Waste management: new challenge after the recent earthquake in Nepal

Solid waste management (SWM) is one of the major challenges in the capital city, Kathmandu in Nepal, where more than 1.46 million people reside in an area of 97 sq. km (ref. 1). Kathmandu valley produces about 620 tonnes/day solid waste from its five municipalities. The existing mechanism has already been struggling to manage the solid waste[2]. The solid waste generated from three municipalities – Kathmandu, Lalitpur and Bhaktapur – is being disposed at Sisdol landfill in Nuwakot district (about 25 km north of Kathmandu valley) since 2005 with a capacity of handling 275,000 tonnes of waste. Similarly, lack of proper management and mixing of the sewage system directly into the Bagmati River and its tributaries has turned the river water black, leaving no possibility for aquatic life. The recent earthquake in Nepal (25 April 2015, magnitude 7.8) has added to the challenge of managing waste in the Kathmandu valley, as an estimated 3.9 million tonnes of additional solid waste has been generated from 73,624 destroyed houses in the valley[3]. Finding a place to dispose this extra waste material is proving to be a challenge. Municipal solid waste, earthquake rubble and deteriorated quality of the river system have collectively become a public health hazard in Kathmandu.

Earthquake-generated waste or rubble mainly consists of brick, stone, concrete blocks, tile, cement, concrete, steel bars, wood, steel pipes and tanks, poly vinyl chloride (PVC) pipes and tanks, electrical wires and cables, and broken glass pieces. Recovery of the earthquake rubble should receive high priority for two reasons. First, some of this material can be recovered and reused. The concrete and asphalt can be crushed into suitable size and reused for construction of roads[4]. For example, debris from Bhuj earthquake in India has been utilized to construct school buildings[5]. Second, the potential health hazard associated with the handling and management of such material is very high. The debris may also contain dead bodies, animal carcasses and other hazardous materials such as pesticides, asbestos, chemicals, acids, etc. that would require careful handling, treatment and immediate disposal. Use of personal protective equipment such as masks, gloves, hard hat, steel-capped shoe, etc. is, therefore, essential to reduce the chances of injury while dealing with the debris. Appropriate machinery should be used while demolishing the houses to reduce the risk of workers and public injury. The potential spread of different diseases due to the dead bodies and body parts should also be kept in mind. People working in this area should be vaccinated for tetanus[6] and hepatitis A and B.

The earthquake debris is now being piled up by the Nepal Government in different open spaces such as bank of rivers and holes formed following sand quarrying activities in the Kathmandu valley. However, there is insufficient space to manage all the debris by such means. If the debris is not properly managed, some of the stockpiled material may be washed away during rainfall and end up blocking storm water and sewage collection systems. This will further increase the potential health hazard. At present, it is not possible to send the earthquake debris with the municipal waste at Sisdol landfill as its capacity is almost full. The new proposed landfill at Bancharedada in Nuwakot district (about 28 km north of Kathmandu valley) will take more than 5 years to be completed and be ready for use. Regular operations at the Sisdol landfill are obstructed either by the strikes or protests organized by political parties or by the people living near the landfill. Landfill gas and leachate produced from the municipal waste are major by-products of waste breakdown and the main reasons for public protest. While these are inevitable by-products of the landfilling activities, proper management of these by-products is important for the successful operation of the landfill. The development of the new landfill should consider the issue of odour, gas and leachate management in its design and should ensure that the public health concerns are addressed. Landfill design, therefore, should also take into consideration local geology (presence/absence of geological fault) and take steps to prevent possible damage and consequent leakage during future earthquakes.

There is, therefore, an urgent need for recognition of earthquake-generated waste management and disposal issues in urban regions that are vulnerable to earthquakes such as the Kathmandu valley. Sites for sorting and disposal of earthquake debris must be identified in these regions and a waste disposal plan must be put in place by urban planners and administrators. This is essential to reduce the environmental impact and public health issues that follow major earthquakes. Whenever feasible, some material can also be recovered for reuse. The best solution, however, is to make buildings that follow appropriate codes and can withstand large earthquakes. Following appropriate building codes during construction will reduce the chances of building collapse during an earthquake and, consequently, the earthquake-related debris generation and loss of life. Regardless, the management of earthquake-related waste is always a public health issue that cannot be ignored.

1. Central Bureau of Statistics, National Population and Housing Census 2011, National Report, Government of Nepal, National Planning Commission Secretariat, Central Bureau of Statistics, Kathmandu, Nepal, 2011.
2. Central Bureau of Statistics, Environment Statistics of Nepal, Central Bureau of Statistics, Kathmandu, Nepal, 2013.
3. Government of Nepal, Incident report of earthquake 2015, Nepal Disaster Risk Reduction Portal, Kathmandu, Nepal, 2015; http://drrportal.gov.np/incidentreport/ (accessed on 10 June 2015).
4. Karunasena, G., In *Post-Disaster Reconstruction of the Built Environment: Rebuilding for Resilience* (eds Amaratunga, D. and Haigh, R.), Blackwell Publishing Ltd, West Sussex, UK, 2011, pp. 251–267.
5. Gupta, S. and Khandelwal, R., *J. Civ. Eng. Environ. Technol.*, 2015, **2**(1), 100–104.
6. Rouse, J. and Reed, B., Solid waste management in emergencies, technical notes on drinking water, sanitation and hygiene in emergencies (ed. Reed, B.), World Health Organization, Switzerland, Geneva, 2011.

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