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Research article

Are donors adequately managing debris waste from natural (and other) disasters?

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Abstract

Debris waste management is a significant problem when responding to natural or other disasters. Historically, debris management has been an afterthought simply because the initial focus of disaster response is rightly, on saving lives. However, the waste generated by the disaster and created by the ensuing cleanup creates its own risks and the hazardous wastes mixed in with the debris can contribute to longer-term problems including increasing morbidity and mortality and impacts to ecosystem functions and services. We ask the above question and discuss some of the actions the international donor community has taken, survey typical debris management practices, and provide some brief examples of recent debris management approaches. We discuss lessons learned which include a lack of a standard approach to managing disaster waste, and organized waste management activities tend to be associated with and initiated by the international development community and guidance is available from a host of sources. Our discussion and conclusion we point out that while there are significant barriers to effectively managing debris waste it is crucial to overcome them including in providing safety support and appropriate clothing for workers. We conclude with suggestions for a way forward.

Keywords: disaster debris management, waste, international development

Introduction

Natural disasters occur routinely across the planet and the international donor community (IDC), comprising multilateral institutions including the United Nations (UN), the international development banks, and bilateral organizations including the US Agency for International Development (USAID) and many others, have aided less-developed countries in responding to these disasters for decades. Each disaster occurs in its own context, and response requirements can differ both in kind and degree. This is especially so in man-made versus natural disasters. There are, however, some activities that are implemented regardless of the disaster type or location. These include rescue and medical assistance, establishing alternative housing for displaced people including providing food and water and other services, and removing debris and rubble to allow passage of rescue teams and normal traffic patterns.

Sendai Framework Scope & Goals

1. The … framework applies to the risk of small-… and large-scale, … caused by natural or manmade hazards as well as related environmental, …and other… hazards and risks. It … guides…multi-hazard management of disaster risk … at all levels … and … sectors.
2. Prevent new and reduce existing … risk through …implementing… integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures …to… prevent and reduce hazard exposure and vulnerability to disaster, increase(ing) preparedness for response and recovery, and …strengthen(ing) resilience.

Overall, the IDC does an admirable job of responding to disasters, particularly in the humanitarian realm. Local and international staff quickly react and rapidly establish the required infrastructure to respond to the immediate situation. Indeed, their work has saved thousands of lives over the past several decades and their assistance has enabled a more rapid "return to normalcy" than would have been possible without it. The community realizes there are still areas for improvement and the Sendai Framework (UNISDR, 2015) initiated in 2015 and running through 2030 and reflects that. The box at right paraphrases the scope and goals of the framework.

However, holes remain in the efficacy of these responses. Often communication and coordination between actors is problematic. This leads to uneven responses and over- or under-commitment of resources. The IDC has recognized these and other issues and developed guidance addressing them (for example IBRD (Undated); UNDP, 2013; UNDP, 2016; and UNOCHA, 2013). In the main, this guidance is well-thought-out and followed to one extent or another.

We have observed that, while IDC members all have environmental assessment requirements and there is adequate (though minimal) guidance on appropriately managing disaster debris waste, often these requirements and guidance are honored more in the breach than in practice. We understand that these responses are enormously expensive and logistically challenging. However, our assessment is that the IDC's environmental assessment requirements create a fiduciary responsibility for managing this waste. Below, we discuss examples of recent debris waste management practices, the potential for increased risk and negative health and environmental outcomes as a result, and best management practices that could minimize debris-related risk and provide recommendations to address the issue. Our concern focuses on debris management and its impact on response, recovery, resilience, and sustainability.

Results and Discussion

Current management practices in natural disaster debris management have several phases. Much guidance characterizes disaster response as consisting of response and recovery, however Brown, et al (2011), quoting others, categorize these phases as 1) emergency response, 2) recovery, and 3) rebuilding. This approach is useful because it emphasizes that the debris generated by the disaster, in addition to the subsequent debris generated during recovery, requires proper management. They further indicate the position of debris management in each phase as, 1) facilitating preservation of life, providing emergency services, and removing immediate public health and safety hazards such as unstable buildings and debris and rubble interfering with emergency services, among other activities; 2) managing debris as a part of lifeline restoration and building demolition; 3) managing debris generated from and used in re-construction.

During the emergency response phase, the focus, rightfully, is on saving people's lives and moving them to areas of safety. In part, this requires rapid removal of debris, which can include building rubble, uprooted plant material, sediment, wrecked vehicles, and hazardous waste. The focus is on creating space for emergency responders to move about the disaster area and moving building debris to aid in search and rescue operations. Debris is managed only to the extent that it does not block responders. There is no attempt at waste categorization (nor should there be with the exceptions discussed below) but in many cases, the location where the waste is placed does not change subsequently and it becomes a public health problem either attracting vermin or leaching pollutants into the environment.

This approach creates several immediate and longer-term risks. The most immediate risk is the potential for worker exposure to hazardous or infectious waste. The box at right lists some of the hazardous wastes that can be found in homes, farms, and at industrial facilities. Additionally, infectious waste can include wound dressings, laboratory samples or reagents, body parts, and infectious material.

Types of hazardous waste potentially present in disasters

Households & Farms

- Chlorine bleach (other bases)
- Petroleum, oils, and lubricants
- Car batteries
- Asbestos
- Fluorescent lighting
- Ammonium nitrate and other fertilizers
- Pesticides
- Natural gas cannisters

Industrial Facilities

- Organic solvents
- High-strength BOD & COD waste
- Monomers
- PCBs
- Acids & bases
- Mercury & other metals
- Petroleum, oils, and lubricants
- Asbestos
- Pressurized cylinders

Our experience is that local work-for-cash staff who support disaster responses are minimally equipped and trained, as evidenced by the photos below. Both photos are from the covers of two different UN guidance documents on debris management (UNDP, 2016 and UNOCHA, 2013). The one at left shows people working at a rubble pile with no apparent health and safety equipment. The dust is a particular concern since it could potentially contain asbestos. The individuals below at right are equipped with hard hats, gloves, high-visibility vests, and closed shoes, although not work boots. They too lack any form of respiratory or eye protection. In both cases, these workers are subject to immediate risks simply associated with these types of activities but given the lack of respiratory and eye protection, they also could be subjected to risks associated with exposure to dust and organic volatiles (potentially containing asbestos and other carcinogens).

This first phase is rightly focused on saving lives by moving debris and rubble to allow access to trapped people and emergency vehicles. However, those involved in the work are potentially being exposed to significant risks that can have lifelong impacts, especially in the case of inexperienced staff hired specifically to assist with this phase. Also, the placement of hazardous wastes in areas where they can be released into the environment has the potential to have significantly deleterious environmental effects in both the short and long term.

The emergency nature of response activities does not always carry over to the recovery phase, although Brown (2012) indicates that the sense of urgency from the first phase can and often does carry over to this second phase. While this likely contributes to less effective waste management, the real culprits tend to be lack of a pre-disaster plan to manage the waste that comprises critical management areas, including recycling and hazardous waste, lack of budget to implement, and lack of the “enabling conditions” these activities require. Enabling conditions include trained staff to accept and manage waste and implement the recycling, space to establish and operate waste reception and recycling, equipment to handle the waste including trucks, excavators, front-end loaders and similar heavy equipment, equipment to aid in recycling including things such as rock crushers, sorters, and managing the hazardous waste, including overpack drums, impermeable surfaces to store liquid wastes, and ultimately a secure landfill for final disposal of waste that cannot be recycled. On the host nation’s side, there may be inadequate or even no regulations with respect to hazardous waste disposal, poor enforcement of regulations, no interest in slowing the cleanup process, or no interest in funds being spent on waste management rather than cleanup. All these circumstances contribute to the minimal focus on appropriate management of disaster wastes.

This disregard of appropriate disaster waste management also frequently extends to the rebuilding phase. At this point waste management typically is regarded as being complete and now the focus is on rebuilding. However, quite often the rebuilding means continued waste generation as building sites are prepared for new construction. The solid waste generated often is overlooked and simply discarded at the most convenient location. If additional hazardous waste is uncovered, it often is not identified and simply comingled with the solid waste. Thus, workers may be exposed to those immediate associated hazards, and the waste too becomes a source of pollution that could impact the environment including local drinking water supplies.

There are many reasons why disaster waste is not managed with the care it requires including lack of political will, competing priorities, lack of enabling conditions, and, finally, lack of budget. While these are certainly valid issues, the question remains - do these concerns relieve the IDCs of their obligation to protect human health and the environment?

Where does recycling fit in disaster response?

Brown and Milke (2016) evaluated recycling in disasters in Australia (fire), Italy (earthquake), Japan (earthquake and tsunami), New Zealand (earthquake), and the United States (fire and hurricane), and identified seven different variables that impact the ability to effectively recycle disaster waste. They were waste volume, the extent to which waste was mixed, the potential for human and environmental health hazards, the waste’s areal extent, the priority a community puts on recycling, funding mechanisms and their requirements, and local regulatory requirements. Similar variables impact recycling effectiveness in less-developed countries, with the addition of lack of technical equipment (earth movers, backhoes, trucks and recycling equipment) and skilled staff.

Basnayake, Chiemchaisri, and Mowjood (2005) discussing the tsunami of 2004 indicated that recycling in Sri Lanka was relatively slow and very dependent on whether local policies supporting it had been put in place. Note also they indicated asbestos tile (for roofing) was a significant part of the solid waste, presenting problems in handling and sorting. They also report in Thailand, there was little focus on recycling by the government and that while recycling of “re-sellable components” was done and had an impact on deceasing solid waste loads, it was informal. The

UNDP (2016) states that recycling can be effective not only in decreasing landfill rates but also in creating short-term, and potentially longer term, economic opportunity for people impacted by disaster. An unequivocal success story is reported by ehaconnect.org (https://ehaconnect.org/crisis-response-recovery/coordination/). Typhoon Haiyan, which came ashore in Leyte Province, Philippines in 2013, felled hundreds of thousands of coconut trees in addition to destroying thousands of homes. The organizations implementing the response and recovery activities worked with the local farmers to salvage these trees for use in new home construction. This approach resulted in providing jobs and access to local building materials at a time when both were crucial.

Implementing recycling in the context of disaster response and recovery in less-developed countries is difficult for all the reasons discussed in the introduction and earlier in this section. However, when implemented with appropriate attention to human health and safety and environmental impact, it can yield significant benefits. Such benefits include creating a revenue stream for local people impacted by the event, decreasing the need to import basic construction materials such as aggregate, fill, and potentially wood, lessening the need to use landfill space, and creating compost useful in agriculture or in creating new green infrastructure, and if "white goods" such as stoves and refrigerators can be reconditioned, that would significantly lessen landfill space requirements, minimize the loss of refrigerants, and allow those impacted a way to purchase replacement appliance at less than full price.

The potential for negative outcomes

Hazardous materials are a part of everyday life across the world. In the event of a disaster these materials become waste. Homes can contain bleach, refrigerants, natural gas cans, car batteries, inorganic acids, and potentially PCBs in fluorescent light fixtures. Farms contain fertilizers and pesticides and potentially high strength BOD/COD waste. Industrial facilities can contain high strength acids and bases, a wide variety of organic solvents, metal salts, monomers, and other primary and secondary organic chemicals. All three areas can contain larger or smaller quantities of petroleum, oil, and lubricants (POL).

The different risks these wastes present can be immediate or long-term and may impact either human health and/or the environment. For example, should a 1,000-liter high-strength sulfuric acid tank rupture, people cleaning up immediately after could be burned by contacting contaminated sediment or standing pools of acid. The acid also could solubilize other wastes and enhance their ability to disperse into the environment. POLs and other organic chemicals present significant threats to water quality and other environmental variables. High strength BOD/COD wastes (such as those found at sugar centrals and large-scale animal rearing facilities) can have immediate negative impacts on aquatic biota. The photo at left from the aftermath of Typhoon Haiyan shows the extent to which hazardous debris can mix in with other debris. The batteries and gas tanks of the two vehicles are almost certainly empty. Chemicals such as PCB (Carpenter, 1998), which are extremely long-lived and still used in transformers in some less-developed countries, can have significant neurological, developmental, carcinogenic and other human health effects decades after exposure. Similarly, DDT, which still is used in the less-developed world reportedly has recently been shown to increase breast cancer risk in the granddaughters of women exposed to it (Cirillo et al, 2021).

Credit: Satellite image ©2019 Maxar Technologies

Bahamas, Hurricane Dorian, 2019- This Category 5 storm impacted the vast majority of the islands in the Bahamas. UNEP/OCHA (2019) performed the initial assessment of acute environmental risks, identifying… a confirmed inland spill of crude oil … and potential spills at sea from Equinor's oil storage facility on Grand Bahama Island and potential secondary and cascading impacts resulting from damages to the numerous hazardous operation facilities located on Abaco and Grand Bahama Islands. The photo at indicates the extent of the release. A good example of appropriate response managing hazardous waste was highlighted at the Bahamas Power and Light (BPL) power sub-station in Marsh Harbour. UN staff identified a diesel spill into both the sub-station and nearby containment. While BPL had pumping capacity, they had no tankage to manage the waste. Tanks were found and emergency responders, trained in managing hazardous waste were dispatched to address the problem, ahead of an upcoming tropical storm that would have spread the fuel into the environment. An example of less well-thought-out response was the placement of all waste removed during response into the Marsh Harbour landfill. As the town is home to several industrial facilities, this resulted in the comingling of hazardous and solid waste, with yet unknown impact.

Haiti, January 2010 earthquake- This quake was tremendously destructive, destroying 250,000 homes, 30,000 commercial structures, generating an estimated 19 million cubic meters of debris. Across the impacted area. USAID played a central role in overall response, including emergency response. This included supporting the UN Stabilization Mission in Haiti (MINUSTAH) in managing debris removal projects, through the USAID-funded Project Management Coordination Cell (PMCC) that centralized debris management by the humanitarian community, Haiti's government, the participating IDCs, and non-governmental organizations (NGO). According to USAID, the PMCC eventually oversaw 34 removal projects and 28 dumpsites. In addition, World Bank-funded design and operation of a landfill specifically created to manage disaster waste. Unfortunately, a recent visit to the landfill shows that once it was turned over to the government, it ceased to be properly operated, likely in part because of lack of funds and appropriate equipment.

Boxing Day, 2004 Tsunami, Indonesia- The tsunami is estimated to have killed more than 200,000 people in India, Indonesia, the Maldives, Thailand, and Sri Lanka, with Indonesia's Banda Aceh Province being hit particularly hard. Casey (2016) reported that as much as 12.9 million cubic yards of waste was generated, 85 percent of which was estimated to have been transported to the ocean as the waters receded. Working with the Indonesian government, UNDP developed the Tsunami Recovery Waste Management Project (TRWMP) that started in March 2005 and continued through 2012. The box at right identifies some of TRWMP's

Example TRWMP Accomplishments

Component 1-Local government capacity building & land clearance

- More than 1 million meters^3 of tsunami waste cleared in urban areas, recyclable materials rehabilitated 100km of roads, provided 55 hectares of daily cover at landfills and manufactured 12,000 units of wooden furniture.

Component 2-Livelihood rehabilitation and creation

- 72,121 tons of waste recycled between 2005 & 2010 with ~67,000 tons sold successfully in the market.

Component 3-Regional and district landfills

- 11 interim district landfills (26 ha of waste cells) rehabilitated or reconstructed providing safe and controlled waste disposal sites for three to five years, allowing time accomplishments. It also is worth noting that TRWMP paid an average of 1,451 individuals daily in its cash-for-work activity between 2005 and 2008. Basnayake et. al. (2005) report that the responses in both Sri Lanka and Thailand involved much less recycling and in general it seems the responses were not as well supported by the governments.

Conclusion

Lessons learned

There are several lessons we can learn from these brief vignettes. One clear lesson is that there is a lack of a standard approach to managing disaster waste, ranging from ad hoc to highly organized. Another lesson is that organized waste management activities appear to be associated with and initiated by the IDC and that there is guidance available from a host of sources, including (EPA, 2019; UNDP, 2013 & 2016; UNOCHA, 2013; and World Bank, undated). For example, USAID supported implementation of the PMCC in Haiti and the Bank paid for establishing and initially operating an engineered landfill to accept waste. However, without continued national government involvement and support, the landfill has failed. These lessons suggest that, without strong guidance and support from IDC partners, solid waste management will not be a national consideration in disaster planning or implementation.

Another set of lessons revolves around implementing activities such as recycling. While initiating recycling in the response phase is likely counterproductive, it does have its place in the overall disaster management activity. In fact, a properly configured recycling program can have significant benefits including, increased economic support by providing medium-term jobs across the recycling business process (which can last for several years and could lead into full-time employment), reducing the need to import building materials, including aggregate, soil, and potentially finished products such as window frames, structural wood, and even reconditioned white good. If recycling is appropriate and can be well-managed, it provides these benefits and decreases landfill use intensity.

Finally, although not stated, it is implied that without prior planning at the national level and close coordination across all responding partners, managing solid waste will be left to the most expedient and less-costly choices with little regard for human health or environmental impact. While apparently cost-effective in the moment, long-term effects may not be recognized for decades and, when they are, the costs to respond to them may be far greater than any savings.

Solid waste management (SWM) is, often, an afterthought in response, recovery, and even rebuilding post-disaster. The reasons for this include, SWM not being in initial disaster planning, insufficient budget to effectively manage the waste, lack of receiving infrastructure, whether for landfilling of recycling, lack of trained staff, tools, and heavy equipment required, low interest in managing solid waste by the host country government, and finally lack of political will on the part of the IDCs in addressing the short-, medium-, and long-term impacts of poor solid waste management.

While little research has been done on these impacts, they potentially are significant. During response activities untrained individuals lacking even minimal health and safety equipment (boots, gloves, goggles/safety glasses, hard hat, some sort of work-specific clothing, and respiratory protection) are at risk for injury while moving and sorting debris, which could contain toxic and hazardous waste. They could be subjected to crushing injuries, burns from exposure to strong acids or bases, or intoxication resulting from exposures to dusts or organic volatiles. They also could be subjected to potential infection associated with medical waste should they be in an area where that is prevalent. Nitrate fertilizer presents a near term hazard in that its shock sensitivity could cause it to detonate, simply because a sack was dropped, or something fell on a pile. These individuals also may have higher risk for ill health resulting from these exposures even decades, or generations later (Cirillo et. al., 2021).

Other risks to human and environmental health are related to improper management of hazardous wastes. Organic volatiles, POLs, and acid from car batteries (or strong acids or bases from other sources) can easily leach into the drinking water. PCB, while not prevalent any longer, still is used in transformers in in several less-developed countries and when it is present, has the potential to create both environmental and human health problems. Similarly, asbestos is no longer as widely used but still is found in a variety of building products, particularly wallboard, floor, and roof tiles. Pesticides stored at farms that have become waste can have significant negative impact on local ecosystems causing diebacks of fauna. Fertilizers also can have significant impacts causing algal blooms that result in decreased dissolved oxygen levels.

The risks outlined above are real and important not only because of their potential impact on human and environmental health but their associated economic impacts. While almost certainly not of the same scale as the economic impact of the disaster, these economic impacts can drag on the desired “return to normalcy” sought by all who experienced the disaster.

Grasping the nettle of adequately managing disaster debris waste will take political will on the part of both the IDC’s and host country governments. The IDCs, led in part by various UN agencies, already have begun to address disaster waste management with various guidance documents. UNISDR (2015) is charged with implementing the Sendai Framework, which does not include direct reference to waste management but does have language addressing disaster risk governance and “building back better” both of which must include waste management. This leadership is welcome but must go further.

All these steps are just that; they have not been coordinated and there still appears to be little thought given to waste management when national disaster management plans are being developed. To do so will require that host country nations and the IDC acknowledge that poor solid waste management presents risks to human and environmental health and to post-disaster economic growth. Doing so will help to set the agenda for developing business processes for managing solid waste (including hazardous waste) that would include appropriate health and safety training, evaluation of waste for management planning as has been done in the Bahamas (UNEP/OCHA, 2019) and Dominica (UNEP/OCHA, 2017), identifying recycling opportunities, and identifying and operating landfills. For this approach to work long-term, the host country will need to take the ultimate responsibility for managing waste and landfills, which likely will involve identifying budget and potentially drafting, or re-drafting environmental regulations.

Appropriately managing disaster waste has both costs and benefits. Some may argue that including this activity is simply too expensive and unwarranted because of that expense. We argue that the long-term costs associated with improperly managed waste have the potential to impact people, the environment, and post-disaster economic recovery. At a minimum, studies of these impacts in various settings are essential. Meanwhile, the IDC have a duty of care spelled out in their environmental and social policies that they may not be completely meeting.

The Way Forward

While planning for disaster management has been ramping up, particularly over the past decade, it still does not sufficiently acknowledge the need to safely manage the waste generated. This can no longer be left in the “too hard to do pile”. Specific steps can be taken to incorporate adequate safeguards to ensure human safety, minimize environmental impact, and enhance economic opportunity. Planning for debris management must be included explicitly as new plans are developed and older plans revamped. Such planning must provide for:

- Safety of all workers by training in waste management (including hazardous waste), furnishing appropriate safety equipment and supplies, and ensuring operations are performed as directed by safety guidance.
- Assessing potential locations for waste stockpiling, landfilling (both solid and hazardous waste), and recycling.
- Performing early assessment of the potential for:
    - exposure to hazardous (and infectious) waste and
    - Recycling of various materials including, concrete, soil, green materials, iron and other metals, and white goods.
- Establishing coordination and communication processes for solid waste management operations.
- Identifying local firms that can provide equipment and personnel to assist in managing the disaster debris.

Including plans for solid waste management as part of the disaster management planning process is a necessary first step to acknowledging its importance and creating budget space for it to be properly implemented.

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