Decisive Disaster Debris Management

An aerial view of damage to Otsuchi, Japan Credit: U.S. Navy

Millions of tonnes of waste were estimated to have been generated by the earthquake and tsunami in Japan. With natural disasters becoming more common, should nations have better prepared infrastructure and plans to cope with such quantities? And what about recycling opportunities? Nazli Yesiller investigates.

Debris and waste are unavoidable by-products of natural and anthropogenic disasters. Waste management in the aftermath of major disasters is complicated by the priority for life saving and safety efforts. Then comes the interrelated concerns associated with availability of disposal capacity, availability of treatment or recycling/reuse options, transport of wastes, access to waste management facilities, environmental hazards, financial responsibility, and ownership related legal and ethical issues.

The magnitude and significance of waste and debris from natural disasters continue to be highlighted with recent examples around the world. Take the devastating earthquake and tsunami in Japan in March 2011 and major storms, tornados and flooding in central United States in April and May 2011.

But how can nations prepare for hazard mitigation and the management of debris from major disasters? For the purposes of this article, California and its waste management infrastructure and constraints, will be used as an example.

California, similar in geography and demographics to many areas around the world, is selected due to its large population, presence of major metropolitan areas, and high-risk geographic setting for multiple natural disasters.

Regional inadequacies

The most significant issue in the management of disaster debris is the sheer magnitude of waste materials generated in major disasters. The total amount of waste and debris from the March 11, 2011 Japan earthquake and tsunami is estimated to be between approximately 70 and 180 million tonnes, based on early reports in the immediate aftermath of the disaster.

The damage and the amount of waste and debris generated could be expected to be much more if such an event were to occur in a more populated urban area, such as Los Angeles or San Francisco, which are both located in highly active seismic zones. The economic cost of debris management is substantial. Disposal costs for landfilling alone (without collection, transport, or recycling) for the amount of waste estimated to have been generated in the Japan quake are in the order of between $4.8 and $12 billion using typical waste disposal rates ($66/tonne) of a facility located in central coast of California.

The disposal capacity currently available for waste containment in California is approximately 1.7 billion tonnes, based on the data provided by the California state environmental regulatory agency for solid waste, CalRecycle. However, analysis shows that several large, relatively new facilities have significant total disposal capacity, yet only small portions of the sites are currently available for disposal due to the typical phased construction practices used for waste facilities that mean only a small portion of the total capacity is available at any given time.

The geographic distribution of the available disposal capacity in California on a county basis is provided in Figure 1. The available disposal capacity in the two major metro areas of Los Angeles and San Francisco are presented in Figure 2a and 2b. The available waste disposal capacity in the Los Angeles area is on the order of 940 million tonnes, and in San Francisco area the capacity is approximately 216 million tonnes. For the case of a major event that may occur in the city of San Francisco, the available disposal capacity is on the order of 28 million tonnes in the closest areas that are connected by land transportation to the city (i.e., San Francisco and San Mateo counties), with all of the capacity available in San Mateo county in a single facility and zero disposal capacity in San Francisco county (Figure 2b). Similarly, the problem exists on a global scale. For instance, in Germany and Japan where landfill is not the preferred disposal option in the waste hierarchy. Total lack of landfill capacity is reported for multiple regions in Japan, where existing facilities have filled up and construction of new facilities has not been possible due to geographic constraints (terrain as well as population density).

Figure 1. Disposal capacity available in California

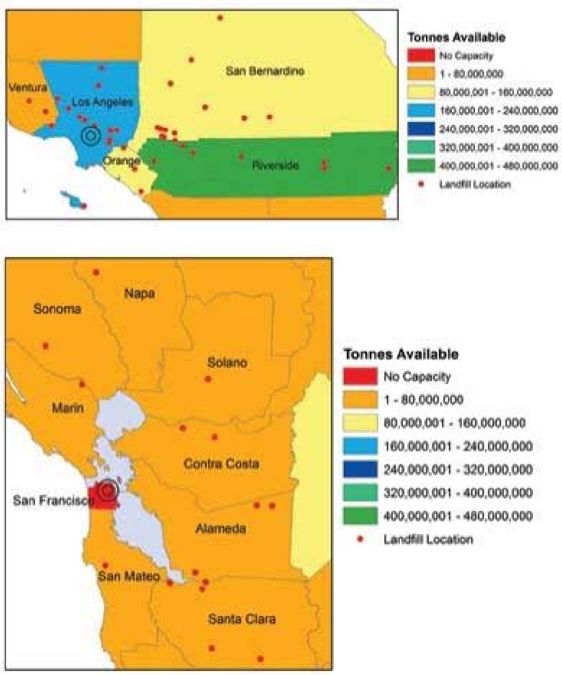

Figure 2a,b. Disposal capacity available in Los Angeles and San Francisco

Dealing with disaster debris and waste

The composition of disaster debris and waste varies according to the type of disaster, geographic location, population density, and socioeconomic setting. Hazardous materials enter the waste and debris stream from various sources including households, commercial activities, institutional sources, as well as industrial facilities. Types and amounts of hazardous materials can vary considerably due to specific source conditions.

Significant amounts of debris with a composition similar to that of Construction and Demolition (C&D) waste are generated in disaster events in urban areas. The materials can consist of concrete; asphalt; masonry; brick/cinder blocks; plaster; drywall; various forms of wood and wood composites/laminates; metals including structural steel, pipes, tubing, and framing components; doors, windows, wiring, and plumbing components; insulation materials; various forms of soil and earthen materials; and vegetation.

In addition, large quantities of metal, composite, and polymeric wastes are generated from vehicles, equipment, and appliances. In rural areas, the debris will typically contain a low amount of synthetic components and advanced singular and composite polymeric and metallurgical materials. High amounts of natural materials and organic matter are present in disaster debris in rural areas and less developed locations.

Disaster debris and waste possess high potential for recycling and beneficial reuse due to the inert nature of the various constituent components. The recycling capacity for California is estimated to be approximately 60 million tonnes per year.

The available recycling capacity is considerably less extensive than the available disposal capacity.

Treating and managing debris and waste

Treatment includes individual or coupled physical, chemical, biological processes applied to wastes prior to recycling and recovery or landfill disposal. Treatment processes are not typically used in the U.S., however, it is common practice in other countries across European and Japan.

Concerns regarding the management of building material debris containing asbestos have been reported in the media subsequent to the recent Japan earthquake. Leaching of toxic and hazardous constituents into the surrounding environment may occur from containment facilities in the case of disposal in under designed facilities.

Restoring public health and safety is the top priority in the aftermath of a major disaster. Fast removal of debris while ensuring environmental protection is challenging. A step-by-step process for sustainable management of disaster debris includes: i) collection of debris, ii) determination of the constituents of debris, iii) determination of potential toxicity of the debris and waste, iv) sorting and separation of the debris, v) recycling of debris constituents, and vi) disposal of residual wastes.

For protection of public health and the environment, all of these steps must occur in a timely manner.

Planning ahead

Maintaining accurate records of waste management infrastructure and well-developed plans is crucial for management of large quantities of disaster debris. Availability of storage capacity is one of the most important issues in the aftermath of a disaster. The capacity may be in the form of landfills at locations where landfill disposal is the main waste management approach.

Records describing availability of other types of storage infrastructure should be maintained at locations where sufficient landfill capacity is not available. Such temporary storage areas may consist of vacant lots, large surface parking facilities, recreational areas, sports fields and courts, and existing large-scale industrial storage buildings/units. Debris may be stored at temporary facilities for extended periods of time until waste management infrastructure is restored.

Temporary storage facilities should be managed to minimise potential health risks and environmental contamination. Specific issues of concern include: air pollution from toxic airborne particles; contaminated surface runoff from hazardous components of the stored materials; leaching from stored materials; seepage of the contaminated runoff and leachate into surface and subsurface water and surface and subsurface soils; and non-secured public access.

Liquid addition to the debris may be considered under dry conditions for dust control. However, this approach is not a long-term solution as contaminated water is generated, which is as harmful as the particulate media in air. Containment systems are required to minimise harmful effluents from the stored materials. Placement of a cover over the stored materials provides an effective alternative. The presence of a barrier material reduces mobility of air-borne toxins and reduces leachate and contaminated runoff, and reduces contamination risks. Such a cover may be constructed using a relatively flexible geomembrane, which conforms to the shape of the debris.

Alternatively, a roof structure may be constructed over supporting posts/columns, which would provide easy access to debris and general protection from precipitation. If available, the use of existing parking lots or other facilities with asphalt or concrete slabs at the ground surface should be preferred over areas with no ground cover. Construction of a barrier layer may be considered using geomembranes or GCLs (Geosynthetic Clay Liners). Geosynthetics need to be covered with soil layers to prevent damage to the barriers.

Manual separation or visual designation of material to be separated is necessary in sorting disaster debris. Heavy equipment can be used to further separate wastes. Typical containers used for hazardous materials such as drums can be identified using visual inspection. Radioactive material can be detected using mobile instrumentation. Availability and access to radiation detectors should be included in disaster preparedness and hazard mitigation documentation. Easy to use, fast response, portable sensors are typically not available for detecting varying levels of hazardous components. Sample collection and testing are required at off-site facilities. Mobile facilities may be set up near disaster areas for such testing. Trained personnel are needed for assessing toxicity and hazard level of disaster debris and waste. Provisions should be included for such testing and analysis in disaster management plans. Improved characterisation and sorting would increase the success of reuse and recycling activities, while protecting human health and the environment.

Availability of recycling infrastructure is critical for sustainable management of disaster debris. In most cases, recycling capacity is less than disposal capacity even for areas with high recycling rates (Figure 3). Establishing and maintaining extra capacity beyond working capacity is uncommon. Plans should be in place for potentially expanding capacity at existing facilities and also for potentially generating additional capacity as necessary. If landfill capacity is available and accessible in the immediate aftermath of a disaster, debris and waste can be directly transferred to landfills.

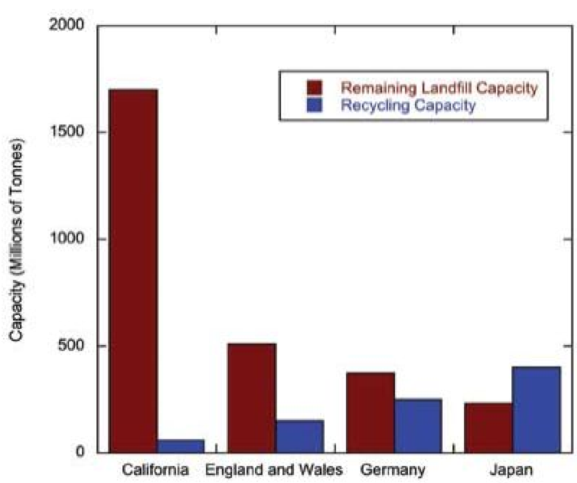

Figure 3. Remaining landfill capacity and available recycling capacity

This is without extensive sorting for rapid removal and prevention of extended exposure and development of disease vectors. Landfill mining can be used in time to extract value from the landfilled wastes by recycling contained waste materials.

Final thoughts

Regional plans should be developed for disaster debris and waste management including consideration of the type and risk of likely disasters, estimates of types and amounts of debris and detailed records of locally and regionally available disposal, storage, recycling and wasteto energy capacity.

Integrated risk management for different types of hazards and associated disaster should include a comprehensive approach with consideration given to full lifecycle. Successful recovery efforts require well planned, well developed, and well applied debris and waste management practices. If such practices are not in place, these natural disasters and human tragedies become environmental disasters as well.

Nazli Yesiller, Ph.D. is the director of the Global Waste Research Institute.
email: nyesiller@gmail.com, web: www.gwri.calpoly.edu

More Waste Management World Articles
Waste Management World Issue Archives

Recent Articles:

Waste Management Privatised in Malaysia (Sep 20, 2011)
Waste Collection Sucks at $5.5 Billion Qatar Development (Sep 20, 2011)
Waste to Energy Must Prove Itself to Take Off in U.S. (Sep 20, 2011)
Plan to Recycle 6000 tpd of Waste Sent to Dallas Landfill (Sep 20, 2011)
Wood Waste to Energy Feasibility Study Financed in Alberta (Sep 19, 2011)
Wood Waste Gasification Facility for Plymouth, UK (Sep 19, 2011)
Waste to Energy Appeal Approved in Gloucestershire (Sep 19, 2011)
Gravity Pressure Vessel Waste to Ethanol Facility Secures Funding in U.S (Sep 19, 2011)
Waste Disposal Contract at Decommissioned UK Nuclear Power Facility (Sep 16, 2011)
Organic waste targeted in UK by date labeling guidance (Sep 15, 2011)

Waste Management World Content Categories:

Collection & Transfer
Recycling
Landfill
Biological Treatment
Magazine Archive
Waste-to-Energy
Markets, Policy & Finance
Opinion