oxfam GB re-use yard in Banda Aceh following the 2004 Indian Ocean tsunami where the yard paid a set rate per type of building waste delivered. The building waste was subsequently cleaned and re-used/recycled in a variety of products.

“Transportation of the building waste can be done by a range of methods, from wooden carts pulled by animals to heavy duty excavators, trucks and skips.”

“In many cases it is preferable to avoid the use of heavy machinery.”

8. WASTE SORTING

The following sub-sections present some typical forms of handling and processing building waste – mainly in connection with centralised waste management programmes – from its location at source to final end-use or disposal.



Islamic Relief project for the clearing and cleaning of building wastes (including rough cut stones) and subsequent re-use for new foundations .

The use of mechanical clearance should be avoided, or carefully controlled, in order to respect peoples' property and possessions and the fact that human corpses might be in the waste. A possible exception to this might be the clearance of roads for emergency access.

The main emphasis of recycling inert building waste is to remove non-recyclable materials such as plastic, timber, and household furnishings before processing begins. This results in a quality product which can be used in road construction and for low strength concrete.

Building waste will often be mixed, for example recyclable concrete and bricks may be mixed with furnishings and other non-recyclable materials. In order to realise the maximum value from building waste in terms of items for re-use and recycling, it is typically necessary to sort through the waste to extract the non-recyclables.

This can be done in a variety of ways, from basic manual sorting to mechanical means, the latter being more appropriate for larger volumes.

Manual Sorting

Building waste can be strewn out on the ground and manual labour used to pick out the non-recyclables and other items. Remaining material such as concrete and bricks can then be collected for processing.

Primary Mechanical Sorting

Alternatively, a basic plant can be constructed locally for the mechanical sorting of building waste. This provides a higher throughput with fewer personnel.

A mobile setup is also possible which allows the equipment to be moved from one site to another for on-site separation.

Picking stations are useful since they can be linked to a slow moving conveyor belt from which waste can be removed manually. These units vary in size from mobile picking stations to larger central locations with a large, stationary setup. Such belts enable up to six people to safely work at the unit, three on either side. The belt is normally used in a raised position to allow the operators to work at waist height.

Primary Screening Unit

Should a larger throughput be required, then a more sophisticated primary screening unit can be used to remove the finer soil fractions from the building waste. These units are highly mobile and only require a single axle truck to move around the site.



A mechanical “grizzly” to the left sorts finer materials from the oversized concrete and bricks, after which large items can be placed on a picking station (to the right) for manual separation.



Typical conveyors with adjustable belt speed for use as a picking station.



A primary screening feedstock for the removal of soil fraction and possible contaminants – plastics, paper, non-recyclables – before crushing.



Locally manufactured mobile crusher in a Pakistan quarry.



Crushing of building waste in Pakistan following the 2005 earthquake, using a small, mobile hand-fed crusher on tracks.



Crushing of building waste in Kosovo using a medium-sized mobile crusher (yellow machine to the left) and a screening unit for separation of the crushed material into three size fractions (green plant to the right).

WASTE CRUSHING

Crushers can generally crush glass, porcelain, granite, bricks, blocks, asphalt and re-inforced concrete. Depending on the location and context, a variety of crushers are available, each suitable for differing purposes and end-products. They can range in size from on-site mobile crushers capable of processing from 45-400 tonnes per day to full-scale plants that can handle up to 500 tonnes per hour.

Some commonly used crusher models appropriate for post-disaster work are described below. Note that for all options there is also a solid second-hand market for crushers and screeners. One does, however, need to ensure that the plant is delivered with adequate guarantees, warranties and service arrangements.

Locally Manufactured Crushers

Many countries have an active quarry industry so there may already be some pre-existing facilities and services that might be used to deal with certain types of waste stream. It is also possible to have locally manufactured small-scale crushers produced to specification and used in the post-disaster clean-up and recycling. Discussions with manufacturers should include consideration for the handling of re-inforcement bars when crushing concrete, as this often requires a larger aperture for the outlet of the feed hopper.

Small Mobile Crushers

Should locally manufactured crushers not be available, there are several options for the purchase of small, mobile crushers which can be used in urban and rural areas.

These smaller crushers can be transported by typical 4x4 vehicles and are operated by remote control, thus allowing access to even the most rural areas of a disaster-affected community. The output crushed material is not suitable for engineered roads or low strength concrete but can be used for access road rehabilitation or as general fill.

Medium Mobile Crushers

For larger quantities of building waste, a medium-sized mobile plant can be used, which would normally feed straight into a screening unit for the separation of the crushed material into two or more size fractions. The final product size will depend on the required use of the recycled material.

Medium-sized crushers for recycling building waste will require an overband magnet for the separation of the re-inforcement bars from the crushed material.

Large Stationary Crushers

Although not typically used in post-disaster work since the spread of building waste in a geographic area makes a mobile crushing solution more cost-effective from a logistics view, a stationary crushing unit can be implemented if the quantity in an urban area is significant, i.e. more than one million tonnes of building waste.

Stationary crushers and screening units have a higher throughput than any of the mobile solutions. They do, however, require a larger facility infrastructure for recycling and stockpiling, for example, and are more costly.

TIMBER AND OTHER WASTE

For timber and vegetal debris within building waste, grinders and shredders can be used to reduce the volume of this waste stream. It can then, for example, be used as mulch in landscaping or for compost.

For other waste streams not typically directly recyclable or re-usable, the norm is for these materials to be disposed of at an authorised dumpsite or landfill. In some cases it may be prudent to allow local communities access to this waste stream – under careful working conditions – to extract any materials which they may find of use. One such example is plastic which can be used to make products such as bags for sale in the local market.

“The use of mechanised clearance should be carefully controlled.”

“Uncleared waste can present continued or increased hazard risks.”

9. IMPACTS AND HAZARDS

Lack of waste management after a disaster can have the following negative impacts on the affected populations, and the environment. It may:

- hinder access, reconstruction and rehabilitation activities;
- encourage uncontrolled dumping;
- represent a continued and increased hazard and public health risk;
- cause hazardous waste risks to health and the environment; and
- be detrimental to future, normal waste operations.

The use of mechanised clearance should be avoided or very carefully controlled because of plot boundaries, bodies in rubble and personal possessions. It is, however, commonly used to re-open roads to allow emergency access.

Uncleared waste may continue to represent a hazard risk. Aftershocks, for example, can further destroy buildings that have not been secured, while high winds might lift uncleared debris such as iron sheeting into the air, which could be a potential threat to people.

Uncleared waste or clearance operations themselves can also impact on surface water drainage or sewage and utilities infrastructure.

10. COMMUNITY INVOLVEMENT AND COMMUNICATIONS

As in all other areas, after a disaster it is vital to work with the affected population, local authorities, competent authorities and local contractors on waste management.

The first people on the scene of a disaster are the affected population. Most communities will have some form of committee in place. Involving the community will help identify what normal practice is, develop preferred options for waste collection, and develop public health and other messages associated with waste management. Strategies for disseminating public information can include signs, posters, flyers, and media such as newspaper articles, radio announcements or TV announcements, as well as public meetings.

Where the community is involved, waste sorting at source will happen almost automatically. Key points have been highlighted above.

Where there is no pre-existing disaster waste management plan, the first step is to establish a large-scale public information plan on how to deal with the large quantities of waste generated by the disaster.

“ Steel, bricks, timber and tiles are likely to offer possibilities for transitional shelter and might be the starting point for reconstruction or some form of revenue generation.”

“ Take steps to ensure that debris items with value remain accessible to the original owner.”

“*The first people on the scene of a disaster are the affected population.*”

“*Where the community is involved, waste sorting at source will happen almost automatically.*”

11. RESPONSIBILITY AND LEGAL ISSUES

Three sets of legal issues usually arise in disaster debris management: **value and ownership, access and safety.**

Value and ownership: Destroyed infrastructure is often the only resource left to affected families following a disaster, not only peoples' personal possessions such as furniture but also steel, bricks, timber and tiles. For many, these offer distinct possibilities for transitional shelter and might even be the starting point for reconstruction or some form of revenue generation. Special consideration might need to be given to multiple owners in multi-storey buildings.

All disaster debris had some value before the disaster, some of which might still remain after the event has taken place. For instance, the owner of a damaged building may want to retain ownership of the bricks because of their value in offsetting a need to purchase bricks with which to rebuild. It is not appropriate for debris management operations to deprive an owner of items which, while damaged by a disaster, are still of some value. Special consideration might need to be given to multiple owners in multi-storey buildings.

Debris management efforts should therefore take steps to ensure that debris items with value remain accessible to the original owner. If people are not able to return to their former homes, then the owner should be compensated – at fair market values – for the items which are taken and used for another purpose, for example, bricks from damaged buildings being used for road sub-surface.

Addressing ownership and value issues needs to be planned in advance of debris removal. Disaster survivors will need to be consulted to the degree possible.

Legal actions by government authorities are also needed to avoid disputes over ownership. This is particularly the case where previous owners of disaster debris may have been killed during the disaster, or where clearance activities uncover objects of economic – possibly cash, gold or jewellery for example – or sentimental value.

The need to preserve plot boundaries – as a starting point for determining land rights and subsequent reconstruction – will require specific attention.

Local government authorities and disaster survivors should be consulted on the necessary legal and social steps required to permit access to private property. These procedures should be in place before debris clearance begins, and include how to handle valuables and personal possessions.

Access is also an issue when establishing temporary processing areas or permanent disposal sites. For the latter, some level of environmental review should first occur ahead of the land being legalised through the normal – but expedited – administrative process. In the case of the former, temporary authorisation should be received from the site owner, which should specify the condition of the site before use as well as what condition it should be in when returned to the owner.

Safety issues are dealt with in the following section.

“Local government authorities and disaster survivors should be consulted on the necessary legal and social steps required to permit access to private property.”

12. HEALTH AND SAFETY

Building waste generated by disasters can include materials and wastes that are hazardous to human health as well as the surrounding environment. These require identification and special handling.

The need to preserve plot boundaries – as a starting point for determining land rights and subsequent reconstruction – will require specific attention.

Additional hazardous wastes such as oils, chemicals and heavy metal containing items should be identified and removed from the waste.

In addition to actual waste materials, in post-conflict situations there is also the risk of UXO and mines being present in the building waste. Co-ordination is required with relevant and specialist organisations in the field to ensure that building waste is clear of such ordnance and safe to handle.

Protective clothing should always be provided when dealing with waste, particularly mixed waste streams. This includes adapted footwear – hard boots to prevent spikes entering the sole and minimise the risk of harm from heavy materials dropping onto feet – gloves, overalls and masks. Equipment such as shovels, buckets, carts and skips should also be provided.

Where possible, people working with waste should have access to changing and washing facilities.

Case Study 5

Indian Ocean Tsunami

After the 2004 Indian Ocean tsunami, UNDP and its partners considered a number of livelihood restoration and creation projects in waste management, as well as opportunities for viable recycling business start-up. Projects included the following:

- composting projects to make organic fertiliser for rice padi and park rehabilitation;
- plastic processing facilities to make and sell plastic chips to recyclers;
- provision of restored tsunami wood to furniture manufacturers;
- wood-fired brick kiln rehabilitation projects to make red bricks using tsunami wood;
- wood-fired limestone kiln rehabilitation projects to make lime using tsunami wood;
- charcoal manufacture from tsunami timber; and
- provision of stone crushers to make secondary aggregate for use in brick projects, concrete preparation and/or as a road base.

Those employed under a cash for work scheme were either pre-existing scavengers, people recruited for the project or those employed directly from camps housing some of the displaced people. The scheme tried to ensure that the most vulnerable people from within the communities were considered. Employment of women was particularly encouraged. In rubble clearance and recycling activities, the programme promoted gender-sensitive approaches in work and wage distribution. The programme also sought to strengthen the long-term capacity of local government on waste management through working with district sanitation departments.

Source: Tsunami Recovery Waste Management Plan

Case Study 6

Sri Lanka

In a shelter programme for returnees in eastern Sri Lanka, the Norwegian Refugee Council (NRC) encouraged beneficiaries to re-use bricks and blocks for shelter reconstruction.

Houses had been destroyed in the fighting and NRC was providing a small 'core' shelter that provided a 9m² full masonry room with an additional 9m² of open, but roofed, area which had foundations. Beneficiaries provided infill for the raised floor using rubble from old houses. They could also use salvaged bricks/block to fill in the walls for the open section of the house.



13. CAPACITY BUILDING AND EMPLOYMENT GENERATION

Aside from voluntary participation within the community, well-designed employment and cash for work programmes can help support the overall clean-up effort as well as provide income to vulnerable populations who may have lost their employment as a result of the disaster.

Immediate employment activities can be designed to rehabilitate and improve access to public facilities, inject cash into displaced populations who have lost sources of income, and to reduce trauma among victims through the provision of work.

Implementation of waste recycling and recovery projects can restore livelihoods. Much of the waste is recoverable and recyclable for use in rehabilitation and reconstruction. Re-use of recycled timber, concrete and bricks will reduce the need to cut trees for new timber and quarry rock for use in concrete, drainage, roads and fill.

Local non-governmental organisations (NGOs) and local companies involved in recycling and waste disposal before a disaster can be valuable collaborators in the post-disaster management of debris. Using local partners will facilitate operations and strengthen local capacity to manage waste and debris in the future.

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14. CONCLUSIONS

This guide does not attempt to address all aspects of this large and complex topic. It is intended to highlight some key issues that shelter specialists may encounter during different levels of disaster and post-disaster operations.

Although building waste management may not seem like an immediate concern during and after a disaster, the large quantities of waste often generated at such times means that this issue needs careful consideration.

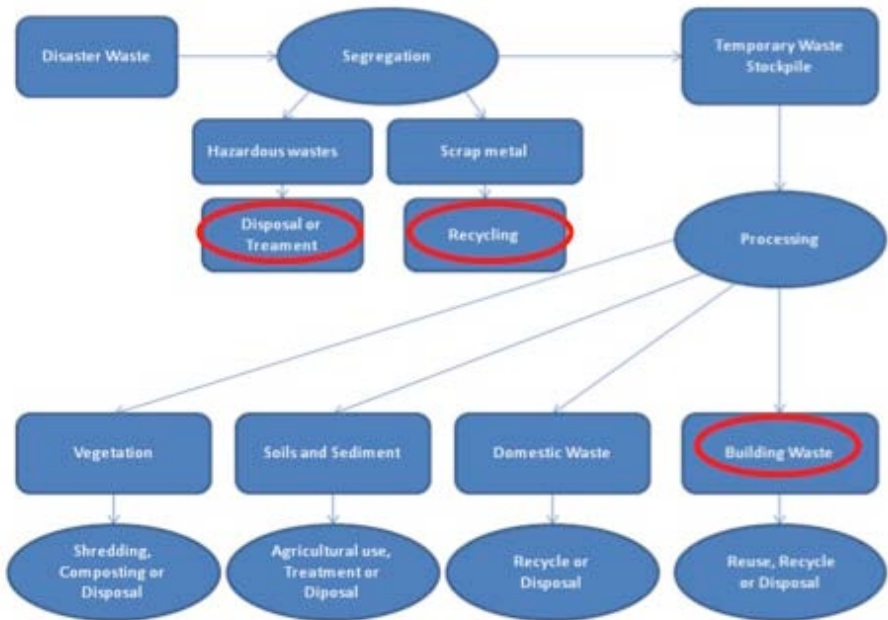
To maximise the re-use of recovered materials, it can be useful to minimise the volume of waste requiring ultimate disposal. It is important that waste management is properly planned, organised and monitored. Complex issues such as land rights, legal aspects, safety concerns and the livelihoods of affected populations need to be considered.

Further references and links are provided at the end of this document for more in-depth information.

APPENDIX 1

WASTE PROCESSING FLOWCHART

This simplified flowchart presents some of the typical steps in handling, treating and processing disaster waste. It is based on the assumption that a centralised waste disposal plan is in place. Each step can be carried out at the source, e.g. a damaged building, or at an off-site processing or disposal site.



APPENDIX 2

RE-USE AND RECYCLE POTENTIAL OF STANDARD BUILDING MATERIALS

MATERIAL	RE-USE	RECYCLE
Plastics	Check local practices and demand for recycled plastic.	Check local practices and demand for recycled plastic.
WOOD		
Timber	<p>Wood can be re-used for a variety of different purposes, ranging from low-quality, temporary work like survey pegs and boxing for concreting to high-quality, permanent uses like floor boards, beams and other architectural features if the recovered material is in a suitable condition.</p> <p>Depending on the type of disaster, rotting, humidity, splitting, presence of nails or screws can affect the potential for re-use.</p>	Untreated timber off-cuts can be chipped into mulch and used in landscaping, animal bedding or used as fuel. Depending on the context, wood from construction and demolition waste competes with forestry and manufacturing wood waste as an input for industrial furnaces and boilers, particularly in pulp and paper mills.
Bamboo	<p>Bamboo is frequently used in low-cost construction such as huts and fencing. During camp closure, bamboo structures can be dismantled and transported for re-use or sale at a local market.</p> <p>It can be affected by fungus in damp climates and attacked by insects. Check the quality before re-using or reselling.</p>	Other uses include compost or chip, dry and use as fuel.

MATERIAL	RE-USE	RECYCLE
INERT MATERIALS		
Bricks / Blocks	<p>Bricks and blocks can be cleaned and re-used if their quality is acceptable. They can be resold to the community and / or re-used in reconstruction programmes. The presence of cement mortar or glues can hinder re-use as they are unable to be cleaned off.</p>	<p>Different forms of brick can be recycled for re-use in reconstruction programmes.</p> <p>Mud bricks degrade easily and can be broken up by hand and used as infill for latrines and trenches. They can also be crushed by hand and spread across the land.</p> <p>Bricks can be crushed to a suitable size and recycled as aggregate to be used in concrete. They can be broken to use as hardcore as sub-bases to concrete work. They can also be broken or crushed as infill in landscaping applications.</p>
Concrete	<p>Damaged concrete cannot be directly re-used.</p> <p>During land rehabilitation after camp closure, concrete can be crushed by manual labour and re-used as filler for abandoned latrine pits, drainage trenches and other surface irregularities. This also provides local income.</p>	<p>Concrete can be crushed and recycled as aggregate or hardcore for building and road base material or foundations</p> <p>Concrete can be crushed manually; with a mobile crushing unit or transported to a specialised concrete crushing plant. Location, volume of concrete waste, local demand for aggregates and availability of other types of aggregates are determining factors in the choice of crushing method. The presence of local quarries or riverbeds providing gravel could mean that recycled aggregate is not viable.</p> <p>Steel rebar may block crushing machines if they are not designed to separate the steel from the concrete. Proper assessment must take place to ensure no asbestos is present prior to crushing.</p>

MATERIAL	RE-USE	RECYCLE
Asphalt	Asphalt cannot be re-used without processing.	Asphalt is frequently recycled during normal road resurfacing in developing countries. Commonly used asphalt recycling equipment includes feed systems added onto a large fixed asphalt production plant or small mobile pieces of equipment for asphalt reheating.
Plasterboard	Plasterboard is likely to be damaged during a disaster and therefore unsuitable for re-use.	Gypsum makes up approximately 90% of the weight of a piece of plasterboard. Gypsum can be recovered and used : <ul style="list-style-type: none"> • in the manufacture of new drywall; • as an ingredient in the production of cement; • for application to soils and crops to improve soil drainage and plant growth; • an ingredient in the production of fertiliser products; • an additive to composting operations. However, this is unlikely in most emergency responses.
ROOFING MATERIALS		
Roof thatching	The type and quality of thatching material can vary. It is prone to decay in damp conditions and can be ruined by vermin. Thatched roofs are also very flammable. Thatching is usually replaced once a year and is unlikely to be re-used or sold.	Thatching can be composted where composting facilities are available. In the case of IDP or refugee camp closure, it can be spread on the ground or ploughed into the soil and left to decompose naturally.
Roofing tiles	If in reasonable condition, roofing tiles can be re-used.	Recovered tiles can be crushed and used as aggregate, landscaping or infill purposes. Check local market for demand and prices.
Corrugated iron sheets	If in reasonable condition, the sheets can be re-used. However corrugated iron sheets can easily corrode.	Scrap metal is a lucrative business in most countries. Corrugated iron sheets can be sold and exported to iron smelting plants. Check local market for demand and prices.

MATERIAL	RE-USE	RECYCLE
OTHER		
Metals		Demand for resale and recycling of scrap metals is high in most countries. Iron and steel are the most recycled materials worldwide. Steel is unique among major construction materials in that it always contains recycled content; it is completely recyclable at the end of its product life and may be recycled without loss of quality. It can be smelted and recycled. Check local demand and prices, which can vary according to location.
Steel rebar	Rebar cannot be re-used for structural purposes as it will have lost its main properties	In low cost shelter, rebar is often stripped by the resident population and sold on local markets. Check local markets for demand and prices. The presence of rebar can complicate the crushing of concrete. Some specialised crushing machines have magnets to automatically separate the steel from the concrete. Others require prior sorting.
Hazardous waste	Hazardous materials should be identified at source and immediately separated from the rest of the waste stream to avoid contamination. Hospital waste, agriculture related wastes (e.g. pesticides and fertilisers), oil and oil contaminated wastes should be identified as soon as possible and collected and disposed of by trained personnel.	The recycling of hazardous materials should only be undertaken by trained professionals with appropriate protective gear. The presence of asbestos should be identified as soon as possible. It should be separated from other types of waste and collected and disposed of by trained specialists.
Miscellaneous	Electronic debris should be separated from other wastes. They should be disposed of in special landfills, if available. Check local practices.	White goods, such as refrigerators, stoves, washers and dryers should be segregated and recycled, if possible. Check local practices.

APPENDIX 3

MAIN ELEMENTS OF A WASTE MANAGEMENT PLAN

The following points summarise some key considerations in planning a debris management programme. The planning should be done, where possible in collaboration and agreement with other international organisations involved in disaster response, the Emergency Shelter and/or WASH Cluster if applicable, local authorities, local waste management service companies or organisations, local NGOs and community-based organisations (CBOs).

1) Assess the post-disaster debris situation with relevant partners and determine:

- existing waste handling capacity;
- types of debris;
- presence of hazardous materials;
- quantities (volumes) of materials;
- whether or not there is an existing waste management plan; and
- location of different types of materials – houses, factories, public spaces and so forth.

2) Understand the scope of debris management efforts – who does what – by:

- consulting with clusters such as Emergency Shelter and WASH, if in place.

3) Determine legal requirements and social norms related to assessing private property and collecting debris:

- who owns the waste?
- who has liability?
- are there any disaster exemptions?
- site ownership issues.

4) Determine whether waste processing will take place on-site or whether it will be transported to a central processing site.

- On-site processing should be used if most of the debris will be left for use by the owner.

5) Determine whether processing will be done through labour-intensive methods, machine intensive methods or a combination of both.

- Machine intensive methods are usually done off-site.

6) Consult with local authorities and disaster survivors on compensation issues and how much and how compensation will be paid.

7) Establish a protocol for handling valuables and personal effects collected.

8) Establish personnel and equipment requirements for debris processing.

9) Define management and reporting requirements for debris collection and processing activities.

10) Identify specialists services – if available – procedures and locations for handling and disposal of hazardous waste.

11) Develop a training plan for personnel involved in the operation including:

- handling of hazardous materials;
- valuables and personal possessions; and
- safety and any other skills required.

12) Develop a budget covering:

- labour;
- equipment and machinery;
- transport;
- management tasks;
- compensation requirements; and
- safety requirements.

13) Develop a schedule covering the debris disposal operation.

14) Develop an exit strategy that includes:

- realistic and verifiable targets;
- a transition to existing authorities, private sector waste management organisations or local or international NGOs, depending on available capacities; and
- consideration of alternative approaches such as the establishment of a CBO with project management responsibilities early in the project process.

15) Begin implementation.

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USEFUL WEBSITES

Aggregain – Online Guide to Sustainable Aggregates: www.aggregain.org

Construction Waste Management in Sri Lanka: www.cowam-project.org

Disaster Waste Recovery homepage: www.disasterwaste.org

Groupe d'Expertise et d'Intervention Déchets Post-Catastrophe:
www.robindesbois.org/geide

International Society for the Environmental and Technical Implications of
Construction with Alternative Materials: www.iscowa.org/

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Online Guide to Drywall Recycling: www.drywallrecycling.com/

Recycling Construction Debris – article: [www.architectureweek.com/2001/0926/
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Shelter Centre website: www.sheltercentre.org

Swiss Resource Centre and Consultancies for Development: www.skat.ch/

Training Manual: Debris Management in Disaster Recovery: [www.stopwaste.org/
docs/disaster_debris_management_training_manual.pdf](http://www.stopwaste.org/docs/disaster_debris_management_training_manual.pdf)

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