



University of  
**Salford**  
MANCHESTER

# Capacity building of disaster waste management for disaster risk reduction

Karunasena, GI, Amaratunga, RDG and Haigh, RP

<b>Title</b>	Capacity building of disaster waste management for disaster risk reduction
<b>Authors</b>	Karunasena, GI, Amaratunga, RDG and Haigh, RP
<b>Type</b>	Conference or Workshop Item
<b>URL</b>	This version is available at: <a href="http://usir.salford.ac.uk/id/eprint/9701/">http://usir.salford.ac.uk/id/eprint/9701/</a>
<b>Published Date</b>	2010

USIR is a digital collection of the research output of the University of Salford. Where copyright permits, full text material held in the repository is made freely available online and can be read, downloaded and copied for non-commercial private study or research purposes. Please check the manuscript for any further copyright restrictions.

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



**RICS**

the mark of  
property  
professionalism  
worldwide

DAUPHINE  
UNIVERSITÉ PARIS

# COBRA 2010

## The Construction, Building and Real Estate Research Conference of the Royal Institution of Chartered Surveyors

**Held at Dauphine Université, Paris, 2-3 September 2010**

ISBN 978-1-84219-619-9

© RICS

12 Great George Street  
London SW1P 3AD  
United Kingdom

[www.rics.org/cobra](http://www.rics.org/cobra)

September 2010

The RICS COBRA Conference is held annually. The aim of COBRA is to provide a platform for the dissemination of original research and new developments within the specific disciplines, sub-disciplines or field of study of:

### **Management of the construction process**

- Cost and value management
- Building technology
- Legal aspects of construction and procurement
- Public private partnerships
- Health and safety
- Procurement
- Risk management
- Project management

### **The built asset**

- Property investment theory and practice
- Indirect property investment
- Property market forecasting
- Property pricing and appraisal
- Law of property, housing and land use planning
- Urban development
- Planning and property markets
- Financial analysis of the property market and property assets
- The dynamics of residential property markets
- Global comparative analysis of property markets
- Building occupation
- Sustainability and real estate
- Sustainability and environmental law
- Building performance

## The property industry

- Information technology
- Innovation in education and training
- Human and organisational aspects of the industry
- Alternative dispute resolution and conflict management
- Professional education and training

## Peer review process

All papers submitted to COBRA were subjected to a double-blind (peer review) refereeing process. Referees were drawn from an expert panel, representing respected academics from the construction and building research community. The conference organisers wish to extend their appreciation to the following members of the panel for their work, which is invaluable to the success of COBRA.

Rifat Akbiyikli	Sakarya University, Turkey
Rafid Al Khaddar	Liverpool John Moores University, UK
Ahmed Al Shamma'a	Liverpool John Moores University, UK
Tony Auchterlounie	University of Bolton, UK
Kwasi Gyau Baffour Awuah	University of Wolverhampton, UK
Kabir Bala	Ahmadu Bello University, Nigeria
Juerg Bernet	Danube University Krems, Austria
John Boon	UNITEC, New Zealand
Douw Boshoff	University of Pretoria, South Africa
Richard Burt	Auburn University, USA
Judith Callanan	RMIT University, Australia
Kate Carter	Heriot-Watt University, UK
Keith Cattell	University of Cape Town, South Africa
Antoinette Charles	Glasgow Caledonian University, UK
Fiona Cheung	Queensland University of Technology, Australia
Sai On Cheung	City University of Hong Kong
Samuel Chikafalimani	University of Pretoria, South Africa
Ifte Choudhury	Texas A and M University, USA
Chris Cloete	University of Pretoria, South Africa
Alan Coday	Anglia Ruskin University, UK
Michael Coffey	Anglia Ruskin University, UK
Nigel Craig	Glasgow Caledonian University, UK
Ayirebi Dansoh	KNUST, Ghana
Peter Davis	Curtin University, Australia
Peter Defoe	Calford Seaden, UK
Grace Ding	University of Technology Sydney, Australia
Hemanta Doloi	University of Melbourne, Australia
John Dye	TPS Consult, UK
Peter Edwards	RMIT, Australia
Charles Egbu	University of Salford, UK
Ola Fagbenle	Covenant University, Nigeria
Ben Farrow	Auburn University, USA
Peter Fenn	University of Manchester, UK
Peter Fewings	University of the West of England, UK

Peter Fisher	University of Northumbria, UK
Chris Fortune	University of Salford, UK
Valerie Francis	University of Melbourne, Australia
Rod Gameson	University of Wolverhampton, UK
Abdulkadir Ganah	University of Central Lancashire, UK
Seung Hon Han	Yonsei University, South Korea
Anthony Hatfield	University of Wolverhampton, UK
Theo Haupt	Cape Peninsula University of Technology, South Africa
Dries Hauptfleisch	University of the Free State, South Africa
Paul Holley	Auburn University, USA
Danie Hoffman	University of Pretoria, South Africa
Keith Hogg	University of Northumbria, UK
Alan Hore	Construction IT Alliance, Ireland
Bon-Gang Hwang	National University of Singapore
Joseph Igwe	University of Lagos, Nigeria
Adi Irfan	Universiti Kebangsaan Malaysia, Malaysia
Javier Irizarry	Georgia Institute of Technology, USA
Usman Isah	University of Manchester, UK
David Jenkins	University of Glamorgan, UK
Godfaurd John	University of Central Lancashire, UK
Keith Jones	University of Greenwich, UK
Dean Kashiwagi	Arizona State University, USA
Nthatisi Khatleli	University of Cape Town, South Africa
Mohammed Kishk	Robert Gordon's University, UK
Andrew Knight	Nottingham Trent University, UK
Scott Kramer	Auburn University, USA
Esra Kurul	Oxford Brookes University, UK
Richard Laing	Robert Gordon's University, UK
Terence Lam	Anglia Ruskin University, UK
Veerarak Likhitrungsilp	Chulalongkorn University, Thailand
John Littlewood	University of Wales Institute, Cardiff, UK
Junshan Liu	Auburn University, USA
Champika Liyanage	University of Central Lancashire, UK
Greg Lloyd	University of Ulster, UK
S M Lo	City University of Hong Kong
Mok Ken Loong	Yonsei University, South Korea
Martin Loosemore	University of New South Wales, Australia
David Manase	Glasgow Caledonian University, UK
Donny Mangitung	Universitas Tadulako, Malaysia
Patrick Manu	University of Wolverhampton, UK
Tinus Maritz	University of Pretoria, South Africa
Hendrik Marx	University of the Free State, South Africa
Ludwig Martin	Cape Peninsula University of Technology, South Africa
Wilfred Matipa	Liverpool John Moores University, UK
Steven McCabe	Birmingham City University, UK
Annie McCartney	University of Glamorgan, UK
Andrew McCoy	Virginia Tech, USA
Enda McKenna	Queen's University Belfast, UK
Kathy Michell	University of Cape Town, South Africa
Roy Morledge	Nottingham Trent University, UK

Michael Murray	University of Strathclyde, UK
Saka Najimu Stanley Njuangang	Glasgow Caledonian University, UK University of Central Lancashire, UK
Henry Odeyinka Ayodejo Ojo Michael Oladokun Alfred Olatunji Austin Otegbulu Beliz Ozorhon Obinna Ozumba	University of Ulster, UK Ministry of National Development, Seychelles University of Uyo, Nigeria Newcastle University, Australia Bogazici University, Turkey University of the Witwatersrand, South Africa
Robert Pearl Srinath Perera Joanna Poon Keith Potts Elena de la Poza Plaza Matthijs Prins Hendrik Prinsloo	University of KwaZulu, Natal, South Africa Northumbria University, UK Nottingham Trent University, UK University of Wolverhampton, UK Universidad Politécnica de Valencia, Spain Delft University of Technology, The Netherlands University of Pretoria, South Africa
Richard Reed Zhaomin Ren Herbert Robinson Kathryn Robson Simon Robson David Root Kathy Roper Steve Rowlinson Paul Royston Paul Ryall	Deakin University, Australia University of Glamorgan, UK London South Bank University, UK RMIT, Australia University of Northumbria, UK University of Cape Town, South Africa Georgia Institute of Technology, USA University of Hong Kong, Hong Kong Nottingham Trent University, UK University of Glamorgan, UK
Amrit Sagoo Alfredo Serpell Winston Shakantu Yvonne Simpson John Smallwood Heather Smeaton-Webb Bruce Smith Melanie Smith Hedley Smyth John Spillane Suresh Subashini Kenneth Sullivan	Coventry University, UK Pontificia Universidad Católica de Chile, Chile Nelson Mandela Metropolitan University, South Africa University of Greenwich, UK Nelson Mandela Metropolitan University, South Africa MUJV Ltd. UK Auburn University, USA Leeds Metropolitan University, UK University College London, UK Queen's University Belfast, UK University of Wolverhampton, UK Arizona State University, USA
Joe Tah Derek Thomson Matthew Tucker	Oxford Brookes University, UK Heriot-Watt University, UK Liverpool John Moores University, UK
Chika Udeaja	Northumbria University, UK
Basie Verster Francois Viruly	University of the Free State, South Africa University of the Witwatersrand, South Africa
John Wall Sara Wilkinson Trefor Williams	Waterford Institute of Technology, Ireland Deakin University, Australia University of Glamorgan, UK

Bimbo Windapo	University of Cape Town, South Africa
Francis Wong	Hong Kong Polytechnic University
Ing Liang Wong	Glasgow Caledonian University, UK
Andrew Wright	De Montfort University, UK
Peter Wyatt	University of Reading, UK
Junli Yang	University of Westminster, UK
Wan Zahari Wan Yusoff	Universiti Tun Hussein Onn Malaysia, Malaysia
George Zillante	University of South Australia
Benita Zulch	University of the Free State, South Africa
Sam Zulu	Leeds Metropolitan University, UK

**In addition to this, the following specialist panel of peer-review experts assessed papers for the COBRA session arranged by CIB W113**

John Adriaanse	London South Bank University, UK
Julie Adshead	University of Salford, UK
Alison Ahearn	Imperial College London, UK
Rachelle Alterman	Technion, Israel
Deniz Artan Ilter	Istanbul Technical University, Turkey
Jane Ball	University of Sheffield, UK
Luke Bennett	Sheffield Hallam University, UK
Michael Brand	University of New South Wales, Australia
Penny Brooker	University of Wolverhampton, UK
Alice Christudason	National University of Singapore
Paul Chynoweth	University of Salford, UK
Sai On Cheung	City University of Hong Kong
Julie Cross	University of Salford, UK
Melissa Daigneault	Texas A&M University, USA
Steve Donohoe	University of Plymouth, UK
Ari Ekroos	University of Helsinki, Finland
Tilak Ginige	Bournemouth University, UK
Martin Green	Leeds Metropolitan University, UK
David Greenwood	Northumbria University, UK
Asanga Gunawansa	National University of Singapore
Jan-Bertram Hillig	University of Reading, UK
Rob Home	Anglia Ruskin University, UK
Peter Kennedy	Glasgow Caledonian University, UK
Anthony Lavers	Keating Chambers, UK
Wayne Lord	Loughborough University, UK
Sarah Lupton	Cardiff University
Tim McLernon	University of Ulster, UK
Frits Meijer	TU Delft, The Netherlands
Jim Mason	University of the West of England, UK
Brodie McAdam	University of Salford, UK
Tinus Maritz	University of Pretoria, South Africa

Francis Moor	University of Salford, UK
Issaka Ndekugri	University of Wolverhampton, UK
John Pointing	Kingston University, UK
Razani Abdul Rahim	Universiti Teknologi, Malaysia
Linda Thomas-Mobley	Georgia Tech, USA
Paul Tracey	University of Salford, UK
Yvonne Scannell	Trinity College Dublin, Ireland
Cathy Sherry	University of New South Wales, Australia
Julian Sidoli del Ceno	Birmingham City University, UK
Keren Tweeddale	London South Bank University, UK
Henk Visscher	TU Delft, The Netherlands
Peter Ward	University of Newcastle, Australia



# Capacity building of disaster waste management for disaster risk reduction

Gayani Karunasena,  
Department of Building Economics, University of Moratuwa  
Email: [gayani@becon.mrt.ac.lk](mailto:gayani@becon.mrt.ac.lk)

Dilanthi Amaratunga,  
School of Built and Human Environment, University of Salford  
Email: [r.d.g.amaratunga@salford.ac.uk](mailto:r.d.g.amaratunga@salford.ac.uk)

Richard Haigh,  
School of Built and Human Environment, University of Salford  
Email: [r.p.haigh@salford.ac.uk](mailto:r.p.haigh@salford.ac.uk)

## Abstract

Natural hazards are extreme events that could cause harm on both socio-economic and ecological systems which ultimately become major disasters. Therefore, identification of vulnerabilities and risks of major hazards are important for any country. Sri Lanka is also in the process of developing a risk profile of natural hazards after the Asian Tsunami of 2004. In this context, various national and local level workshops have been conducted for capacity building of non structural measures for disaster risk reduction. On this, this paper highlights a natural hazard: disaster waste which has high impact on disaster risk reduction, but given less attention in Sri Lanka where its creation and impact is unavoidable. Specially, absence of proper disaster waste management strategies eventually put health and safety of victims at a risk. Further, in the long term it affects increased frequency of disasters in spite of smaller impacts, such as floods. Thus, this paper highlights capacity gaps identified in post disaster waste management and its impact on disaster risk reduction. Semi structured interviews was conducted to collect data from stakeholders involved in disaster waste management at national and local levels. Unavailability of single point responsibility, statutorily enforceable rules and regulations and capacity constraints are identified as gaps in disaster waste management. Enhancement of administrative and operational level capacities of national agencies, specifically by granting legal powers and increasing awareness among the society will enable overcoming of above gaps.

**Key words:** Capacity building, Disaster waste, Risk reduction

## 1 Introduction

Impacts of disasters, whether natural or man made, have not only human but environmental dimensions as well. Casualties including deaths, injured and misplaced people are major physical impacts of any kind of a disaster while property damages, collapsing buildings, infrastructure and crop destruction are some critical matters which impact with environmental dimensions (Shaw, 2006). Among these, generation of disaster waste resulting from collapsing buildings and infrastructure is unavoidable which cause serious environmental and economical burden on normal living conditions, reconstruction and general municipal waste collection processes (UNEP, 2005). Specifically, waste disposal has emerged as a critical issue in responding to a disaster in any country. Further, disasters are so closely intertwined with environment that proper environmental management and governance is essential for long term peace, stability and security in disaster prone countries particularly, in developing countries where affected communities rely heavily on natural resources for survival. Impacts on health and safety of victims in absence of proper waste management strategies and approaches increase risks.

Risk is an equally unavoidable component associated with any activity which plays a huge role in the present world (Wang and Chou, 2003). Disaster risk is a measure of expected losses due to a hazard event occurring in a given area over a specific period (Khan *et al*, 2007). Thus, there is a need to adapt specific strategies to reduce disaster risk and effectively manage disasters. These problems are equally applicable in Sri Lanka which is prone to frequent natural disasters. United Nations Environment Protection Report (2005) stated that debris generated by the Asian Tsunami in 2004 was not properly disposed, reused or managed. This paper aims to explore capacities of post disaster waste management, challenges faced and its impacts on disaster risk reduction. Forthcoming sections of the paper discuss disaster risk in the contexts of disaster waste management, field survey findings and proposed model for the study.

## 2 Disaster risk reduction

Risk means the probability of a particular hazardous event or condition occurring and the losses it would cause (McEntire, 2005). Mainly it would depend upon the nature of the hazard, vulnerability and economic value of affected elements (Khan *et al*, 2007). El-Sayegh (2008) argued that risk is more than economical or physical loss due to immeasurable uncertainty. Thus, strategies towards disaster risk reduction play a key role. According to Mitchell (2006) disaster risk reduction referred to reduction or prevention of suffering and strain of disasters on people and things they value and to

promote safety and sustainable development in communities all over the world. Bien *et al* (2006) further indicated it as a shared objective promoting resilience offering opportunities for more holistic and proactive responses. Accordingly, it can be defined as taking measures in advance, addressing risk reduction, involving environmental protection, social equity and economic growth.

Gopalakrishnan (2007) introduced three fundamental aspects of disaster risk reduction as disaster response, preparedness and mitigation which corresponds with two phases in the disaster cycle, risk reduction (before) and recovery (after) phase. Khan *et al* (2008), further enhance it into three stages as before, during and after a disaster with purposes to avoid, reduce or recover from its losses. International Strategy for Disaster Reduction (2008) introduced strategies for reducing disaster risks through a plan of five priorities:

- Ensure disaster risk reduction as a national and a local priority with a strong institutional basis for implementation.
- Identify, assess and monitor disaster risks and enhance early warning.
- Use knowledge, innovation and education to build a culture of safety and resilience at all levels.
- Reduce underlying risk factors.
- Strengthen disaster preparedness for effective response.

Further, it emphasises on implementing the profile consistent with aforesaid priorities in the country in a more systematic and consistent effort to support national disaster reduction efforts (ISDR, 2008).

## **2.1 Disaster risk reduction in Sri Lanka**

Sri Lanka has become prone to disasters, both natural and manmade with increasing losses to life and property during the recent decades. Natural disasters in Sri Lanka are commonly caused by floods, cyclones, landslides, droughts and coastal erosion (Jayawardane, 2006). With the impact of Asian Tsunami in 2004, major disaster risk reduction strategies are designed in Sri Lanka for implementation. The planned risk profile is intended to address major natural disasters and Disaster Management Centre (DMC) is to play the key role. Main objective of this profile is to provide decision makers and planners credible information on locations, frequency and impacts of main hazards as well as information on vulnerable elements at risk. With this knowledge, policies and strategies can be formulated, mitigation, preparedness and contingency plans can be developed and risk reduction elements can be factored into development projects. Five national level institutes are involved in preparing disaster risk profile in respect of each hazard type illustrated at table 1.

**Table 1: Institutes Involved in Preparing Disaster Risk Profiles.**

<b>Hazards &amp; tasks</b>	<b>Institute</b>
Project coordination, logistics, monitoring, evaluation and technical support	Disaster Management Centre (DMC)
Landslide hazards and risk mapping	National Building Research Organization
Coastal hazards and risk mapping	Coastal Conservation Department
Flood hazards and risk mapping	Department of Irrigation
Drought hazards and risk mapping	Department of Agriculture, University of Peradeniya
Cyclone hazards and risk mapping	Department of Meteorology

A disaster risk profile consists of two phases as developing hazard maps and developing risk maps. At the end DMC expects to achieve following outputs:

- Rationale for development of a hazard and risk atlas.
- Description of methodology and definition of key terms.
- Hazard and risk maps that depict physical vulnerability of Districts, DS Divisions and GN Divisions to specific hazards coupled with a brief description of frequency of occurrence and impacts that it has had on mortality in the past.
- An overlay on hazard areas of vulnerable elements at risk capturing physical, social, economic and environmental vulnerability.
- An analysis of vulnerability, coping capacity of society and recommendations.

## **2.2 Disaster waste & its impacts on disaster risk reduction**

In a disaster, generation of waste is unavoidable. Generally, waste is defined as any losses produced by activities that generate direct or indirect costs but do not add any value to the product from the point of view of a client (Formoso *et al*, 1999) or any substance or object which the holder intends or is required to discard. Peterson (2004) indicated that disaster waste become critical as it differs from the normal situation which generates waste in a more or less stable quantities and composition whereas in a post disaster, it radically changes in type and quantity. Specifically, disaster waste may contain or be contaminated with certain toxic or hazardous constituents. Srinivas and Nakagawa (2007) indicated that disaster debris as the most critical environmental problem faced by countries affected by the Asian Tsunami in 2004. Further, General Accounting Office Report on *Hurricane*

*Katrina: Continuing debris removal and disposal issues* also highlighted that how failures in disaster debris management continue to impact on environmental health of citizens at the end of three years (GAO 2008). Rapid Environment Impact Assessment conducted on Haiti Earthquake also highlighted importance of proper debris management to avoid damage to environment, livelihoods and recovery efforts (Kelly, 2010). In addition, many had highlighted the importance of focusing on long term ecologically and economically sustainable debris management strategies for a resilient future (Lauritzen, 1998; Baycan and Petersen, 2002; Blakely, 2007). Specifically, it is essential for long term peace, stability and security in disaster prone countries particularly, in developing countries where affected communities rely heavily on natural resources for survival (Karunasena *et al*, 2009). Thus, it is important to maximize environmentally sustainable values while minimizing disaster waste generation and impact.

In Sri Lanka, risk assessments conducted in recent past indicated that most disaster waste management programs conducted at local levels with collaboration of NGOs do not consistently meet current best practices due to lack of readily available guidance, practical procedures and resources (UNDP, 2005; UNEP 2005). Paper titled “Utilization of Tsunami debris for reconstruction process in Sri Lanka” by Gunawardena and Rajakaruna (2005), pointed out inadequate education material on how to recycle Tsunami debris, lack of awareness and training for technical people on standards and reuse of materials, poor waste management plans, legislations related to scope and lack of appropriate monitoring systems, minimal legislation related to landfill activities and standards, lack of experience on debris recycling, insufficient economic incentives for recyclers and high initial costs as key challenges in disaster waste management. Further, there is no proper garbage discharge in Sri Lanka and many drains are blocked, causing health problem such as dengue (Perera, 2003). Thus, economical and environmentally sound waste management programmes are essential not only for disaster waste but also for municipal solid waste management in Sri Lanka.

### **3 Research methodology**

Literature review and documentary survey was conducted on risk reduction and waste management in post disaster management. Pilot interviews were conducted at both national and local levels including both government and non government organisations involved in disaster waste management in Sri Lanka. A detail profile of pilot interviews is illustrated at table 2.

**Table 2: Profile of Pilot Interviews**

Organisation	Type	Number of interviews
Disaster Management Centre (National)	Gov.	1
Sarvodaya Shramadana Movement (National)	Non-Gov.	1
Sri Lanka Operations Centre (Local)	Gov.	1
Galle Municipal Council (Local)	Gov.	1

One each government and non governmental organisations were selected at national levels and two government organisations were selected at local level. One interviewee from each was selected from top or middle management involved in post disaster management processes having experience in waste management. Semi-structured interviews were conducted to gather data as it facilitated in depth analysis and gather different views and opinions of respondents within scope of the study.

Content analysis was used in order to analyze collected data. Nvivo software was used for easier and speedy content analysis. Relevant coding structures were prepared using software and analysed in order to determine existing capacities. Coding structure prepared mainly focuses on existing capacities as illustrated at figure 1.



**Figure 1: Coding Structure**

## 4 Pilot interviews' findings

### 4.1 Capacities of disaster waste management – national

National level government institutes such as DMC, are mostly involved in policy making, resource allocation, prioritization of activities, budget allocation and monitoring of disaster management plans whereas all other related activities are delegated to local levels (Refer Sri Lanka Disaster Management

Act, No.13 of 2005). Non government institutes such as Sarvodaya provide knowledge and valuable ideas to the government sector which they gain through practical experience.

Further, findings revealed that in large scale disasters, waste were managed with the collaboration of national and local level organisations. Roles and functions of an organisation in disaster waste management varied based on the type of a disaster. As a result, organisations not owing any responsibility over disaster waste made contributions at massive disasters in their own specialized areas. For example, while one organisation cleaned roads, another cleared debris from the sea shore. Moreover, some organisations provided equipment and technical knowledge whereas some other organisations gave financial assistance.

Most national level government institutes focus more on administrative level activities whereas non government organizations focus on operational level activities. A significance fact is that government institutes don't identify their capacities to guide others on assigning tasks and gain active participation. Further, most non government institutes do not highlight these facts due to political influences, bureaucracy, de-motivation and time consuming processes. All interviewees revealed that community unawareness has a major influence on proper disaster management. In addition, inadequate legal powers and lack of operational powers are identified as major capacity gaps at national level. This is differentiated in point of view of non government organisations which only have a social responsibility or public interest.

Therefore, issues of non government organisations highly deviate from issues of government organisations. In case of workforce and physical assets, government organisations lack capacities whereas non government organisations such as Sarvodaya possess a 75,000 volunteer base and physical resources. However, most of these resources idle as there are fewer opportunities to involve in large scale disaster management activities. As a result change of attitudes of government institutes should be encouraged in getting maximum utility from in-house NGOs by sharing responsibilities, assigning considerable amount of liabilities and getting active commitment.

#### ***4.2 Capacities of disaster waste management – local***

Pilot interviews revealed that capacities at local levels are different from each district. Galle district is in sufficient capacity levels in terms of finance, technology, physical assets, management and legal powers. Specifically, government organizations in Galle district have sufficient facilitation from professionals and NGOs which give support to handle post disaster waste successfully, by introducing

new technology on waste handling, conducting workshops, research studies and financial assistance. For an example the COWAM (Construction Waste Management) project within the EU-ASIA PRO ECO II B Post Tsunami Programme was initiated to manage C&D waste in Sri Lanka. The Galle Municipal Council was selected as the beneficiary, since the area was highly built up and suffered devastation. The aim was to provide Galle area with practical solutions for implementing a sustainable C&D waste management programme and for it to become a model for all other local authorities in the country. This involves preparation of guides for public on waste management, control illegal dumping, give legal support, select suitable places for gathering waste, supply human and physical resources, implement rules and regulations and reduce use of virgin construction material. In addition, research on waste management, testing construction and recycled materials and sharing knowledge of professionals are also identified achievements of this project.

Organizations in Ampara district such as Sri Lanka Operations Centre are running with sufficient capacity. Government organizations function with financial capacity aided by donations, technologies and physical assets of NGOs. Further, training and awareness programmes are conducted to retain and enhance skills of government organisations to maintain existing capacities. For an example, in Ampara few waste management projects were initiated after the Asia Tsunami in 2004 targeting recycling of plastic items and composting of degradable components (Van der Wel and Post, 2007).

Most common issues are unawareness among community, lack of technology, physical assets and finance. This is further aggravated due to absence of pre-plans, less coordination among organizations, less innovation of technology and improper post disaster waste management mechanisms. The lack of authority to function is another common issue which impact bottom level government organizations as they have not been given enough power to initiate or implement any work without coordinating with top level departments. Other than these, lacks of professionals, lack of coordination among service providers, less research, unavailability of long term plans and frail rules and regulations affect each organisation. This is mainly impacted by improper guidance of national level organizations and absence of local frameworks for post disaster waste management. Though general solid waste management rules and regulations prevail in Sri Lanka, they are not properly implemented due to absence of penalties or incentives.

Accordingly, findings revealed that capacity of post disaster waste management exist with certain gaps which need to be addressed. Further, findings established most capacity requirements relate with functions of national level agencies involved with disaster waste management such as planning, coordinating and implementing statutorily enforceable legislation, resource allocation, budget allocation etc.



## 5 Discussion

Proposed approaches for capacity building for disaster waste management are based on various assumptions extracted from other sectors such as health and public administration identified through secondary data. Further, proposed approaches are refined in line with pilot interviews' findings.

- Skills and confidence building

It focuses on human resources: education and training to improve ability to perform functions. In addition, it attracts public for jobs and retention of individuals as they pursue such careers. This dimension focuses particularly on managerial and technical levels to extend their overall performance of a given task. In addition, development of policies and position statements supporting concepts of career progression and opportunities to apply skills development are also important to build confidence.

- Organizational implementation

This focuses on improving organization structures and processes related with waste management. This involves establishing goals, hierarchy for waste management and formal and informal communication within organization. Further, emphasis is on existing capacities on assessment of types of waste generation, risk involvement, identification of cost effective material, monitoring and evaluation methods, incentives to people involved and rules and regulations on post disaster waste management.

- Linkages and collaborations

Third focuses on building partnerships and collaborations as a means of building capacities by mechanisms which exchange skills and practice knowledge. The linkages that exist for waste management includes universities and practices, experienced researchers, different professional groups, policy makers, UN agencies, government and non government organizations, community groups and different countries. Networking and building partnerships will further bring benefits by enhancing research.

- Continuity and sustainability

This focuses on continuously maintaining acquired skills and knowledge. However, literature does not explore this concept well where it is important for post disaster waste management. Crisp *et al* (2000) suggest that capacity can be sustained by applying skills to practice. It further, can be enabled by providing opportunities to extend skills and experience which may be linked with a concept of career development.

- Investments in infrastructure

Fifth focuses on investing in infrastructure to enable smooth and effective management of waste. For example, issues related to inadequate funds for establishing recycle plants, obtaining necessary

technical know how etc, shall be addressed in relation to capacity building. Hence, information on calls for funding, fellowships and conferences is important for long term survival. Hurst (2003) argued that information flow varied between trust and experience.

- **Research and development**

Sixth focuses on developing research capacity in post disaster waste management that is useful for practice. This will add new knowledge and inventions close to practice enhancing effectiveness and efficiency of post disaster waste management. The notion 'close to practice' means that research is highly relevant to practice or policy concerns. This involves creating opportunities for research such as scholarships, funds etc.

- **Communication and coordination**

It focuses on avenues of enhancing communication and coordination capacities of post disaster waste management. This will address issues encountered among non government organizations and volunteer groups related to communication and coordination such as non existence of practical guides, transparency and accountability. This involves developing policies and strategic plans which are statutorily enforceable and creating information databases for easy reference, etc.

As discussed, the proposed approaches set out a tentative by which capacity building can be enhanced for post disaster waste management. However, it may be affected by such external factors as cultural, social, economical, political, legal and environmental. The proposed approaches provide a basis by which capacity building can be enhanced in post disaster waste management.

## **6 Conclusion**

Literature and pilot interviews reveal that though government had ambitious plans and high expectations for speedy recovery in the post Asian Tsunami period, capacity gaps prevailing in various scales under various organizations and circumstances are significant factors limiting success of post disaster management in Sri Lanka. This is also visible in post disaster waste management as well. The government organizations involved in post disaster waste management are suffering from institutional capacity gaps such as poor communication, lack of coordination and lack of authority to function. From the viewpoint of non-governmental organizations, lack of coordination, security restrictions and policy issues have been identified as main areas of concern. In addition, priority should be given to recycling process to enhance entire capacity of relevant organizations, even though recycling incurs excessive cost. These established importance of capacity building of post disaster waste management processes through enhancing capacities of individual, organizational, institutional and community levels with skills development, information management and resource acquisition for

a sustainable system. Accordingly, this paper presents proposed approaches to enhance capacities for effective disaster waste management in Sri Lanka.

## References

1. 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, 117-125.
2. Blakely E. (2007) *Collaborating to build communities of opportunity*, Roosevelt Institute Symposium, November 2007, New Orleans Louisiana.
3. El-Sayegh S.M. (2008) *Risk assessment and allocation in the UAE construction industry*. International journal of project management, 26(1), 431-438.
4. Formoso C.T., Isatto E.L. and Hirota, E.H. (1999) *Method for waste control in the building industry*, Proceedings IGLC-7, 7th Conference of the International Group for Lean Construction, 26-28 July. Berkeley: CA Restoring
5. General Accounting Office (2008) *General Accounting Office reports & testimony. Hurricane Katrina: Continuing debris removal and disposal issues*, GAO-08-985R. Washington, DC: GAO.
6. Gopalakrishnan S. (2007) *Disaster*. Stanley Medical College, Chennai.
7. Gunawardena D.A. and Rajakaruna, A.(2005) Utilization of Tsunami debris for reconstruction process in Sri Lanka.
8. International Strategy for Disaster Reduction (2008) *Disaster Risk Reduction Strategies and Risk Management Practices: Critical Elements for Adaptation to Climate Change*, [www.unisdr.org/eng/library/lib-terminology-eng%20home.htm](http://www.unisdr.org/eng/library/lib-terminology-eng%20home.htm)
9. Jayawardane A.K.W. (2006) *Disaster mitigation initiatives in Sri Lanka*. Deen faculty of engineering and professor of Civil Engineering. University of Moratuwa.
10. 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 13(2):171-190
11. Kelly C. (2010) *Rapid Environmental impact Assessment: Haiti Earthquake-January 12, 2010*, [www.smtn.org](http://www.smtn.org)
12. Khan H. Vasilesc L. G. and Khan, H.(2007) *Disaster Management Cycle – a theoretical approach*: Management and Marketing Craiova, 2008(1), 43-50.
13. Lauritzen E. K.(1998) *Emergency construction waste management*, Safety Science, 30, 45–53
14. McEntire D. A. (2005) *Why vulnerability matters Exploring the merit of an inclusive disaster reduction concept*, Disaster Prevention and Management, 14 (2), 206-222.
15. Mitchell T. (2006) *Building a disaster resilient future*. (PhD). University College London.

16. Perera, K. L. S. (2003) "An Overview Of The Issue Of Solid Waste Management In Sri Lanka" Proceedings of the Third International Conference on Environment and Health, Chennai, India. pp. 15-17
17. Petersen M. (2004) *waste management following disasters*, International conference on post disaster reconstruction, 22-23 April, UK. Coventry: IF Research group.
18. Shaw R. (2006) *Indian Ocean tsunami and aftermath: need for environment-disaster synergy in the reconstruction process*, Disaster Prevention and Management 7(1):5-20
19. Srinivas H. and Nakagawa Y. (2008) *Environmental implications for disaster preparedness: Lessons Learnt from the Indian Ocean Tsunami*, Journal of Environmental Management, 8(1), 4-13
20. UNDP (2005) *Tsunami Recovery Waste Management Programme (TRWMP) NAD-Nias*, UNDP, Indonesia.
21. UNEP (2005) *Sri Lanka post tsunami environmental assessment*, United Nation Environment Program (UNEP) Geneva: UNEP (DEP/0758/GE)
22. Van der Wel A. and Post V. (2007) *Solid Waste Management in Sri Lanka: Policy & Strategy*, CORDAID Tsunami Reconstruction 4
23. Wang M. and Chou H. (2003) *Risk allocation and risk handling of highway projects in Taiwan*, Journal of Management Engineers, 19(2), 60–80.