



# University of HUDDERSFIELD

## University of Huddersfield Repository

Karunasena, Gayani and Amaratunga, Dilanthi

Capacity gaps in post disaster construction & demolition waste management

### Original Citation

Karunasena, Gayani and Amaratunga, Dilanthi (2015) Capacity gaps in post disaster construction & demolition waste management. *Engineering, Construction and Architectural Management*, 22 (4). pp. 446-466. ISSN 0969-9988

This version is available at <http://eprints.hud.ac.uk/27109/>

The University Repository is a digital collection of the research output of the University, available on Open Access. Copyright and Moral Rights for the items on this site are retained by the individual author and/or other copyright owners. Users may access full items free of charge; copies of full text items generally can be reproduced, displayed or performed and given to third parties in any format or medium for personal research or study, educational or not-for-profit purposes without prior permission or charge, provided:

- The authors, title and full bibliographic details is credited in any copy;
- A hyperlink and/or URL is included for the original metadata page; and
- The content is not changed in any way.

For more information, including our policy and submission procedure, please contact the Repository Team at: [E.mailbox@hud.ac.uk](mailto:E.mailbox@hud.ac.uk).

<http://eprints.hud.ac.uk/>

# Capacity Gaps in Post Disaster Construction & Demolition Waste Management

## Abstract

**Purpose** –This paper focuses on the identification of the existing capacities of post disaster C&D waste management in developing countries, with a special emphasis on Sri Lanka to determine the capacity gaps and related influencing factors.

**Design/methodology/approach** –Multiple case studies and expert interviews were conducted to gather primary information on the existing capacities of disaster C&D waste management. Three case studies, including fifteen individuals and six experts representing government, non-government institutions and others, were selected.

**Findings** –The results revealed the existing capacities, capacity gaps and influencing factors for post disaster C&D waste management in the areas of skills and confidence building, links and collaborations, continuity and sustainability, research and development, communication and coordination, organisational implementation and investment in infrastructure.

**Research limitations/implications** – This study limited disaster C&D waste to debris generated from totally or partially damaged buildings and infrastructure as a direct impact of natural disasters or from demolished buildings and infrastructure at rehabilitation or at early recovery stages.

**Originality/value** – The research enabled an analysis of existing capacities and identified capacity gaps in post disaster C&D waste management with influencing factors developing countries.

**Key Words** - Disaster waste, C&D, Capacity Gaps, Influencing Factors, Developing countries

**Paper Type** - Research paper

## 1. Introduction

Disasters, with devastating impacts in terms of physical damage, create enormous amounts of demolition waste through the destruction of buildings and infrastructure, and this is considered to be a grave consequence of disasters (USEPA, 1995; 2008; FEMA, 2007). Shibata *et al* (2012) highlighted that the Great East Japan earthquake and tsunami, which occurred in 2011, had an estimated generated waste in the Fukushima prefecture of 16 billion kilograms which is equivalent to 14 years of waste generation. The Haiti earthquake in 2010, hurricane Katrina in 2005, and the Indian Ocean tsunami in 2004 are some examples of single events that generated large volumes of waste overwhelming existing solid waste management capacities and requiring special approaches (Basnayake *et al*, 2005; Luther, 2008; Brown *et al*, 2010b). Brown *et al* (2011b) stated that disaster debris impacts not only on the public and on the environment but also on rescue and emergency services, on the provision of lifeline support and on the socio-economic recovery of affected areas (Brown and Milke, 2009; Brown *et al*, 2010a). Thus, the management of waste created by disasters has become an increasingly important issue to be addressed in responding to a disaster (Thummarukudy, 2012).

Comment [G1]: R1 - 1

According to Pilapitiya *et al* (2006), waste management and disposal is a significant weakness which has been noted internationally when responding to disasters. Risks to the public and the environment, by prolonged exposure to disaster waste after the Indian Ocean tsunami in 2004, was highlighted by Srinivas and Nakagawa (2008) such as the contamination of soil and water (affecting the soil fertility of agricultural lands and water bodies) by damaged septic tanks and toilets. Failures in disaster waste management after hurricane Katrina continued to impact on the environmental health of citizens even after three years (GAO, 2008). Brown *et al* (2011a) revealed a number of gaps in existing legislation, organisational structures and funding mechanisms relating to disaster waste management. Thus, there emerges the crucial importance of designing early stage strategies for disaster waste management with predefined disaster waste management procedures and adequate capacities (Baycan and Petersen, 2002; Basnayake *et al*, 2005; UNDP, 2006; Ekici, 2009; Moe, 2010; Brown *et al*, 2011a). These strategies should be anchored to national disaster waste management policies along with flexibility for further development to ensure continuity and sustainability (Baycan and Petersen, 2002; Joint UNEP/OCHA, 2010).

Comment [G2]: R1 - 2

This is equally applicable in Sri Lanka which was heavily impacted upon by the Indian Ocean Tsunami of 2004 and the three decades of civil war, revealing various management

issues in disaster waste management. Basnayake *et al* (2005) stated that an approximate cost of 5-6 million US dollars was incurred in the management of debris in Sri Lanka, where waste was not properly disposed of, reused or managed (UNEP, 2005). In this context, this study explores the existing capacities of post disaster C&D waste management in Sri Lanka. Accordingly, this paper focuses on the capacities of dealing with post disaster waste in general, on the justification for the selection of the Sri Lankan context and on existing capacities, capacity gaps and factors influencing capacity building in particular.

## **2. Capacities of Post Disaster Waste Management**

### *2.1. Concept of Capacity Building/Development*

Capacity building is an essential component in the development of theory and practice, especially among various global, international and national organisations such as the World Bank, international donor agencies and civil societies (Pieterse and Donk, 2002).

LaFord *et al* (2002) considered capacity building as an indefinable concept. During the 1990s, capacity building focussed on issues relating to management and administration (Grindle and Hilderbrand, 1995). It was termed as a *capabilities approach* providing opportunities to improve people's quality of life through access to a wide range of capabilities (Sen, 1981) and as *capacitation*, an effort to measure and promote relief and development programmes by donors (Wolfe, 1996). Morgan (1998) said it was a *risky, murky, messy business, with unpredictable and unquantifiable outcomes, uncertain methodologies, contested objectives, many unintended consequences, little credit to its champions and long time lags*. UNESCO (2006) defines capacity building as *a process by which individuals, groups, organisations, institutions and societies increase their ability to perform (a) core functions, solve problems, define and achieve objectives and (b) understand and deal with development needs in a broad context and in a sustainable manner*, adding that the focus of capacity building has changed from individual training to the integration of individual capacities to institutions and systems. Ginige *et al*, (2010) and Ginige and Amaratunga, (2011) indicated that capacity exists in different forms such as skills, knowledge, technology and resources.

### *2.2. Capacity Needs for Post Disaster Waste Management*

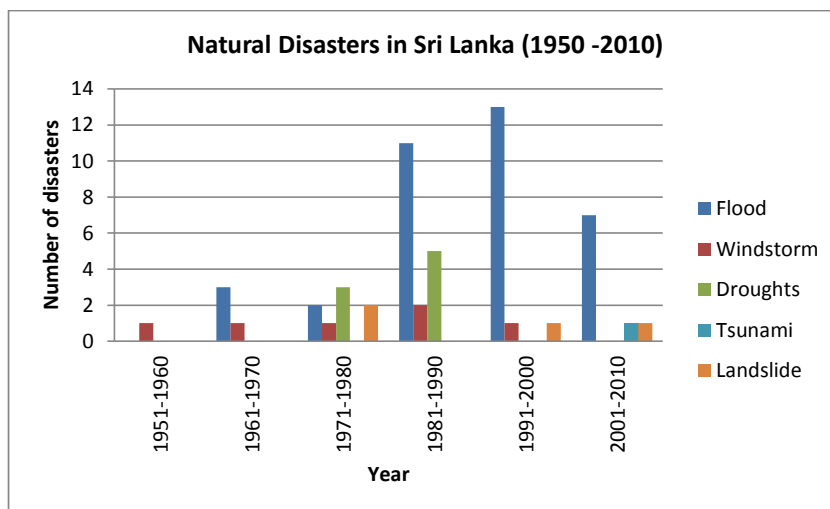
Recent decades have placed more focus on capacity building to increase resilience to natural hazards due to associated economic, social and environmental challenges. Capacity building dominates disaster management policies and practices in developing countries which are

more vulnerable to disasters, particularly to the impacts of climate change due to poverty, weak governance and ecosystem degradation (Webb and Rogers, 2003). Coping with disasters and enhancing the capabilities of communities are priority targets for vulnerable countries (Ozden, 2007). Hartwig *et al* (2008) identified it as a key concept facilitating sustainability in developing countries. Boyd and Juhola (2009) explained that it provides an opportunity to understand the strengths, weaknesses, threats and opportunities when planning towards a resilient future through the identification of broader issues around the sustainable development of a particular programme, project or process, including unique cultural, social and ecological characteristics. Capacity building is necessary due to a lack of financial, institutional and technological capacities and access to knowledge to deal with risks and benefits (Ayele and Wield, 2005).

According to Brown *et al* (2011a) the sustainability of disaster waste management systems depends not only on required technologies or guides but also on the development of institutional and human capacities that enhances preparedness and responses to future disasters. Institutional capacities need to be built to prevent, prepare and respond to disasters, enhancing the resilience of disaster-affected communities (Baycan and Petersen 2002; Tadele and Siambabala, 2009). Intervention by communities can be more successful than institutional intervention (leading to genuinely positive impacts on human well-being), building on local knowledge and existing capacities (Allen, 2006). Many researchers have highlighted that the capacity building of local level government, particularly in developing countries, is also essential (Peterson, 2004; UNDP, 2006; Bjerregaard, 2007). Additionally, Milke (2011) pointed out the important processes of capacity building such as the development of educational modules for processing, the storage and disposal of post disaster waste and the development of a free database and information source for disaster waste management.

### **3. Study Background and Post Disaster Waste Management**

Sri Lanka is prone to natural disasters such as floods, windstorms, landslides and droughts as illustrated in Figure 1 (DMC, 2005b; Karunasena *et al*, 2009).



**Figure 1: Natural disasters in Sri Lanka from 1950 to 2010**

A cyclone in 1978, floods and landslides in 2003 and the tsunami in 2004 were major disasters that caused immense damage, interrupting the economic and social activities of affected areas (DMC, 2005a). [Table 1 provides the number of natural disasters and people reported as affected and killed by such major natural disasters for the period from 1950 to 2010.](#) In addition, various human-induced hazards are caused by deforestation, indiscriminate coral, sand and gem mining and industrial pollutants (DMC, 2005b). Three decades of ethnic war has also caused huge economic and human impacts. The Indian Ocean tsunami in 2004 is widely acknowledged as the largest, most devastating natural catastrophe reported in the history of Sri Lanka.

**Comment [G3]:** RI - 3

**Table 1: Impacts of natural disasters in Sri Lanka from 1950-2010**

Period	Number of disasters reported	Number of people reported as killed	Number of people reported as affected	Damage US\$ ('000s)
1951-1960	Windstorm -1	200	250,000	
1961-1970	Flood -3	109	380,000	16,500
	Windstorm -1	206	1,822,347	37,300
1971-1980	Flood - 2	10	728	
	Windstorm -1	740	1,005,000	100,000
	Drought - 3	0	2,500,000	
	Landslide - 2	54	2000	
1981-1990	Flood - 11	638	3,550,000	38,000
	Windstorm -2	37	394,400	
	Drought - 3	0	4,200,00	
1991-2000	Flood - 13	64	3,095,736	283,010
	Windstorm -1	5	375,000	
	Landslide - 1	65	130	
2001-2010	Flood - 7	235	695,000	29,000
	Landslide - 1	218	22,328	1,520
	Tsunami - 1	35,399	1,019,306	1,316,500

Source: Asian Disaster Reduction Centre; Disaster Management Centre(Sri Lanka)

Accordingly, over the decades, the number of disasters reported has increased and floods, droughts and landslides are frequent natural disasters. Mostly, frequent natural disasters are managed by local government authorities, except in the case of critical disasters. Subsequent to the Indian Ocean tsunami in 2004, recognising the magnitude and urgency of the disaster situation, Sri Lanka established three task forces: the Task Force for Rescue and Relief (TAFRER), the Task Force for Law and Order and Logistics (TAFLOL) and the Task Force for Rebuilding the Nation (TAFREN), to provide effective co-ordination (TAFREN, 2005a; TAFREN, 2005b; Jayewardene, 2006). The National Council for Disaster Management (NCDM) was established under the Disaster Management Act No. 13 of 2005, and is a high-level inter-ministerial body that provides direction to the disaster risk management work in the country (DMC, 2005a; 2005b; 2006a, 2006b; Jayawardane, 2006; Karunasena *et al*, 2009; Karunasena *et al*, 2012). The Disaster Management Centre (DMC) within the Ministry of Disaster Management and NCDM is the lead agency implementing activities relating to all phases of Disaster Risk Management (DRM) in the country. Its activities are carried out in coordination with relevant stakeholder ministries, national and provincial level government and private entities, civil society, non-government organisations, and community based organisations and communities.

The literature has revealed that within the disaster waste removal programmes implemented in Sri Lanka due to the occurrence of the Indian Ocean tsunami in 2004 many failures occurred due to the non-existence of pre-planned disaster waste management strategies and enforceable or mandatory rules and regulations (Basnayake *et al*, 2005; UNEP, 2005). A review of national policies on disaster management (refer to the Sri Lanka Disaster Management Act, no 13 of 2005) and waste management (refer to the National Environmental Act, no 47 of 1981) disclosed that no specific provisions on disaster waste management exist. The findings revealed that one of the key reasons is the lack of priority given by responsible authorities to this area and that there is a lack of awareness of the damage caused by disaster waste. Peace time C&D waste is classified as solid waste in Sri Lanka as no regulations specifically dealing with C&D waste exist. Rules and regulations relating to peace time solid waste management processes are imposed on the management of disaster C&D waste (National Environment Act, 1981; National Environment (Amendment) Act, 1988). The National Disaster Management Plan and the National Emergency Operation Plan are expected to be implemented in the future, but these contain inadequate provision for disaster waste management. Though, these plans provide a clear explanation of the roles and responsibilities that need to be focused upon by the relevant authorities during disaster

Comment [G4]: RI-4

management, none of this focus is relevant to disaster waste. Thus, it is pertinent that Sri Lanka, as a country, prepares sustainable post disaster waste management strategies. Brown *et al* (2011a) revealed that most developing countries do not have plans prepared in advance for disaster waste management.

As with most other developing countries, Sri Lanka disposed of its disaster waste during the post Indian Ocean tsunami with the assistance of international aid organisations and UN agencies (Perterson, 2004; UNDP, 2006; Brown *et al*, 2011a). Evidence of large scale processing of disaster waste in Sri Lanka is non-existent as most of the waste is disposed of by land fill (Basnayakeet *al*, 2005). Disaster C&D waste generated after the Indian Ocean tsunami in 2004 at Telwatte (Hikkaduwa) was used to fill coral mined pits and lands with the CEA's permission (Basnayakeet *al*, 2005). The only recycling plant for construction waste, established in Galle, for processing post tsunami construction waste was subjected to operational delays and the transportation costs of moving waste for recycling, ~~and this~~ was costly, significantly reducing the benefits of recycling (COWAM, 2008; Raufdeen, 2009).

Karunasenaet *al*, (2012) revealed that the lack of a sound legal framework, finance and technology constraints, community unawareness, a lack of human resources and physical assets, and the inadequate capacities of responsible authorities, all emerge as key challenges within post disaster C&D waste management in Sri Lanka. When the lack of financial, institutional and technological capacities and access to knowledge to deal with risks and benefits emerge as constraints, this explains why the concept of capacity building is of such?specific importance in order to address such issues (Ayele and Wield, 2005). The National Disaster Management Committee of Sri Lanka is of the opinion that the capacities of Sri Lankan entities are inadequate for the implementation of a successful disaster waste management programme (DMC, 2009a). The importance of capacity building, in respect of natural disasters, to mitigate the damage caused by improper co-ordination and the immature processes of related organisations and communities through the enhancement of the capacities of local government authorities, is thus established (Keraminiyageet *al*, 2008; Baycan and Petersen, 2002; Hettiarachchi, 2007, UNEP, 2005; Brown *et al*, 2011a). In this context, the literature establishes the need for capacity building for post disaster waste management in Sri Lanka in seven areas: skills and confidence building, organisational implementation, linkages and collaborations, continuity and sustainability, investment in infrastructure, research and development, and communication and coordination (Karunasenaet *al*, 2010). Thus, the next section presents the methodology adopted to explore the existing capacities of the above mentioned areas of post disaster C&D waste

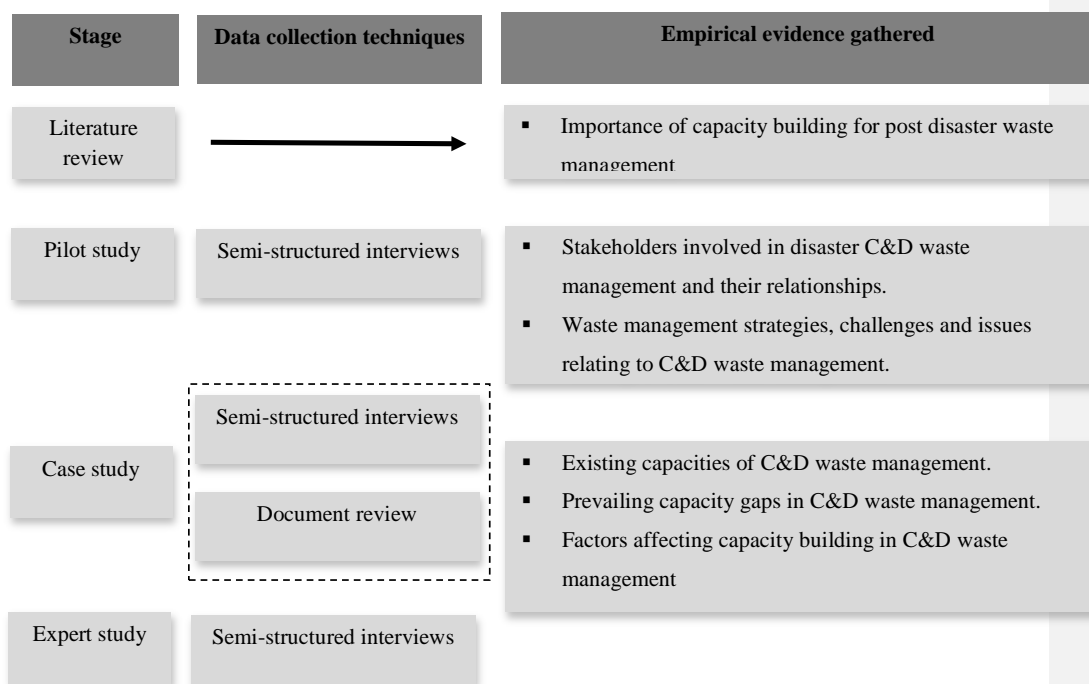
Comment [G5]: RI-5



management in order to identify the capacity gaps and the influencing factors that need to be addressed for sustainable post disaster waste management.

#### 4. Research Methodology

The research methodology was designed in four phases to achieve the objectives of this research study, as illustrated in Figure 2.



**Figure 2: The research methodology adopted**

The first phase was a literature review. This was conducted on capacity building and disaster waste management, both globally and in the Sri Lankan context specifically. The purpose of this was to establish the importance of capacity building in post disaster C&D waste management.

The second phase mainly focused on preliminary investigations of the current status of post disaster C&D waste management in Sri Lanka. Pilot interviews were conducted due to the inadequacy of information revealed by the literature review on post disaster C&D waste management processes in Sri Lanka. Most of the literature revealed information on the improper management of disaster waste in terms of the challenges and issues during the Indian Ocean tsunami in 2004. There is a significant gap in information on existing practices on post disaster waste management specific to C&D waste. Thus, five semi-structured

interviews were conducted covering both national and local level entities involved in either disaster management or peace time solid waste management. Based on the above findings (refer to Karunasena *et al*, 2012) an in-depth investigation was carried out to explore the existing capacities of post disaster waste management.

Thus, as illustrated in Figure 2, the third phase involved data collection on the existing capacities, capacity gaps and the influencing factors of post disaster C&D waste management. A case study approach was selected as the most appropriate method to proceed with the data collection under qualitative phenomena, as it focused on contemporary events and did not require the control of a behavioural event. Three cases were selected under the multiple case study design and capacity gaps were selected as the unit of analysis. The case studies were selected to represent key stakeholders involved in post disaster C&D waste management: government, nongovernment institutions, and other sectors, as shown in Table 2.

**Table 2: Profile of the case interviews**

Cases	Type	No of interviews	Entity	Designation
Case A	Government	07	Disaster Management Centre (DMC)	Director-Mitigation & Technology
			Ministry of Environment and Natural Resources (MENR)	Assistant Environment Manager
			Ministry of Resettlements and Disaster Relief Services	Development Assistant - Disaster Management
			Central Environmental Authority (CEA)	Assistant Director – Waste Management
			Coast Conservation Department (CCD)	Senior Engineer – Research & Design
			Marine Pollution Prevention Authority (MPPA)	Assistant Manager - Operations
			Ministry of Nation Building and Infrastructure Development	Additional Secretary- Planning & Development
Case B	Non government	04	Sarvodaya Shramadana Movement	Manager-Community Disaster Management Centre
			Asian Disaster Preparedness Center (ADPC)	Programme Coordinator
			International Union for Conservation of Nature (IUCN)	Programme Coordinator
			Practical Action	Project Manager – Disaster Risk Reduction
Case C	Others	04	United Nations' Development Programme (UNDP)	National Programme Officer
			International Federation of Red Cross and Red Crescent Societies (ICRC)	Disaster Management Coordinator - ICRC
				National Coordinator – Sri Lanka Red Cross Construction Delegate - ICRC

According to Yin (2009), the interview is one of the most important sources of case study information, where it utilises guided conversations rather than structured queries. Furthermore, semi-structured interviews are used to allow the expressing of opinions in an openly designed interview situation rather than in a standardised interview or a questionnaire (Flick, 2006). Thus, semi-structured interviews allow sufficient flexibility to approach different respondents, covering the same areas of data collection, while enabling an adaptation of the questions, to clarify doubts and ensure that the response is properly understood by repeating and rephrasing the questions (Noor, 2008). Accordingly, fifteen semi-structured interviews were conducted (refer to Table 24) within the case studies including professionals experienced in post disaster waste management, representing the entities of government, non-government institutions, and other sectors at national level and these interviews were utilised as the unit of data collection. In addition, documentary reviews were conducted for this study to further clarify the data gathered through the semi-structured interviews at the case study stage. Details of previously conducted programmes and projects were specifically gathered through documents such as annual reports, yearly progress reports, etc. The fourth phase involved interviews with six experts which were conducted in order to further verify the gathered information through the case studies.

The cross-case analysis technique was used as a suitable data analysis technique as the research contained three case studies. Code-based content analysis and cognitive mapping techniques were used to analyse each individual case, based on the seven themes of skills and confidence building, organisational implementation, linkages and collaborations, continuity and sustainability, investment in infrastructure, research and development, and communication and coordination. Content analysis is a method of analysis of large sets of data in the simplest way as it produces a uniform schema of categories which facilitates the comparison of the different cases to which it is applied. NVivo (Version 7) was used to assist the data analysis process as it facilitates both content analysis and cognitive mapping.

## **5. Research Findings**

The research findings are discussed under three sub headings, as follows.

### *5.1. Existing Capacities of Post Disaster C&D Waste Management*

The existing capacities identified in post disaster waste management are summarised in Table 3.

**Table 3: Existing capacities of post disaster C&D waste management**

Area	Existing capacities
Skills and confidence building	Types and levels at which programmes/ projects conducted
	<ul style="list-style-type: none"> <li>Many training programmes focus on technical skill development at local level</li> <li>One project initiated to manage C&amp;D waste generated from disasters (COWAM)</li> </ul>
	Policies and position statements
	<ul style="list-style-type: none"> <li>Recruitment/ promotions based on government rules and regulations in government sector and on agency policies in others sector</li> </ul>
	Programmes/ projects evaluation
Organisational implementation	<ul style="list-style-type: none"> <li>Monitoring and evaluation mainly through observations and incidents apart from progress review meetings, committees and competitions</li> </ul>
	Roles, responsibilities and contributions
	<ul style="list-style-type: none"> <li>Most entities play proactive roles in disaster waste management</li> <li>Local authorities responsible for management of peace time solid waste /disaster waste</li> <li>Solid Waste Management Support Units established to enhance capacities at national level</li> </ul>
	Policies, rules and regulations
Linkages and collaborations	<ul style="list-style-type: none"> <li>Guidelines for post disaster debris management developed after the Indian Ocean Tsunami</li> </ul>
	Strategies adopted
	<ul style="list-style-type: none"> <li>All entities have linkages with DMC in addition to other state organisations</li> <li>Other linkages visible with non-government organisations for funds and technology and with training institutions and universities to share knowledge and develop programmes</li> <li>International linkages to obtain technical assistance and expert knowledge</li> </ul>
Continuity and sustainability	Strategies adopted
	<ul style="list-style-type: none"> <li>Coordinating committees established under DMC</li> <li>Special unit on sustainability named “Haritha Lanka” established</li> <li>Collaboration with DMC and other state organizations for projects</li> <li>New concepts and long term projects introduced for municipal solid waste management</li> </ul>
	Strategies adopted
	<ul style="list-style-type: none"> <li>All government entities gain funds from the Government Treasury except certain institutions.</li> <li>Additional procurement made through donor funds, competitive bidding, training programmes, collaborative projects and global network support</li> <li>At local level funds obtained from government projects, loans and Provincial and Local authorities</li> </ul>
Investments in infrastructure	Strategies adopted
	Strategies adopted
	<ul style="list-style-type: none"> <li>More opportunities for innovative and collaborative research programmes</li> <li>Priority for short term research programmes/ scholarships</li> <li>Research symposiums conducted to share/ disseminate research findings</li> </ul>
	Strategies adopted
Research and development	Strategies adopted
	<ul style="list-style-type: none"> <li>All entities co-ordinate mainly through DMC</li> <li>Formal approaches for communication and coordination during emergencies established</li> </ul>
	Policies for transparency and accountability
	<ul style="list-style-type: none"> <li>Monitoring mechanism - results based disaster management systems, actions and impact matrices</li> </ul>
Communication and coordination	Strategies adopted
	Strategies adopted
	Strategies adopted

Although this research discusses disaster waste management, on certain occasions it is hard to distinguish [practices on disaster](#) waste management from disaster management and even harder to distinguish disaster C&D waste. Thus, the researcher presents the analysis in a [general disaster waste management](#) context and, where possible, with specific reference to disaster C&D waste.

Comment [G6]: RI-7

▪ *Skills and confidence building*

Skills and confidence building focus on training and educating human resources to improve the ability to perform functions. Different types and levels at which capacity building programmes are conducted, approaches for capacity building at different levels, policies and position statements to support career progression, recruitment and retention, and programme monitoring and evaluation measures at individual and project level, were identified.

The findings revealed that most training programmes focus on the technical skill development of dealing with waste management at local level with limited soft skills' development and specific thematic areas [such as hazard mapping and running special models](#).

Comment [G7]: RI-8/RI-9

Programmes on livelihood development, vulnerability and risk reduction, adaptation and community strengthening, and awareness programmes for pre-school and school children on good practice waste management practices are conducted at community level. The experts revealed few other programmes on the capacity enhancement of employees at provincial and national levels. Other sector entities mostly provide support through hard cash, resources and equipment at all levels. Monitoring and evaluation is conducted mainly through observations of incidents, in addition to joint evaluations, progress review reports, competitions, beneficiary and financial evaluations using statistical and non-statistical measures. The only reported Construction Waste Management (COWAM) project was initiated after the Indian Ocean tsunami in 2004 in Sri Lanka for training and providing assistance to provincial councils and local authorities on sustainable C&D waste management (Raufdeen, 2009; COWAM, 2008). Recruitment and promotions are based on general government rules and regulations in the government sector and agency policies in other sectors. Thus, it tends to lower the interest among professionals to get involved with governmental disaster management activities due to [the high risk involved and](#) the fact that there are fewer incentives such as the unavailability of pension schemes/life insurance policies [as much recruitment is contract based](#).

Comment [G8]: RI-10

▪ *Organisational implementation*

This section presents an analysis of the existing capacities of national level entities in organisational implementation, exploring how organisational structures and processes improve disaster C&D waste management. It addresses roles and responsibilities, contributions to disaster waste management, policies, rules, regulations and strategies for post disaster waste management.

The findings revealed that most entities play a proactive role in disaster waste management. Local authorities are responsible for the management of peace time solid waste including disaster waste. As noted, “*peace time C&D debris is also categorised as municipal solid waste and the task of handling it has been given to relevant local governments.*” At national level only the implementation of environmental laws is executed with the power to take legal action in cases of violations. However, various small scale projects on the reuse and recycling of waste and training have been developed with funds in order to enhance capacity building in disaster waste management, although the only recycling plant established for C&D waste is at Galle. In addition, Solid Waste Management Support Units have been established to enhance capacities at national level and C&D waste processing units at local level. Guidelines for post disaster debris management and enforceable rules and regulations for peace time solid waste management in the Western province were developed after the 2004 Indian Ocean tsunami.

▪ *Linkages and collaborations*

Linkages and collaborations focus on partnerships as a means of building capacities by exchanging skills, practical knowledge and resources. It involves identifying the types and levels at which linkages and collaborations are built, the procedure of building partnerships and factors influencing the building of partnerships in post disaster waste management [as illustrated in Figure 3](#).

The findings revealed that all entities have main linkages with the DMC in Sri Lanka. In addition, linkages with other state organisations exist to support capacity building. Government entities specifically have linkages with line ministries and departments to share information. Linkages with training institutes and universities to share knowledge and develop programmes and with non-government and other sector entities to obtain funds and technology are visible. International linkages exist to obtain technical assistance and expert knowledge. Most of these linkages are project based and short term, except for a few long term partnerships with international networks such as the UN and the IFRC, established within the policies of each entity.

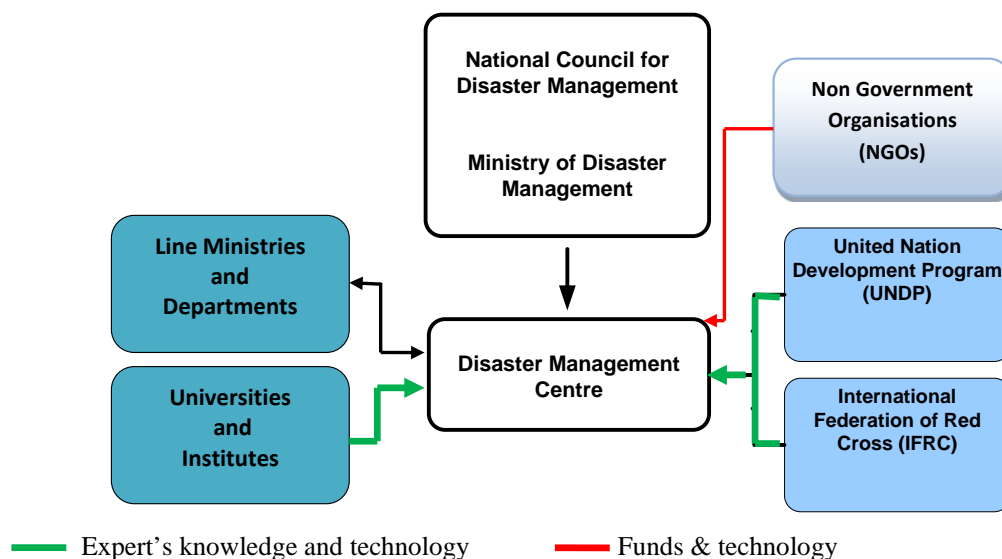


Figure 3: Linkages and collaborations among different stakeholders

▪ *Continuity and sustainability*

Continuity and sustainability focus on how to maintain acquired skills and knowledge and how to continue to implement programmes and projects for the benefit of future generations. Coordination committees are established under the DMC and are given required information to coordinate the programmes. Additionally, a special unit on sustainable issues called “*Haritha Lanka*” has been established by MENR. Non-governmental and other sector entities collaborate with the DMC and other state entities when conducting programmes to ensure continuity and sustainability. The experts revealed that regional centres with libraries, training centres, conference halls and accommodation have been built to facilitate the long term retention of acquired skills. Long term projects such as “*Pilisaru*”, support units such as the “Solid Waste Management Support Unit” and new concepts such as zoning and the ‘seven steps programme’ have been implemented at national level to support local authorities in dealing with peace time solid waste management in the long term.

▪ *Investment in infrastructure*

This section presents an analysis of the existing capacities in investment in infrastructure at national level. It focuses on avenues for investment in infrastructure to enable the smooth and effective management of disaster waste, such as recycling plants and dumping sites.

The findings revealed that all government entities obtain funds from the Government Treasury. Certain institutions independently earn money through the issue of licences, permits and taxes in addition to Treasury funds. Further procurements are made through donors, competitive bidding, training programmes and collaborative projects by entities in all sectors. Non-governmental and other sector entities additionally obtain funds from global networks. Special committees to identify funding avenues, specifically at non-governmental entity level have been established. Investments are further facilitated through loans, provincial councils, local authorities and government projects such as “*Pilisaru*” to undertake peace time solid waste management at local levels (Fernando, 2011).

Comment [G9]: RI-6

▪ *Research and development*

Research and development focus on developing research capacity at personal and entity levels, and at national level.

The findings revealed many opportunities, especially in the short term, for innovative and collaborative research programmes. However, long term and continuous research projects are also visible, such as flood hazard mapping. Resource centres with updated details have been established and research symposiums are conducted to share and disseminate research findings among interested parties. The experts revealed that certain entities, such as non-governmental and other sector entities, provide grants for foreign training programmes.

▪ *Communication and coordination*

This section analyses aspects of communication and coordination in post disaster waste management at national level.

The findings revealed that formal communication and coordination in emergency situations occur through the DMC with which all entities coordinate. Few entities have appointed responsible persons or committees with predefined procedures for communication and coordination. Resources delivering new technology are also provided through the “*Sahana*” disaster management system (Perera, 2008). Monitoring mechanisms such as result based disaster management systems and actions and impact matrices have been established to maintain transparency and accountability. Progress reviews conducted through meetings and responsible persons or committees with predefined roles are also used to ensure transparency and accountability.



The next section presents the capacity gaps and the factors which influence the capacity building of post disaster C&D waste management, as identified through the exploration of existing capacities.

### *5.2. Capacity Gaps and Factors influencing Capacity Building for Post Disaster C&D Waste Management*

The capacity gaps and the factors which influence post disaster C&D waste management are summarised in Table 4. Limitations (already mentioned in previous sections) are also applicable here.

Comment [G10]: RI-12

**Table 4: Capacity gaps and the factors which influence post disaster C&D waste management**

Capacity gaps	Influencing Factors	
	External	Internal
<b>Skills and confidence building</b> <ul style="list-style-type: none"> <li>Fewer opportunities for personal development – training/workshops</li> <li>Unavailability of formal procedures for the preparation, conducting, monitoring and evaluation of training and awareness programmes</li> <li>Unavailability of strategies to retain valuable human resources</li> </ul>	<ul style="list-style-type: none"> <li>Repetition/duplication of programmes and committees</li> <li>Lack of capacities of participants</li> <li>Lower number of participants with high female representation</li> <li>Language barriers</li> <li>Non-functioning of important and necessary committees</li> </ul>	<ul style="list-style-type: none"> <li>Lack of in-house trainers</li> <li>Inadequate resources - human and physical</li> <li>Lack of awareness among national level officers</li> <li>Inappropriate assignment of ministerial functions</li> <li>Traditional bureaucratic red tape</li> <li>Unavailability of pension schemes / life insurance policies for staff</li> </ul>
<b>Organisational implementation</b> <ul style="list-style-type: none"> <li>Unavailability of provision for disaster waste management in existing policies</li> <li>Unavailability of single point responsibility at national level for post disaster waste management</li> <li>Inefficiency and ineffectiveness of prevailing peace time solid waste management practices, policies and responsible authorities</li> <li>Non-revision of existing waste management systems/procedures</li> </ul>	<ul style="list-style-type: none"> <li>Unenforceability of prevailing rules and regulations</li> <li>Scarcity of land</li> <li>Deviation at administrative and local government structures</li> <li>Unavailability of a uniform system to manage solid waste</li> <li>Non-functioning of important and necessary committees</li> <li>Unavailability of historical data on disaster waste generated</li> <li>Lack of political support</li> </ul>	<ul style="list-style-type: none"> <li>Inadequate resources - physical and human</li> <li>Unavailability of responsible persons/committees on waste management</li> <li>Unavailability of a supportive system to fill vacancies in government sector.</li> <li>Insufficient cadre positions</li> <li>Unavailability of pre-planned scheme for disaster waste management</li> <li>Inadequacy of existing spot fining system</li> </ul>
<b>Linkages and collaborations</b> <ul style="list-style-type: none"> <li>Unavailability of formal procedures to establish linkages and collaborations</li> <li>Availability of projects with complete proposals without implementation</li> <li>Reduced active participation of NGOs and INGOs</li> </ul>	<ul style="list-style-type: none"> <li>Lack of capacities of working groups</li> <li>Lesser commitment from responsible parties</li> <li>Language barriers</li> <li>Bad impressions of NGOs and INGOs</li> </ul>	<ul style="list-style-type: none"> <li>Lack of funds</li> <li>Lack of transparency and accountability in linkages</li> <li>Lack of collaboration</li> </ul>
<b>Continuity and sustainability</b> <ul style="list-style-type: none"> <li>Less consideration of incorporation of sustainable concepts into disaster waste management practices</li> <li>Loopholes in prevailing solid waste management practices, policies and with responsible authorities?</li> <li>Unavailability of formal procedures for monitoring and evaluation of implemented projects</li> </ul>	<ul style="list-style-type: none"> <li>Culture of people</li> <li>Public attitude of environmental values</li> <li>Unavailability of avenues to convert waste into profitable businesses</li> <li>Unauthorised and illegal projects</li> <li>Inadequate government participation</li> <li>Lesser quality standards maintained</li> <li>Duplication of work</li> </ul>	<ul style="list-style-type: none"> <li>Lack of motivation among employees on waste management</li> <li>Inadequate funds</li> <li>Unawareness on new developments/ technologies on sustainability</li> <li>Government procedures hampering long term career development</li> <li>Less diversification</li> <li>Unavailability of supportive systems to fill vacancies in government .</li> </ul>
<b>Investments in infrastructure</b> <ul style="list-style-type: none"> <li>Loopholes in government rules and regulations on fund raising and procurement</li> <li>Less consideration for environmental protection</li> </ul>	<ul style="list-style-type: none"> <li>Unsupportive attitudes of investors on waste management</li> <li>Inadequate quantities of disaster waste generated</li> <li>Lack of political will</li> <li>Unavailability of a disaster fund</li> </ul>	<ul style="list-style-type: none"> <li>Inadequate funds</li> <li>Less flexibility of policies, rules and regulations</li> <li>Inadequate capacities of staff in fund raising</li> <li>Unethical practices</li> <li>Lack of avenues to independently earn funds, such as taxes</li> </ul>
<b>Research and development</b> <ul style="list-style-type: none"> <li>Reduced interest in research and development -<a href="#">by the</a> government sector</li> <li>Inadequate opportunities for collaborative research programmes</li> <li>Inadequate transfer/sharing of knowledge and technical know-how</li> </ul>	<ul style="list-style-type: none"> <li>Attitudes on research and on the development of government officers</li> <li>Duplication of research work</li> <li>Traditional governmental practices that do not facilitate new approaches in the long run</li> </ul>	<ul style="list-style-type: none"> <li>Inadequate resources</li> <li>Inadequate knowledge on research methods among government officers</li> <li>Less opportunities for career development</li> <li>Unethical practices</li> <li>Insufficient allocations for staff development</li> </ul>
<b>Communication and coordination</b> <ul style="list-style-type: none"> <li>Uniformity of prevailing centralised framework</li> <li>Inadequate efficiency and effectiveness of existing systems</li> </ul>	<ul style="list-style-type: none"> <li>Less commitment- CBOs</li> <li>Political influences</li> <li>Established traditional mechanisms</li> <li>Unavailability of identified responsible persons</li> <li>Lack of responsiveness and accountability within the system</li> </ul>	<ul style="list-style-type: none"> <li>Inadequate resources</li> <li>Inadequate implemental powers</li> <li>Reluctance to change officials</li> <li>Unavailability of a supportive system to fill vacancies in government sector</li> <li>Lack of top level support</li> </ul>

▪ *Skills and confidence building*

As illustrated in Table 34, the lack of formal procedures for the preparation, conducting, monitoring and evaluation of training and awareness programmes is a major capacity gap as evidenced by the lesser number of programmes conducted on soft skills' development as against the many programmes conducted for technical skills' development at local authority level. This was evident by external factors having an influence, such as slow participation with high female representation within capacity building programmes. Repetition and duplication of programmes is one reason for high female participation as males are responsible for supporting their families. Furthermore, among participants, there is a lack of capacity as concerns language barriers especially in the Northern and Eastern provinces as most experts are not fluent in the Tamil language. Fewer opportunities for personal development such as training, workshops and scholarships and inadequate strategies to retain valuable human resources are identified as the other main capacity gap prevalent in skills and confidence building. As mentioned previously, because of certain factors such as the facts that most jobs in this area are contract based and pension schemes and life insurance policies are generally unavailable, there can be much job dissatisfaction in this sector. A lack of awareness among officers at national level, traditional bureaucratic red tape, inappropriate assignment of ministerial functions, inadequate resources and a lack of in-house trainers are other internal influencing factors in the government sector. Most skill building programmes are conducted via the government sector.

Comment [G11]: RI-13

Comment [G12]: RI-13

Comment [G13]: RI-13

▪ *Organisational implementation*

The lack of pre-planned schemes for disaster waste management, low collaboration among stakeholders and the non-functioning of important and necessary committees were key factors that affected proper disaster waste management during the aftermath of the Indian Ocean tsunami in 2004, which prevail as capacity gaps to date. These factors continue to exhibit capacity gaps to this day. For example, the adverse effects caused by improper disaster waste management on water quality, air quality, flora and fauna, visual impacts and the socio-economy have been identified. These gaps lead to further capacity gaps such as the unavailability of provision for disaster waste management within existing policies and not having a single point of responsibility at national level. The ignorance of responsibilities on disaster waste management, the lack of capacities of officials at national level and a lack of political support all influence the above. The unavailability of a uniform system to manage solid waste and the unenforceability of prevailing rules and regulations are external

Comment [G14]: RI-13

Comment [G15]: RI-13

influencing factors which lead to inefficiencies and ineffectiveness in prevailing peace time solid waste management practices and policies and a lack of efficiency and effectiveness in responsible authorities and these factors further aggravate the problem. Examples are absence of waste management practices such as segregation, reuse and recycling, a lack of proper prior assessment of waste removal procedures and inadequate facilities for hazardous waste processing. During the Indian Ocean tsunami in 2004, disaster C&D waste was not recycled or reused to its optimum capacity in Sri Lanka, but was disposed of in landfill sites. The non-revision, retraining or monitoring of existing solid waste management systems at frequent intervals in line with above. Inadequate resources are identified as internal influencing factors. The lack of a supportive system to fill vacancies in government sector and insufficient cadre positions lead to a lack of human resources. A lack of political support and the scarcity of land that can be utilised for disaster waste management are identified as external influencing factors which lead to open dumping and improper waste management practices.

Comment [G16]: RI-13

#### ▪ *Linkages and collaboration*

A lack of formal procedures to establish linkages and collaboration is a major capacity gap, impacting on internal factors such as transparency and accountability. Risk assessments conducted during the post-Indian Ocean tsunami period revealed that most disaster waste management programmes conducted at local authority level, with the collaboration of NGOs, regularly fell short of current best practices due to a lack of readily available advice, practical procedures and resources. Inadequate funds have resulted in an abundance of projects (with complete documentation) that have been unable to be implemented. It is further affected by the reduced active participation by NGOs and INGOs compared to the period immediately after the Indian Ocean tsunami in 2004 due to the bad impressions created concerning them. Furthermore, a lack of capacity in working groups such as community based organisations, less commitment from responsible parties and language barriers especially in the Northern and Eastern provinces are external factors affecting linkages and collaboration as a means of capacity building by exchanging skills and practical knowledge.

Comment [G17]: RI-13

#### ▪ *Continuity and sustainability*

The aforementioned loopholes in prevailing peace time solid waste management practices and policies, unavailability of formal procedures for the monitoring and evaluation of implemented projects exist as capacity gaps impacting on the continuity and sustainability of

post disaster waste management in Sri Lanka. A lack of avenues to convert waste into profitable businesses and inadequate government participation are external factors that adversely affect the continuity and sustainability of implemented projects. A [lack of financial capability and technology prevents the acquisition of the necessary physical resources required for successful long-term post disaster waste management programmes such as equipment and infrastructure](#). Unauthorised projects, low quality standards and duplication of work further aggravate the above, due to a lack of formal monitoring and evaluation procedures. A lack of motivation amongst employees, inadequate funds, unawareness of new developments and sustainability- related technology lead to inadequate consideration of sustainable concepts in disaster management practices. [However, the literature has revealed many guidelines and projects initiated to achieve sustainability in the country, excluding disaster waste, such as guidelines for establishing National Sustainable Development Strategies \(NSDS\) and a special unit for sustainability called “Haritha Lanka” and the establishment of the Green Building Council of Sri Lanka in 2010.](#) In terms of the external influencing factors, cultural and public attitudes on environmental values and insufficient motivation among the general public to deal with waste management are cited. Less diversification, prevailing government procedures and a lack of a proper system to fill vacancies in government sector are internal factors that affect the maintenance of acquired skills and knowledge.

Comment [G18]: RI-13

Comment [G19]: RI-13

#### ▪ *Investment in infrastructure*

The loopholes in the rules and regulations on fund raising and in procurement procedures are major capacity gaps impacting on investment in infrastructure at government sector entity level. The low flexibility in policies, rules and regulations and unethical practices cause lower transparency in project selection and evaluation procedures, inadequate fund raising capacities within staff and a lack of independent avenues to earn funds which lead to these factors affecting investment in infrastructure [such as collection of funds via taxation](#). The unsupportive attitudes of donors and a lack of being able to [process](#) large quantities of disaster waste commercially, [except in the case of the tsunami](#) adversely affect environmental protection related investments. The absence of a disaster fund is a major external influencing factor affecting investment in infrastructure for waste management. [Examples are: This leads to a lack of funds to acquire technology and equipment, and operational issues relating to salvaging, recycling and the reuse of waste material we are experienced.](#) The lack of political will and the unsupportive attitudes of the general public regarding recycling products also

Comment [G20]: RI-13

influence investment. [As revealed](#) by the research, [the culture of Sri Lanka does not promote the reuse of materials from a destroyed house.](#)

- *Research and development*

Negative attitudes regarding research and development and the duplication of research work are some external factors which cause less interest in research and development, especially in the government sector. [For example, even the Disaster Management Centre does not have a special unit for research and development.](#) Inadequate resources and traditionally adverse government practices do not facilitate collaborative research opportunities. Poor knowledge of research methods, fewer career development opportunities and insufficient allocations for staff development are some internal influencing factors. [For example, although employees are eligible to take paid leave to engage in research work, generally such leave is not approved.](#) This is aggravated by contractual appointments that curtail long term career development. Unethical practices negate the opportunities for the transfer and sharing of knowledge and technical know-how among related parties.

- *Communication and coordination*

Established traditional mechanisms, the non-availability of responsible persons at local levels and the low levels of commitment of community based organisations are external factors that affect the efficiency and effectiveness of existing communication and coordination systems during emergency situations. The lack of responsiveness and accountability of related parties also adversely affects transparency and the accountability of existing communication and coordination systems. [Examples are the absence of a clear line of authority, inadequate delegation and devolution of authority, inadequacies in training, communication and information management systems, power imbalances, and a lack of clarity on policy directives;](#) all these [comprised key capacity constraints identified in government entities.](#) Inadequate resources, [a lack of implementation power and an absence of a supportive system to fill vacancies in government](#) are other internal factors that affect the prevailing centralised framework. [The DMC in Sri Lanka have cited a lack of statutory enforcement powers, inadequate levels in transport and communication facilities, office accommodation and necessary infrastructure as significant factors that adversely affect performance.](#)

Comment [G21]: RI-13

Apart from these capacity gaps identified within the aforementioned seven areas, the findings further revealed capacity gaps influencing post disaster waste management in a general

context. An example is the vacuum between relief and early rehabilitation which leaves disaster waste unattended. A lack of awareness of people's needs has also been identified as a prevailing capacity gap. A study conducted on disaster waste management after the Samoan tsunami in 2009 by Brown *et al* (2011d) also revealed similar capacity gaps such as the unavailability of responsible authorities, low synergy among ministries, a lack of strategy for coordination, and the unavailability of disaster funds and formal procedures to monitor funds.

In this context, temporary storage areas for recycling and waste processing have been identified as an important element by many authors (FEMA, 2007; USEPA, 2008) as they provide extra time to appropriately sort, recycle and dispose of the waste (Brown *et al*, 2011a). Furthermore, community participation and integration has been identified as an essential part of any 'peace-time' solid waste management programme after any disaster (Brown *et al*, 2011a) and it has been identified that training should be provided for waste management operators (Joint UNEP/OCHA, 2010). In addition, UNEP (2008) identified that training should be given in order to educate non-waste personnel (the community) to assume waste management functions during a disaster. Ultimately, UNEP (2008) emphasised that every city or community which is prone to disasters should have a plan including a detailed strategy for debris collection, temporary storage and staging areas, recycling, disposal, hazardous waste identification and handling, administration, and dissemination of information to the public while identifying any additional removal, transport and handling personnel and equipment that might be needed.

## **6. Conclusions**

Existing capacities, capacity gaps and factors affecting capacity building in post disaster C&D waste management have been presented within seven identified areas: skills and confidence building, organisational implementation, continuity and sustainability, investment in infrastructure, research and development, communication and coordination, and linkages and collaboration. The findings revealed gaps in legal powers, finance, management, technology, physical assets and human resources prevalent within the current practises of post disaster C&D waste management in Sri Lanka. It also revealed that these gaps mostly relate to, and affect, the functional activities of national entities in post disaster waste management. Thus, the necessity for capacity-building in post disaster C&D waste

management within national level entities in Sri Lanka was established. . Ultimately, this study contributes to both theory and practice by identifying seven areas for capacity building at national entity level in post disaster C&D waste management and provides a further contribution by deriving capacity gaps and factors affecting capacity building within the identified seven areas in post disaster C&D waste management. Overall it contributes to practice by presenting facts or issues to be considered when preparing policies, legislative acts, regulations or rules pertaining to post disaster C&D waste management.

Comment [G22]: RI-14

## References

1. Allen, K.M. (2006), "Community-based disaster preparedness and climate adaptation: local capacity building in the Philippines", *Disasters*, Vol. 30 No.1, pp. 81–101.
2. Ayele, S, and Wield, D. (2005), "Science and capacity building and partnership in African Agriculture: Perspectives on Mali & Egypt", *Journal of International Development*, Vol. 17, pp 631-646.
3. Basnayake, B.F.A., Chiemchaisri, C., Mowjood, M.I.M., (2005), "Solid wastes arise from the Asian tsunami disaster and their rehabilitation activities: case study of affected coastal belts in Sri Lanka and Thailand", *Tenth International Waste Management and Landfill Symposium*, Sardinia.
4. Baycan, F. and Petersen, M. (2002), "Disaster waste management-C&D waste", In: ISWA, ed. *Annual Conference of the International Solid Waste Association*, 8–12 July 2002. Istanbul, Turkey, pp 117-125.
5. Bjerregaard M. (2007) *MSB/UNDP Debris management Guidelines*. Disaster Waste recovery.
6. Boyd, E. and Juhola, S. (2009), "Stepping up to the climate change: opportunities in re-conceptualising development futures", *Journal of international development*, Vol.21, pp792–804.
7. Brown, C. and Milke, M.W. (2009), "Planning for Disaster Waste Management. Christchurch, New Zealand: Waste", *MINZ 21st Annual Conference*, 14-16 Oct, 9pp.
8. Brown, C., Milke, M. and Seville, E. (2011b) "Implementing a disaster recovery programme: a demolition and debris management perspective", *International conference on building resilience*, 19<sup>th</sup> -21<sup>st</sup> July, Kandalama: Sri Lanka.



9. Brown, C., Milke, M. and Seville, E. (2011d) "Disaster waste management for the 2009 Samoan Tsunami", International conference on building resilience, 19<sup>th</sup>-21<sup>st</sup> July, Kandalama: Sri Lanka.
10. Brown, C., Milke, M. and Seville, E. (2010), "Waste management as a life line?" A New Zealand case study analysis", International Journal of Disaster Resilience in the Built Environment, Vol.1 No.2, pp. 192-206.
11. Brown, C., Milke, M. and Seville, E. (2011a) "Disaster Waste management: A review article", Waste Management, Vol.31, pp.1085-1098.
12. Construction Waste Management (COWAM) (2008), Strategy for Sustainable Construction and Demolition Waste Management in Galle, Sri Lanka. Available at: [http://www.cowamproject.org/cms/Content/download/Interim\\_Report\\_Vision\\_2018.pdf](http://www.cowamproject.org/cms/Content/download/Interim_Report_Vision_2018.pdf) [Accessed 11 October 2008].
13. Disaster Management Act, No 13 of 2005 (2005), Published as a Supplement to Part II of the Gazette of the Democratic Socialist Republic of Sri Lanka of May 13, 2005. Colombo: Government publications bureau.
14. Disaster Management Centre (DMC) (2005a), Annual report 2005. Colombo: Disaster Management Centre.
15. Disaster Management Centre (DMC) (2005b), Towards a safer Sri Lanka – Road Map for Disaster Risk Management, Disaster Management Centre, Colombo.
16. Disaster Management Centre (DMC) (2006a), Annual report 2006, Disaster Management Centre, Colombo.
17. Disaster Management Centre (DMC) (2006b), Towards a safer Sri Lanka – Road Map for Disaster Risk Management, Disaster Management Centre, Colombo.
18. Disaster Management Centre (DMC) (2009a), Newsletter (1st Quarter): Working together for Disaster Risk Reduction, Disaster Management Centre, Colombo.
19. Ekici, S., McEntire, D.A. and Afedzie, R., (2009), "Transforming debris management: considering new essentials", Disaster prevention and management, Vol.18 No.5, pp. 511-522.
20. Fernando, J. (2011), "National "Plisaru" waste management programme", International conference on building resilience, 19<sup>th</sup>-21<sup>st</sup> July, Kandalama: Sri Lanka.
21. Flick, U. (2009), An Introduction to Qualitative Research (1st-4<sup>th</sup> edition). London: Sage.
22. General Accounting Office (GAO) (2008), General Accounting Office reports & testimony. Hurricane Katrina: Continuing waste removal and disposal issues. GAO-08-985R. Washington, DC: GAO.

23. Ginige, K. and Amaratunga D. (2011) "Chapter 02: Capacity Development for Post-Disaster Reconstruction of the Built Environment", In Amaratunga D. and Haigh, R. (eds.), Post disaster reconstruction of the built environment: rebuilding and resilience, Wiley-Blackwell, Oxford.
24. Ginige, K., Amaratunga, D. and Haigh, R. (2010), "Developing Capacities for Disaster Risk Reduction in the Built Environment: Capacity analysis in Sri Lanka", International Journal of Strategic Property Management, Vol.14 No.4, pp. 287-303.
25. Grindle, M.S. and Hilderbrand, M. E. (1995), "Building sustainable capacity in the public sector: what can be done?", Public administration and development, Vol.15, pp.441-463.
26. Hartwig, K., Pashman, J. Cherlin, E., Dale, M. Callaway, M., Czaplinski, C., Wood, E. W., Abebe, Y., Dentry, T. and Bradley, E.H. (2008), "Hospital management in the context of health sector reform: a planning model in Ethiopia", International journal of health planning and management, Vol.23, pp. 203–218.
27. Hettiarachchi, N.D. (2007), Disaster Management in Sri Lanka: Mobilizing Response Measures during Disasters, avoiding Human Misery. National Relief Services Center and Ministry of Resettlement and Disaster Relief Services.
28. Jayawardane, A.K.W., (2006), Disaster mitigation initiatives in Sri Lanka, International Symposium on Management Systems for Disaster Prevention, 9<sup>th</sup>-11<sup>th</sup> March 2006, Kochi, Japan.
29. Joint UNEP/OCHA Environment Unit (JEU), (2010), Disaster Waste Management Guidelines. Geneva: Joint UNEP/OCHA Environment Unit.
30. Karunasena, G., Amaratunga, D., and Haigh, R. (2010), "Capacity building towards sustainability: context of post disaster waste management", *International research conference on sustainability in built environment*, 18th – 19th June, Colombo, Sri Lanka.
31. Karunasena, G., Amaratunga, D., and Haigh, R. (2012), "Post Disaster Construction & Demolition Waste Management: A Sri Lanka Case Study", *International Journal of Civil Engineering and Management*, 13(2), 171-190.
32. Karunasena, G., Amaratunga, D., Haigh, R. and Lill, I. (2009) "Post Disaster Waste Management Strategies in Developing Countries: Case Of Sri Lanka", International Journal of Strategic Property Management, Vol.13 No.2, pp. 171-190.
33. Keraminiyage, K. Amaratunga, D. and Haigh, R. (2008), Post tsunami recovery capacity gaps in Sri Lanka. Building Resilience, 11-15th Feb., Sri Lanka, pp. 1011–1022.

34. LaFond, A.K., Brown, L.B. and Macintyre, K (2002), "Mapping capacity in the health sector: a conceptual framework", *International Journal of Health Planning and Development*, Vol.17, pp 3-22.
35. Luther, L. (2008), *Managing Disaster Waste: Overview of Regulatory Requirements, Agency Roles, and Selected Challenges*, Congressional Research Service. Available at: <http://wikileaks.org/wiki/CRS-RL34576> [Accessed 25 February 2006].
36. Milke, M (2011), "Disaster waste management research needs", *Waste Management*, Vol.31, pp. 1-2.
37. Moe, T.L. (2010), "Cleanup after Katrina: an analysis on policy, process, priorities, problems, and politics", *Disaster prevention and management*, Vol. 19 No. 3, pp. 345-361.
38. Morgan, R.K. (1998), *Environmental impact assessment: a methodological perspective*, Kluwer Academic Publishers, Dordrecht.
39. National Environmental Act, No 47 of 1980 (1980), Colombo: Government publications bureau.
40. Noor, K.B.M.(2008), Case study: a strategic research methodology. *American journal of applied science*, Vol.5 No.11, pp. 1602-1604.
41. Ozden, A.T. (2007), "Constituting a sustainable after disasters: The role of Architecture", *Journal of Faculty of Built Environment*, Vol.9 No.3, pp. 1-17.
42. Perera, M.A.L.R (2008), "Ex Ante Preparedness for Disaster Management: Sahana in Sri Lanka", In Amin, S. and Goldstien, M (eds.), "Data against natural disasters: Establishing Effective Systems for Relief, Recovery, and Reconstruction", The World Bank, Washington, DC.
43. Petersen, M. (2004), Restoring waste management following disasters. In: IF, ed. *International conference on post disaster reconstruction*, 22-23 April 2004, UK. Coventry: IF Research group.
44. Pilapitiya, S., Vidanaarachchi, C. and Yuen, S. (2006), "Effects of the tsunami on waste management in Sri Lanka", *Waste Management*, Vol.26 No.2, pp. 107-109.
45. Raufdeen, R. (2009), *Construction Waste Management: Current status and challenges in Sri Lanka*, COWAM publication.
46. Sen, A. (1981), *Poverty and Famine: An Essay on Entitlements and Deprivation*, Clarendon, Oxford.
47. Shaw, R., and Goda, K. (2004), "From disaster to sustainable civil society: the Kobe experience", *Disaster*, 28(1), pp. 16-40.

48. Shibata,T., Solo-Gabriele, H. and Hata, T. (2012), “Disaster Waste Characteristics and Radiation Distribution as a Result of the Great East Japan Earthquake”, *Environmental Science Technology*, Vol.46, pp. 3618–3624.
49. Srinivas, H. and Nakagawa, Y. (2008), “Environmental implications for disaster preparedness: Lessons Learnt from the Indian Ocean Tsunami”, *Journal of Environmental Management*, Vol.89 No.1, pp 4-13.
50. Tadele, F., and Siambabala, M. A. (2009), “Building disaster resilience through capacity building in Ethiopia”, *Disaster Prevention and Management*, Vol.18 No.3, pp. 317-326.
51. Task Force for Rebuilding the Nation (TAFREN) (2005a.) *Recovering from the Tsunami: A report on the progress of the post-tsunami recovery of Sri Lanka and the role of TAFREN in the recovery effort*, The Task Force for Rebuilding the Nation, November 2005.
52. Task Force for Rebuilding the Nation (TAFREN) (2005b). *District wise post tsunami rehabilitation and reconstruction projects: Rebuilding Sri Lanka, Post Tsunami Recovery and Reconstruction strategy Update of Part II – Progress made and problems encountered*, Task Force for Rebuilding the Nation, Colombo, Sri Lanka.
53. Thummerukudy, M. (2012), “Chapter 11: Disaster waste Management: An overview”, In Shaw, R. and Tran, P. ( 1 eds.), *Environment disaster linkages*, Emerald Group Publishing limited.
54. United Nations Development Programme (UNDP) (2006), *Post-Tsunami Recovery and Reconstruction Strategy*, United Nations Development Programme:Colombo.
55. United Nations Educational, Scientific and Cultural Organization (UNESCO) (2006), *Guide for planning education in emergency and reconstruction: chapter 03-capacity building*, International Institute for Education Planning, Paris.
56. United Nations Environmental Programme (UNEP) (2005), *Sri Lanka post tsunami environmental assessment*, United Nation Environment Programme (UNEP). Geneva: UNEP, (DEP/0758/GE).
57. United States Environmental Protection Agency (EPA) (1995), *Characterization of building related construction and demolition waste in the United States*. EPA 530-R-98-010, 1998.
58. United States Environmental Protection Agency (EPA) (2008), *Planning for Natural Disaster Waste*, available at: <http://www.epa.gov/CDmaterials/pubs/pnodd.pdf> [Accessed 10 June 2007].

59. United States Federal Emergency Management Agency (FEMA) (2007), Public Assistance: Waste Management Guide, available at: <http://www.fema.gov/government/grant/pa/demagdes.html> [Accessed 10 June 2007].
60. Webb, P and Rogers, B.(2003), Addressing the “In” in Food Insecurity. Washington, D.C.: Food and Nutrition Technical Assistance (FANTA) Project, Academy for Educational Development (AED).
61. Wolfe, M. (1996), Elusive Development, Zed Books, London.
62. Yin,R.K., (2009), Case study research: Design and Methods, 4th ed., Sage Publications, London.