KNOWLEDGE NOTE 4-4

CLUSTER 4: Recovery Planning

Debris Management

GFDRR
Global Facility for Disaster Reduction and Recovery

THE WORLD BANK

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Some 20 million tonnes of waste resulted from the Great East Japan Earthquake (GEJE). The amount of debris in Iwate Prefecture was 11 times greater than in a normal year, and in Miyagi 19 times greater. Appropriate treatment and disposal depends on the type of debris or waste, while recycling should also be considered. Authorities should prepare for disasters by designating temporary storage sites and routes for transporting waste. Japan's existing debris management plans are being revised to include methods for estimating the amount of disaster waste generated by tsunamis and appropriate measures for dealing with it.

FINDINGS

THE MANY CAUSES OF DISASTER

Disasters have a variety of causes including earthquakes, tsunamis, typhoons, floods, and fires. Over the past decade, several major disasters have destroyed social infrastructure all over the world: Sumatra's Andaman earthquake in 2004, Hurricane Katrina in 2005, the Great Sichuan Earthquake in 2008, and the earthquakes in New Zealand and Turkey in 2011. Differences in the nature and geographical extent of the environmental effects, and other waste-related problems that may arise, are dictated by many variables including: the cause of the disaster, types of local industry, building densities, and so forth. In other words, big differences exist and it is extremely difficult to generalize.

THE AMOUNT OF DISASTER WASTE AND ITS CLASSIFICATION

The GEJE generated large amounts of disaster waste. Japan's Environment Ministry estimated 20 million tonnes as on May 21, 2012. This number is very large even when compared with the 15 million tonnes from the Great Hanshin-Awaji (Kobe) Earthquake, the 20 million tonnes from the 2008 Sichuan earthquake, or the 10 million m^3 found in Indonesia alone following the 2004 Indian Ocean tsunami (Brown, Milke, and Seville 2011).

Estimates for the Kobe earthquake in 1995, based on the unit waste generation intensity for totally destroyed structures, were 61.9 tonnes/household and 113 tonnes/building. Although there are few reports on the per-unit-floor-space amount, one value reported for the Kobe earthquake was 0.62–0.85 tonnes/square meter (m^2), and a contemporary review put it in the range of 0.20–1.44 tonnes/m^2 (Takatsuki, Sakai, and Mizutani 1995).

TSUNAMI SEDIMENT DEPOSITS AND THEIR PROPERTIES

Tsunami sediment deposits consist mainly of sand, mud, and other bottom material, but their properties and compositions vary widely. Some examples of deposits causing concern are those mixed with the ruins of homes crushed by tsunamis, those containing oils, and those that release offensive odors or dust due to putrefaction or drying. Deposits may also be mixed with substances such as pesticides, acids, alkalis, and other hazardous chemicals from industries in the disaster-stricken areas. Doing nothing about such substances raises public health concerns. The tsunami from this earthquake left heavy deposits. To estimate the amount, we multiplied the tsunami-inundated area by the average thickness of the deposits and a volume-to-weight conversion factor, and obtained a total estimated 11,990,000–19,200,000 m^3 and 13,190,000–28,020,000 tonnes for the six disaster-stricken prefectures of Aomori, Iwate, Miyagi, Fukushima, Ibaraki, and Chiba (JSMCWM 2011). The deposit height is between 2.5 and 4 centimeters.

The gist of the chemical analysis results is as follows. Ignition loss (600°C, 3 hours) had a spread of 1.2 percent to 16.3 percent, and there were some samples influenced by the organic matter and oils in the seabed mud. Hexane extracts exceeded 0.1 percent in a number of samples, and on the high end oily mud was at 9.8 percent. While tests for heavy metals did not detect much, lead was detected in many samples in the mg/kg range. Leaching amounts of heavy metals (using a method based on Environment Ministry Notification No. 46) were found in some instances to exceed environmental quality standards for soil contamination from lead, arsenic, fluorine, and boron. In the cases of lead and arsenic, it is conceivable that natural sources were responsible for exceeding leaching standards. Because concentrations of fluorine and boron are high in the seawater of this area, the influence of seawater is a possibility. There were no samples in which the content of persistent organic pollutants (POPs) such as dioxins, PCBs, or pesticides exceeded the standards (for example, for PCBs the standard is the destruction target of 0.5 parts per million [ppm] for PCB treatment, for dioxins it is the environmental quality standard for soil and for sediment in bodies of water, and for other substances it is the established reference guidelines). The levels found were generally the same as the results of environmental monitoring surveys of sediment and soil that were performed in recent years by the Environment Ministry in nearby water and land areas. Because our investigation is based on 62 samples and a limited study, a more detailed study may be carried out in the future, but it is safe to say that at this point no serious contamination in particular has been found.

Essentially, the guidelines for disposing of tsunami deposits call for removing pieces of wood and other materials, detoxifying them, and then using them as fill in landfills or for embankments. In urban areas, where hydraulic excavators are hard to use, removal is performed by people with shovels or other tools. After being gathered, deposits are carried away by heavy machinery, while septic tank pumper trucks can be used for sludge, which has a high water content. After removal, the deposits are put in temporary storage sites; pieces of wood and concrete, which can be used as civil engineering materials, are separated out. If the deposits contain hazardous substances, they are detoxified by washing and/or physical/chemical treatment, and then either likewise used as material, or taken to a municipal solid waste disposal site if they cannot be effectively used. It was decided that if tsunami deposits contain no pieces of wood or other matter and are not contaminated with hazardous substances, they could be left in place after making arrangements with landowners.

HAZARDOUS WASTE SEPARATION AND DISPOSAL

The types of waste that present dangers, and the methods of handling them, require various cautions, particularly if operations are on-site. There are hazardous wastes such as gas cylinders, building materials containing asbestos, and transformers and capacitors containing PCBs. The Japan Society of Material Cycles and Waste Management (JSMCWM) has prepared a disaster-waste quick reference chart, and it is desirable that personnel performing waste removal should use this (or others like it) to learn about hazardous wastes.

Here is an example from Sendai City of how to treat hazardous waste: such waste, ranging from household cleaners, paints, lead-acid automobile batteries, and emergency power supply systems used by industries, are all being stored separately in a space about the size of a baseball field. Of these types of waste, a decision has been made only about gas cylinders and fire extinguishers—which should be treated by the related industries—while the treatment and disposal of other materials is still undecided. A high level of caution is needed in daily dealings with household hazardous waste, and further detailed measures are required to tackle this issue when establishing plans to deal with disasters.

LESSONS

BASIC FRAMEWORK FOR DEALING WITH DISASTER WASTE

On April 5, 2011, the Science Council of Japan issued the "Urgent Proposal Related to Measures for Earthquake Disaster Waste and Prevention of Environmental Impact." The proposal's overall framework was drafted by the JSMCWM, and then issued in collaboration with the Japan Society of Civil Engineers and the Japan Society on Water Environment. The medium- and long-term response was also taken into consideration in formulating a basic policy for the disposal of earthquake waste and the minimizing of environmental impacts. The essential points are given below:

- Waste is to be treated and disposed of quickly, while keeping in mind the securing of public health and the handling of hazardous waste. Priority is to be given to dealing with putrefied organic matter and quickly removing it from cities and streets, or—while taking measures such as spreading lime to delay putrefaction—to determining locations of hazardous wastes such as medical waste, asbestos, and PCBs, and trying to process each waste type in the proper manner.

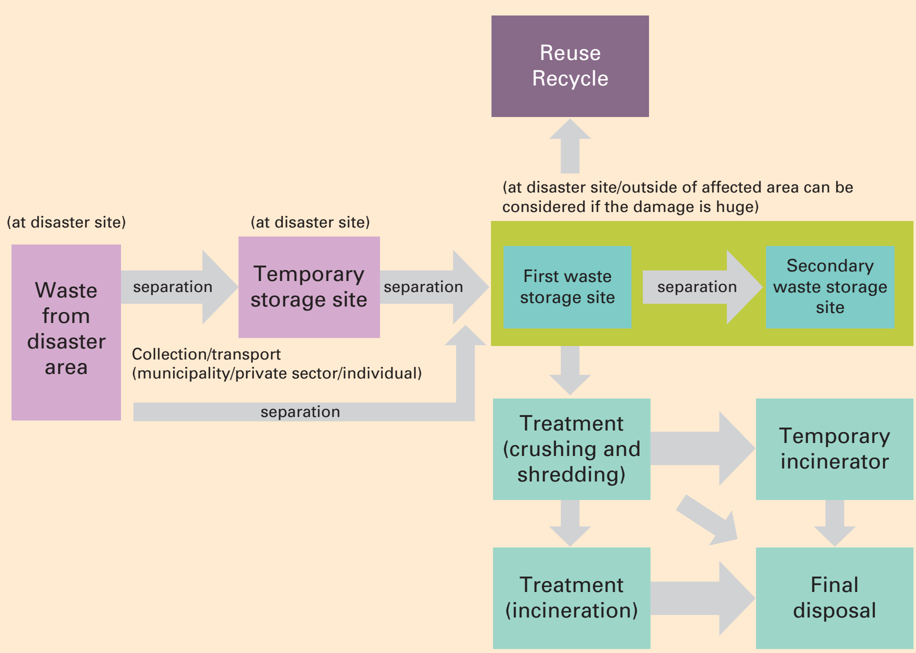
- Temporary storage sites are to be created (which take the water environment into consideration) and waste is to be uniformly separated. Waste collection locations are to be decided on immediately, and putrefied materials including sludge-type items, flammable materials, and hazardous wastes should not be mixed. Care is to be taken not to create huge piles, to prevent fires and other such events, and not to cause contamination of water, soil, or groundwater.

- Recycling should be considered, to help put resources to use in recovery and reconstruction. Concrete debris might be recycled in the recovery and rebuilding phases, wood scraps could substitute for fossil fuels in power generation and other applications, and various other types of recycling could be conceived.

- Local employment and wide-area cooperation should be facilitated in disaster-waste recycling. It was determined that in this case what is promoted internationally as "cash for work" could be effective. On dealing with disaster waste in the Tohoku region, even if wastes were to be recycled, the region would not have sufficient treatment and disposal capacity, which raises the possibility of wide-area cooperation. A case can be made for taking a nationwide response: integrating industry, government, academia, and the citizenry.

Figure 1 shows the basic flow involved in operating temporary storage sites and preliminary waste storage sites to facilitate the local management of municipal solid waste. These storage sites play a major part in the smooth removal of debris from disaster areas.

FIGURE 1: **Separation and treatment of earthquake waste**



For instance, it was known that since much of the disaster-stricken area in the Tohoku region comprises narrow coastal zones and also because of the urgent need for land for temporary housing and other purposes, it was not easy to secure land for temporary storage sites. In all geographical areas, authorities should prepare for disasters beforehand by designating places for temporary storage sites, traffic routes for waste transport, and other related needs.

In situations such as when a tsunami has scattered individuals' private possessions and mixed them with disaster waste, removal and processing must proceed while also determining who owns what. At the end of March 2011, the government issued "Guidelines on the Removal and Other Treatment of Collapsed Homes and Other Property after the Tohoku Region Pacific Coast Earthquake" (Ministry of the Environment 2011), which contained the following three points:

- Make sure everyone knows in advance the plans for where operations will be conducted, schedules, and other particulars.
- Before removal, take photographs and make other records of buildings, automobiles, motor scooters, and boats.
- For ancestral tablets, photo albums, and other items that are valuable to owners and other persons, as well as chattels, provide opportunities to return them to the respective owners and other persons.

Valuables such as precious metals and safe boxes should be put into temporary safekeeping. Efforts should be made to contact the owners or relevant parties in the event they are identified, and the valuables should be returned when the owners or relevant parties so request. When the owners or other relevant parties are unknown, the guidelines call for the valuables to be processed as directed by the Lost Property Act.

SEPARATION AND RECYCLING: THE SENDAI CITY MODEL

Following is one conceivable classification scheme for the composition of disaster wastes from earthquakes and tsunamis:

- Waste consumer electric appliances and electronics, and various household effects
- Waste wood, concrete rubble, tiles, and so on
- Plants, trees, and other natural items
- Large structures and so on
- Deposits (silt, bottom sediment, and so on)
- Wrecked vehicles and boats
- Hazardous wastes (asbestos, pesticides, PCBs, and so on)

- Evacuation center waste
- Infectious waste, human corpses, and animal carcasses

Depending on the composition of each type, it is necessary to identify and carry out the appropriate treatment and disposal methods, while keeping in mind the possibilities for recycling. Table 1 lists the specific types of waste that fall under the above categories, and their recycling and disposal methods. Although people tend to concern themselves with removing disaster waste quickly, they should from the outset consider how wastes could be recycled to reuse valuable resources and prevent wasting landfill space.

Disaster waste and tsunami deposits generated in Sendai City were estimated to be around 1.35 million tonnes and 1.3 million tonnes, respectively. As of April 2012, these could be treated as follows:

- Concrete, which accounts for about half of the 1.35 million tonnes of disaster waste, can possibly be reused as material for reconstruction.
- Strategies for waste other than tsunami deposits are near completion.

The city had already estimated the amount of disaster waste only three weeks after the March 2011 earthquake, and set up a target of disposing of it within three years. Realizing that it was impossible to treat the waste using only existing facilities, the city decided to set up additional temporary incinerators, which were constructed in the autumn of 2011. Three temporary incinerators (one stoker furnace and two rotary kilns; 480 tonnes/day of total disposal capacity) were installed in three designated temporary storage sites along the coastal area. The following items were separate and recycled: wood lumber (for fuel use), metals, tires, four items designated in the Home Appliance Recycling Law, automobiles, and motorcycles. These items were carried out in turn to each place to be recycled.

Including wastes that are supposed to be landfilled, the amount of waste collected and moved to temporary storage sites is measured by a king-size weighing scale, and in some cases the results are recorded in a manifesto sheet.

FINANCIAL SUPPORT

To facilitate disposal of disaster waste, half the cost is covered by government subsidies, and a tax-exemption system is applied to 80 percent of the remaining cost (that is, a local government has to pay only 10 percent of the total cost). Additional measures are being taken this time to reduce the burden on local governments considering the size of the enormous damage caused by the GEJE.

TABLE 1: **Classification and treatment of earthquake waste**

Category	*Outline*	*Type of waste*	*Recycling and disposal method*
Waste from household goods	Household goods destroyed by earthquake and tsunami	• Valuables and mementoes • Home appliances (TVs, refrigerators, air conditioners, washing machines) • Other home appliances • Tatami mats, mattresses	• Each item stored for return to owner • Home appliance recycling system • Metal recycled after dismantling and crushing; organic material incinerated, inorganic matter disposed of in landfill • Tatami mats, mattresses
Waste from collapsed houses	Collapsed houses and buildings (including furniture) destroyed by the earthquake and tsunami	• Timber from houses, furniture • Concrete, asphalt, waste tiles • Asbestos-containing building materials • Plasterboard	• Desalted if necessary. Potential usages include: 1) particle board, charcoal, and reuse of material; 2) use as fuel in cement kilns; 3) energy recovery from incineration • Crushed and used as aggregate for roadbed material and in construction • Controlled management: disposed of in landfill, melted • Controlled managment: disposed of in landfill
Wood	Scattered and accumulated garden trees, pine wood, and other trees	• Garden trees, live trees, etc.	• Desalted if necessary. Potential usages include: 1) particle board, charcoal, and reuse of material, papermaking material; 2) use as fuel in cement kilns; 3) energy recovery from incineration
Bulky waste	Large-sized and unusual waste from factories and infrastructure	• Tanks, power poles, feedstuffs, fertilizer, and fishing nets that each require a specific disposal method	• Crushed and separated and then recycled, incinerated, or disposed of in landfill. Caution is required for hazardous substances such as asbestos.
Deposits generated by the tsunami	Gravel and mud left in disaster area after the tsunami. Most is bottom sediment from water bodies, but sometimes organic materials and contaminants are included.	• Sediments mixed by the tsunami with the debris of collapsed houses and other debris. Some include oil. Odor and dust could arise on putrefaction and drying. Hazardous chemicals such as acids, alkalis, and pesticides from the disaster area could be included.	• Used as fill for landfills or embankments after removing woody debris and detoxifying. Detoxified by washing or incineration when material contains hazardous substances. Non-recyclable items are taken to final disposal site and disposed of as general waste. Where there is no wood debris and no contamination with a hazardous substance, they could be left in place after making arrangements with landowners.
Vehicles/ships	Automobiles/ships	• Automobiles, motorbikes, tires, ships, etc.	• Automobile recycling system. Tires chipped and used as a supplemental fuel. Ships are dismantled, recycled, and disposed of. Caution required for asbestos materials.
Hazardous waste	Asbestos, PCBs, etc.	• Batteries, fluorescent lamps, fire extinguishers, gas cylinders, waste oil, waste liquids, transformer oil, etc.	• Controlled management undertaked as necessary for each type of waste.

RECOMMENDATIONS FOR DEVELOPING COUNTRIES

PREPARING A DISASTER WASTE MANAGEMENT PLAN IN ADVANCE

It is essential to make disaster waste disposal plans beforehand to help reduce the need for decision making with insufficient information in the wake of a disaster. Guidelines on measures to manage disaster waste and on measures to treat waste from flooding were established in Japan in 1998 and 2005. Both sets of guidelines require that any plan should specify how to:

- Establish basic policies for waste management.
- Construct and manage the system that deals with waste management.
- Classify disaster waste and secure necessary equipment and temporary storage sites for disaster waste.

In 2010, 72 percent of municipalities across the country (a rather high rate), had disaster waste management plans in place. But they are now being revised to include the following:

- Estimation method for the amount of disaster waste generated by tsunamis, and countermeasures for dealing with the waste.
- Multiple predictions for disasters of different scales.

Accordingly, periodical review of disaster waste management plans is indispensable.

BUILDING COOPERATIVE STRUCTURES WITH VARIOUS ORGANIZATIONS AND INSTITUTIONS

When disasters occur, cooperative ties with various organizations and institutions are key to the smooth management of disaster waste. This is because many problems and administrative needs arise, while the number of appropriate policy experts is limited and the waste disposal sites in the affected areas are often damaged. Above all, much more waste is generated in these circumstances. Developing cooperative relations between local governments in the surrounding affected areas and with communities far from the stricken areas should be considered. Sendai City, for example, which was affected by the GEJE, over the course of a year received 58 staff from 8 organizations to help promote its waste management plans. For waste collection, the city received help from 7,510 staff from 10 organizations, as well as 88 vehicles.

In addition to cooperating with industries and local municipalities, building and making effective use of cooperative relationships with academic organizations, other expert groups, and nonprofit organizations are also recommended.

BOX 1: **Preliminary findings of the United Nations Environment Programme's (UNEP'S) expert mission on Japan's earthquake waste**

- The contingency plans put in place by some prefectures before the earthquake allowed them to respond more quickly to the waste management challenge (for example, in Sendai City, which had contingency plans, three incinerators were already in place processing 460 tonnes of waste a day).
- While Japan has done much to advance global best practices on handling disaster debris, there is still scope for substantial optimization so as to lower the costs of postdisaster debris management and reduce its environmental impacts.
- Commendable emphasis has been placed on waste segregation and recycling. Waste is divided into several categories such as wood, metals, electrical items, tatami mats, fishing nets, vehicles, plastics, and so on. Some segregated materials are already being reused: for instance, tree trunks are being sent to a paper mill, shredded wood is being sent to a cement company for use as fuel in the manufacturing process, and building rubble is being recycled as building material, landfill, or in road construction.
- Maximizing the possibilities for waste recovery and recycling while minimizing the need for transportation are priorities for effective debris management.
- Under Japanese law, the manufacturers of cars and white goods (refrigerators, washing machines, and so on) are responsible for the final disposal of their products. But the volume of disaster debris generated is likely to overwhelm their intake capacity, which may need to be expanded.
- Despite the magnitude of the challenges, and their own personal tragedies, the officials in the various Japanese cities are doing systematic and dedicated work to manage the debris in a time-bound fashion.
- Opportunities exist for learning from best practices in various cities, and a systematic approach to capturing them and disseminating them would be beneficial.
- The national guidelines produced for disaster debris management could be locally adapted, with input from academic experts to reflect local circumstances. This will lead to more environmentally optimal outcomes.
- There is scope for improved monitoring and communication of the waste management activities in the disaster-impacted areas, which will enable everybody to appreciate the challenges faced and the efforts made.

Source: http://www.unep.org/newscentre/Default.aspx?DocumentID=2676&ArticleID=9067&l=en.

CUSTOMIZING THE REMOVAL PROCESS TO LOCAL CONTEXTS

Each country has its own environmental safeguards, technology, and recycling practices. Utilizing these local practices are crucial in effective debris management.

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