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Recycling disaster waste: Feasibility, method and effectiveness

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ABSTRACT

Recycling is often employed as part of a disaster waste management system. However, the feasibility, method and effectiveness of recycling varies between disaster events. This qualitative study is based on literature reviews, expert interviews and active participatory research of five international disaster events in developed countries (2009 Victorian Bushfires, Australia; 2009 L'Aquila earthquake, Italy; 2005 Hurricane Katrina, United States; 2010 and 2011 Canterbury earthquakes, New Zealand; 2011 Great East Japan earthquake) to answer three questions: What are the main factors that affect the feasibility of recycling post-disaster? When is on-site or off-site separation more effective? What management approaches improve recycling effectiveness? Seven disaster-specific factors need to be assessed to determine the feasibility of disaster waste recycling programmes: volume of waste; degree of mixing of waste; human and environmental health hazards; areal extent of the waste; community priorities; funding mechanisms; and existing and disaster-specific regulations. The appropriateness of on or off-site waste separation depends on four factors: time constraints; resource availability; degree of mixing of waste and human and public health hazards. Successful recycling programmes require good management including clear and well enforced policies (through good contracts or regulations) and pre-event planning. Further research into post-disaster recycling markets, funding mechanisms and recycling in developing countries is recommended.

1. Introduction

Disasters often create significant volumes of debris and waste: in some cases overwhelming existing solid waste management capacity. Recycling is often employed as part of a disaster waste management system to manage these large volumes.

There are many parts of disaster waste that can be recycled: vegetation, natural aggregates, construction and demolition debris (concrete, bricks, timber, metal etc.), vehicles and boats, electrical goods and appliances. Sometimes these materials can be recycled in existing markets or can be used in post-disaster applications. Typical reuses include landfill cover, aggregate for concrete, fill for land reclamation and compost for fertilisation and slope stabilisation (Channell et al., 2009). Some materials can also be used beneficially to generate energy (Yepsen, 2008; USEPA, 2008).

Recycling guidance is provided in a number of documents. There are several disaster waste planning documents that include recycling advice (UNOCHA, 2011; USEPA, 2008; Solis et al., 1995). Some authors, such as Skinner (1995) and Reinhart and McCreanor (1999) provide post-disaster recycling advice based on peace-time C&D recycling practices.

The benefits of recycling disaster waste are evident in many past disaster waste management programmes: Marmara Earthquake (Baycan, 2004; Baycan and Petersen, 2002), Kosovo (DANIDA, 2004), Northridge Earthquake, US, 1994 (USEPA, 2008; Gulledge, 1995), Lebanon (Jones, 1996), Great Hanshin-Awaji Earthquake (Kobayashi, 1995), Indian Ocean Tsunami, Thailand and Sri Lanka (Basnayake et al., 2005; UNDP, 2006). The benefits include:

- Landfill space reduction.
- Raw material demand reduction.
- Waste management cost reduction (this depends on relative waste management option costs, including transportation).
- Job creation.

The benefits are similar to those identified for recycling in everyday waste management systems (Kartam et al., 2004; Blengini, 2009; Kofoworola and Gheewala, 2009; Hsiao et al., 2002).

As well as benefits, authors have identified potential barriers to recycling post-disaster. A comprehensive summary of the barriers is provided in Brown et al. (2011b). Barriers include: limited time to collect and process materials; insufficient specialised processing

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equipment (Baycan and Petersen, 2002); difficulty in physical separation of the materials (Baycan, 2004; Lauritzen, 1998); no desire to offset raw material use in the rebuild (Lauritzen, 1998); higher costs compared to alternative disposal methods (Solis et al., 1995); and recycling markets unable to handle large quantities of recycled materials (Solis et al., 1995; Lauritzen, 1998).

The literature does not, however, include any critical analysis of why some disaster events achieve very high recycling rates (for example, a 95% following the 2000 Cerro Grande Wildfire in New Mexico (USEPA, 2008)), whereas other events recycle to a much lesser extent (in Louisiana, following Hurricane Katrina, the favoured waste management option was landfilling). There appears to be a need to identify why more recycling happens following some disasters compared to others. Knowing the key driving factors, will help authorities to make disaster waste management more effective, meaning that the system chosen is better able to meet the goals of the relevant authorities.

The aim of this research is to qualitatively determine, based on five international disaster case studies and a broader literature review, the common disaster-specific factors that influence the feasibility, the choice of methods and the effectiveness of post-disaster recycling. Specifically, it aims to answer the following:

- What are the main factors that affect the desirability and/or feasibility of recycling post-disaster?
- In what situation is on-site or off-site separation more effective?
- What management approaches improve recycling effectiveness?

First the study methodology is outlined, then the case studies are briefly summarised. The majority of the paper is dedicated to discussing the key factors identified, through thematic analysis of the case study findings, for each of the three questions above.

2. Methodology

This research is based on a multi-hazard, multi-context, embedded, multi-case study analysis. It is part of wider research on all aspects of disaster waste management (Brown, 2012). Qualitative data was collected for five case studies: 2009 Victorian Bushfires, Australia; 2009 L'Aquila earthquake, Italy; 2005 Hurricane Katrina, United States; 2010 and 2011 Canterbury earthquakes, New Zealand; and 2011 Great East Japan Earthquake, Japan. These cases were chosen such that a range of disaster scales, hazard types and contexts could be compared. The cases were restricted to those in developed countries due to the marked difference in institutional frameworks and disaster response capacities. While there are common issues, the nature of disaster responses in developing countries generates unique and complex issues (Brown, 2012), worthy of a separate analysis.

The data were obtained from a combination of: 21 semi-structured interviews with disaster recovery and waste management experts across the case studies; review of more than 200 documents; and active participatory research by the lead author during the response to the 2011 Canterbury earthquakes. The interviewees were selected to ensure a range of views of the disaster waste management process: ranging from government officials to waste management contractors and landfill operators. Note that two case studies were desktop studies—Hurricane Katrina and the Great East Japan Earthquake. The data sources are listed in Table 1.

The semi-structure interview topics are listed below:

(1) Disaster impacts (number of deaths, number of damaged properties, lifeline disruption etc.);
(2) Waste properties (volume, nature, hazards);
(3) Pre-disaster waste management systems (normal waste volumes, spare capacity in system, future waste strategy) and disaster waste management plans;
(4) Organisational structures (strategy and operations);
(5) Legislative frameworks and post-disaster legislative or regulatory decisions;
(6) Funding frameworks (pre and post-disaster);
(7) Waste management operations (emergency response; waste collection, transportation, handling and disposal; hazardous waste; health and safety; monitoring and record keeping; timing, costs, public information; and other.)

The data were analysed using a cross case study analysis. The data from each case study were combined using a combination of pattern matching, explanation building and logic models (Yin, 2009). The waste management and recycling programmes from the case studies were compared to identify the factors that drove the recycling programmes and their effect on recycling feasibility, separation method selection and recycling programme effectiveness.

3. Case study descriptions

3.1. 2009 Victorian Bushfires, Australia

The "Black Saturday" bushfires in Victoria, Australia, on 7 February 2009, killed 173 people in 78 communities. They were reported as the worst bushfires in Australian history to date. Over 430,000 hectares of land and 2000 properties were destroyed (VBRRA, 2009). The waste generated was primarily the charred remains of residential properties and surrounding vegetation. No regulatory requirement for recycling was made by environmental authorities following the event. However, in order to reduce costs of demolition and debris management, and ensure best environmental practices, the contractor appointed by the government instigated an on-site recycling programme within two weeks of starting. The programme primarily recycled metal and concrete as demolition was taking place. Vegetation was also mulched and donated to communities to enable erosion protection on the burnt landscape (Brown et al., 2011a). The proceeds from the recycling, almost AUD1.6 million, were donated to community and bushfire recovery projects (VBRRA, 2010). Neither demolition activities or the wider recovery programme were significantly affected by the recycling programme.

3.2. 2009 L'Aquila earthquake, Italy

On 6 April 2009, the Abruzzo region in Italy was struck by a 6.3 magnitude earthquake. 314 people died and an estimated 70,000 residents were forced to evacuate (Dolce, 2009). L'Aquila has a high proportion of historic multi-storey unreinforced masonry buildings. Approximately 25% of the 72,000 damaged buildings require complete demolition (Dolce, 2010). The demolition and repair programme will generate an estimated four million tonnes of debris: the intent is to recycle the aggregate from the waste (estimated 70–80% of the waste).

In L'Aquila, waste managers faced several barriers in achieving their recycling objectives. The major barrier was the limited number of temporary storage facilities (for separating and storing recyclables) available. Strict environmental regulations slowed the establishment of additional storage and processing facilities. Strict environmental regulations also made it difficult to identify suitable sites for using the recycled crushed aggregate as engineering fill (typically quarry remediation). In addition, there was an absence of standards for use of recycled aggregate in construction, further