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A measurement of the effectiveness and efficiency of pre-disaster debris management plans

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ABSTRACT

Disaster debris management operations make up a significant portion of recovery expenses. The following study aims to examine how the presence of a plan makes disaster debris management effective and efficient. Ninety-five counties in the United States who received major disaster declarations between 2012 and 2015 were surveyed to examine the quality of their debris management processes. Forty-nine of these counties had debris management plans while forty-six did not. Statistical tests were conducted to address discrepancies in the effectiveness and efficiency of the debris management processes between the two groups. Such tests suggest that counties with pre-disaster debris management plans were more effective. These counties recycled almost twice as much disaster debris as counties without plans, and received over three times as much Public Assistance from the Federal Emergency Management Agency (FEMA). Counties with plans also reported higher levels of perceived preparedness for future debris challenges than counties without plans. Overall, counties with pre-disaster debris management plans were partially more efficient than counties without plans. They removed more cubic yards of debris per day, but there were no statistically significant differences between the two groups in the volume of debris removed per dollar.

1. Introduction

The Federal Emergency Management Agency (FEMA) (2012) defines debris as, "Scattered items and materials either broken, destroyed, or misplaced by a disaster" (p. vii). Such debris can be classified into a variety of categories, including: construction and demolition (C&D) materials, vegetative waste, household hazardous waste (HHW), appliances, and electronic devices (Fetter and Rakes, 2011). Average costs for debris management account for about twenty-seven percent of the total costs for every given disaster (FEMA, 2012). Moreover, the municipal waste management capacities are often instantly overwhelmed by debris after disasters (Fetter and Rakes, 2011). The Environmental Protection Agency (EPA) (2008) estimates that every one million cubic yards of debris would lessen a landfill's life by approximately five years.

Disaster debris poses an array of challenges for response and recovery. According to Brown et al. (2010), disaster debris can block access ways and impede the availability of lifeline services. They go on to explain that poor debris management practices can consume integral resources following a disaster, which in turn diminishes the speed of the recovery process (Brown et al., 2010).

A lack of understanding of the debris management process often hampers the response and recovery phases of disaster debris. Some of these aspects include: funding mechanisms, responsible offices, and the role of the residents in debris separation. In 1995, the EPA released a report entitled "Planning for Natural Disaster Debris." This report aims to provide communities with a guide for understanding the debris management process and developing a plan. It was last updated in 2008. The EPA (2008) cites the lessons learned from specific cases of disasters throughout the United States. They found that areas with debris management plans in place prior to the events had overall smoother debris management processes. For example, Palm Beach County, Florida had a debris management plan in place before Hurricane Frances hit in 2004. The county developed its debris management plan after experiencing the consequences of not being prepared for debris management in 1999 with Hurricane Irene. Furthermore, Escambia County, Florida had a debris management plan in place when Hurricane Ivan hit in 2004. The county drafted its debris management plan in 2003. Escambia's acting director of solid waste management stated that the time spent planning was time well spent (EPA, 2008).

The EPA (2008) debris management-planning guide also describes the consequences of not being prepared with a debris

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management plan through the case of San Diego County, California. The county did not have a debris management plan in 2003 when it experienced two wildfires, and subsequently indicated that time could have been saved and FEMA reimbursements might have been easier to obtain had a plan been in place (EPA, 2008). On a similar note, Reinhart and McCreanor (1999) refer to the case of Kauai where the county did not have a debris management plan prior to a 1992 calamity known as Hurricane Iniki. The authors explain that debris management was hindered by inaccessibility at the only landfill on the island, and several illegal dumps were subsequently established that required eventual cleanup (Reinhart and McCreanor, 1999).

Swan (2000) asserts that if debris clearance is not properly planned, the transition between the Public Works and Solid Waste Management offices can result in conflict and can also impose additional costs and time. The EPA posits that pre-disaster waste estimations are beneficial in both pre-disaster planning and post-disaster response, and can be carried out with the use of Geographic Information System (GIS)/hazard maps (Brown et al., 2011). Furthermore, Ekici et al. (2009) argue that a debris management plan can promote local control over recovery as well as an increased chance to receive FEMA reimbursements because the process is recorded and carefully controlled.

Moreover, Brown and Milke (2016) stress the usefulness of pre-disaster debris management plans in promoting the recycling of disaster debris. They attribute inadequate plans as a possible explanation for the low recycling rates of debris from Hurricane Katrina, and conclude that pre-disaster planning can strengthen a disaster waste-recycling program. According to Brown and Milke, pre-disaster planning helps to identify the likely resources required for recycling. This includes: personnel, trucks, staging and disposal sites, recycling facilities, etc. They support their argument by citing the case of Christchurch, New Zealand where pre-disaster planning resulted in the establishment of a suitable temporary staging area after experiencing a major earthquake. The temporary staging site helped to strengthen the efforts of search and rescue operations, and expedited the reopening of city streets (Brown and Milke, 2016).

Even though the disaster debris management literature stresses the importance of pre-disaster debris management plans and cites examples of the lessons learned from specific disasters that were not prepared with debris management, there appear to be no studies that attempt to quantify the "effectiveness" and "efficiency" of debris management planning. Both of these concepts are essential to debris management because they measure the quality of the process and outcomes. The purpose of this research therefore is to examine how pre-event planning benefits disaster debris management.

This research focuses on disaster debris management in the United States and frequently cites FEMA policies. The importance of debris management planning can also be applied to other countries. For example, in examining disaster debris management from a global perspective, Asari et al. (2013) argue that planners should determine the quantity of waste, temporary storage sites, and disposal or recycling options. However, they assert that it is important to plan for these events during normal times. Asari et al. share the guidelines put forth by the Japan Society of Material Cycles and Waste Management (JSMCWM) with the international community. These guidelines place a heavy emphasis on planning in the pre-disaster environment (Asari et al., 2013).

Even though there are common issues related to disaster debris in most places, the nature of disaster responses in developing countries often brings unique and complex issues (Brown and Milke, 2016). For example, Zawawi et al., 2016 explain that in many cases developing countries do not implement proper landfill restrictions, or leave the disaster debris in temporary places. They classify this practice as a factor that often delays the recovery phase in Malaysia (Zawawi et al., 2016). According to Asari et al. (2013), many developing countries lack pre-disaster debris management plans beyond those developed by international aid organizations. They recommend that these nations and their local governments review existing guidelines to establish simple plans, and gradually revise them to adapt to their needs and circumstances (Asari et al. (2013)). On a similar note, Zawawi et al., 2016 propose the adoption of a post-disaster waste management plan for Malaysia to fit into the nation's existing disaster management guidelines.

2. Background on debris management in the United States

2.1. Debris management techniques

There are multiple techniques for debris management depending on the composition of the debris and the available resources. FEMA (2012) recommends that recycling be considered early in the process to potentially reduce costs. They assert that in instances when recycling is considered, it should be coordinated with FEMA, the State, and the EPA. According to FEMA, candidates for recycling include: metals, soil, C&D materials, and wood (FEMA, 2012). Furthermore, the EPA (2008) promotes recycling and reuse because it will lessen the burden on disposal facilities, reduce costs, provide a valuable material resource, conserve natural resources, and help reduce greenhouse gas emissions. They also recommend that disaster debris management plans include a strategy for reuse, recycling, and mulching/composting (EPA, 2008).

As previously mentioned by Fetter and Rakes (2011), municipal waste management capacities are often instantly overwhelmed by debris after disasters. For this reason, they explain, temporary debris staging and reduction sites (TDSRS) are often developed to serve as locations for sorting and holding debris before transporting it to the appropriate disposal sites (Fetter and Rakes, 2011). Swan (2000) recommends that communities generate lists of potential TDSRS before disasters. Such lists, he posits, should begin with public lands in order to avoid costly leases (Swan, 2000).

Chipping and mulching are potential disposal methods for woody debris. According to FEMA (2012), the two terms are used interchangeably. They define the process as, "Reducing wood-related material by mechanical means into small pieces to be used as mulch or fuel. Woody debris can be reduced in volume by about 75%, based on data obtained during reduction operations" (FEMA, 2012, vii).

Burning is another method for debris disposal, but it is usually only permitted for clean, woody debris with strict guidelines due to the potential environmental hazards. FEMA (2012) recommends three methods for reducing clean, woody debris by burning. One method involves controlled open air burning, but they caution that such a practice should be terminated if mixed debris enters the waste stream. Another method consists of air curtain pit burning. However, FEMA warns that the air curtain pits must be precisely configured in order to function properly. They also recommend portable air curtain burners. According to FEMA (2012), this is the most efficient available system because the pre-manufactured pit is engineered to precise dimensions in order to complement the blower system.

2.2. Role of the residents

Residents play a crucial role in the debris management process based on their compliance with debris separation and collection

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