

Northumbria Research Link

Citation: Perera, Srinath, McAlinden, Christopher and Ameratunga, Dilanthi (2010) Investigating the status of disaster management within a world-wide context: a case study analysis. In: 18th CIB World Building Congress, 10-13 May 2010, Salford, Manchester, UK.

URL:

This version was downloaded from Northumbria Research Link:
<http://nrl.northumbria.ac.uk/13016/>

Northumbria University has developed Northumbria Research Link (NRL) to enable users to access the University's research output. Copyright © and moral rights for items on NRL are retained by the individual author(s) and/or other copyright owners. Single copies of full items 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 are given, as well as a hyperlink and/or URL to the original metadata page. The content must not be changed in any way. Full items must not be sold commercially in any format or medium without formal permission of the copyright holder. The full policy is available online: <http://nrl.northumbria.ac.uk/policies.html>

This document may differ from the final, published version of the research and has been made available online in accordance with publisher policies. To read and/or cite from the published version of the research, please visit the publisher's website (a subscription may be required.)

www.northumbria.ac.uk/nrl



Investigating the Status of Disaster Management within a world-wide context: A Case Study Analysis

Perera, S.

Northumbria University

(e-mail: srinath.perera@northumbria.ac.uk)

Alinden, C.M.

University of Ulster

(e-mail: cmcalinden@live.co.uk)

Amaratunga, D.

University of Salford

(e-mail: r.d.g.amaratunga@salford.ac.uk)

Abstract

Disasters can be described as feats of spontaneous occurrences, in that they can happen at any minute at any time. There are two classifications of disasters, which are, natural disasters that cannot be predicted and continuously occur throughout society. While the other classification of disaster is that of man-made disasters, where disasters are caused not by natural phenomena, but by man's or society's actions, involuntary or voluntary, sudden or slow, with grave consequences to the population and the environment (Hays, 2008). Both these types of disasters can be controlled to a certain extent through appropriate disaster management plans and if managed efficiently have the potential to reduce the likelihood of overwhelming loss of lives and property. The Disaster Management cycle is split into four elements of response, recovery, mitigation and preparedness which contribute to emergency protocols of a nation when disaster strikes. Therefore, nations should incorporate them in their development plans and ensure efficient follow-up measures at community, national and international levels. This paper investigates worldwide disasters in order to examine how these disasters were managed and to identify the lessons learned. It provides an analysis of five worldwide case studies of recent disasters (Tsunami in Sri Lanka, Hurricane Katrina in New Orleans, Earthquake in Pakistan, Summer floods in the UK and Flooding of the West-Link in Northern Ireland) mapping those to the four staged disaster management cycle. The paper analyses in detail the strategies adopted at each stage of the cycle comparing strengths and weaknesses of each case. It concludes that there had been satisfactory progress in both response and recovery phases but more attention is needed for disaster mitigation and preparedness.

Keywords: disaster management, response, recovery, mitigation, preparedness, case studies

1. Background

The world is in serious need of a sustained and comprehensive disaster reduction strategy as over the past few decades, a good deal of attention has been paid to disaster management. As a result, a number of theories have become increasingly refined to explain how disasters come about. The occurrences of disasters within worldwide context are on the increase and have become of growing interest within society. The examples of earthquakes in the Middle East and Haiti or flash floods throughout the UK have highlighted the urgent need for nations to provide the public with the necessary information needed to protect from such likely events. Within Northern Ireland (NI) a major road that links all other routes to the city of Belfast known as the West-Link was flooded in flash floods on 16th August 2008 (BBC News, 2008a) when torrential rain swept throughout NI and the newly constructed underpass was filled with 1000s of litres of water. Although there has been many a disaster gone before the West-Link, in today's society with the amount of technology and experts in there given fields disasters such as the West-Link may have been avoided. Addleson (1992) and Houghton (2005) believe that disasters continue to occur because of economic pressures to reduce costs or cut corners, reliance on untested innovation, coupled with poor communication and a failure to adhere to the available recommendations for good building practice. CIB (199) add that all of these influences can trigger the following main categories of errors. A number of other potential reasons of how and why these disasters took place may be down to climate change/global warming not only having an impact in NI but the rest of the world. This may be down to geological positioning in that countries such as in the Middle East experience earthquakes or that of tsunamis more frequently compared to other countries (Ravilious, 2007) or is it down to the construction industry not implementing structures to deal with particular types of disaster typical to the regions concerned.

1.1 Disaster management cycle

Messe (2003) identifies the four key phases in disaster management as Response, Recovery, Mitigation and Preparedness. These can be described as response being the efforts to minimize the hazards created by a disaster with such examples being search and rescue techniques. Recovery is the returning of the community to a state of normalcy. Examples include temporary housing, grants and medical care to re-establish and settle destabilised and affected population. Mitigation is minimizing the effects of disaster which may include building codes and zoning, vulnerability analyses and public education. Preparedness can be described as the planning process and how to respond to disasters, for example: preparedness plans; emergency exercises/training; warning systems. These key elements are then represented alongside various disaster scenarios to give the reader an extent of what occurred during each stage. The disasters in question on a worldwide scale are the Sri Lankan Tsunami, Hurricane Katrina, The Pakistan Earthquake and the UK floods. Within N.I the most poignant and recent event to date which was analysed is that of the West-link flooding where a major road network into and out of one of N.I's main cities was flooded leading to extreme chaos.

2. World disaster management case studies

2.1 Sri Lankan tsunami

On the 26th December 2004, a tsunami wave began to impact the eastern coast of Sri Lanka after the earth's plates passed over one another causing an earthquake. A second wave struck roughly 20 minutes later and the complexity interaction between water-energy, sea-bed and terrestrial terrain meant that the effects of the tsunami were different in various places. Overall, the tsunami left a major impact on two-thirds of the coastline with seawater penetrating from tens to hundreds of metres inland resulting in the destruction of 100,000 homes taking away many livelihoods.

2.1.1 Response

According to ADBI (2005) in the immediate aftermath of the tsunami, the Ministry of Public Security, Law and Order set up an operations centre, known as the Centre for National Operations (CNO). Their main aim was to handle the immediate response activities and the Secretary to the Ministry was appointed to oversee the coordination of these rescue and relief activities. Sri Lankan institutions responded reasonably well. As ADBI (2005) claimed that essential medical aid, emergency food and other relief supplies were mobilized within a day. Temporary shelters were also provided in the form of undamaged schools, religious buildings, and tents. Amongst all the aftermath communities and groups co-operated across all differences that had divided them in the past. Public and private sector organizations cooperated and organized relief efforts at different community levels (ADBI, 2005).

2.1.2 Recovery

The lack of awareness of the nature of a tsunami, among the Sri Lankan public, is quoted as one of the reasons for this mammoth death toll Karim (2004). Weerakoon et.al.(2007) states that during the immediate relief stage, Sri Lanka received humanitarian relief aid from donors all over the world. The aid included financial assistance, equipment, materials and human resources for rescue/relief missions. A number of years on and Sri Lanka is yet to recover fully from the devastation of the tsunami.

2.1.3 Mitigation

It is clear that the post tsunami recovery attempts in Sri Lanka were less than successful due to the fact that the governments of developing countries often face, with regards to post disaster recovery, is a limited response capacity to implement recovery strategies (UNDP, 2006). As a result, the governments of affected countries specifically developing countries are financially incapable of launching successful long term recovery programmes (RICS, 2006). A lack of appropriate knowledge can be recognised as another factor hindering the implementation of successful recovery plans as Sri Lankan authorities may have been incapacitated when responding to post tsunami recovery attempts due to the fact that Sri Lanka had not experienced a tsunami for centuries and there was no reasonably predicted reason for them to be prepared for devastation of that scale.

2.1.4 Preparedness

Since the tsunami, Sri-Lanka has now engaged with the Red Cross in order to prepare for future events of a tsunami re-occurring. As Wijesinghe (2009) states a safety programme was set up in response to the 2004 tsunami, it has a theme of timely response to disasters and preparedness and volunteers are the foundation behind its success. According to Wijesinghe (2009) the Gampaha branch has conducted a series of training programmes, and refresher courses facilitated by the Japanese Red Cross and have written, printed and distributed 8,000 textbooks on water safety in Sri Lanka.

2.2 Hurricane Katrina

Hurricane Katrina hit the south-eastern part of the USA on the 29th August 2005 with devastating effects. Wind speeds of 127 miles per hour/200 kilometres per hour Met Office (2009) crashed into the New Orleans shores causing fatalities and damaging livelihoods. Smith (2005) claims, that Hurricane Katrina in economic terms is the worst natural disaster in the history of the United States.

2.2.1 Response

There were a number of responses to the Hurricane, both short and long term, in the south-east USA for example, there was the immediate evacuation of hundreds of thousands of people while the remainder of people in New Orleans sheltered in the Super-dome football stadium. Further, post responses included the reconstruction of broken levees by engineers and the flood water in the streets of New Orleans to be drained away as their collapse largely contributed to the consequent flooding and deaths in New Orleans Met Office (2009). Even though the USA is one of the wealthiest developed countries in the world, it highlighted that when a disaster is large enough, even very developed countries struggle to cope with natural disasters.

2.2.2 Recovery

After hurricane Katrina the government proposed the following actions to secure New Orleans to its previous state as proposed by DHS (2008):

- Rebuilding communities
- Rebuilding the economy
- Removing debris and restoring the environment
- Providing health care, social services, food and education
- Providing immediate recovery and relief
- Providing immediate medical response and relief measures
- Security and better preparation for future storms

It is important to realise that the city of New Orleans was a complete white wash by the hurricane and the proposals as mentioned above could take months even years before they even materialise, to restore normality within the city.

2.2.3 Mitigation

A disaster like Hurricane Katrina, although infrequent, may require financial institutions to implement their disaster recovery plans and to improvise creative solutions to address unforeseen difficulties quickly. The FFIEC (2008) proposed the following to take into consideration to minimise disasters as the likes of Katrina:

- Thoroughly plan/prepare
- Consider disaster drills
- Assess disaster drills
- Consider alternate transportation methods
- Do recovery facilities have sufficient capacity

All the points above have been implemented by coastal cities around the USA in order for people to understand the mitigation options to consider when a hurricane strikes.

2.2.4 Preparedness

Levees, protective embankments which had helped New Orleans escape previous damage, were broken by the storm surge moving inland through rivers raising the level of Lake Pontchartrain and straining the levees by the pressure on them. It should be taken into account that safer more protective levees should be built. The strong winds although did not directly kill many people, it did produce a storm surge leading to the flooding of coastal areas Met Office (2009) and was responsible for many deaths. It is believed that the City of New Orleans could have prepared itself much better for this type of disaster as it is hard to believe how New Orleans will recover from the hurricane. FFIEC (2008), have provided lessons they learned from the effects of Hurricane Katrina of which are FFIEC (2008):

- Communications outages made it difficult to locate missing personnel.
- Access to reliable transportation
- Lack of electrical power or fuel for generators
- Multiple facilities were destroyed outright or sustained significant damage.

Hopefully the lessons learned can prepare New Orleans and other coastal cities across the USA to be better prepared for disaster.

2.3 Pakistan earthquake

On October 8, 2005, an earthquake measuring 7.6 on the Richter scale hit the North West Frontier Province of Pakistan and the state of Azad Jammu and Kashmir, causing more than 70,000 deaths, incalculable injuries and wide-scale destruction of private houses and public infrastructure.

2.3.1 Response

Immediately after the earthquake, the government and non-governmental organizations focused on relief to help victims survive. Haigh and Amaratunga (2008) commented that as part of the relief scheme, the Government of Pakistan provides a financial assistance grant to those who had suffered a death within their family, those injured in the earthquake and those who had suffered damage to their homes. In addition the earthquake caused many landslides and rendered landless the people in high risk areas. Therefore, if people receive cash assistance, they still have no land to reconstruct on and will end up having to live in official or makeshift camp sites.

2.3.2 Recovery

The Government of Pakistan's first priorities following the earthquake were to provide victims with temporary shelter to survive the impending winter. The central government created the Federal Relief Commission to coordinate relief efforts and implement a 'National Action Plan' (Haigh and Amaratunga, 2008). Having struggled with its efforts to first distribute tents and later corrugated iron sheets, the government decided to facilitate the relief and rehabilitation process through a financial assistance scheme by quickly distributing a cash grant to those whose houses had been damaged (Moen, 2006).

2.3.3 Mitigation

Haigh and Amaratunga (2008) suggested that the design of and the problems that have plagued the implementation of the housing reconstruction program of Earthquake Reconstruction and Rehabilitation Authority can teach us a lot about how to reform local government institutions.. The design of the housing reconstruction program and its failings has highlighted the acute need for developing additional capacities. These capacities include appropriate managerial structures, necessary infrastructure, sufficient resources, and the development of social mobilisation and information management capacities (Haigh and Amaratunga, 2008). Until this is done, it is unreasonable to expect buildings and infrastructure to withstand future earthquakes to a reasonable level.

2.3.4 Preparedness

The Earthquake Reconstruction and Rehabilitation Authority's failure to publicise its policies, have left many people feeling victimised and unprepared for the earthquake in terms of response and recovery (Haigh and Amaratunga, 2008). For example, the majority of deaths resulted in a failure to publicise the schedule of inspection visits. Even people directly involved in the reconstruction process did not appear to have complete and up to date knowledge of the various Earthquake Reconstruction and Rehabilitation Authority's policies (Haigh and Amaratunga, 2008) giving the feeling that the association is oblivious to local problems which may have been the difference between a person's fight for survival.

2.4 UK floods

The summer of 2007 saw the wettest period of rain-fall on record as more than 414mm of rain fell across England and Wales in the months May, June and July. The heavy rain caused widespread flooding bringing chaos to parts of north-east and central England and a month later, to parts of central and southern England and Wales.

2.4.1 Response

The floods highlighted that there was still too much learning on the job by dedicated professionals rather than pre-planned responses moving into action. Although the key policies to improve the country's response to flooding and other similar major events are outlined as proposed by Hadrill (2007):

- Clarification and guidance on how to respond to floods
- Better co-ordination and implementation of responses at regional or national level
- Best-practice learning should be encouraged

The responses above were carried out during the summer floods but were not strictly adhered to by key professionals in charge of the necessary response actions; this may have had a very significant impact if carried out correctly and promptly.

2.4.2 Recovery

Since the floods the Government had to develop a long-term strategy for the fight against flooding. Following an industry-wide review into lessons that should be learned, Hadrill (2007) believes action is needed in the following four areas:

- National targets and leadership supporting local empowerment
- Identifying and reducing flood risk for today and tomorrow
- Planning policy fit for the future
- Preparing for floods and how to respond

The Environment Agency says a total of 56,000 homes and businesses were flooded during the floods and since then, 73,000 people have signed up for its free flood-warning scheme. Also thirty-four new flood defences have been completed since last summer, providing protection for over 30,000 homes.

2.4.3 Mitigation

Hadrill (2007) states that the public has a right to know the level of flood risk across the country and how many homes and businesses are at high risk of flooding both now and in the future. The Environment Agency should make publicly available all maps and flood risk information showing relative risk of flooding from all sources across the country as soon as possible and annually thereafter. He also proposed that the Government should produce a 25-year national strategic plan to

fight against flooding to achieve proposed targets across the key forms of flood defences, such as coastal flooding, inland flooding and drainage.

2.4.4 Preparedness

The UK Government needs to ensure that the country is much better prepared for floods, in particular, how to identify and protect critical infrastructure and other key sites at a local level and how to promote appropriate insurance protection, especially among Small Medium Enterprises (Hadrill, 2007). It should be noted that one body should be accountable for overseeing and coordinating response efforts. As according to Hadrill (2007) there are currently too many organisations each with too many competing priorities to be able to give the fight against flooding the focus that it deserves, as one national body should be given overall responsibility in the analysis and research for the fight against flooding. The floods in the summer of 2007 also demonstrated the need for flood risk management to be properly coordinated, incorporating all sources of flooding with key emphases on setting clearer targets and developing new and better long-term strategies.

2.5 Flooding of the west-link

The West-Link flooding occurred in N I on 18th August 2008 where a multi-million pound underpass that was being built to control the flow of traffic entering and exiting the city of Belfast was submerged under 20ft of flood water causing widespread chaos across NI as one of the major construction projects in Belfast was seen as a failure in many a public's opinion.

2.5.1 Response

In response contractors made immediate notification with the emergency services i.e. police/fire departments to implement an emergency programme immediately, on site under the categories of Bronze/Silver/Gold. The first aim of the emergency services was to close the road to ensure the safety of the public, while on site the contractor drew on resources that they could use to begin the cleaning process. Further to this AMEY (2008) states that as a result of the immense flooding Northern Ireland Water deployed resources and contractors throughout the event and around the clock to try and cope with the situation. Crisis meetings were also held in the offices of the civil service to consider all effects of rainfall not only in Belfast but across the whole of NI.

2.5.2 Recovery

To recover from such a catastrophe all necessary resources were employed to re-open the road. Additional contractors were then employed to pump water out of the underpass. When the water was cleared the contractor then installed monitoring points on the floor slab of the underpass to check for movement and then managed and maintained the drainage system which was to be cleaned and checked on a regular basis. Further to this, all road lighting and all electrical services had to be cleaned and tested, with all lighting in the underpass replaced and inspected. Finally the whole road had to be power-washed and cleaned to remove the sludge which was carried out and disposed off site by half a dozen slurry tankers.

2.5.3 Mitigation

Monitoring regimes were put in place, although one was already implemented in the Clowney river which was inspected on a regular basis, the frequency of the inspections and research of weather reports were increased. The emergency services were also deployed to be on stand-by and river monitors introduced to measure warnings upon the river reaching certain levels. A physical model (prototype) exercise of the underpass was assembled to test the regime in that it performed as expected to reduce the risk of further flooding. Further mitigation considerations introduced as, outlined by AMEY (2008):

- Provide advance warning of potential flooding events
- Assess the overall performance of the upstream and downstream culverts
- Open the Penstock Valve on the Black-staff culvert when heavy rain is forecast
- Monitoring of the Trash Screens where to be enhanced
- The excess flows to be routed to underground storage tanks

2.5.4 Preparedness

In preparation some seven years ago hazards such as flooding were identified in a risk management workshop and the underpass was designed in compliance with local authority regulations and designed to the appropriate level of rainfall. Although the risk of excessive rainfall was an issue to prepare for, it may have prevented the extreme flooding, although a certain amount of risk will always remain.

3. Discussions & conclusions

The paper evaluated 5 recent world wide disasters mapping these to the four stage disaster cycle proposed by Messe (2003). The summary of the analysis is presented in Table 1 *Summary of Comparison of World Wide Disasters*

	<i>Response</i>	<i>Recovery</i>	<i>Mitigation</i>	<i>Preparedness</i>
<i>Sri-Lankan (Tsunami)</i>	<i>Ministry of public security set up an operations centre to oversee rescue and relief actions; Medical aid and food was provided</i>	<i>Donors all over the world donated any emergency reserves; Need for adequate and reliable infrastructure to deal with effects of future Tsunamis</i>	<i>Poor response capacities; Local government to implement post disaster recovery strategies; Inefficient knowledge and training of disasters lead to lives being lost</i>	<i>Sri-Lanka and Red Cross engaged to prepare for future events; Training in first aid and life rescue was laid down as criteria</i>

<i>New Orleans (Hurricane Katrina)</i>	<i>Evacuating of civilians; Those who didn't evacuate sheltered in the Super-dome stadium; Poor construction of levees aided the Hurricanes destruction</i>	<i>Restore transportation; Rebuild economy; Provide enhanced security; Strengthen infrastructure</i>	<i>Consider disaster plans; Assess disaster drills; Think of essential necessities needed during a disaster</i>	<i>No accesses to reliable transportation; No electrical and fuel reserves; No back-up communications systems</i>
<i>Pakistan (Earthquake)</i>	<i>Government and non-governments focused on relief to help victims; Grants where issued</i>	<i>Shelters provided; Central government created NAP to co-ordinate relief efforts; Financial assistance schemes; Earthquake proof housing</i>	<i>Need for additional capacities, infrastructure, and financial resources to cope with earthquakes; Insufficient immobilisation of resources</i>	<i>Civilians felt unprepared and a sense of insecurity; More inspection visits; Distribute knowledge of earthquake reconstruction</i>
<i>UK Summer floods (Flooding)</i>	<i>Emergency services deployed; Although lack of co-ordination of responses; Insurance companies provided flood cover</i>	<i>Inadequate preparation of floods; Plan a policy fit for purpose; Identify and reduce flood risk</i>	<i>Make flood maps available showing levels of risk; Introduce a 25 year national strategic plan; Improve building regulations to cope with flooding</i>	<i>Government to identify how to protect key infrastructure; Only allow one government body the control of fighting future floods</i>
<i>West-Link (Flooding)</i>	<i>Emergency services deployed; Emergency programmes implemented; Closure of roads; Clean-up process began; Extra resources were provided; Crisis meetings held</i>	<i>Re-open roads; Additional contractors employed; Monitoring points installed on slab of underpass; New electrical services in underpass; Power-wash of sludge</i>	<i>Monitoring regimes put in place; Frequent inspections of drains; Weather reports increased; Emergency services on stand-by; A prototype tested to improve features of underpass</i>	<i>Risk management workshops 7 years ago dealt with flood issues and culverts were designed accordingly; Advanced meetings held</i>

. In the case studies analysed it is clear that the response to disasters in most cases have been adequate or satisfactory. Although recovery has been slow especially in the case of Hurricane Katrina there had been marked improvement. It is clear that most attention is needed for mitigation and improving

disaster preparedness. Much work is needed in these areas to make societies and communities around the world to be made them resilient to possible disasters.

As disasters are continually disrupting society with enormous damage to human life environment and the economy, it emphasises the need to achieve a greater understanding of the four main phases of the disaster management cycle to decrease the public's vulnerability of disasters through identifying their specific needs at the different stages of the disaster management plan. There may also be the recommendation for investigating disasters from the past and how governments back then were able to deal with terrorist threats or the events of a likely tsunami or hurricane in comparison to more recent disasters. In all, this study has presented a range of the different types of disaster, the approaches before, during and after a disaster and how they affect different livelihoods. The evaluation and categorisation and mapping of disasters to the disaster management life cycle enable a better understanding of the status of disaster management on a worldwide context.

This paper focused to give an account for the importance of disaster management in the four key elements of the disaster cycle through a discussion of literature findings on disasters, the types of disasters, different categories of disaster, case studies on recent catastrophic events and the role of that particular nation in implementing its role in providing disaster management using the four key stages of recovery, response, mitigation and preparedness.

Table 1 Summary of Comparison of World Wide Disasters

	<i>Response</i>	<i>Recovery</i>	<i>Mitigation</i>	<i>Preparedness</i>
<i>Sri-Lanka (Tsunami)</i>	<i>Ministry of public security set up an operations centre to oversee rescue and relief actions; Medical aid and food was provided</i>	<i>Donors all over the world donated any emergency reserves; Need for adequate and reliable infrastructure to deal with effects of future Tsunamis</i>	<i>Poor response capacities; Local government to implement post disaster recovery strategies; Inefficient knowledge and training of disasters lead to lives being lost</i>	<i>Sri-Lanka and Red Cross engaged to prepare for future events; Training in first aid and life rescue was laid down as criteria</i>
<i>New Orleans (Hurricane Katrina)</i>	<i>Evacuating of civilians; Those who didn't evacuate sheltered in the Super-dome stadium; Poor construction of levees aided the Hurricanes destruction</i>	<i>Restore transportation; Rebuild economy; Provide enhanced security; Strengthen infrastructure</i>	<i>Consider disaster plans; Assess disaster drills; Think of essential necessities needed during a disaster</i>	<i>No accesses to reliable transportation; No electrical and fuel reserves; No back-up communications systems</i>
<i>Pakistan (Earthquake)</i>	<i>Government and non-governments focused on relief to help victims; Grants where issued</i>	<i>Shelters provided; Central government created NAP to co-ordinate relief efforts; Financial assistance schemes; Earthquake proof housing</i>	<i>Need for additional capacities, infrastructure, and financial resources to cope with earthquakes; Insufficient immobilisation of resources</i>	<i>Civilians felt unprepared and a sense of insecurity; More inspection visits; Distribute knowledge of earthquake reconstruction</i>
<i>UK Summer floods (Flooding)</i>	<i>Emergency services deployed; Although lack of co-ordination of responses; Insurance companies provided flood cover</i>	<i>Inadequate preparation of floods; Plan a policy fit for purpose; Identify and reduce flood risk</i>	<i>Make flood maps available showing levels of risk; Introduce a 25 year national strategic plan; Improve building regulations to cope with flooding</i>	<i>Government to identify how to protect key infrastructure; Only allow one government body the control of fighting future floods</i>
<i>West-Link (Flooding)</i>	<i>Emergency services deployed; Emergency programmes implemented; Closure of roads; Clean-up process began; Extra resources were provided; Crisis meetings held</i>	<i>Re-open roads; Additional contractors employed; Monitoring points installed on slab of underpass; New electrical services in underpass; Power-wash of sludge</i>	<i>Monitoring regimes put in place; Frequent inspections of drains; Weather reports increased; Emergency services on stand-by; A prototype tested to improve features of underpass</i>	<i>Risk management workshops 7 years ago dealt with flood issues and culverts were designed accordingly; Advanced meetings held</i>

Therefore, continued research for the future could highlight:

Establishing a relationship between disaster management and its implementation,

Recognising the best practices of other countries and implying them to others

Demonstrating the importance of a good disaster management plan

Further research may well elicit how an evolving timeline of technological advances reduces the cost of disaster management.

References

ADBI., 2005. *Tsunami: Immediate Impact and Response* Available online: <http://www.adbi.org/discussion-paper/2005/11/10/1491.tsunami.sri.lanka/tsunami.immediateimpact.and.response/> [Accessed 29th March 2009]

Addleson, L., 1992. *Building Failures: A guide to diagnosis, remedy and prevention* 3rd edition. London: Butterworth-Heinemann

Amey., 2008. *Broadway Underpass, West-link, Belfast* Available online: <http://www.roadsni.gov.uk/broadwayunderpassfloodingreport.pdf> [Accessed 8th Feb 2009]

BBC NEWS., 2008 (a). *Clear-up Continues as Water Falls* Available online: http://news.bbc.co.uk/1/hi/northern_ireland/7567374.stm [Accessed 2nd Jan 2009]

BBC NEWS., 2008 (b). *Underpass Defended after Flooding* Available online: http://news.bbc.co.uk/1/hi/northern_ireland/7569043.stm [Accessed 3rd Jan 2009]

CIB., 1993. *Building pathology: A state of the art report*, Holland: International Council for Building Research and Information

DHS.,2008. *The First Year after Hurricane Katrina:What the Federal Government Did* Available online: http://www.dhs.gov/xfoia/archives/gc_1157649340100.shtm [Accessed 10th Feb 2009]

Haigh. R and Amaratunga. D., 2008. BEAR, BUILDING RESILIENCE International Conference on Building Education and Research, School of the Built Environment: University of Salford, UK

FFIEC., 2008. *Lessons Learned From Hurricane Katrina: Preparing Your Institution for a Catastrophic Event Are we prepared?* Available online: http://www.ffiec.gov/katrina_lessons.htm [Accessed 22nd March 2009]

Hadrill. S., 2007. *Flooding in the UK* Available online: <http://www.abi.org.uk/BookShop/ResearchReports/Flooding%20in%20the%20UK%20Full.pdf> [Accessed 15th March 2009]

Hays. W., 2008. *Glossary of New Concepts in Disaster*. Available online: <http://pdm.medicine.wisc.edu/home.html> [Accessed 23rd Oct 2008]

Houghton. E., 2005. *Built Well? A forensic approach to the prevention diagnosis and cure of building defects*. London: RIBA Enterprises Ltd

Karim. N., 2004. *Options for Floods and Drought Preparedness in Bangladesh*, in *Second International Conference on Post-disaster Reconstruction: Planning for Reconstruction* Coventry University: UK.

Messe. M., 2003. *The Role of Local Institutions and their Interaction in Disaster Risk Mitigation*: Available online: <http://www.fao.org/docrep/006/ad710e/ad710e03.htm> [Accessed 19th Oct 2008]

Met Office., 2009. *Hurricane Katrina* Available online: <http://www.metoffice.gov.uk/education/secondary/students/katrina/index.html> [Accessed 31st Jan 2009]

Moeen. C., 2006. *For a review of the relief programme, One Year After the Earthquake*, South Asian Journal Vol. 14. [Accessed 31st Jan 2009]

Ravilious. K., 2007, *National Geographic News*. Available online: <http://news.nationalgeographic.com/news/2007/07/070726-lebanon-quake.html> [Accessed 14th Oct 2008]

RICS., 2006. *Mind the Gap! Post-disaster reconstruction and the transition online humanitarian relief*. Available online: <http://www.rics.org> [Accessed 1st Feb 2009]

Smith. M., 2005. *Hurricane Katrina Whicita: Kansas*

UNDP., 2006 (b). *Post-Tsunami Recovery and Reconstruction Strategy*. United Nations Development Programme: Colombo

Weerakoon. D, Jayasuriya. S, Arunatilake.N, Steele. P., 2007. *Economic Challenges of Post-Tsunami reconstruction in Sri Lanka*, Asian Development Bank Institute: Tokyo.

Wijesinghe. R., 2009. Communications Manager, International Federation in Sri Lanka. Available online: <http://www.reliefweb.int/rw/rwb.nsf/db900sid/FJTC-7PSJWE?OpenDocument>
[Accessed 22nd March 2009]