Environmental Pollution Caused by Natural Disasters

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EXECUTIVE SUMMARY

One of the major problems that the world is facing is the environmental pollution. Among these, the appropriate management of the hazardous and special wastes is significantly important especially for the economically developing countries. Another problem that the authorities in the waste management are combating is the wastes of natural disasters such as flooding, earthquake and fire. Lack of the related regulations and necessary systems, experts in the field and ignorance of the authorities make the solution of these problems much more difficult.

At an earthquake, buildings, bridges, dams, factories, chimneys of factories and monuments collapse and the communication and power lines, sewer system and drinking water lines are damaged. These wastes block the roads, so the rescue and first-aid groups, related heavy duty machines can not reach the disaster areas easily. Also, due to the damage of the communication lines authorities can not obtain sound information about the extent of the disaster and give necessary orders to the related people because of the damage of the communication lines.

The amount of the demolishing waste depends on the type of the area such as urban or rural area, intensity of the earthquake and the number of demolished buildings and facilities. When the amount of demolishing wastes is estimated, also the amount of the wastes generated during the repair and construction of wastes should be considered.

The composition of the wastes is important for the determination of the recycling programs. The composition of demolishing wastes has been continuously changing due to the developments in the field of the construction materials. They generally contain iron, steel, aluminum, glass, bricks, asphalt, paper, lime, wooden materials and some organics which contain non-hazardous materials. Thus new technologies have been developed to process/recover/recycle these materials after earthquakes.

Types and composition of the wastes generated at the earthquake region is completely different from the waste generated at daily life. People will be generally consuming canned food consequently generating wastes of tin, aluminum and plastic cups/containers. Besides, due to the short-cuts of the electricity, food will be easily spoiled at homes. Municipalities can not accomplish the collection of wastes properly, thus these wastes will be a threat to public health. Therefore people should be trained about keeping this kind of food at cool places at their homes burying them in the gardens to convert them into compost.
Air pollution caused by the fires at the inhabited areas will reach to significant levels by mixing with toxic and carcinogenic gases emitted from the damaged factories.

Also irritating odors and spread of epidemic diseases take place due to the dead bodies which are not buried immediately.

Contamination of the environment and the drinking water sources with the various chemicals from the demolished and damaged factories cause significant disasters both for the public health and the deterioration of the environment.

It is important to group the necessary precautions to be taken to minimize the negative impacts and the environmental pollution/public health threats consequences of earthquakes into two groups as “Necessary Preparation Activities to be Realized Before Earthquakes” and “Necessary Activities to be Realized After Earthquakes”. Also “Disaster Management Plan” should be prepared and updated continuously.

Keywords: earthquake, disaster management plan, waste, management, demolition, recovery

INTRODUCTION

Environmental pollution caused by the wastes generated from the activities of the human beings has been continuously increasing. Pollution problems has been reaching to significant levels by the large amount of wastes generated from the natural disasters such as earthquakes, volcanic activities, natural forest fires, tornados, flooding, tsunami, etc. Since these wastes are generated at huge amounts at a very short time period, their management in both economically and environmentally sound manner is difficult (Petersen, 2004). On the other hand, if they are not managed properly immediately, they become a threat both to the environment and public health (Srinivas and Nakagawa, 2008). Earthquake is a geologic phenomenon which requires extraordinary effort to cope with (Gunn, 1990; Young et al., 2004). Generally buildings, bridges, dams, factories, chimneys of factories, monuments collapse, fire starts, communication lines and power plants and drinking water and sewer systems damage during the earthquakes. The demolishing wastes block the roads causing the reaching of the rescue groups and the necessary heavy duty machines/equipments to the disaster area very difficult and sometimes impossible. Due to the damage of the communication lines, the authorities can not obtain dependable information about the disaster area and can not give the necessary orders to the related people. Also, clean drinking water can not be supplied to the people and sewage is spread around causing the pollution of the soil and threatening the public health. Due to the damage of the fire, department and vehicles as well as the disabled appointed personnel and blocking of the roads disaster areas are not reached easily. Rescued people from the earthquake and fire areas can not be treated properly because of the collapse of the health-care institutions, disabled/impaired medical doctors and health-care personnel. If the relief and rehabilitation programs are not applied immediately and the wastes are not removed properly, they will cause the spread of epidemic diseases. Thus, waste management and disposal have become as very significant issues after the occurrence of the disasters (Peterson, 2004; Diaz, 2005; UNEP, 2005; Shaw, 2006; Karunasena et al., 2009).

Contamination of the environment and the drinking water sources with the various chemicals from the demolished and damaged factories cause significant disasters to the public health beside the deterioration of the environment.

Also irritating odors and spread of epidemic diseases take place due to the dead bodies which are not buried immediately.
Air pollution caused by the fires at the inhabited areas will reach to significant levels by mixing with the toxic and carcinogenic gases emitted from the damaged factories.

Another significant negative impact is the disposal of demolishing wastes having pH of 12.5 or more, causing the changing of the marine ecology and threatening the aquatic life.

**TYPES OF THE WASTES GENERATED**

A huge amount of waste is accumulated by the demolishing of the buildings, bridges, etc. during the natural disasters. Demolishing wastes contain high amount of minerals, construction materials and small amount of hazardous materials. The composition of the demolishing wastes has been continuously changing due to the developments in the field of the construction materials. They generally contain iron, steel, aluminum, glass, bricks, asphalt, paper, lime, wooden materials, roof materials and some organics which contain non-hazardous synthetic materials. Thus, new technologies have been developed to process/recycle/recover these materials/wastes after the earthquakes.

The amount of the demolishing waste depends on the type of the area such as urban or rural area, intensity of the earthquake, and the number of the demolished/damaged buildings, bridges, factories, etc.

When the amount of the demolishing wastes is estimated also the amount of the wastes generated during the repair and construction of the damaged/demolished buildings and bridges after the earthquake should also be considered. Generally only 20-30 percent of the domestic wastes are construction and demolishing wastes. According to a research conducted in the USA, it was found out that the amount of the construction and demolishing wastes not related to earthquakes was 136 million tons, while the domestic wastes was 208 million tons. 48 percent (65 million tons) of the wastes was generated from the demolishing of buildings, 44 percent (60 million tons) from the renovation of buildings, 8 percent (11 million tons) from the construction of the new buildings. The percentages indicate how much demolishing and construction waste will be generated during an earthquake and the repair/construction of the buildings after the earthquake. The significance about the amount of these wastes to be handled is much more clearly understood if it is considered that 2.9 million tons of construction and demolishing waste requires a sanitary landfill which is expected to operate for five years. Also the fee of transportation of 2.7 million tons of these wastes is 60 million, burying in sanitary landfill is 120 million, in other words approximately 180 million US Dollars, indicates the economic portrait of handling these wastes properly (Kocasoy, 2007).

**MINIMIZATION OF THE NEGATIVE IMPACTS OF EARTHQUAKES**

It is very difficult both for the public and the authorities to make sound decision under the negative physical conditions of the earthquake. Therefore, it is necessary to group the necessary precautions to be taken to minimize the negative impacts and the environmental pollution consequence of the earthquakes into two groups as “Necessary Preparation Activities to be Realized Before Earthquakes” and “Necessary Activities to be Conducted After Earthquakes”. This is important especially for countries such as Turkey, which are located on the earthquake zone. Turkey has experienced 90 significant (Magnitude>5.0) earthquakes between 1903 and 2004. Among them, the earthquake occurred at Erzincan in 1939 caused the death of 32,968 people and the one took place at Kocaeli in 1999 caused the loss of 17,480 lives. The earthquakes which caused the demolishing of more than 20,000 buildings are presented at Table 1 (KOERI, 2009).

The activities to be conducted before and after the earthquakes are explained in detail in the following sections.
Table 1. Earthquakes Caused the Collapse of More Than 20,000 Buildings in Turkey (KOERI, 2009)

<table>
<thead>
<tr>
<th>Date</th>
<th>Town/City</th>
<th>Magnitude (M_S)</th>
<th>Mortality</th>
<th>Number of Buildings Collapsed</th>
</tr>
</thead>
<tbody>
<tr>
<td>27.12.1939</td>
<td>Erzincan</td>
<td>7.9</td>
<td>32,968</td>
<td>116,720</td>
</tr>
<tr>
<td>20.12.1942</td>
<td>Erbaa/Tokat</td>
<td>7.0</td>
<td>3,000</td>
<td>32,000</td>
</tr>
<tr>
<td>27.11.1943</td>
<td>Ladik/Samsun</td>
<td>7.2</td>
<td>4,000</td>
<td>40,000</td>
</tr>
<tr>
<td>01.02.1944</td>
<td>Gerede/Bolu</td>
<td>7.2</td>
<td>3,959</td>
<td>20,865</td>
</tr>
<tr>
<td>19.08.1966</td>
<td>Varto/Muş</td>
<td>6.9</td>
<td>2,396</td>
<td>20,007</td>
</tr>
<tr>
<td>27.06.1998</td>
<td>Ceyhan/Adana</td>
<td>6.2</td>
<td>146</td>
<td>31,463</td>
</tr>
<tr>
<td>17.08.1999</td>
<td>Gölcük/Kocaeli</td>
<td>7.8</td>
<td>17,480</td>
<td>73,342</td>
</tr>
<tr>
<td>12.11.1999</td>
<td>Düzce</td>
<td>7.5</td>
<td>763</td>
<td>35,519</td>
</tr>
</tbody>
</table>

Necessary Precautions to be Taken Before Earthquakes

The necessary activities to be realized at the areas which are prompt to the earthquakes are summarized as follows:

- “Disaster Management Plan” should be prepared by public and non-governmental organizations at the nearest town/city. In this management plan, the units, departments, people and the authorities and responsibilities of them should be clearly identified. They should act immediately without waiting any directive during an earthquake.
- In case of the damage/demolishing of the public institutions/buildings, and the disability of the authorities, it should be clearly indicated who will be taking over the authority and responsibility and the place that these services will be conducted.
- In case of the damage of the normal communication lines, it should be clearly identified what will be the “emergency communication systems” and these systems will be prepared and always kept ready for operation in order to be able to get dependable information about the earthquake area and keep people informed about the situation.
- In case of the blockage of the highways/roads, the transportation means (marine/air transportation) of the rescue teams should be determined beforehand. Also, planning of the renovation and opening of the damaged and blocked highways should be made.
- The inventory of the heavy duty machines and how they will be transferred (by highways, marine or airways, etc.) to the earthquake area should be planned.
- In case that the operators of heavy duty machines are injured, the method of appointing/involving other experienced operators should be planned.
- In case of the damage/collapse of the hospitals, health-care institutions and the disability of the related experts/people at these institutions, it should be decided where and who will be giving these treatment services and how the rescued people will be transferred to these areas.
- The responsibilities/services of the non-governmental organizations, means of communication and transfer of them to the affected areas should be planned.
- The awareness and training courses for the local people about how to behave and how to help others should be organized.
- Identification of the temporary houses and how people will be transferred to these houses for people who will loose their houses should be planned.
- Planning of the collection and distribution of the financial aids and donations should be made.
- The experts who will prepare “Earthquake Impact Maps” for the potential earthquake places with respect to the center of the earthquake occurred and the places they will be working should be identified.
- The places where the dead people will be buried and how the religious ceremonies will be conducted should be planned.
Most of the time, due to the generation of the huge amount of the earthquake wastes, it is almost impossible to bury them in the existing sanitary landfills. Thus, the means of transportation of these wastes to the temporary storage areas and methods of their treatment (sorting, burying, recycling, recovery) after earthquake should be planned.

The amount and types of the wastes to be generated during the earthquakes is completely different from the waste generated routinely during the daily life. People will be generally consuming canned food thus generating wastes of tin, aluminum and plastic cans/bottles. Besides, due to the short-cuts of the electricity, the food will easily be spoiled at homes. Municipalities can not accomplish the collection of wastes properly, thus these wastes will cause another source of threat to public health. Therefore people should be informed/trained about keeping this kind of materials at cool places at their homes and burying them in the gardens to convert them into compost.

The appointed people according to “Disaster Management Plan” should be informed and trained properly.

Activities to be Conducted After the Earthquake

One of the most important activities to be conducted after the earthquake is to construct homes for the people who have lost their houses. New job opportunities should be developed for those who have lost their jobs. Psychological therapy sessions should be arranged for people especially for children.

The activities related to the environmental pollution and the removal/disposal of the wastes properly are summarized below.

- The wastes accumulated at the temporary storage areas should be sorted and transported to the final treatment/disposal areas without causing soil pollution.
- Recycling/recovery of wastes are much more economic than burying them in sanitary landfills. The economy of this process depends on many factors such as applied solid waste management policies in the country, contract specifications, applied recycling/recovery projects. Recycling/recovery processes involve sorting and treatment of these wastes according to the demand of the market. There are some companies establishing recycling/recovery plants with capacity of 500-1500 tons per day at economically developing countries.
- The construction and demolishing wastes are generally used as concrete aggregates due to the lack of sufficient land area for the storage of these wastes and the diminishing of the natural aggregate sources.
- The wooden materials in the construction and demolishing wastes should be used in the adjustment of the parks, animal beds, and for burning as fuels in boilers and stoves. The asphalt wastes generated from the demolishing of roofs of buildings should be used in filling the holes.
- The plastic construction materials in the wastes should be recovered to be used as construction materials and aggregates. The tires mixed with cement can be used in the repair of roads, filling holes around bridges and construction of retaining walls and foundations.
- Special care should be taken in the usage of special materials such as asbestos generated from the demolished buildings. Asbestos should be mixed with glass and heated to be encapsulated in the glass. The obtained glass blocks can be used for different purposes.

Management of Construction and Demolishing Wastes

Planning of the management of the construction and demolishing wastes covers applied technology, recycling/recovery centers and economic aspects. The specifications about them are summarized in the following sections.
• **Technology**
The amount and composition and the amount of various components of the wastes to be recovered should be determined for the selection of the recycling/recovery technology. Also, collection, sorting, processing and identification of required machines, market potential and demand and meeting quality requirements are very important.

Although the amount and the components of the demolishing wastes can be determined from the plans/projects of the demolished plans, it is very difficult to accomplish it. According to the type of the waste, the appropriateness of the recycling center for recycling/recovery of waste to the product according to the market demand and packaging and putting them into the market should be determined. Since the sorting and processing of wastes most of the time can not be accomplished at the site that waste are generated, transportation methods of these wastes should also be planned.

• **Recycling Centers**
The recycling centers should be operated in coordination with the local waste management authorities, construction sector and environmental management authorities. The economic benefits of recycling/recovery of these wastes should be explained to local authorities.

The authorities should be convinced about the extension of the life-time of sanitary landfills, decrease in the expenses of disposal of wastes, and the decrease of the expenses of the construction of buildings by the usage of recovered construction material.

The public and private authorities should be informed about the results obtained, benefits and financial gains by the application of the recycled/recovered material in the construction sector.

• **Economic Aspects**
The initial investment and operation expenses should be considered when the recycling/recovery programs are planned. The repair of the damaged buildings as well as the construction of new buildings should also be included within the scope of this plan.

**CONCLUSION**

The moral and material losses at the natural disasters such as natural fire, flooding, earthquake, etc. are too severe and some of them can not be recovered. Thus, in order to minimize the effects of these disasters both on local people, the economy of the country and the environment, the precautions and activities summarized at the manuscript should be conducted and the management plans should be prepared and updated continuously.

**REFERENCES**


