University of Southern Queensland
Faculty of Engineering and Surveying

Natural Disaster Risk Management in South Asia

A dissertation submitted by

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Abstract

Global economic growth and unprecedented population expansion coupled with climate change and unsustainable development will continue to cause an increase in the frequency, intensity and severity of natural disaster events into the future. Only through a clear understanding and appreciation of disaster risks can decision makers adequately prioritise the implementation of resilience building measures into development programs.

The aim of this dissertation is to critically analyse the natural disaster risk management strategies, emergency preparedness and response readiness of South Asian countries. To this end the available literature and statistical data was first analysed before a comparative study was undertaken of how the frameworks and mechanisms of the South Asia Region compare to global standards. Three South Asian countries, Bangladesh, India and Pakistan were studied in detail in an attempt to measure the region against these world standards. As part of this analysis a study of the roles that the various actors play in disaster risk management, specifically the restoration of engineering services after a disaster event was undertaken. Further detailed case studies were conducted to analyse how these frameworks and mechanisms were actually implemented during disaster events.

This combination of research methods revealed that significant advancements have been made in recent years towards individual communities, districts, states, countries and regions becoming more resilient to natural disaster events. The available literature and statistics reveal that there are vast areas for improvement available particularly with regard to reducing the damage to infrastructure caused by floods, earthquakes and storms. It has been conclude that a holistic approach towards disaster risk management that includes improved regional and global cooperation is vital to public safety and economic well being. One of the key outcomes of this research suggests that private companies have a responsibility to place greater importance on disaster risks when investing in infrastructure and development programs.

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Certification of Dissertation

I certify that the ideas, designs and experimental work, results, analyses and conclusions set out in this dissertation are entirely my own effort, except where otherwise indicated and acknowledged.

I further certify that the work is original and has not been previously submitted for assessment in any other course or institution, except where specifically stated.

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Nash Hancock

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Glossary of Terms

US$ - unless otherwise stated all currency measurements in this paper are in US Dollars

ADPC – Asian Disaster Preparedness Centre

ADB – Asia Development Bank

EM-DAT – International Disaster Database EM-DAT: The OFDA/CRED International Disaster Database

GDP – Gross Domestic Product

GIS – Geographic Information Systems

GFDRR – Global Facility for Disaster Reduction and Recovery

HFA – Hyogo Framework for Action 2005-2015

IPCC – Intergovernmental Panel on Climate Change

ISDR – International Strategy for Disaster Reduction is the framework adopted by the United Nations member states in 2000

Liquefaction of Soil – A mechanism where saturated/partially saturated soil loses strength/stiffness in response to stress, for example during an earthquake, causing the soil to behave like a liquid

MDG - Millennium Development Goals

NGO – Non-Government Organisation

Non-Structural Measures – Refers to the non-physical elements, awareness, education, policies, legislation, regulations, knowledge, public involvement, methods and operating practices that can reduce impacts and potential risks

RedR – the international Register of Engineers for Disaster Relief

Resilience – The ability of a system, community, environment or society to adapt to and resist hazards in order to remain functional

Risk Finance – Financial mechanisms created to reduce vulnerability to natural disaster events by implementing instruments including insurance policies and catastrophe bonds which spread risk in exchange for a premium

Risk Transfer – Mechanisms for removing the risk from one area, region, system, environment, time period or community and shifting that risk to another location. Climate change is the ultimate method of risk transfer. For example high polluting industrial countries transfer the risks of anthropogenic climate change to other nations more susceptible to the effects of severe weather and rising sea levels. Furthermore the climate modifying countries accrue the present risk to a future time when the effects and losses due to climate change will surface

SAARC – South Asian Association for Regional Cooperation

Structural Measures – Refers to the physical construction that decreases or avoids the potential impacts of hazards, this includes engineering measures, the construction of hazard resistant and protective structures and infrastructure

UN – United Nations

UNDP – United Nations Development Program

UNICEF – United Nations Children's Fund

UNISDR – United Nations Office for Disaster Risk Reduction

USGS – United States Geological Survey

Vulnerability – Physical, environmental, social and economic factors and processes that increase the susceptibility of a community to hazards

WFEO – World Federation of Engineering Organisations

WMO – World Meteorological Organisation

1 Introduction

1.1 Background

Since 1980 there have been on average more than 300 natural disaster events per year across the globe, killing an estimated 75 000 people each year, affecting more than 180 million lives and costing more than USUS$75 billion annually.

The South Asia Region (see Figure 1) experiences on average about 40 natural disaster events each year, resulting in about 17 000 lives lost, affecting about 60 million people and causing damages amounting to at least USUS$3.7 billion annually (EM-DAT 2014).

These figures are quite significant and highlight the importance of effective disaster risk management techniques. Engineers play a key role in disaster risk management throughout the world.

Figure 1: South Asia Political Boundary Map (Free World Maps 2014)

1.2 Aim

This project seeks to critically analyse the natural disaster risk management strategies, emergency preparedness and response readiness of countries in the Southern Asian Region including a gap analysis between selected Southern Asian countries and world standards. A focus area will be the roles which the various stakeholders play in disaster risk reduction with particular reference to the restoration of engineering services post disaster event. The final section of this research project will contain an assessment of recent natural disaster events and one high potential risk scenario as case studies.

1.3 Objectives

A broad objective of this study is to generate discussion amongst fellow engineers and decision makers about natural disaster risks and the importance of integrating disaster risk reduction mechanisms into sustainable development.

The specific objectives of this project are to:

1. Research literature and background material relating to:
    - The type, frequency and severity of natural disaster events globally and in South Asia
    - Global disaster risk management strategies
    - Disaster risk management strategies for the three dominant types applicable to South Asia
2. Select up to 3 countries in South Asia for a study of:
    - Natural disaster events experienced, specifically the three dominant types
    - Risk management strategies for these dominant types
    - Framework, protocols and recent performance compared to global standards
3. Review, assess and evaluate the roles in disaster management and resilience (specifically the restoration of engineering services post disaster in South Asia) of:

- Government Organisations
- Non-Government Organisations (NGOs)
- Private organisations

4. Using the results of the research conduct a number of case studies in South Asia focussing on the implementation of the frameworks and strategies in place

5. Report findings in the required written and oral formats

1.4 Justification

As discussed, a broad objective of this research is to generate discussion about the role of natural disaster risk management in sustainable development. It is hoped that this project will promote further research of natural disaster risk management through the compilation of literature review, statistical data and case studies.

Based on this, the research is justified through reference to the code of ethics for one of the key professions involved with natural disaster risk reduction: Engineers. Engineers Australia (2010) indicates that in order for an engineer to practice competently they must act on the basis of adequate knowledge. To this end this research aims to promote education and awareness of relevant engineering topics, risk management and more specifically disaster risk reduction, that are not commonly covered in tertiary engineering studies.

Further justification of this project pertains specifically to the role of engineers and the impact of their works on sustainable development. One of the key aspects identified by Engineers Australia (1997) is that engineers in developed countries such as Australia have a responsibility to assist in the achievement of sustainability across the globe. This research project has been undertaken with that responsibility in mind and considers the implications of its outcomes and the impact that it may have on the global community (see Appendix D: Consequential Effects of This Project).

1.5 Limitations

Given the aims, objectives and time available for this undergraduate project, the research and recommendations of this paper are focussed on the South Asia Region, with a restricted element of research and literature references from examples in other global regions.

The time period in focus in this study will be limited to between 1980 and 2013.

1.6 Methodology

The methodologies employed and the approach taken to achieve the aims and objectives of this research project involved a number of steps and are outlined in the methodology overview in Figure 2 below. As this project is predominantly a desktop assessment, literature review and the critical analysis of secondary sources of available information will comprise a significant portion of the work.

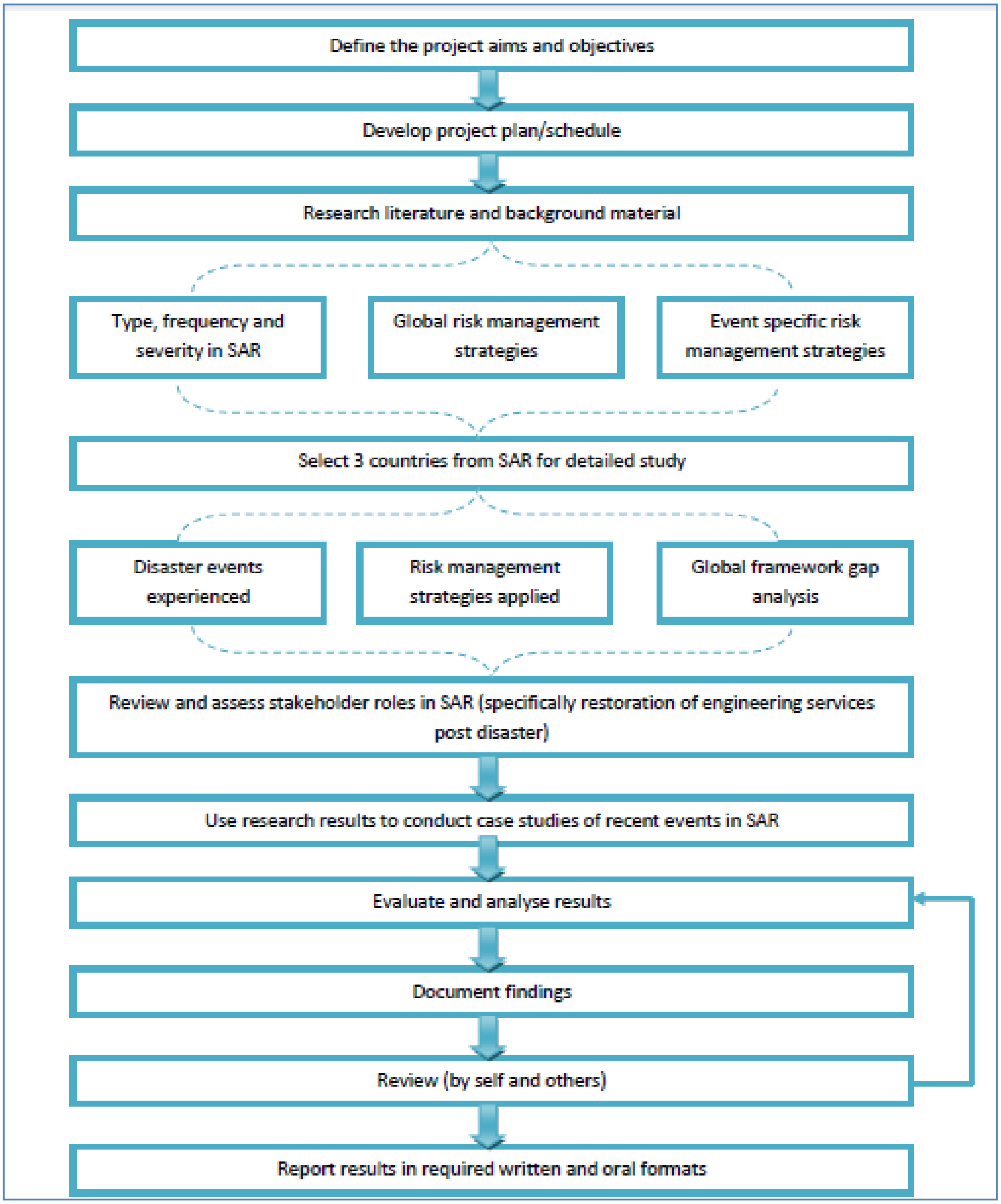

Figure 2: Project Methodology Overview

1.7 Outline

The remainder of this document is structured as follows:

CHAPTER 2: This chapter contains the initial literature review of the background information and statistical data and is necessary in providing the building block for the remainder of the research project.

CHAPTER 3: In this chapter the focus of the research is narrowed down to selected countries and specific disaster types. Through the critical analysis of gaps identified in these selected countries a greater understanding of how South Asia stands against global disaster risk management strategies is fulfilled.

CHAPTER 4: This chapter further narrows the research down into a specific area of disaster risk management that involves the restoration of engineering services after natural disaster events. This allows the research to focus on an area explicitly related to civil engineering.

CHAPTER 5: Case studies are undertaken in this chapter in order to measure the success of South Asian countries in the implementation of specific natural disaster risk management strategies, frameworks and mechanisms.

CHAPTER 6: Conclusions and further work are incorporated into this chapter to discuss the achievements of this research and summarise the findings while providing ideas and opinions of what areas need to be studied next.

CHAPTER 7: An Appendices section has been included to contain ancillary information that is pertinent to the research paper however for reasons of succinctness has been incorporated into an appendix to be referred to by the main body.

2 Literature Review & Statistical Analysis

The previous chapter provided a brief introduction to the topic and the issues associated with natural disasters in South Asia and across the globe. This upcoming chapter delves deeper into the topic by reviewing literature and statistical data on the subject. The overarching structure of this chapter is as follows:

- Type, frequency and severity analysis providing topic definitions, summarising specific statistical data and providing global as well as South Asian regional facts

- Global strategies for risk management which covers the broad scoped strategies as well as more specific mechanisms applicable to the types of natural disaster events typically experienced in South Asia

Relevant data for this research project has been sourced online through Google, Google Scholar, Emerald Insight, Cambridge Journals and Engineering Village 2 - Compendex. Statistical data for the types, frequency and severity of natural disasters was sourced from EM-DAT CRED the International Disaster Database, Centre for Research on the Epidemiology of Disasters (EM-DAT). PreventionWeb, the United Nations Office for Disaster Risk Reduction (UNISDR) sponsored database, was also an invaluable tool.

Only literature published in English was used for this research project due to time constraints of having documents translated, however the vast majority of reference material found was already in English. The search criteria used were restricted to sources from 1980 to present.

2.1 Type, frequency and Severity

The most efficient approach regarding the **Types** considered in this project was to align with the available resources, i.e. EM-DAT which provides data on the following disaster types:

- Earthquake
- Volcano
- Mass movement dry
- Mass movement wet

- Storm
- Flood
- Extreme temperature
- Drought
- Wildfire
- Epidemic
- Insect infestation

The **Frequency** of these disaster events is recorded each year and measured in actual numbers of individual events. The **Severity** can be measured in the following quantitative categories:

- Number of fatalities
- Number of people injured
- Number of people affected
- Number of people made homeless
- Total financial damage (USUS$)

2.1.1.1 Natural Disaster Statistical Data

EM-DAT is an emergency events database that has partnerships with the World Bank, the United Nations (UN) and other organisations when discussing statistics and trends of natural disasters (EM-DAT 2014).

A note from EM-DAT (2014) on the criteria for natural disaster events to be entered into the database at least one of the following criteria must be satisfied:

- 10 or more people reported killed
- 100 or more people reported affected
- Declaration of a state of emergency
- Call for international assistance

Once a disaster triggers the above criteria and the details have been confirmed it is entered into EM-DAT. Since 2003 disasters that span across several country boarders have been assigned a single identification number and recorded as a single event (EM-DAT 2014).

EM-DAT (2014) indicates that there is no standard global procedure for financial damage estimations used as the basis for its data, and it has been noted by the UN (2013c) that the direct disaster loss estimates could be at least 50% higher than internationally reported.

A note on the definition of categories from EM-DAT:

- **Flood** – General river flood, flash flood, storm surge/coastal flood
- **Earthquake** – Ground shaking, earthquake related tsunami
- **Storm** – Tropical storms, extra-tropical storms (winter storm), local/convective storms
- **Total Affected** – Is the sum of people injured, people made homeless and people affected

2.1.1.2 Natural Disaster Risk Definition

This section aims to provide a broad definition of natural disaster risk to be utilised throughout this research paper. The main focus of this definition involves the negative aspects of natural disaster risk. However it should be noted that the opportunities and positive possibilities arising from natural disaster events in terms of betterment and resilience will also be discussed in subsequent sections of this report.

A natural disaster is defined by UNISDR (2014) as:

> "A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources"
>
> (Source: http://www.unisdr.org/we/inform/terminology)

According to the World Bank (2012) there are three key elements that result in natural disaster risk:

1. **Natural Hazards** – Earthquakes, Storms, Floods, Drought. These can be considered a fixed variable

2. **Exposure** – of people and property to the natural hazards

3. **Vulnerability** – of the people and property exposed

Wisner and Uitto (2009) and the Asian Disaster Preparedness Centre (ADPC) (2010) explain further suggesting that **Risk** is a function of the **Hazard** multiplied by the **Vulnerability** minus the level of disaster **Mitigation** implemented. The local **Capacity** to provide self protection from risk and the degree to which political, social and economic limitations affect this capacity can also be added to the equation as a dynamic denominator. This gives:

$$Risk = \frac{(Hazard * Exposure * Vulnerability) - Mitigation}{Capacity}$$

Equation 1: Simplified Equation of Natural Disaster Risk

Intensive risk refers to the high severity, mid to low frequency disasters, and usually concerns major hazards, while **extensive risk** concerns the low severity, high frequency disasters and is usually associated with localised disasters (UN 2013c)

2.1.2 Global Data

There is a general pattern, which has been globally identified and accepted by relevant stakeholders, that the frequency and intensity of natural disasters is increasing and has been doing so for at least the past 4 decades (World Bank 2012, see also Figure 3). The financial losses resulting from natural disasters amount to hundreds of billions of dollars annually (see Figure 5) and these figures are projected to double by 2030 (UN General Assembly 2013).

These losses are directly enhanced by investment and development decisions that fail to adequately account for the risk posed by natural disasters (UN General Assembly 2013). Losses not only represent the direct financial impact, but also that the money spent on recovery and post disaster management would have been originally budgeted for other expenditure and investment which is now rendered unavailable. The results are negative impacts on production, growth and development that can take decades to reclaim.

Figure 3 shows the annual occurrences of natural disasters globally from 1980 to 2013. Figure 4, Figure 5 and Figure 6 indicate that globally the death rate from natural disasters is increasing only slightly from 1980 while the financial damage resulting from natural disasters and the number of people affected is increasing significantly and is trending to continue to do so into the future.

It should be noted that the use of exponential trend lines for statistical data analysis is consistent with data reporting groups such as the Munich Re Group (Munich Re Group 2008).

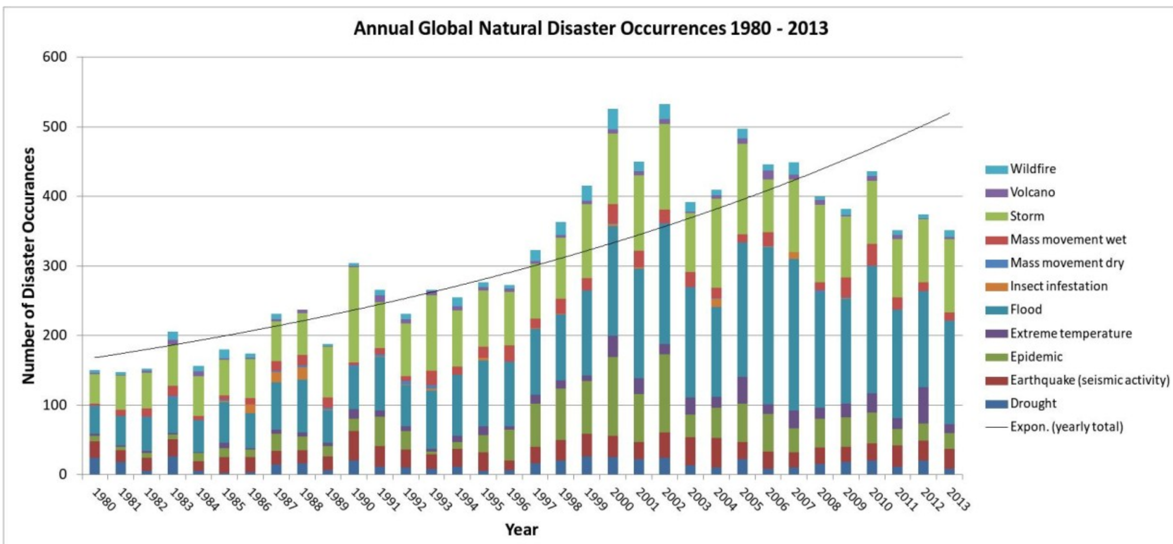

Figure 3: Annual Global Natural Disaster Occurrences 1980-2013 (EM-DAT 2014)

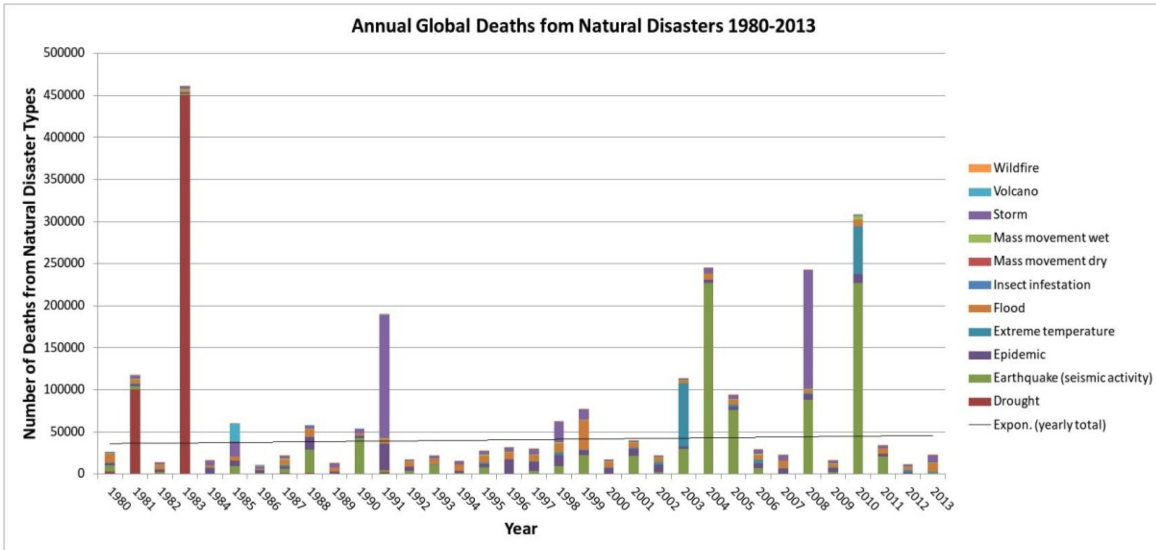

Figure 4: Annual Global Deaths from Natural Disasters 1980 to 2013 (EM-DAT 2014)

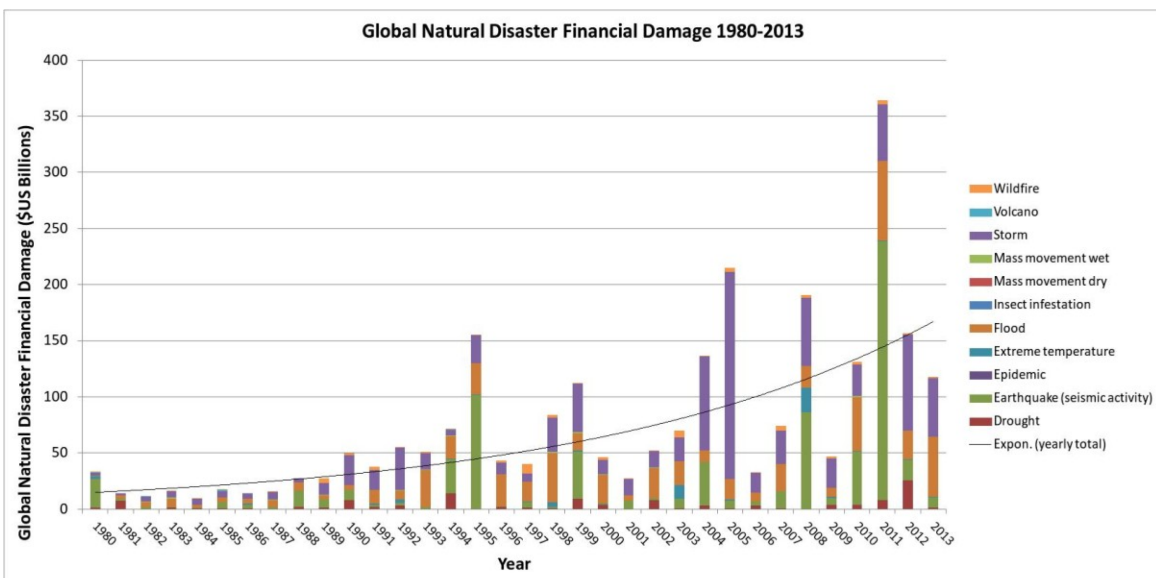

Figure 5: Annual Global Natural Disaster Financial Damage 1980 to 2013 (EM-DAT 2014)

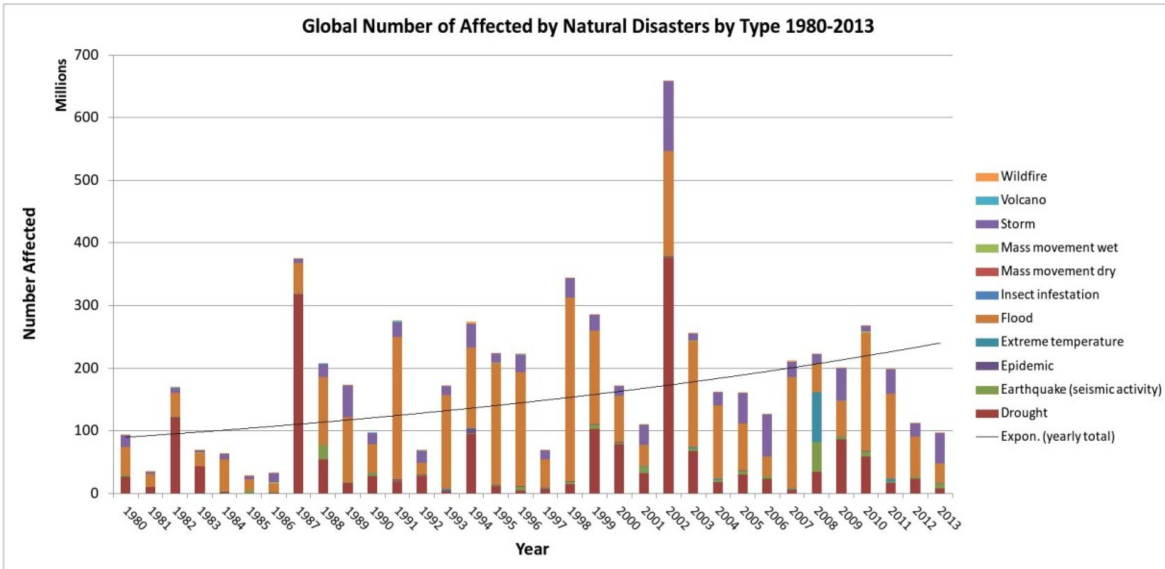

Figure 6: Global Annual Numbers of People Affected Type 1980-2013 (EM-DAT 2014)

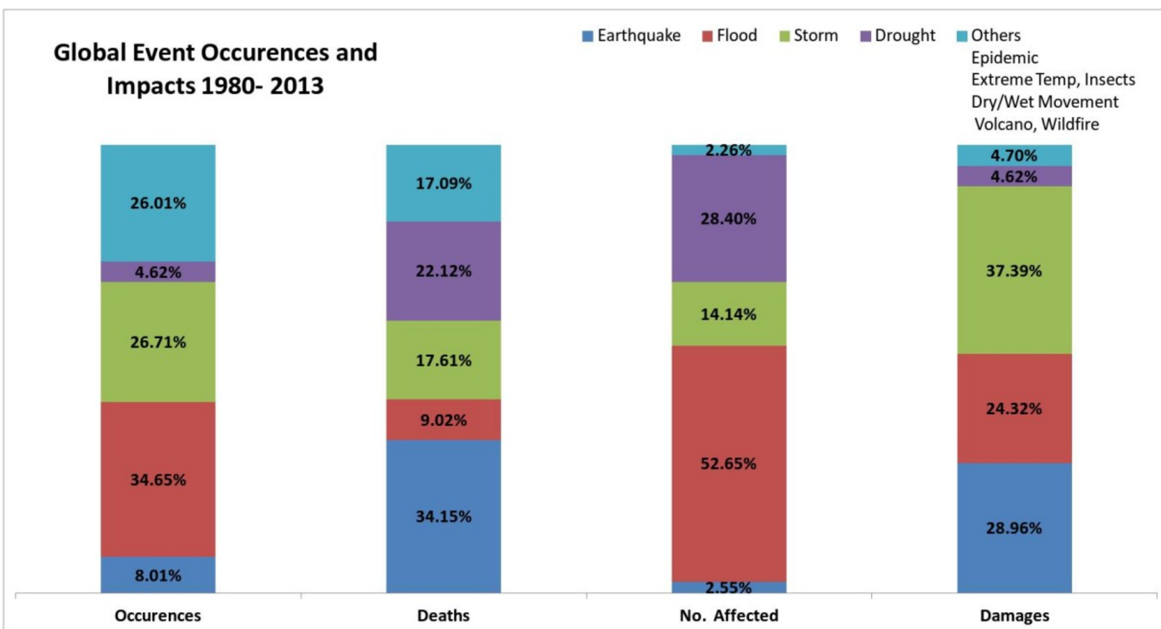

Figure 7: Global Event Occurrences and Impacts 1980-2013 (EM-DAT 2014)

2.1.2.1 Summary of global statistics

The following summary of statistics is from Figure 7:

- Floods, storms and epidemics are the three leading natural disaster types accounting for about 73% of all natural disaster events between 1980 and 2013

- Storms, earthquakes and floods account for 90% of the losses from natural disaster events globally between 1980 and 2013

    - In this study period the global cost of natural disasters was USUS$2.55 Trillion (approximately USUS$74.9 billion annually), of this USUS$952 billion resulted from storms, USUS$737 billion from earthquakes, and USUS$619 billion from floods

- Earthquakes, drought and storms account for about 74% of the total number of deaths from natural disaster events from 1980 to 2013

    - Since 1980-2013 over 2.5 million people have been reported killed by natural disaster events, in the past decade the average has been over 100 000 people every year

    - Of this 2.5 million deaths: about 560 000 result from drought, 867 000 from earthquakes and 447 000 from storms since 1980

- Since 1980 approximately 183 million people have been affected by natural disasters every year

- Figure 8 below shows the % breakdown of earthquake resultant hazards, this is important because the hazards and therefore the risk reduction strategies are different for ground shaking and tsunami events

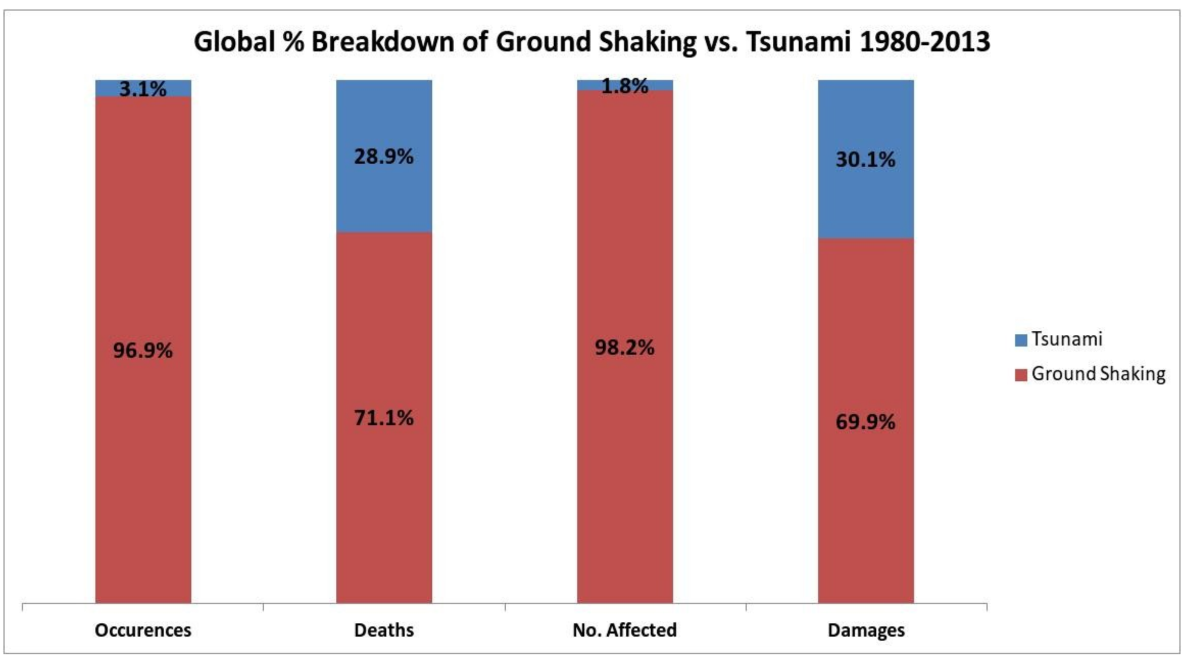

Figure 8: Global % Breakdown of Ground Shaking vs. Tsunami 1980-2013 (EM-DAT 2014)

2.1.2.2 Some global facts from the UNISDR (2012b)

- In the last 30 years the number of people living in flood prone river basins has increased by 114%
- During that same 30 year period the number of people living on coastlines exposed to cyclone has increased by 192%
- More than half of the world's large cities with populations from 2-15 million people are located in areas that are highly vulnerable to seismic activity.

2.1.2.3 Climate Change

The Intergovernmental Panel on Climate Change (IPCC) (2012b) indicated that the following future occurrences will be likely due to climate change:

- Average tropical cyclone wind speed will increase
- The frequency of heavy precipitation or the proportion of heavy rainfall in total rainfall will increase
- Heavy rainfall associated with tropical cyclones will increase

The increase in exposure combined with the abovementioned climate predictions will result in higher economic losses from natural disaster events.

2.1.3 Southern Asia Region Data

The Southern Asia Region is defined by the UN (2013) as consisting of:

- **Afghanistan**
- **Bangladesh**

- **Bhutan**
- **India**
- **Iran (Islamic Republic of)**
- **Maldives**
- **Nepal**
- **Pakistan**
- **Sri Lanka**

EM-DAT has the same country composition for Southern Asia as the UN however the World Bank (2012 and 2014a) omits the Islamic republic of Iran from its definitions. For the purposes of this project the UN and EM-DAT definition shall be used.

2.1.3.1 Some facts about the Southern Asia Region

- South Asia contains some of the fastest growing megacities in Asia and also some of the most vulnerable to natural disasters (Jabeen 2012, World Bank 2012)

- Mumbai, Delhi, Dhaka, Kolkata and Karachi are all forecast to have over 100 million inhabitants by 2015, the South Asia Region's population has doubled to 1.4 billion in last 40 years, no other region in the world has a concentration of megacities as does South Asia (World Bank 2012)

- The population in South Asia is trending to increase to over 2.5 billion by 2050 and more than 50% of this population is expected to reside in urban areas (see Figure 9)

- Estimations indicate that approximately 40% of people in Dhaka live in slums, 50% in Delhi and up to 60% in Mumbai (World Bank 2012)

- The high vulnerability of Water Sanitation and Hygiene services (WASH) in slum areas increases the impact resulting from extensive natural disaster events (Johannessen et al 2013)

- Of the nine countries in the South Asia Region listed above the UN (2013b) indicates:

- Bangladesh and Nepal are considered Low-Income countries
- India, Pakistan and Sri Lanka are considered lower middle income countries
- Bangladesh, India, Iran, Nepal, Pakistan & Sri Lanka are considered developing economies
- Afghanistan, Bangladesh, Bhutan and Nepal are considered to be among the world's least developed countries

- The UN (2013c) identify that both intensive and extensive disaster risk is disproportionately concentrated in lower income countries
- Even with the increasing occurrences and severity of natural disasters in South Asia the vulnerability to and consequences from natural disasters is not a significant component of development agendas. Awareness and understanding of natural disaster risks among key stakeholders remains low (World Bank 2012).

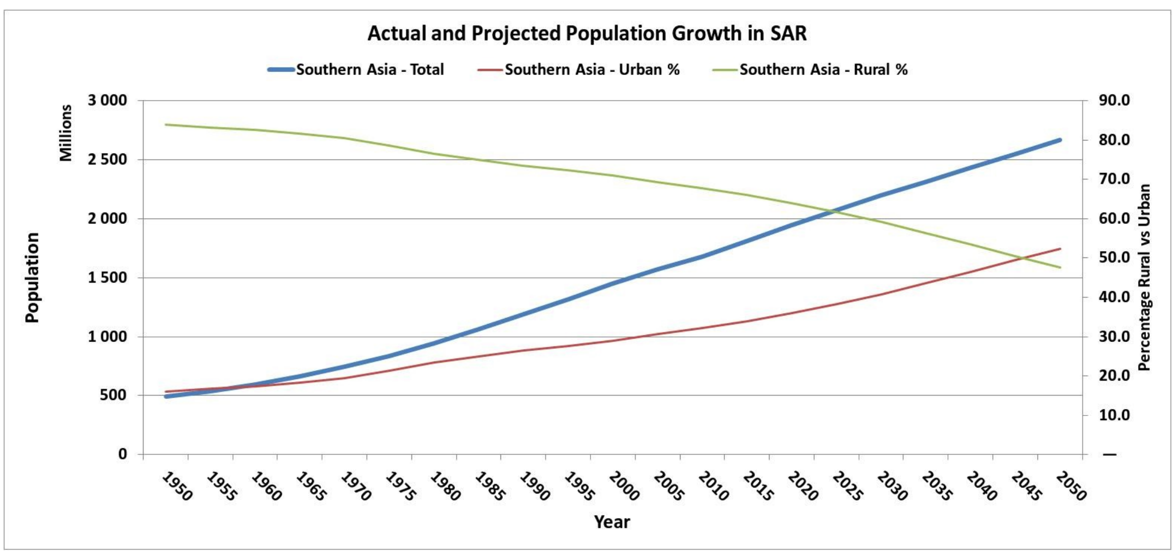

Figure 9: Actual and Projected Population Growth in SAR (UN 2012 and 2013a)

Figure 10 shows the natural disaster occurrences in the South Asian Region, the trend line of which follows the same increasing pattern of its global comparison. However, the trend for the number of deaths resulting from natural disaster events in South Asia (see Figure 11) indicates that this statistic has been decreasing since 1980 as has the number of people affected (see Figure 12). The one consequence of natural disasters in South Asia that is increasing rapidly is the damage caused and the resulting financial losses (see Figure 13).

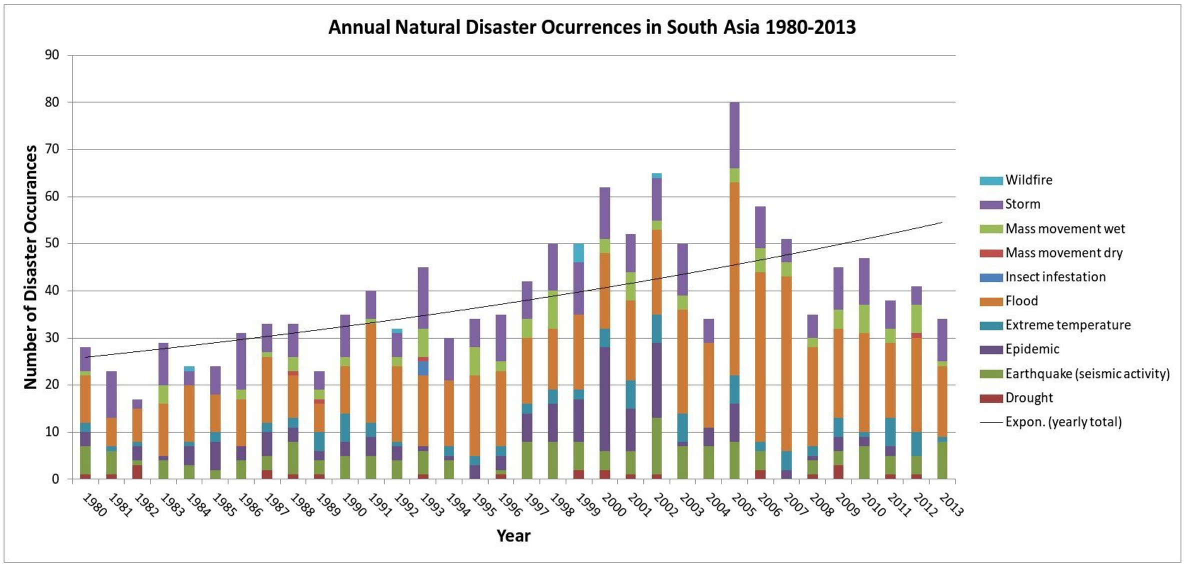

Figure 10: Annual Disaster Occurrences in Southern Asia 1980-2013 (EM-DAT 2014)

The high number of natural disasters in 2005 is comprised of higher than average occurrences of flooding events in India, Afghanistan and Pakistan during that year (EM-DAT 2014).

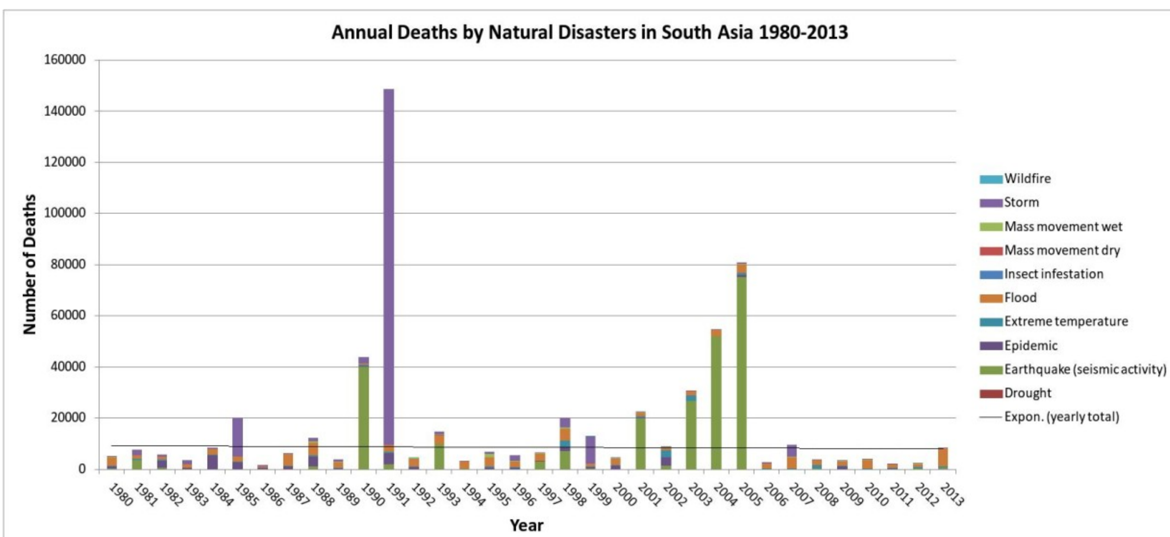

Figure 11: Annual Deaths by Natural Disaster Types in Southern Asia 1980-2013 (EM-DAT 2014)

The high number of deaths recorded during 1991 was a result of a cyclonic event hitting Bangladesh and killing almost 140 000 people. While the increase in deaths during 2004 and 2005 result from the Sumatra earthquake and tsunami affecting India and Sri Lanka during 2004 (killing 16 000 people in India and 35 000 in Sri Lanka) and Kashmir (Pakistan) earthquake in 2005 resulting in 73 000 deaths (EM-DAT 2014 and The World Bank 2012).

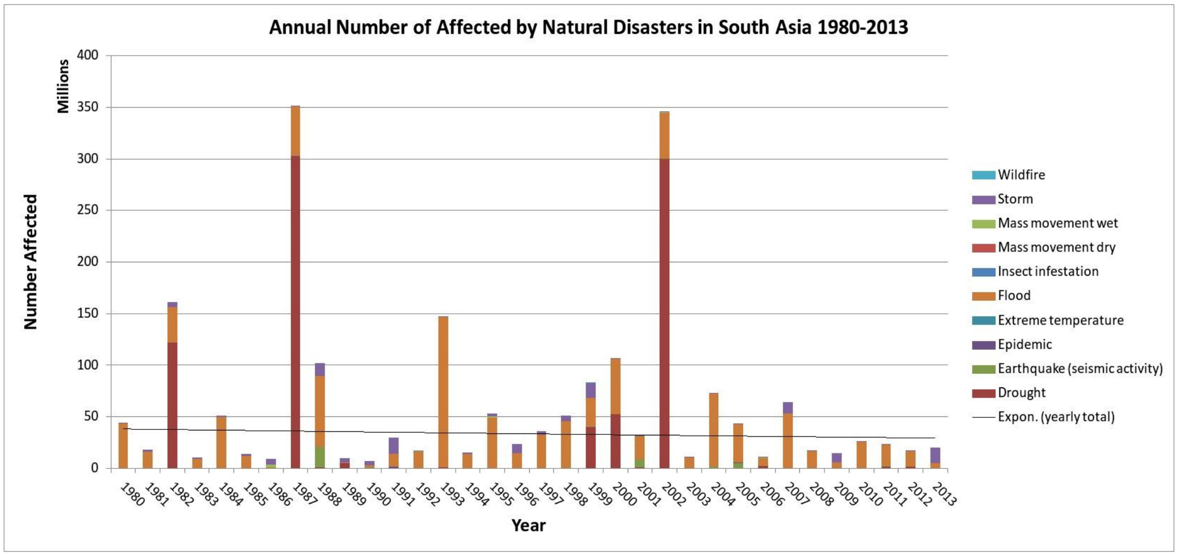

Figure 12: Annual No. Affected by Natural Disasters in SAR by Type 1980-2013 (EM-DAT 2014)

The data spikes in the total number of people affected by natural disasters are a result from drought in India during 1987 and again in 2002 affecting an estimated 300 million people during each occurrence (EM-DAT 2014).

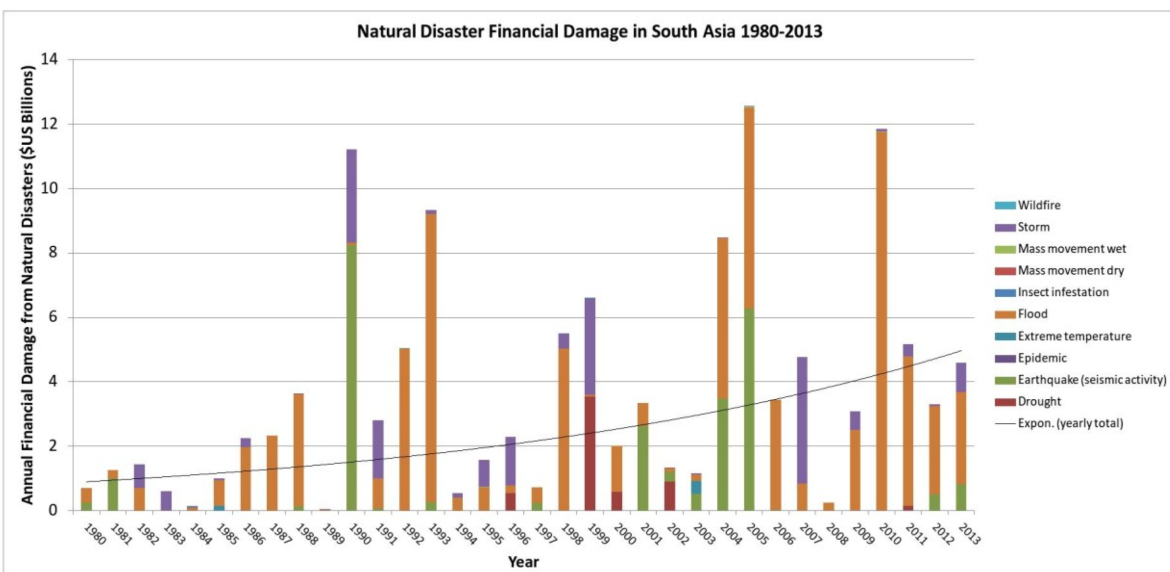

Figure 13: Natural Disaster Financial Damage in Southern Asia 2980-2013 (EM-DAT 2014)

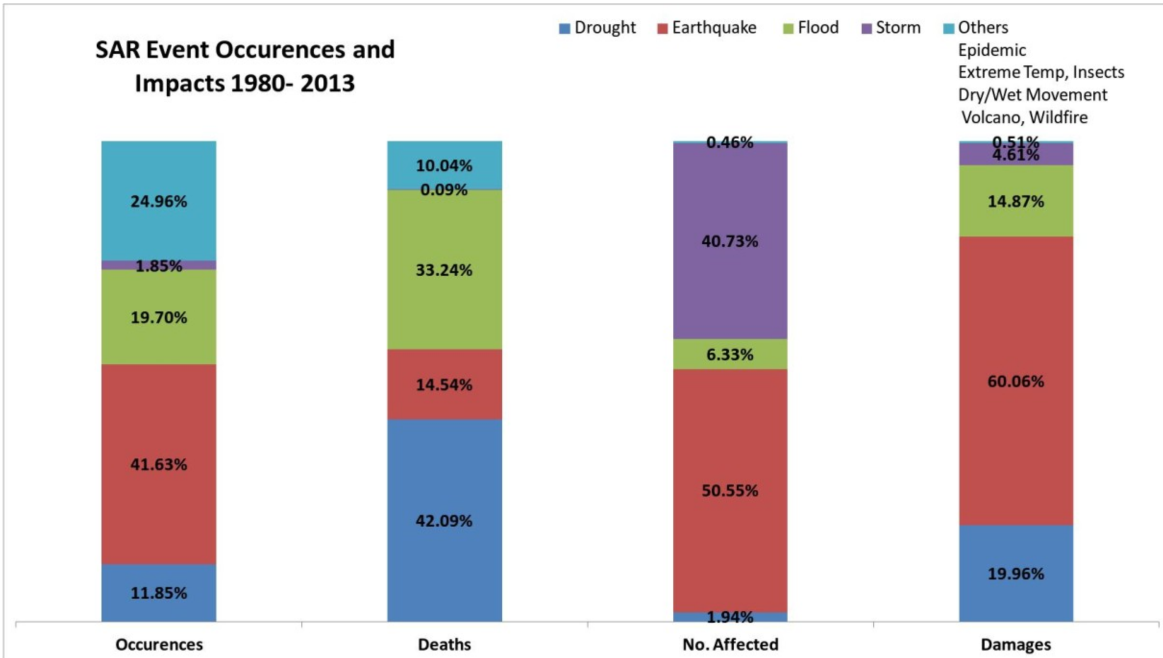

Figure 14: SAR Event Occurrences and Impacts 1980-2013 (EM-DAT 2014)

2.1.3.2 Summary of statistics

The following is a summary of statistics from Figure 14:

- Floods (41.6%), Storms (19.7%) and Earthquakes (11.9%) account for about 73% of all natural disasters in the South Asia Region from 1980 to 2013.

- Floods (60.1%), Earthquakes (20%) and Storms (14.9%) comprise 95% of the total damages resulting from natural disaster events in the South Asia Region from 1980 to 2013

  - In this study period the cost of natural disasters in South Asia was USUS$124 billion (approximately USUS$3.7 billion annually), of this: USUS$75 billion was from floods, USUS$25 billion from earthquakes, and USUS$19 billion from storms

- Earthquakes (42%), Storms (33%) and Floods (15%) make up 90% of the total number of deaths resulting from natural disaster events in South Asia from 1980 to 2013

- In this study period over 580 000 people have been reported killed by natural disaster events, in the past decade the average has been over 17 200 people every year
- Of this 580 000 deaths: about 245 000 result from earthquakes, 193 000 from storms and 85 000 from floods since 1980

- On average every year since 1980 approximately 6 million people have been affected by natural disasters in South Asia
- Figure 15 below shows the % breakdown of earthquake resultant hazards

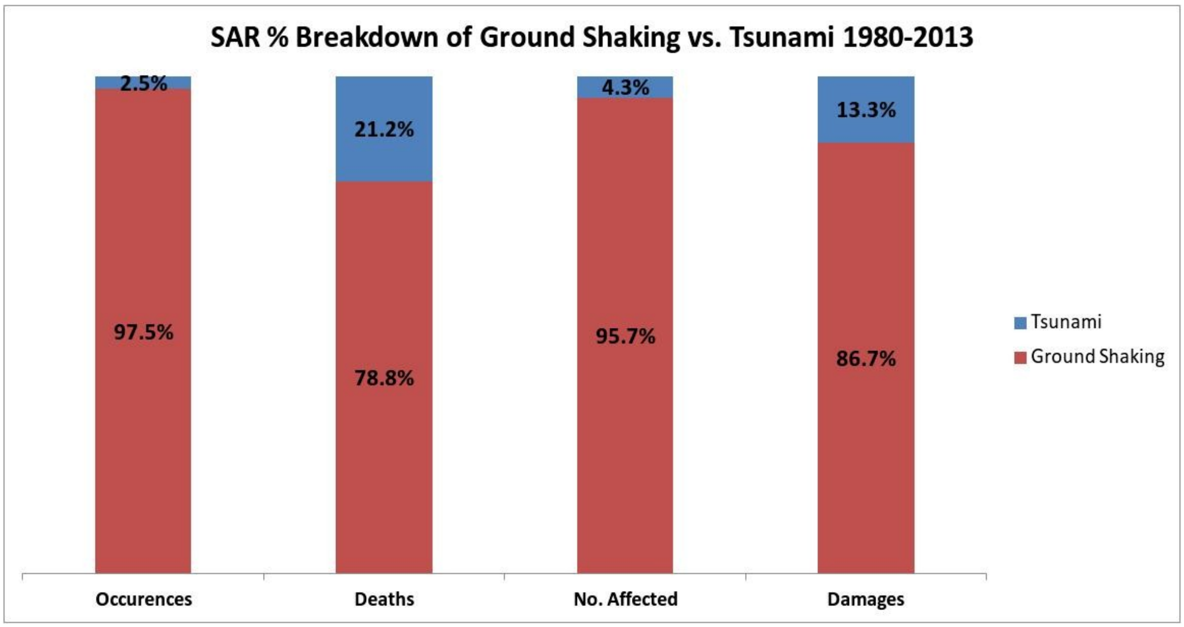

Figure 15: SAR % Breakdown of Ground Shaking vs. Tsunami 1980-2013 (EM-DAT 2014)

The conclusion that can be drawn, from the statistics at least, is that significant progress has been made in preventing the loss of life due to natural disaster events in the South Asia Region. However as the figures also indicate the financial damages and resulting losses are rapidly escalating. Takeuchi (2001) indicates that this shift from loss of life to financial damage is ubiquitous wherever development is occurring.

2.2 Global Strategies for Risk Management

This section will encompass an overview of the major global actors in disaster risk management and the strategies employed. This will be followed by a focussed discussion on the broad global level risk management strategies for the dominant disaster types experience in South Asia, these being floods, storms and earthquakes.

2.2.1.1 United Nations

The UNISDR is the UN secretariat of the International Strategy for Disaster Reduction and the disaster risk reduction community which comprises the various actors that work together to share information and reduce disaster risk. UNISDR is the central driver for the implementation of disaster risk reduction framework (UNISDR 2014).

The Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation was globally adopted in 1994 and was seen as a milestone set of guidelines for risks and impacts relating to natural disasters. A review of these guidelines specified several key areas for improvement. At the World Conference on Disaster Reduction in Kobe, Hyogo, Japan in 2005 this review was used to develop the framework and priorities for action for 2005-2015. This became known as the Hyogo Framework for Action (HFA) (UN 2014).

This framework provides the guiding mechanisms for countries to reference and measure against and forms the platform to build specific risk management strategies that target individual disaster subgroups (i.e. floods, storms and earthquakes).

The HFA priorities for action and the underlying rationales are summarised below.

1. **Ensure that disaster risk reduction is a national and local priority with a strong institutional basis for implementation**

Countries that develop the necessary legislation, policies and frameworks and utilise specific measurable indicators to track progress against these have an enhanced capacity to reduce natural disaster risks. Having these measurable performance indicators provides the basis for engagement and compliance of all sectors of society.

Key activities are:

- Implement and progressively review national, institutional and legislative frameworks to support disaster risk reduction

- Ensure that disaster risk reduction is part of policy and planning
- Assess, allocate and appropriately manage resources
- Promote community participation

2. Identify, assess and monitor disaster risks and enhance early warning

Quality risk management will always begin with a full understanding of the hazards (disaster types) and the vulnerabilities (physical, social, economic and environmental). This understanding coupled with the dynamics of such hazards and vulnerabilities in the short and long term provide the basis for appropriate risk management and subsequent action to mitigate these risks.

Key activities are:

- Develop and progressively upgrade national and local risk assessments including maps and multi risk event analysis
- Create and periodically review people centred early warning systems
- Implement and progressively strengthen vulnerability, hazard and risk identification, analysis and reduction capacity
- Compile accurate statistical data on disasters, monitor regional as well as trans-boundary disaster events and identify, research and analyse long and short term trends and issues

3. Use knowledge, innovation and education to build a culture of safety and resilience at all levels

Providing information to the public concerning disaster hazards, vulnerabilities and capacities to respond will create a culture motivated to disaster prevention and resilience.

Key activities are:

- Information management and exchange at all levels (local, national and regional) and between all relevant stakeholders including the general community, government, private sectors, expert panels and the scientific community

- Education and training regarding disaster risk at all levels including schools, tertiary facilities, disaster risk expert groups and the scientific community

- Disaster risk related research

- Utilise media outlets to encourage a culture of disaster awareness

4. Reduce the underlying risk factors

Development planning projects as well as post disaster planning opportunities can be used to reduce the risk of natural disasters, particularly for hazards involving water, weather and geological events.

Key activities are:

- Environmental and natural resource management

- Food security and resilience

- Ensure the protection of critical public facilities against disasters

- Social and economic development practices

- Implementation and strengthening of land use planning and other technical measures including building codes

- Financial disaster risk reduction and risk sharing

5. **Strengthen disaster preparedness for effective response at all levels**

The impacts and losses resulting from natural disaster events can be significantly reduced if authorities, communities and individuals are well prepared and equipped with the capacity for effective disaster management.

Through the implementation abovementioned action priorities and key activities individuals, communities, countries and regions can become more disaster resilient and more effective in reducing the vulnerability and overall impact of natural disaster risks

2.2.1.2 Post 2015 Disaster Risk Reduction (HFA-2)

The UNISDR is the administrating body that is coordinating the progression of disaster risk reduction guidelines post 2015. The role of the UNISDR moving forward is seen as supporting international cooperation, information and knowledge management and policy development and technical cooperation (UNISDR 2013c).This is to be achieved through extensive consultation with multiple stakeholders, including local and national governments, NGO's, academics, experts and private sector representatives. These consultations are undertaken at regional, sub-regional and individual country levels (UNISDR 2013b).

Some of the key points from the UNISDR (2013a) highlighted through these consultations for disaster risk reduction post 2015 are:

- Disasters are commonly viewed as external impacts to systems, the paradigm should change to viewing disasters as the result of risk drivers embedded in development policies and practices which accumulate risk
- Development methodologies need to change to be able to enhance resilience, seize opportunities and ensure sustainable development
- There needs to be greater promotion of risk sensitive private investment through new and enhanced existing incentive processes
- As opposed to a standalone tool/guideline, the HFA-2 needs to interlink into sustainable development protocols (including Millennium Development Goals (MDG) and the Kyoto Protocol)

- Further cooperation is needed between countries and regions in assessing and managing the trans-boundary and global aspects of risk reduction

- Three main focus points moving forward are – risk prevention, risk reduction and strengthened resilience

As intended the HFA is an excellent overriding document to build on and develop risk management strategies from however it does not provide detailed strategies for disaster risk reduction specific to the key natural disaster events experienced in South Asia (floods, storms and earthquakes).

2.2.1.3 AS/NZS ISO 31000:2009 Risk Management – Principles and guidelines

The International Standards Organisation, through consultation with Australia and New Zealand, has developed ISO 31000:2009 *Risk Management – Principles and guidelines*. This standard is focussed on risk management at an organisational level and can be applied across several operational aspects including safety, financial, environmental and project management. While it does not specifically mention natural disaster risk management it does provide the mechanisms that could be implemented to help manage natural disaster risk. These mechanisms include:

- Principles that if followed will facilitate effective risk management

- Risk management framework including:

    - Organisational commitment

    - The organisational context of risk and understanding this risk

    - Policy creation, implementation and integration into the organisation

    - Accountability within the organisation and appropriate resource allocation

    - Internal and external communication mechanism development

- Monitoring, review and continual improvement

2.2.1.4 The World Bank

The World Bank is a significant global actor in disaster risk reduction. It provides technical and financial support for:

- Risk assessment and reduction
- Disaster preparedness and financial protection
- Resilience recovery and reconstruction

The World Bank does this through an institutional mechanism, the Global Facility for Disaster Reduction and Recovery (GFDRR). This facility is an organisation of 41 countries and 8 international organisations and is specifically committed to the reduction of vulnerability to natural hazards in developing countries (The World Bank 2014b).

Some of the projects currently implemented by the World Bank include:

- inaSAFE – free software which produces hazard maps and impact scenarios that can be used as the basis for risk management activities including planning, preparedness and risk awareness. This work is in cooperation with the Australian and Indonesian Governments (inaSAFE 2014)
- The Open Data for Resilience Initiative is a joint UN/World Bank initiative that provides open access to post disaster risk management strategies based on actual disaster events (the Haiti earthquake for example) (GFDRR 2014)

2.2.1.5 World Federation of Engineering Organisations

The World Federation of Engineering Organisations (WFEO) is an international NGO that represents the engineering profession on a global scale. One of the technical committees of WFEO is the Committee on Disaster Risk Management (WFEO-CDRM). There are three subcommittees under the WFEO:

- Water Related Disaster Risk Management
- Earthquake Related Disaster Risk Management

- Capacity Building for Natural Disaster Risk Management

WFEO-CDRM provides an interactive community based approach to natural disaster hazard management that includes structural and non-structural methods. It is currently in the process of developing standards for water and earthquake disaster preparedness as well as disaster risk educational packages and hazard response and readiness plans (WFEO-CDRM 2014).

2.2.1.6 Asian Disaster Preparedness Centre

The Asian Disaster Preparedness Centre (ADPC) is an independent NGO that operates in all South Asian countries except Iran. It is worth mentioning here as it is a significant player in disaster risk management. Through partnership with several international agencies ADPC works to deliver technical assistance and support to address the needs expressed by the countries it serves. ADPC uses scientific methodologies ranging from Geographic Information Systems (GIS) to economic modelling to enhance risk reduction at national and sub-national levels, specifically ensuring disaster risk policy and guidelines are implemented and integrated into the development process (ADPC 2014a).

ADPC (2010) defines their disaster risk management as a cycle with the following 5 phases:

1. **Mitigation** involving structural and non-structural measures

2. **Prevention** connecting avoidance and minimisation of risk along with education promoting a culture of prevention

3. **Preparedness** of response procedures including insurance, early warning systems and evacuation facilities

4. **Response** through the provision of assistance and intervention during and after disaster events

5. **Recovery** of post disaster areas with an agenda to improve on the existing disaster resilience levels

This process links with the HFA methodology and ADPC enacts a number of the action priorities and key activities including (ADPC 2014b):

- Providing risk and loss estimates at national and local geographical scales including risk mapping and scenario based investment planning
- Vulnerability analysis and early warning system development
- Community centred risk awareness and risk assessment

2.2.1.7 South Asian Association for Regional Cooperation

The South Asian Association for Regional Cooperation (SAARC) was originally formed in 1985 and contains Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. It was formed based on the recognition that regional economic, social and technical cooperation between South Asian countries would be highly beneficial (SAARC 2014).

SAARC developed seven strategic goals that have been used in conjunction with the Hyogo Framework for Action and Millennium Development Goals to develop disaster risk management strategies and frameworks in South Asian countries. These seven strategic goals are defined by SAARC (2006) in the Comprehensive Framework on Disaster Management as follows:

1. Professionalising the disaster management system
2. Mainstreaming disaster risk reduction
3. Strengthening of community institutional mechanisms
4. Empowering community at risk particularly women, the poor and the disadvantaged
5. Expanding risk reduction programming across a broader range of hazards (all hazards approach)
6. Strengthening emergency response systems; and
7. Developing and strengthening networks of relevant national, regional and international organizations.

2.2.2 Flood Risk Management

This section identifies the global strategies that are specific to flood management.

2.2.2.1 International Centre for Water Hazard and Risk Management

The International Centre for Water Hazard and Risk Management (ICHARM) was formed through the support of the United Nations Organisation for Education Science and Culture (UNESCO) in 2006 to achieve the following objectives (ICHARM 2011):

- Improvement in education for water related disaster management through a masters course as well as a Ph.D. Program in Disaster Management
- The development of a global system that can deliver efficient access to flood basin data for any basin in the world
- Establish cooperation with engineers for the integration of satellite based data with on the ground data
- Support disaster risk assessment and disaster preparedness at local levels through relevant stakeholder partnerships

ICHARM has also released a Large-scale Flood Report (Chavoshian and Takeuchi (ed.) 2011), as a response to the increase in flood disaster events across the globe.

Kundzewicz and Schellnhuber (cited in Kundzewicz 2011 p 12) indicate that there have been 3 main strategies for flood management in the past:

- **Protection** within financial and practical limits
- **Adaption** of living conditions to accommodate flooding
- **Retreat** to areas of lower risk, from areas of high risk that were incorrectly settled to begin with

Kundzewicz (2011) describes some of the current structural and non-structural measures as:

Structural:

- Usually large scale physical defence systems
- Includes dykes, dams, flood control reservoirs, floodways and diversions as well as channel capacity improvements, dredging

Non-Structural:

- Source control:
    - This includes catching water where it falls and slowing downstream transfer
    - Enhancing infiltration, reducing runoff, increasing catchment storage resulting in a reduced peak flood level
- Laws, policy, regulation
- Land use planning
- Efficient forecasting and warning systems
- Awareness, education and enhanced dissemination of information

Kundzewicz and Schellnhuber (cited in Kundzewicz 2011 p 12) further categories and divide these mechanisms of flood risk management into:

- Pre flood preparedness
- Operational flood management
- Post flood response

With specific regard to the structural mechanisms of risk reduction Takeuchi (2001) considers the fact that often the structural flood infrastructure can increase the financial damage of the flood event. Often it is the flood protection infrastructure itself that accounts for a high percentage of the overall damage and losses. This indicates that careful cost benefit analysis must be undertaken prior to investment in these infrastructures.

Should funds be invested in flood resilient/resistant structures (bridges, roads etc) at a high cost or should investment be made in low cost structures that are easily maintained or replaced after an event? Obviously involved with this cost benefit analysis are the additional factors such as the importance of these structures for post disaster recovery, e.g. are they essential transport routes for emergency services etcetera.

Johannessen et al (2013) go further to suggest that in certain cases these structural measures such as levees and embankments have actually been the cause of more severe flood damages. Furthermore in some cases where development has not been appropriately monitored and controlled, settlements have been allowed to develop behind the flood barriers resulting in increased vulnerability of the population.

Takeuchi (2001), Johannessen et al (2013) and Kundzewicz (2011) describe the best approach to flood management as holistic in nature, taking into account both the structural and non-structural mechanisms throughout the entire flood catchment area. This approach reduces the net risk by reducing the vulnerability and exposure of the population while increasing the capacity for risk reduction.

2.2.3 Storm Risk Management

This section identifies the major global actors in storm risk management and highlights the objective of these groups and the strategies they employ in the disaster risk reduction process.

2.2.3.1 Meteorological Based Storm Risk Management

The World Meteorological Organisation (WMO) is a major contributor to global disaster risk reduction. Established under the United Nations the WMO drives global cooperation in meteorological services recognising that weather and climate have no international boundaries. The majority of the world's countries, and all of South Asia's countries, are members (WMO 2014b).

The Global Framework for Climate Services has been developed as an implementation mechanism for the proactive approach detailed in the HFA, in particular science based risk management and early warning systems. Each member country has obligations to the WMO through their individual national meteorological and hydrological service providers (e.g. Australian Bureau of Meteorology, Indian Meteorological Department etc).

Through multinational cooperation, the WMO (2014a) aims to provide the amalgamated data and modelling to be used in multiple hazard analysis at local, national, regional and global levels to enhance:

- Overall hazard risk assessment through the provision of data and forecasting services
- Loss and damage datasets by modelling historical and future meteorological data projections
- Early warning systems by climate and weather modelling and forecasting
- Risk reduction in climate vulnerable sectors such as agriculture, infrastructure, tourism and other industry areas
- Risk reducing investment decision making
- Risk financing and the transferral of risk

2.2.3.2 International Group for Wind Related Disaster Risk Reduction

It was identified at the 7th International Conference on Wind Engineering by Tamura (2009) that there was a general lack of collaboration and organisation between national, regional and global actors in wind related disaster risk management. In addition to this the structural damage incurred was common in many post disaster investigation reports across the globe. In response to this the International Group for Wind Related Disaster Risk Reduction (IGWRDRR) was launched under the UNISDR in 2009 and is currently working on the following objectives (IGWRDRR 2011):

- To implement the HFA in the specific target area of wind related risk reduction
- To store/warehouse up to date information and technology concerning wind related disasters and provide the mechanisms for disseminating this data to relevant stakeholders
- To complement the work of existing international organisations in preparing wind related disaster evacuation, recovery and reconstruction guidelines
- To provide efficient post disaster investigation
- To establish global consensus on:
    - Extreme wind damage with regard to different construction methods
    - International guidelines for wind related disaster risk reduction
    - Wind loading codes and standards
- Facilitate regular international workshops and conferences

2.2.3.3 Resilience of buildings and infrastructure

Through the literature review process of this project it has been identified that there are no formal global guidelines for building construction with regard to wind related disasters that are endorsed by the major international expert bodies. This may be due to difficulties in creating international standards including the variance of availability of building materials, experienced professionals and labour in different countries.

Instead individual country standards and techniques are the source of guidance with regard to design and construction compliance. For example in Australia the construction would have to comply with at least AS/NZS 1170.2:2011 *Structural Design Actions Part 2: Wind Actions* and AS4040.3-1992 *Methods of testing sheet roof and wall cladding Method 3: Resistance to wind pressures for cyclone regions*.

Post disaster reconstruction methods are under the same circumstances. As Ahmed (2011) and Lloyd-Jones (ed. 2009) indicate that it is common practice to adopt local building and reconstruction practices. Again as an example in Australia post disaster reconstruction may involve reference and adherence to HB132.2-1999 *Structural Upgrading of Older Houses – Cyclone Areas*. While it may be necessary to adopt local building methods with regards to building materials available, there may be an opportunity to increase disaster resilience through the development of regional or global standards for post disaster infrastructure rebuilding.

2.2.4 Earthquake Risk Management

Unlike storms and floods, earthquakes are not as easy to predict in terms of event occurrence as well as event severity and the effects on communities. This section will provide a brief history which has led to current practices of earthquake event prediction. This will be followed by a discussion of current capabilities to predict injuries, casualties and losses from earthquakes, as well as protection methods and overall risk reduction during earthquake event.

This section will essentially be split into two subcategories, ground shaking and tsunami with discussion of both.

2.2.4.1 Prediction of Earthquake Events and Early Warning

Ground Shaking

The theory of plate tectonics and the use of seismology to explain the earth's geological system was first accepted in the late 1960's. Since then technological advances such as Global Positioning Systems (GPS) have helped with monitoring and data gathering however the physics that govern earthquakes is difficult to measure as it is deep in the earth (Wyss 2000).

Currently research and investigation is being undertaken for various methodologies of earthquake prediction, including remote sensing techniques for crust displacement, ground thermal changes and electric and magnetic changes (Alvan and Omar 2009). However according to Wyss (2012) for the majority of earthquake cases the sum of the current predictive methods only yield about a 10 second warning before the disaster strikes and that this warning may only be useful to as little as 10% of the population at risk.

Tsunami

According to the German Centre for Geosciences (2008) 90% of all tsunamis are a direct result of an earthquake. Thus the warning for a tsunami event is limited by the abovementioned earthquake warning times. The 2004 tsunami, as an extreme example, took 15 minutes from the earthquake event to reach land and kill over 140 000 people.

The total death toll of the 2004 tsunami is estimated at 230 000 lives. There was no early warning system for the incoming tsunami in the affected region. As a response to this the Intergovernmental Oceanographic Commission (IOC) has coordinated the implementation of early warning systems in the Indian Ocean, the Mediterranean and the Caribbean (UNESCO 2014), with initial testing indicating that the warning systems are functional (UN News Centre 2011 and UNISDR 2012a).

There are also other organisations that provide tsunami risk management and early warning systems, including the US based National Oceanic and Atmospheric Administration's National Tsunami Warning Centre.

2.2.4.2 Predicting Earthquake Losses, Casualties and Injuries

Having established that earthquake event prediction is in its infancy and that much more work lies ahead in this area of research, it is therefore necessary to discuss earthquake risk management in its other forms. One of the more recent areas is the development of accurate earthquake scenario modelling and real time loss estimates post event occurrence.

By utilising post earthquake reconnaissance through the use of geo-referenced, metadata embedded digital photography, Bardet and Liu (2010) indicate that losses and damage can be assessed more rapidly and earthquake engineering and scientific knowledge will improve. By means of the ubiquitous camera phone with GPS capability this method of data capture has the potential to increase, this could apply to both ground shaking and tsunami events provided the telecommunications infrastructure remains functional post event.

Ground Shaking

Wyss (2004) indicates that in the year of publication loss estimates from hypothetical earthquake modelling were beginning to bee at an accuracy level to be of use to earthquake planners and risk managers. Real time loss estimates post event for some areas of the globe have been reduced to minutes or even seconds however for other regions, predominately developing regions, this timeframe can be hours or even days. More recently Wyss et al (2012) found, through comparison of event loss predictions and actual post event data, that losses are consistently underestimated by a factor of 2 for small quakes and up to a factor of 700 hundred on average for large quakes. This is due to probabilistic methods of hazard estimation being used, as opposed to deterministic methods including the vulnerability/fragility of infrastructure and soils conditions (Wyss et al 2012).

Tsunami

There are several tsunami modelling methodologies and programs available worldwide from a range of nations, institutions and collaborative joint efforts between bodies. These can be employed to assess risk and run scenarios for individual cities, countries and regions and are an important part of overall risk reduction. IOC (2009) provides a comprehensive guideline for, among other focus areas, the assessment of Indian Ocean coastal community vulnerability through tsunami scenario modelling. Another example is from the USGS (2013) which provides hypothetical tsunami impacts for the Californian coast.

2.2.4.3 Overall Risk Reduction

Ground Shaking

Momani (2012) describes an approach to earthquake risk reduction using set guidelines to integrate modelled earthquake risk, socio-economic conditions and cost-benefit analyses into strategies, plans and procedures. As an example of this integrated approach the Global Earthquake Model (GEM) (2014) addresses the actual mechanisms to implement this by providing:

- Risk exposure and consequence databases and the appropriate data capturing tools to populate these databases
- Uniform building classification system to capture the structural condition of infrastructure accurately
- Socio-economic vulnerability tools to combine with the physical risk

Tsunami

Based on the Indian Ocean methodologies in IOC (2009) the following key points are essential to successful risk reduction:

- Initially a clear definition of the geographical area being assessed and the time frame over which the risk reduction measures are to be taken is needed

- Strategic mitigation through the utilisation of structural and non-structural mechanisms

    - Structural mechanisms include both the engineered/built (such as dykes and seawalls) and natural environment (wetland extensions, natural physical barriers and exclusion zones)

    - Non-structural includes those listed for other hazards e.g. Building codes, guidelines, land use planning, risk transfer and insurance etc

- Three basic alternative approaches involve: protection from events, accommodation/living with events and retreat from the high risk areas

- At all stages of decision making processes the public should be involved

- Education and awareness of the risks and the reduction techniques are essential

2.3 Chapter Summary and Conclusion

Gross natural disaster risk can be assessed and measured as being the product of a hazard, the exposure of people and infrastructure to this hazard and the vulnerability of these groups to the hazard. Net risk is the ratio of this product, minus the existing mitigation mechanisms in place, to the capacity of the people/infrastructure to adequately respond to the natural disaster hazard.

The review of the literature undertaken has shown that the exposure and vulnerability of people and infrastructure is increasing and will continue to do so into the foreseeable future. The capacity of people to respond and the mitigation measures in place globally as well as specifically in South Asia is reducing the net risk to people overall. However the net risk to infrastructure has continued to increase at an alarming rate. Further analysis of the statistics has shown that floods, storms and earthquakes are the three most significant natural disaster event types experienced around the world and in South Asia.

With regards to the global strategies for disaster risk reduction there are a number of high level key organisations involved. These organisations have developed very important guidelines and protocols that can be utilised throughout the world as building blocks for the creations and continual improvement of natural disaster management systems. A review of available literature has also established that there are a number of organisations who develop and disseminate disaster risk management mechanisms specific to the three types most commonly experienced around the world. It is up to the individual countries and regions of the globe to examine these methodologies and implement them in a manner that targets their specific natural disaster risk areas.

3 Selected Southern Asia Region Country Study

The previous chapter examined the available natural disaster statistics and risk management strategies at a high level to provide the basis for more specific research. Thus the next chapter incorporates the following sections of this research paper:

- The selection of three South Asia countries for analysis
- Summary of the 3 key natural disaster events experienced in these selected countries including a brief look at the vulnerability and exposure in those countries
- The disaster risk management strategies applied in these countries with regard to these key disaster types
- A gap analysis between these countries and global standards

3.1 Selection of 3 Southern Asia Region Countries

Table 1, Table 2 and Table 3 below contain the raw data from EM-DAT (2014) determined the selection of the countries for the detailed study of natural disasters and disaster risk management. The selection was based on the total number of fatalities during time range of 1980 to 2013. The 3 countries with the highest fatality levels were selected for each of the main natural disaster types (floods, storms and earthquakes) and the three dominant countries were chosen.

3.1.1 Earthquakes

Table 1 below indicates that Pakistan, Iran and India are the three countries in the South Asia Region with the highest fatality occurrences resulting from earthquakes. It can be seen that these countries also experience the largest financial losses and total numbers affected.

Country	Number of Earthquakes	Number Killed		Total Number Affected		Total Damage (USUS$,000)	
		Total	Annual Average	Total	Annual Average	Total	Annual Average
Pakistan	25	74,745	2,198	6,722,371	197,717	5,326,500	156,662
Iran Islam Rep	74	74,388	2,188	1,905,159	56,034	11,658,628	342,901
India	18	49,846	1,466	28,501,754	838,287	5,222,300	153,597
Sri Lanka	1	35,399	1,041	1,019,306	29,980	1,316,500	38,721
Afghanistan	28	9,277	273	537,616	15,812	29,060	855
Nepal	4	816	24	709,850	20,878	305,000	8,971
Maldives	1	102	3	27,214	800	470,100	13,826
Bangladesh	7	36	1	19,125	563	500,000	14,706
Bhutan	2	12	0	20,028	589	0	0

Table 1: Earthquake Data Summary for SAR 1980-2013 (Source EM-DAT 2014)

3.1.2 Floods

Table 2 below shows that in South Asia India, Bangladesh and Pakistan have the highest fatality levels resulting from flood events. This correlates with the higher total number of affected persons and the total damage as well.

Country	Number of Floods	Number Killed		Total Number Affected		Total Damage (USUS$,000)	
		Total	Annual Average	Total	Annual Average	Total	Annual Average
India	202	47,321	1,392	701,776,012	20,640,471	35,698,629	1,049,960
Bangladesh	71	12,576	370	247,627,450	7,283,160	11,228,800	330,259
Pakistan	64	10,372	305	61,340,253	1,804,125	17,798,378	523,482
Nepal	37	5,634	166	3,549,427	104,395	1,037,429	30,513
Afghanistan	69	3,624	107	658,404	19,365	344,000	10,118
Iran Islam Rep	63	3,551	104	3,653,464	107,455	7,652,528	225,074
Sri Lanka	51	1,206	35	11,756,387	345,776	964,064	28,355
Bhutan	3	222	7	1,600	47	0	0
Maldives	2	0	0	1,949	57	6,000	176

Table 2: Flood Data Summary for SAR 1980-2013 (Source EM-DAT 2014)

3.1.3 Storms

Table 3 below indicates that fatalities resulting from storm events in South Asia are highest in Bangladesh, India and Pakistan. The data for total number affected and total damages is also higher in these three countries.

Country	Number of Storms	Number Killed		Total Number Affected		Total Damage (USUS$,000)	
		Total	Annual Average	Total	Annual Average	Total	Annual Average
Bangladesh	115	167,400	4,924	56,195,332	1,652,804	5,363,700	157,756
India	103	23,525	692	69,744,517	2,051,309	11,302,375	332,423
Pakistan	18	1,469	43	2,194,313	64,539	1,710,936	50,322
Afghanistan	5	362	11	22,661	667	5,000	147
Iran Islam Rep	10	274	8	179,794	5,288	28,540	839
Nepal	6	97	3	184	5	3,600	106
Sri Lanka	6	43	1	544,380	16,011	57,000	1,676
Bhutan	2	29	1	65,000	1,912	0	0
Maldives	1	0	0	23,849	701	30,000	882

Table 3: Storm Data Summary for SAR 1980-2013 (Source EM-DAT 2014)

3.1.4 South Asia Region Country Selection

Based on the above data the following three countries have been selected for the applicable sections of this research paper:

- **Bangladesh**
- **India**
- **Pakistan**

3.1.5 Selected Country Impact Summary

Table 4 below contains a summary of the cumulative impacts of the three most significant disaster types (earthquakes, floods and storms) in the South Asia Region. These have been compared in relative terms to individual country population size and Gross Domestic Product (GDP).

The detailed annual data figures from which the summary in Table 4 was taken can be found in Table 11, Table 12 and Table 13in Appendix B: Selected South Asian Country Data.

The data illustrates the significance of natural disaster event impacts, comparing affects and losses to population and GDP further emphasise the implications. The following points have been highlighted from the datasets in Table 4 and as well Appendix B: Selected South Asian Country Data and refer to earthquake, flood and storm events in the selected countries between 1980 and 2013:

- Approximately 8% of the population of Bangladesh is affected by earthquakes, storms and floods each year with the highest annual figure being 54.4% in 1988
- On average earthquake, flood and storm events in Bangladesh result in losses of 1.28% of GDP annually with the highest recorded figure of 9.75% recorded in 1998
- Approximately 2.5% of India's population are affected by earthquake, floods and storms each year with the highest annual figure of 13.9% occurring in 1993
- On average earthquake, flood and storm events in India result in losses of 0.3% of GDP annually with the highest recorded figure of 2.8% recorded in 1993
- Approximately 1.4% of Pakistan's population are affected by earthquake, floods and storms each year with the highest annual figure of 11.8% occurring in 2010
- On average earthquake, flood and storm events in Pakistan result in losses of 0.5% of GDP annually with the highest recorded figure of 5.4% recorded in 2010

To avoid the repetition of data analysis the events that resulted in the high impacts identified above will be undertaken in the subsequent section of this report.

Country	Average Number of Deaths per year	Average Number Affected per year (Millions)	Average Damage per year (USUS$ Billions)	Average Annual People Affected as % of Population	Average Annual Damage as % of GDP
Bangladesh	5,294	8.94	0.50	7.99	1.28
India	3,550	23.53	1.54	2.48	0.32
Pakistan	2544	2.06	0.73	1.37	0.50

Table 4: Selected Country Cumulative Impacts from Earthquakes, Floods and Storms 1980-2013 (Source: EM-DAT 2014, UN 2013a and the World Bank 2014c)

3.2 Natural Disaster Events in Selected Countries

3.2.1 Bangladesh Country Overview, Vulnerability and Exposure

Geographic location and climatic region combined with low economic income as well as being one of the world's least developed countries makes Bangladesh (see Figure 16) highly vulnerable to earthquakes, floods and storms (The World Bank 2012).

Some key aspects relating to natural disaster vulnerability and exposure in Bangladesh include:

- The population of Bangladesh is estimated at over 160 million and at current growth rates this is expected to reach over 233 million by 2050 (United Nations 2013a)
- More than 80% of the population is exposed to floods and earthquakes and more than 70% is exposed to cyclone events (The World Bank 2012)
- Bangladesh and the surrounding region has experienced 7 seismic events in the past 150 years with a magnitude greater than 7 (Richter Scale) (Government of Bangladesh 2010a)
- Three large rivers, the Ganges, Brahmaputra and Meghna) converge together in Bangladesh before forming a delta to the Bay of Bengal (See Figure 16 below)
- This delta area is predominantly less than 10m above sea level, contains the two largest cities of Dhaka and Chittagong and has a general population density of greater than 1000 people per square kilometre (CIESIN 2007)

- Flooding (comprising of flash floods, monsoon floods, heavy rain, drainage congestion and storm surges) is considered a normal phenomenon in Bangladesh and in a typical year approximately 20-25% of the country is inundated by river spills and drainage congestion (Ministry of Environment an Forest 2005)

- Heavy precipitation associated with the monsoon is expected to increase in the South Asian Region as a result of climate change and if so this will resulting in more frequent and more intense flooding in Bangladesh (IPCC 2012b)

- Bangladesh's capital, and main port city, of Dhaka currently has approximately USUS$8.43 billion worth of assets and about 844 000 people exposed to extreme events (i.e. flooding, storm surge and cyclones) and it has been estimated that by 2070 this figure could be as high as USUS$544 billion in assets and as much as 11 million people (Nicholls et al 2008)

- Munich Re Group (2004) indicate that, based on information from various statistical authorities, the city of Dhaka is responsible for up to 60% of Bangladesh GDP and that it is exposed to high risk from earthquake, flood and tropical storms

Figure 16: Map of Bangladesh (Source: Nation Master 2014)

3.2.1.1 Bangladesh Data Analysis

Figure 17 below indicates that the number of earthquake, flood and storm events in Bangladesh has been increasing during the study period of 1980 to 2013. This follows the global and south Asia regional trends highlighted in previous sections of this report.

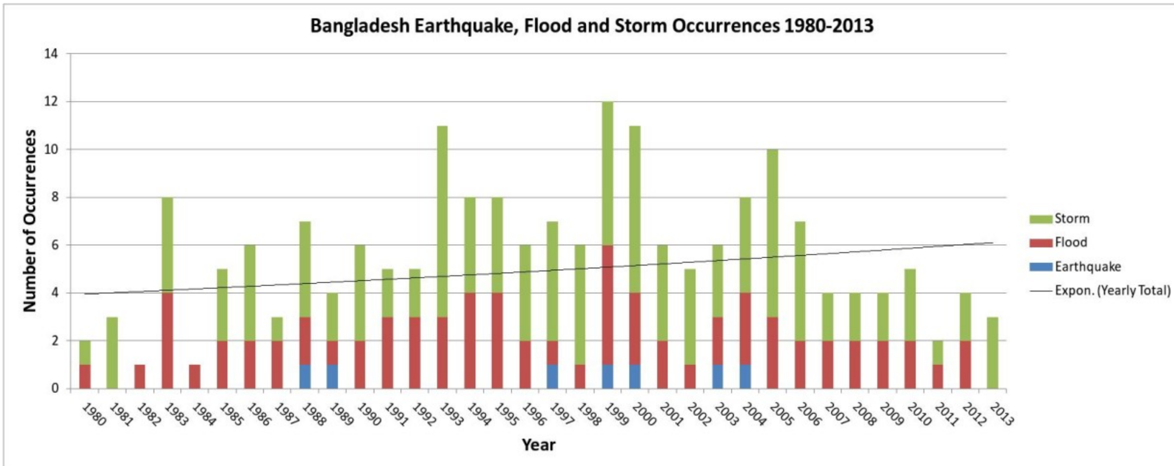

Figure 17: Bangladesh Earthquake, Flood and Storm Occurrences 2980-2013 (Source EM-DAT 2014)

Figure 18 below shows the overall gradually decreasing trend in deaths resulting from earthquakes, floods and storms in Bangladesh from 1980 to 2013. The spike in 1985 is a reflection of a severe cyclonic storm slightly to the north of Chittagong while to prominent spike in 1991 was another cyclone also north of Chittagong (Damen 2003). The slight spike in 2007 can be attributed to cyclone Sidr (The World Bank 2012).

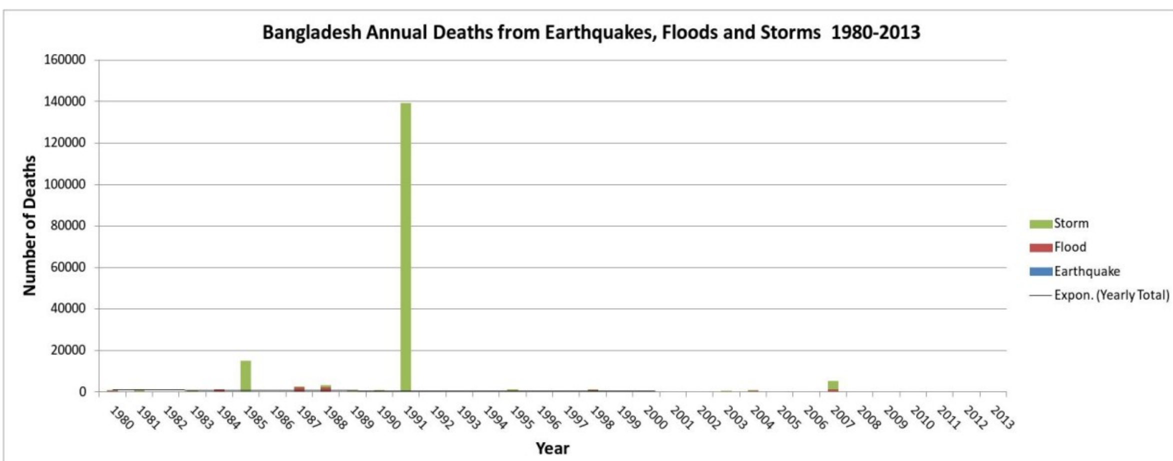

Figure 18: Bangladesh Annual Deaths from Earthquakes, Floods and Storms 1980-2013 (Source EM-DAT 2014)

Figure 19 below shows the declining trend in the number of people affected by storms, floods and earthquakes in Bangladesh between 1980 and 2013. This is consistent with the general trend in the South Asia Region. As can be seen the numbers affected in some years are quite significant. The 1988 flooding was due to a combination of heavy monsoonal rains in the river catchment areas and high tides resulting in more than half the country flooding for more than one week, with up to 28 million people made homeless (UN 1988). The high figure in 2004 was again a result of wide spread monsoonal rain across South Asia (UNICEF 2004).

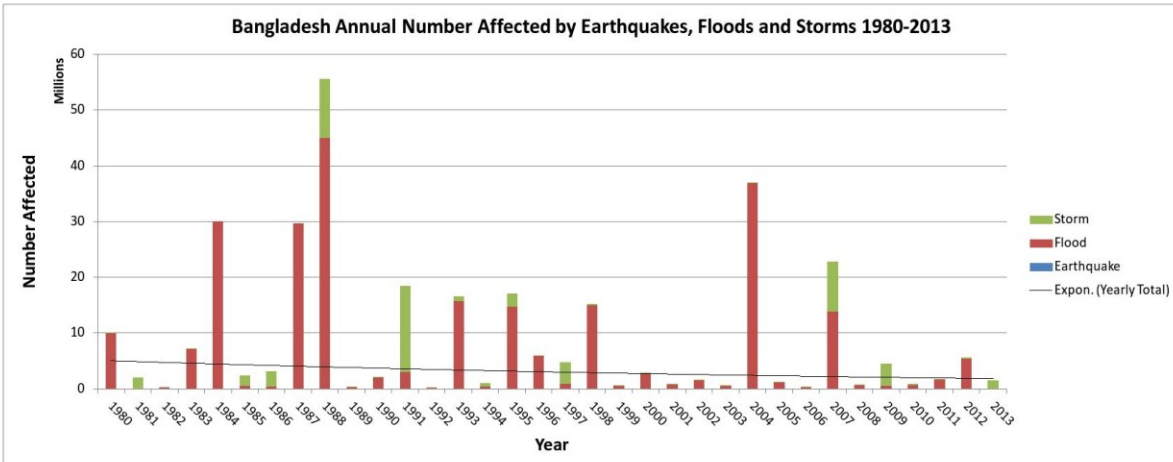

Figure 19: Bangladesh Annual Number Affected by Earthquakes, Floods and Storms 1980-2013 (Source EM-DAT 2014)

Figure 20 below shows only a slightly increasing trend in financial damage resulting from earthquakes, floods and storms in Bangladesh between 1980 and 2013. The notable flood damage spike in 1998 was the result of monsoon rainfall combined with tidal surges (BBC 1998). The storms in 1991 and 2007 were cyclonic events as described above and the flooding in 2004 and 1988 was also monsoon related as described above.

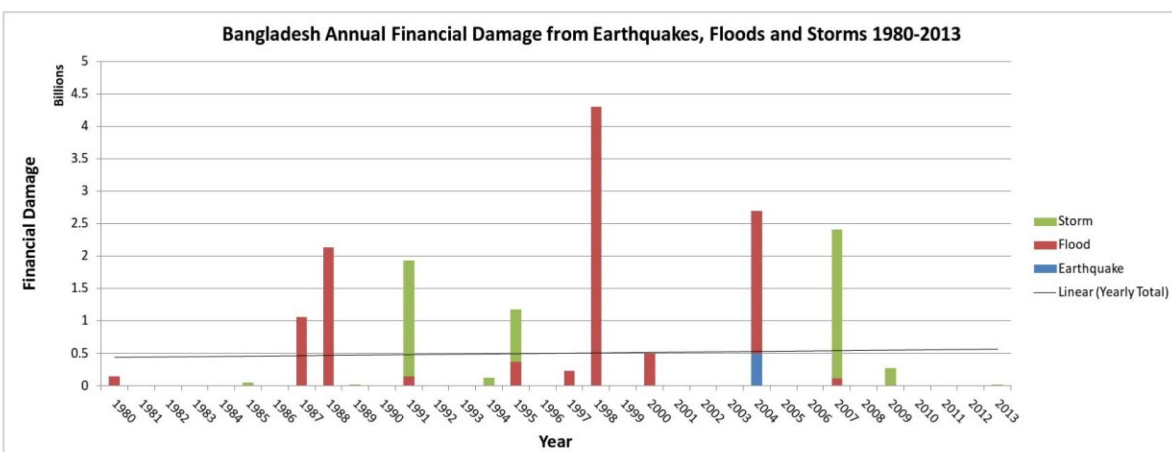

Figure 20: Bangladesh Annual Financial Damage from Earthquakes, Floods and Storms 1980-2013 (Source EM-DAT)

The following summary of statistics for Bangladesh between 1980 and 2013 is based on Figure 21 below:

- On average there is 1 earthquake event every 5 years killing on average 1 person every year, affecting 10 000 people and causing almost USUS$15 million in damage annually

- There are on average 2 flood events each year, resulting in 370 deaths annually, affecting almost 7.3 million people and causing about USUS$330 million in damages

- On average there are 3 storm related disaster events each year, killing on average almost 5000 people, affecting 1.65 million and causing USUS$16 million in damages each year

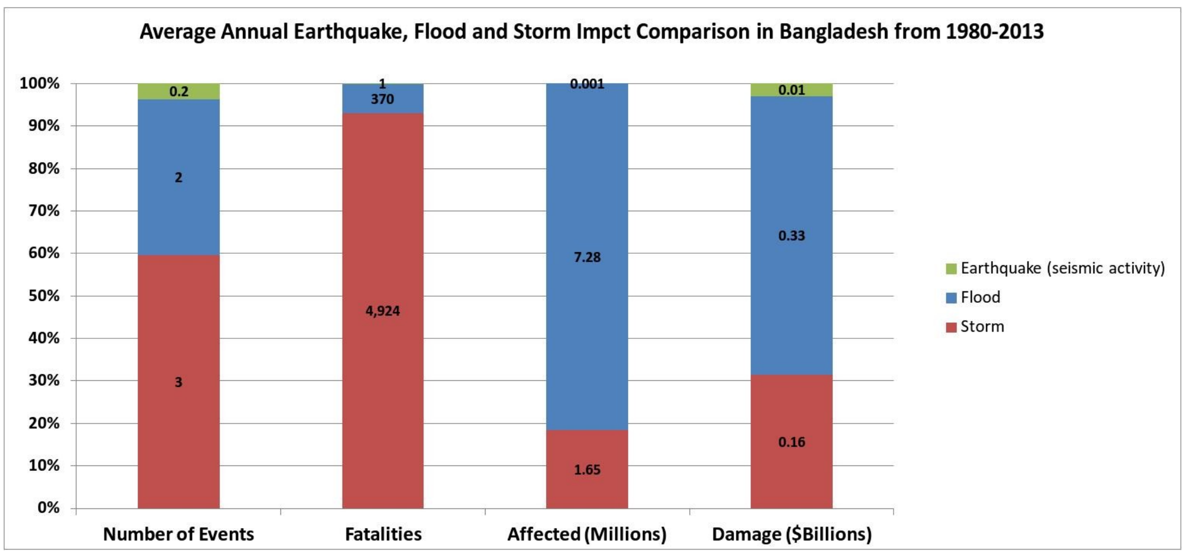

Figure 21: Average Annual Impact Comparison for Earthquakes, Floods and Storms in Bangladesh from 1980-2013 (Source EM-DAT 2014)

3.2.2 India Country Overview, Vulnerability and Exposure

India (see Figure 22 below) has a geographic diversity ranging from the Himalayas and associated glacial regions in the north to tropical islands in the south with deserts and forested mountain areas in between. India’s extensive rural areas, large dense urban centres and populations concentrated along rivers make India's population and economic assets highly vulnerable to natural disaster events (The World Bank 2012).

Some key aspects relating to natural disaster vulnerability and exposure in India include:

- The population of India is estimated at over 1.27 billion and at current growth rates this is expected to reach about 1.78 billion by 2050 (United Nations 2013a)

- About 60% of the country is exposed to earthquakes of varying intensity, 75% of India's coast is exposed to cyclonic events and over 8% of the landmass is exposed to flooding (The World Bank 2012).

- The Indian and Eurasian tectonic plates colliding has caused the formation of the Himalayas and has resulted in some of the world's most destructive earthquakes in history of which India is highly vulnerable (USGS 1999)

- India's major port city of Mumbai has approximately USUS$46.2 billion worth of assets and about 2.8 million people exposed to extreme events (cyclones, floods and storm surges) and by 2070 these figures could reach USUS$1.6 trillion and 11.4 million in assets and population exposed respectfully (Nicholls et al 2008)

- More intense fluctuations of severe drought and heavy precipitation associated with the monsoon is expected in India as a result of climate change (IPCC 2012b)

Figure 22: Map of India (Source: Nation Master 2014)

3.2.2.1 India Data Analysis

Figure 23 below shows the general increasing trend of earthquake, flood and storm occurrences in India between 1980 and 2013. Again this follows the general trend seen on a global scale as well as in the South Asia Region.

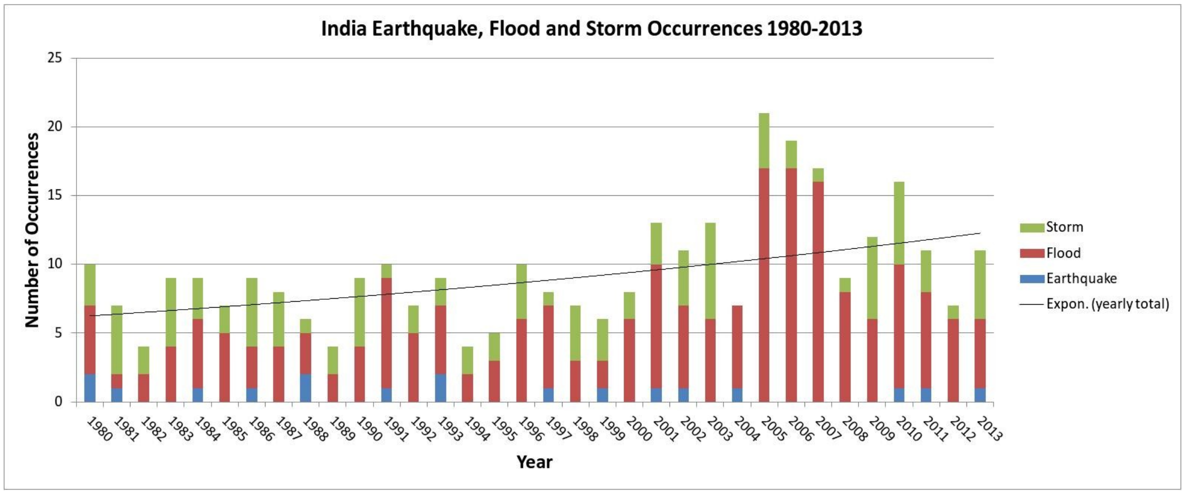

Figure 23: India Earthquake, Flood and Storm Occurrences 2980-2013 (Source EM-DAT 2014)

The annual number of fatalities resulting from earthquakes, floods and storms in India has remained fairly constant between 1980 and 2013 with significant peaks in certain years resulting from the following events:

- In 2001 India experienced a 7.7 magnitude earthquake in Gujarat killing more than 20 000 people (EM-DAT 2014 and USGS 2010b)
- The Indian Ocean earthquake related tsunami in 2004 was responsible for more than 16 000 deaths in India (EM-DAT 2014)
- In 1993 a 6.2 magnitude earthquake struck in the Maharashtra state of India killing almost 10 000 people (USGS 2010a)
- In 1999 a severe cyclone hit Orissa on India's east coast resulting in more than 10 000 people losing their lives (Red Cross 2002)

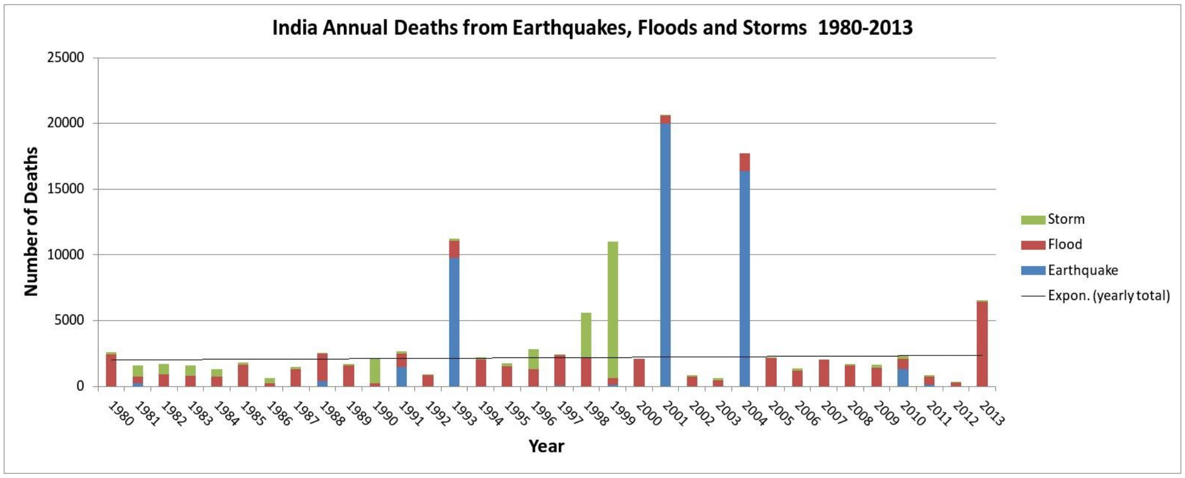

Figure 24: India Annual Deaths from Earthquakes, Floods and Storms 1980-2013 (Source EM-DAT 2014)

Figure 25 indicates a slightly increasing trend in the number of people affected by earthquakes, floods and storms in India between 1980 and 2013. The most significant event was a flood that occurred in 1993 associated with extremely high volumes of monsoonal rainfall in the north of India which resulted in almost 130 million people affected (EM-DAT2014 and UN 1993)

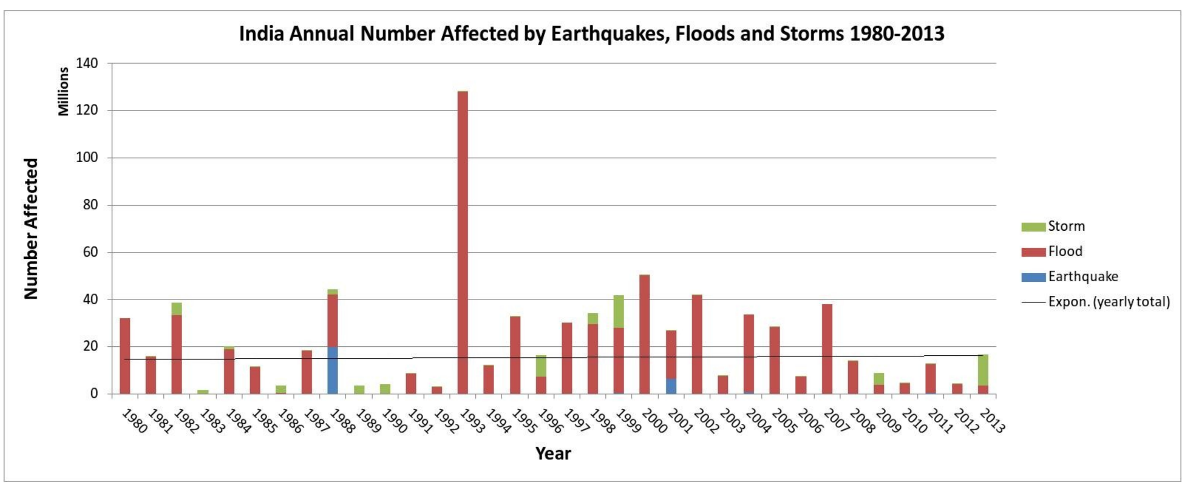

Figure 25: India Annual Number Affected by Earthquakes, Floods and Storms 1980-2013 (Source EM-DAT 2014)

Figure 26 below shows the increasing trend in damages incurred in India as a result of earthquakes, floods and storms from 1980 to 2013. The flooding in 1993, as mentioned above is the most significant. The 2005 flooding that occurred is the next most significant and was a result unprecedented monsoonal rainfall in the Gujarat region (UN 2005).

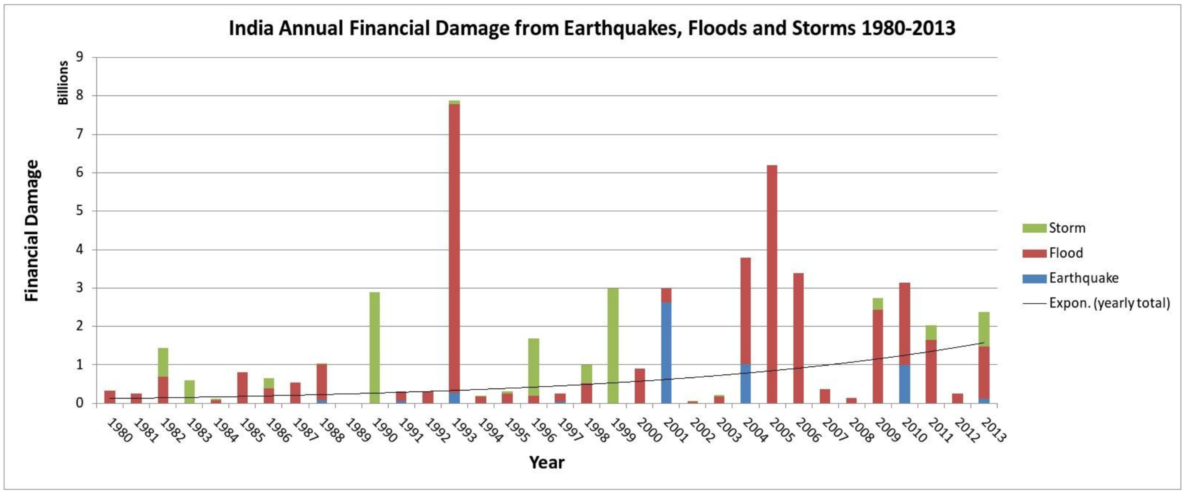

Figure 26: India Annual Financial Damage from Earthquakes, Floods and Storms 1980-2013 (Source EM-DAT)

The following summary of statistics for India between 1980 and 2013 is based on Figure 27 below:

- On average there is 1 earthquake event every year killing on average almost 1500 people every year, affecting 840 000 people and causing almost USUS$150 million in damage annually
- There are on average 6 flood events each year, resulting in 1400 deaths annually, affecting about 20.6 million people and resulting in about USUS$1.05 billion of damages
- On average there are 3 storm related disaster events each year, killing on average almost 700 people, affecting 2.05 million and causing USUS$300 million in damages each year

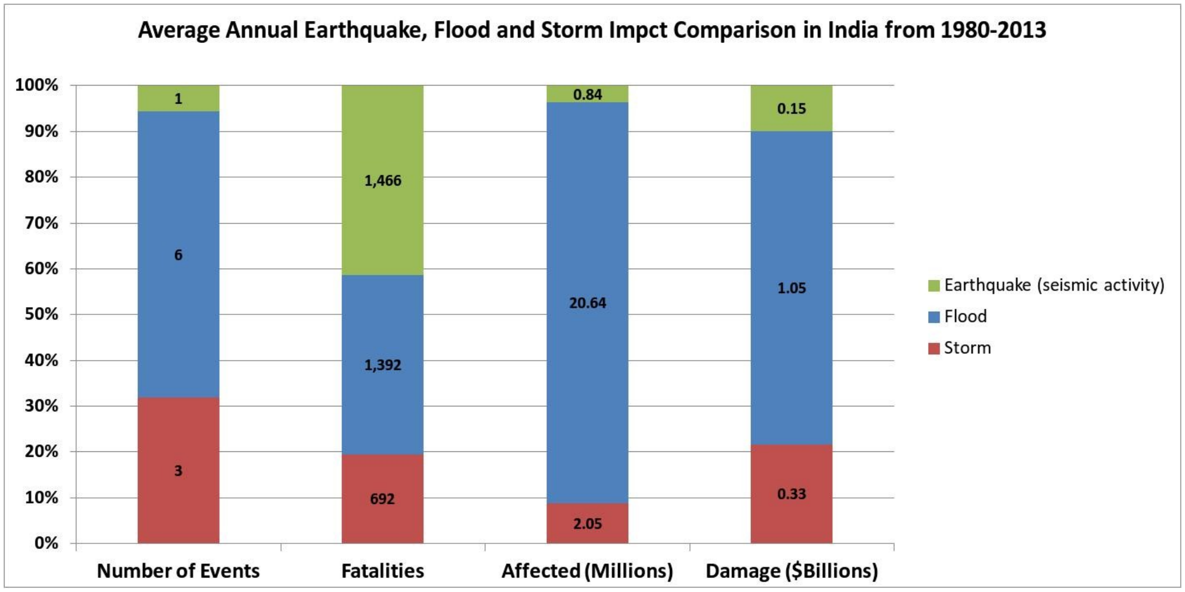

Figure 27: Average Annual Impact Comparison for Earthquakes, Floods and Storms in India from 1980-2013 (Source EM-DAT 2014)

3.2.3 Pakistan Country Overview, Vulnerability and Exposure

Pakistan (see Figure 28 below) has a diverse geography with Himalayan and Karakoram mountains to the north, the Indus plain and the Balochistan plateau in the centre leading down to a coastline on the Arabian Sea. Pakistan has dense population centres situated in areas that are exposed to multiple hazard types, predominantly floods and earthquakes (The World Bank 2012).

Some key aspects relating to natural disaster vulnerability and exposure in Pakistan include:

- The population of Pakistan is estimated at over 188 million and at current growth rates this is expected to reach over 371 million by 2050 (United Nations 2013a)
- Pakistan is highly exposed to earthquakes in the northern regions and the entire country is highly exposed to flooding, mainly due to monsoonal rain patterns (The World Bank 2012)
- Approximately 40% of walls built for houses in Pakistan use vulnerable material (unbaked bricks, wood and bamboo) and more than 70% of houses have used vulnerable materials (cement/iron and wood/bamboo) for roof construction (Government of Pakistan 2012a)

- The main port city of Karachi in Pakistan has approximately USUS$630 million worth of assets and about 49 000 people exposed to extreme events (cyclones, floods and storm surges) and by 2070 these figures could reach USUS$29.5 billion and 473 000 in assets and population exposed respectfully (Nicholls et al 2008)

- Munich Re Group (2004) indicate that, based on information from various statistical authorities, the city of Karachi is responsible for up to 20% of Pakistan's GDP and that it is exposed to high risk from earthquake

- Pakistan can be expected to experience more intense fluctuations of severe drought and heavy precipitation associated with the monsoon as a result of climate change (IPCC 2012b)

Figure 28: Map of Pakistan (Source: Nation Master 2014)

3.2.3.1 Pakistan Data Analysis

Figure 29 below shows the increasing trend in the number of earthquakes, floods and storms experienced by Pakistan from 1980 to 2013. Again, this follows the general global and regional trends identified in previous sections of this report.

Note that the trend lines included in the Pakistan data analysis have used the linear trend lines as opposed to exponential trend lines used throughout other sections; this was due to the gaps in data (i.e. zero values) that do not translate into exponential trend lines n the Microsoft Excel software used.

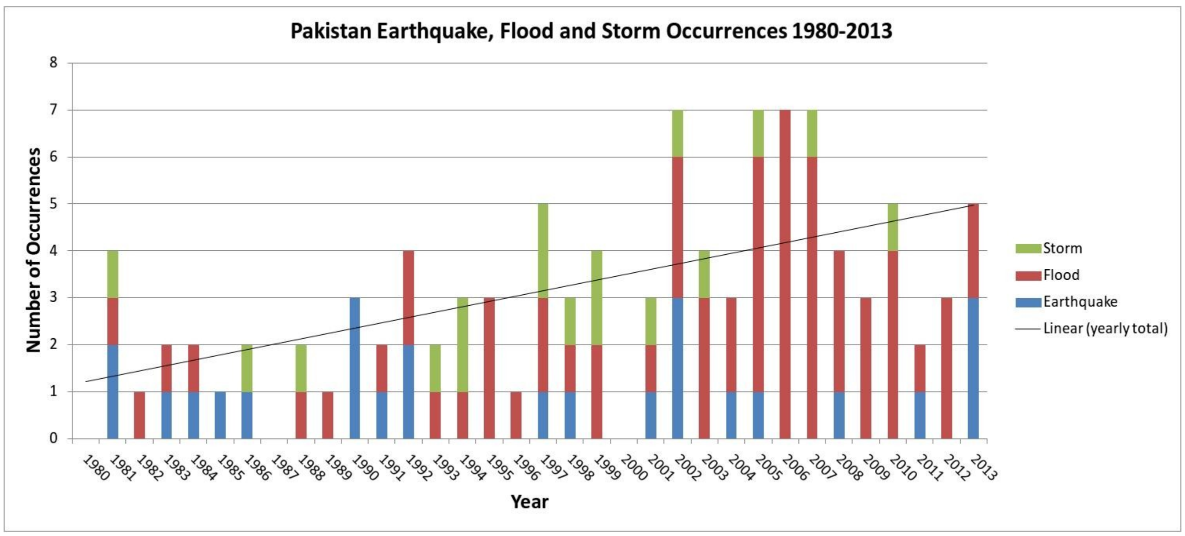

Figure 29: Pakistan Earthquake, Flood and Storm Occurrences 2980-2013 (Source EM-DAT 2014)

Figure 30 below shows the slightly increasing trend in the number of deaths resulting from earthquakes, floods and storms in Pakistan between 1980 and 2013. The spike in 2005 occurred as a result of a 7.6 magnitude earthquake about 100 km north east of the capital Islamabad resulting in more than 73 000 deaths (USGS 2007 and EM-DAT 2014).

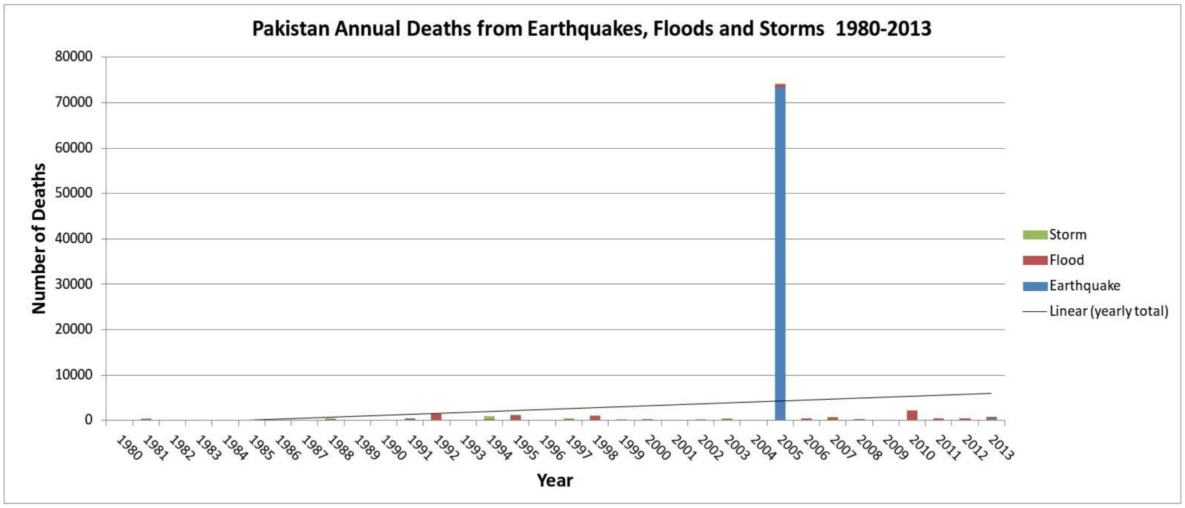

Figure 30: Pakistan Annual Deaths from Earthquakes, Floods and Storms 1980-2013 (Source EM-DAT 2014)

Figure 31 below indicates an increasing trend in the number of people affected by earthquakes, floods and storms in Pakistan based on data from 1980 to 2013. The following details are in reference to the high spikes in data figures:

- In 2010 more than 20 million people were affected by widespread flooding resulting from monsoonal rainfall in the catchment of the Indus River (Singapore Red Cross 2010)
- Flooding due to excessive rainfall in the north east of Pakistan (Kashmir region) in 1992 resulted in over 12 million persons affected (UN 1992)
- The USGS (2007) recorded a 7.6 magnitude earthquake 2005 affecting more than 5 million people (EM-DAT 2014). This was combined with several flood events affecting a total of more than 7 million persons as well (EM-DAT 2014)

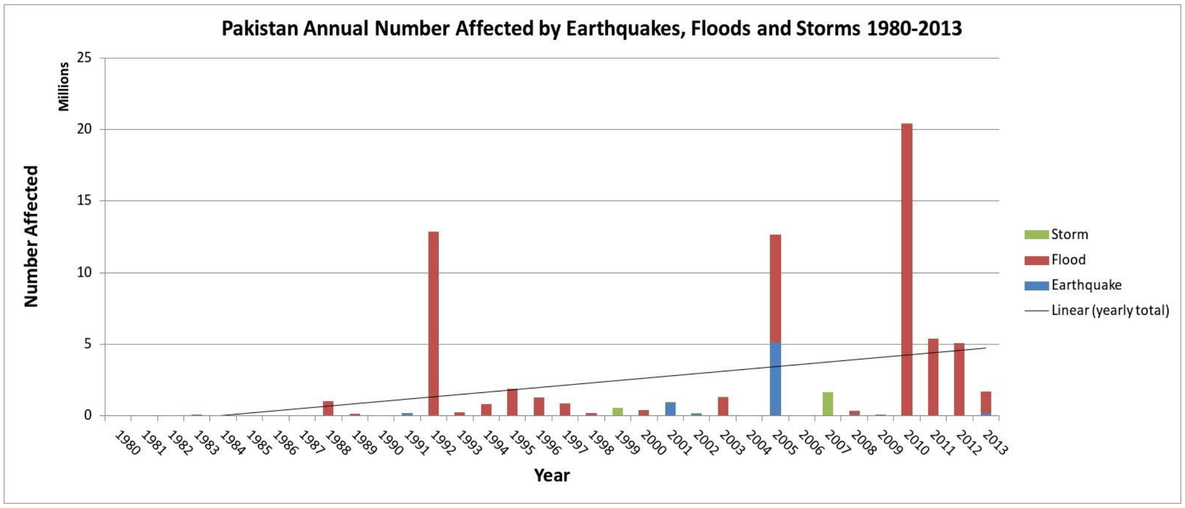

Figure 31: Pakistan Annual Number Affected by Earthquakes, Floods and Storms 1980-2013 (Source EM-DAT 2014)

Figure 32 below shows an upward trend in the financial damage resulting from earthquakes, floods and storms in Pakistan from 1980 to 2013. The spikes in 2010 (flood related) and 2005 (earthquake related) are the result of events described in the above sections of this report.

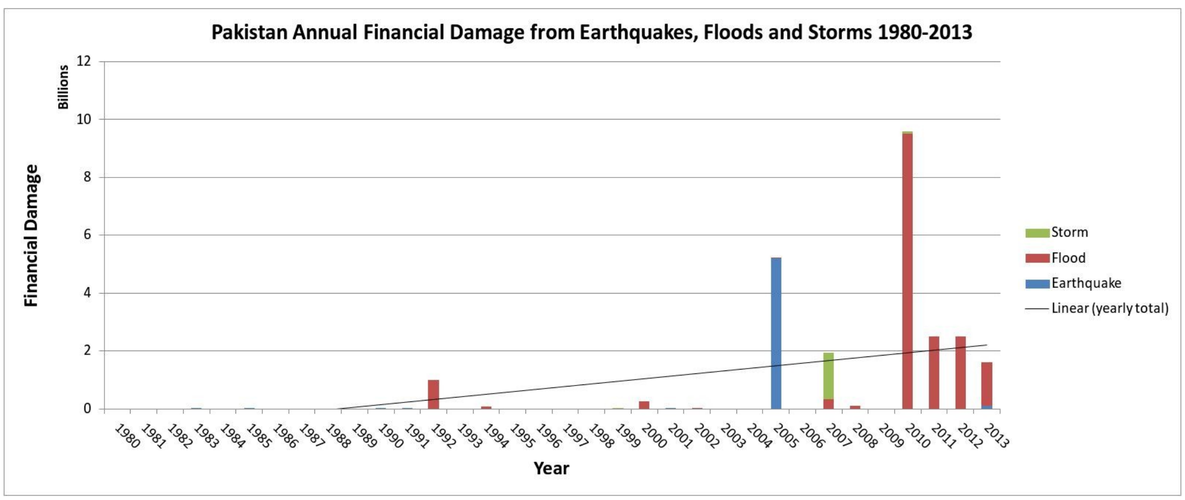

Figure 32: Pakistan Annual Financial Damage from Earthquakes, Floods and Storms 1980-2013 (Source EM-DAT)

The following summary of statistics for Pakistan between 1980 and 2013 is based on Figure 33 below:

- On average there is 1 earthquake event each year killing on average almost 2200 people every year, affecting 200 000 people and causing almost USUS$160 million in damage annually

- There are on average 2 flood events each year, resulting in 305 deaths annually, affecting about 1.8 million people and resulting in about USUS$520 million of damages

- On average there is 1 storm related disaster events each year, killing on average almost 45 people, affecting 60 000 people and causing USUS$50 million in damages each year

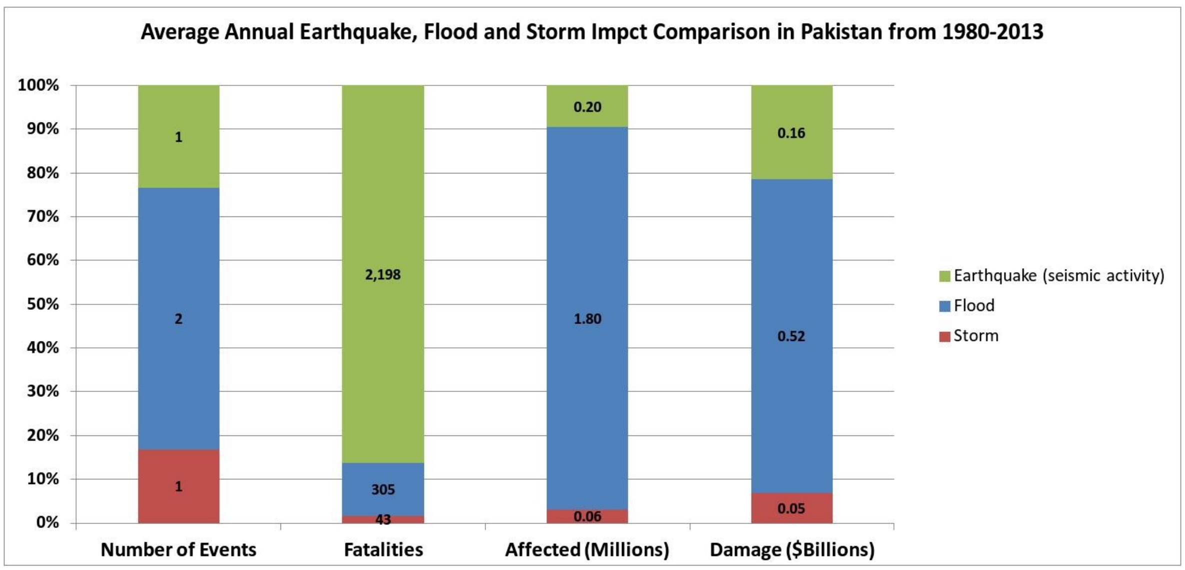

Figure 33: Average Annual Impact Comparison for Earthquakes, Floods and Storms in Pakistan from 1980-2013 (Source EM-DAT 2014)

3.3 Natural Disaster Risk Management Strategies

This section will cover Bangladesh, India and Pakistan in order to gain a broad understanding of the natural disaster risk management strategies and mechanisms employed in South Asia. To limit the breadth of this section a single country only will be included in this body section while the remaining two countries will be included in the Appendix C: Natural Disaster Risk Management in Selected Countries. In this case Bangladesh has been chosen as it had the greatest number of people affected as a proportion of the total population and the largest financial impact as a percentage of GDP.

An overview of the risk management structure of Bangladesh will be provided initially followed by details specific to the three critical disaster types (earthquake, flood and storm). Due to the scope of this research project, disaster risk reduction at national levels will be the focus. a summary and comparison of sub-national level mechanisms will be included to provide an overview for South Asia in general (refer section 3.3.2 General Structure of Disaster Risk Management Strategies Used in South Asia) The key shortfalls of these structures and mechanisms will then be undertaken in the subsequent Gap Analysis section of this report.

3.3.1 Bangladesh

The Standing Orders on Disasters first came into effect in 1997 and were further updated to align with Hyogo Framework for Acton (HFA) and South Asia Association of Regional Cooperation (SAARC) goals in 2010. These standing orders define the roles, responsibilities and obligations applicable to each ministry, division, department and agency of the Government of Bangladesh so that they may clearly understand their duties and how they can incorporate disaster risk reduction into their respective area of governance (Government of Bangladesh 2010b)

The National Plan for Disaster Management, (Government of Bangladesh 2010a) details the disaster risk management system of Bangladesh which is organised on national and sub-national levels. The Disaster Management and Relief Division coordinates these national and sub-national organisations through the Disaster Management Bureau. The strategic goals for this plan are directly drawn from the SAARC which is in turn aligned with the HFA with reference to the Millennium Development Goals (MDG) as well and are as follows:

1. Professionalising the disaster management system

2. Mainstreaming risk reduction
3. Strengthening Institutional Mechanisms
4. Empowering At Risk Communities
5. Expanding Risk Reduction Programming
6. Strengthening Emergency Response Systems
7. Developing and Strengthening Networks

A series of institutions (councils, committees, councils, platforms, programmes etc) have been formed at national and sub-national levels in order to achieve these strategic goals. Together with these institutions is the following regulatory framework, some of which has been implemented already and some of which is to be implemented by 2015:

- Disaster Management Act which came into effect in 2012 after a mandate from the Department of Disaster Management and forms the legal basis from which activities and actions can be managed, delegates broad mandatory obligations to various ministries and defines disaster risk reduction objectives (Government of Bangladesh 2010a)

- The National Disaster Management Policy (Draft) 2012 aims to provide the strategic framework and again highlight the broad objectives of disaster risk management in Bangladesh (Government of Bangladesh 2010a)

- Individual Disaster Management Plans are either in existence or being developed for the 2015 timeframe with National Plan for Disaster Management prescribing the agenda and objectives for each of the regional management plans as well as specific disaster type management plans (e.g. earthquake and cyclone) (Government of Bangladesh 2010a)

According to the Government of Bangladesh (2010a) a series of guidelines have been developed that are intended to assist government bodies, non-government organisations, disaster management committees and civil institutions in implementing disaster risk management. These include:

- Disaster impact and risk assessment guidelines

- Disaster risk reduction funding guidelines
- Emergency response guidelines
- Disaster shelter management guidelines
- Hazard specific risk assessment guidelines

In order to target the most vulnerable areas of the country and to integrate disaster risk reduction into the community level, the Comprehensive Disaster Management Programme Phase II was introduced in 2010 (Ministry of Disaster Management and Relief 2010). This has been funded internationally to the amount of USUS$76 million and has specific targets for 40 of the most vulnerable districts and 9 densely populated cities including:

- Disaster early warning generation
- Improved school safety and household response
- Enhanced search and rescue as well as volunteer capabilities
- Piloting urban risk reduction interventions

Bangladesh has a National Building Code that is applicable to all construction of new buildings, alterations to and repairs of existing buildings (Government of Bangladesh 2012a). This code has provisions for seismic, flood and wind live loads and contains a comprehensive set of analysis and design mechanisms to ensure that, when complied with, buildings are resilient to flood, storm and earthquake events (Government of Bangladesh 2012b).

A National Emergency Management Centre has been established which operates full time to manage information, resources and activities regarding earthquake, flood and storm emergency events (Government of Bangladesh 2009e, 2013a and 2013c).

The Centre for Environmental and Geographic Information Services (CEGIS) plays an ancillary role in disaster risk management by providing services for community based risk management and risk assessment however it is predominantly concerned with flood management and climate change modelling (CEGIS 2014).

With regards to climate change, the Ministry of Environment and Forests in the Government of Bangladesh developed a National Adaption Programme of Action in 2005. This programme is in line with the United Nations Framework Convention on Climate Change and has been integrated into the National Plan for Disaster Management and identifies the potential risks associated with climate change as well as the priorities for action and a project scope of how to achieve these (Ministry of Environment and Forest 2005). Additional work has been incorporated into the Comprehensive Disaster Management Programme Phase II in order to mainstream climate change adaptation policies, plans and budgetary frameworks (Ministry of Disaster Management and Relief 2010).

3.3.1.1 Earthquake

Under the Standing Orders on Disaster the Earthquake Preparedness and Awareness Committee was formed in 2009. This committee has responsibilities associated with earthquake preparedness and awareness, search and rescue equipment and risk reduction requirements (Government of Bangladesh 2010b).

A further requirement stipulated under the standing orders is the development of the Bangladesh Earthquake Contingency Plan under the Disaster Management Bureau the aim of the Earthquake Contingency Plan is to fully integrate earthquake risk management across the array of government sectors and facilitate risk reduction through collaboration, education and resource sharing. This will then allow for the goals of the National Plan for Disaster Management (2010-2015) to be achieved with regard to earthquakes in Bangladesh (Government of Bangladesh 2009e).

The Comprehensive Disaster Management Program, under the Disaster Management Bureau, is the key driving force behind earthquake disaster risk management in Bangladesh. Through this program the following initiatives have been undertaken which provide the background for the Earthquake Contingency Plan:

- An earthquake vulnerability assessment (Government of Bangladesh 2009b) of Bangladesh's three largest cities (Dhaka, Chittagong and Sylhet) including:
    - A comprehensive building inventory that incorporates structure type, day/night occupancy comparison, floor areas, storey height, building contents and seismic vulnerability
    - Vulnerability analysis of highways, railways, bus and ferry systems

    - Utility vulnerability analysis including potable water, waste water and sewage, natural gas, electricity and communication

    - Essential services vulnerability including medical, schools, fire, police and emergency services

- A seismic hazard assessment (Government of Bangladesh 2009f) of Bangladesh's three largest cities (Dhaka, Chittagong and Sylhet) which incorporates:

    - A deterministic of seismic motion in base rock to be used for damage forecasting, vulnerability assessment and mapping

    - A liquefaction potential analysis (whereby saturated or partially saturated soil loses strength in response to high stress levels and behaves like a liquid) with the study areas mapped with probability factors ranging from 1 (low) to 5 (high)

    - A slope failure analysis during earthquake simulations

- An earthquake risk assessment (Government of Bangladesh 2009c) of Bangladesh's three largest cities (Dhaka, Chittagong and Sylhet) has been undertaken in conjunction with the Asia Disaster Preparedness Centre. This risk assessment utilises HAZUS, a natural disaster risk assessment tool developed by the United States Federal Emergency Management Agency, which works through the GIS software ArcGIS. This risk assessment includes the following interdependent analyses:

    - Potential earth science hazards including ground motion and acceleration as well as ground failure caused by landslides, liquefaction and surface fault rupture

    - An inventory of general buildings and infrastructure, essential facilities, transportation systems and utility systems which can be stored as GIS datasets with metadata recorded as well

    - Individual scenario simulations that include the direct physical damage losses as well as the loss of functionality of essential services and lifelines such as emergency services, transportation services and utilities

- Induced and follow on damages from individual scenario simulations which includes the spread of fire after an event as well as the estimated tonnages of debris created

- Direct economic losses which are made up of the cost of repair and replacement of structures and systems, structural, non-structural and building contents damage. These damages are taken from the abovementioned damages analyses and are coupled with economic data

The Bangladesh Earthquake Society has published an Earthquake Resistant Design Manual (Bangladesh Earthquake Society 2006) that covers:

- Seismic design loads
- Detailing requirements
- Quality control and assurance
- Repair, restoration and strengthening of buildings; and
- A checklist for construction work

3.3.1.2 Flood

The Standing Orders on Disaster detail to the various government departments and agencies their responsibilities with regards to flood management. The National Plan for Disaster Management (2010-2015) then stipulates the need for a specific Flood Management Plan (Government of Bangladesh 2010a). This plan was not available via internet sources at the time that this research project was being undertaken and is not referenced by other sources including Government of Bangladesh 2013a.

The Ministry of Water Resources Bangladesh developed the National Water Management Plan 2001 which developed long term strategic water related goals for, at the time of publication, 2011 to 2025. This Plan is directly linked to the National Water Management Policy. The strategies are predominantly concerned with efficiency, reliability and hygiene of water supply with some elements of environmental management as well. Certain flood measures are also identified, coordinated by the Bangladesh Water Resource Planning Organisation, which are repeated in the Emergency Preparedness Plan for Flood Bangladesh June 2013 described below (Government of Bangladesh 2001).

The Bangladesh Department of Disaster Management arranged the Emergency Preparedness Plan for Flood Bangladesh June 2013 (Government of Bangladesh 2013a). This document serves to consolidate the broad methods of a number of flood disaster management mechanisms in use in Bangladesh including:

- An overview of some of the structural and non structural flood management techniques available including
    - Raising national and regional highways above expected flood heights and raising rural and feeder roads on a case by case basis according to set risk reduction criteria
    - River dredging and maintenance of key river systems including embankment raising and drainage works, a significant portion of this is remediation work from human induced sedimentation and erosion
    - Construction of schools and other public facilities to high standards to withstand floods so they can be used as flood shelters
    - Working with communities to foster disaster awareness and develop disaster management plans
- The identification of the organisations and their functions currently working towards flood risk management which include:
    - The Bangladesh Water Resource Planning Organisation – this organisation has the specific role of implementing the Emergency Preparedness Plan for Flood Bangladesh June 2013 – the goals of this organisation and plan are consistent with the structural and non-structural measures identified above (Government of Bangladesh 2001)
    - The Bangladesh Institute of Water Modelling – this institute provides services including hydrological assessments, flood risk mapping and damage assessment and flood mitigation planning and designing services (Institute of Water Management 2014)

- The Bangladesh Flood Forecasting and Warning Centre - operates under the Bangladesh Water Development Board, is supported by the Comprehensive Disaster Management Programme and provides the following services (Flood Forecasting and Warning Centre 2014):
    - Data capture including satellite imagery, meteorological data and river level data from upstream catchments including areas of India
    - Real time data management from numerous locations within key river catchments which feeds directly into the Flood Forecast Model (Model uses MIKE 11 HD Software)
    - The dissemination of flood model data, via web site, email, fax/phone, SMS, radio, television, radio, newspaper and a dial in service, to a range of government departments, NGO's institutions and is available upon request

- The Emergency Preparedness Plan for Flood Bangladesh June 2013 also contains lists of humanitarian needs based on past flood events

The Comprehensive Disaster Management Programme Phase II conducted a Local Level Hazard Maps for Floods, Storm Surge and Salinity Study in June 2013 (Government of Bangladesh 2013c). This study produced the following outcomes with respect to flood management in Bangladesh:

- Field data sampling comparison to MIKE flood model outputs during flood events to verify, validate and calibrate these model outputs

- Flood depth mapping of individual regions and the dissemination of this data to local communities

- Flood level frequency analysis using historic data to establish probability outputs for predictive risk assessment of flooding

- Flood zoning map production for regions based on previous flood events over the past 3 decades

- Predictive flood mapping and modelling based on expected impacts of climate change including the increase of precipitation

The Asian Disaster Preparedness Centre in conjunction with the Bangladesh Disaster Preparedness Centre developed a Handbook on Design and Construction of Housing for Flood-Prone Rural Areas of Bangladesh (ADPC 2005). This handbook achieves the following outcomes with regard to flood risk management:

- Provides a list of currently used techniques and options for the construction of housing in rural areas including plinths, posts, walls and roofing which are based on the local availability of economically viable materials

- Details the procedural steps to be followed to ensure that design and construction of these houses are going to be resilient to flooding. This includes diagrams, instructions, estimated costings and life expectancy of the structure

- Provides simple materials testing procedures with regards to earth based materials usage (e.g. earthen walls and bricks)

- Provides advice on water supply, sanitation, energy supply and hygiene for the buildings

- Provides treatment methods for bamboo accompanied with specific treatment ingredients and procedures to be followed to ensure higher life expectancy of structures

More recently the Government of Bangladesh (2009d) developed the Guiding Principles for Design and Construction of Flood, Cyclone and Storm Surge Resilient House: A CDMP Approach for Cyclone and Flood Prone Rural Areas. As the name suggests this set of guidelines accounts for wind resilience as well as for flooding. What this provides is the methodology and technical detailing for a single design aimed at withstanding flood, storm surge and cyclone. Materials requirements, cost estimations, construction methods and technical drawings are all provided in this document (Government of Bangladesh 2009d).

3.3.1.3 Storm

Both the Bangladesh National Plan for Disaster Management (2010-2015) and the Standing Orders on Disaster (Government of Bangladesh 2010a and 2010b) designate that the Cyclone Preparedness Programme is the key functional body for cyclone related disaster risk reduction in Bangladesh. The Ministry of Disaster Management and Relief, Department of Disaster Management and the Ministry of Food and Disaster Management, Disaster Management Bureau/Comprehensive Disaster Management Programme are the two government sectors responsible for cyclone risk management (Government of Bangladesh 2010a and 2010b).

The Cyclone Preparedness Program is based in Dhaka and has 7 zone offices. These zones subdivide into city locations and then into units of approximately 1 to $2km^2$ containing 2000 to 3000 people. Each of these units has facilities and volunteer staff for warnings, shelter, rescue, first aid and relief groups. As of 2011 there were 3291 units with a total of 49365 volunteers (Cyclone Preparedness Programme 2011). One of the more significant outcomes of the Cyclone Preparedness Programme has been the dissemination of information and warnings from the national level to the local village level. This has been achieved through a simple, integrated community volunteer based system (Government of Bangladesh 2013b).

In 2013 the Department of Disaster Management released the Emergency Preparedness Plan for Cyclones. The objectives of this plan are to reduce risk and to reduce potential impact from cyclone events on the community. This plan (Government of Bangladesh 2013b) contains risk reduction mechanisms including:

- 2 full scenario analyses of separate cyclone events, a category 2 event in the south east and a category 4 event in the south west, which cover:
    - The expected impacts on assets (public and private), services and the environment
    - The immediate humanitarian effects including loss of essential services, loss of income and livelihood, food shortage and malnutrition forecasting
    - The coping mechanisms at government level, including allocation of resources and high level decision making processes as well as at community levels including response times for volunteers and distribution of relief
- An overview of the Standard Operating Procedure for emergency response which incorporates a timeline, action lists and responsibility allocation

- A stock take of available resources on standby for disaster events including cash, food, non-food items (including blankets), emergency communication mechanisms, rescue vessels and cyclone shelters available

- An overview of the early warning system in place for cyclone in Bangladesh which includes reference to the Bangladesh Meteorological Department

As mentioned above, the Government of Bangladesh (2009d) released Guiding Principles for Design and Construction of Flood, Cyclone and Storm Surge Resilient House: A CDMP Approach for Cyclone and Flood Prone Rural Areas. This document targets rural areas and specifically focuses on traditional labouring occupations (fishing, day labour etc), female headed households, elderly households and ethnic minorities. It attempts to provide affordable and safe housing construction methods for these community groups.

3.3.2 General Structure of Disaster Risk Management Strategies Used in South Asia

This section will summarise the disaster risk management strategies of Bangladesh (refer section 3.3.1 Bangladesh above), India and Pakistan (refer sections 9.1.1 India and 9.1.2 Pakistan respectively). By doing so a representative structure for South Asian disaster risk management will be attained and a greater understanding of the strategies used in this region of the world will be achieved.

1. *Government Legislation/Statute*

An overriding statutory document or legislation lies at the top of the disaster management structure. Because this has been enacted by parliament it is enforceable and can stipulate roles and responsibilities that therefore must be followed by law. Examples of these are:

- Bangladesh's *Standing Orders on Disasters 1997* and later the *Disaster Management Act* which came into effect in 2012

- India's *Disaster Management Act 2005*

- Pakistan's *National Disaster Management Ordinance 2007* which then became the *National Disaster Management Act* in 2010

These documents dictate that a governing body is established that has the responsibility of overseeing the implementation of the Act. It will also describe the powers held by this governing body.

There are also Building Codes and Guidelines set at the national level, including:

- The Bangladesh *National Building Code 2012*
- The *National Building Code of India 2005*
- The *Pakistan Building Code 1986* which was amended to become the *Building Code of Pakistan (Seismic Provisions)* in 2007

In each of these countries the responsibility of the implementation of these building codes (and others not mentioned) lies with state, province and local authorities.

2. *Governing Body and Overarching Disaster Management Plan at National Level*

The top level governing bodies and management plans for disaster management are structured similarly for each country. Under each Act a National council, committee or bureau is headed by the Prime Minister and reviews key disaster related policy. Examples of these are:

- The National Disaster Management Council and Disaster Management Bureau in Bangladesh
- The National Disaster Management Commission in Pakistan
- The National Disaster Management Authority in India

Under these bodies is generally a national disaster management plan as stipulated in the Act. For example:

- Bangladesh's National Plan for Disasters (2010-2015)
- Pakistan's National Disaster Management Plan

- India’s National Disaster Management Policy 2009 and the Draft National Disaster Management Plan 2013

3. *Type Specific Management Plans/Guidelines*

Under the National Plan will typically sit type specific management plans for the natural disaster events identified via a risk assessment process. For example:

- Bangladesh has the National Earthquake Contingency Plan, the National Water Management Plan, Emergency Preparedness Plan for Floods and the Emergency Preparedness Plan for Cyclones

- India has the National Disaster Management Guidelines for the Management of: Floods, Cyclones and Earthquakes

- Pakistan has a slightly different approach; it has the National Disaster Management Plan: Main Volume, Human Resource Development Volume, National Multi-Hazard Early Warning System Plan Volume and Instructor’s Guideline on Community Based Disaster Management Volume. These collectively cover similar aspects as India and Bangladesh for floods, cyclones and earthquakes

4. *Sub-National Level*

These national level plans flow down into sub-levels who have set roles and responsibilities which then also flow into further sub-levels. For example:

- Bangladesh has 64 districts, each with a District Disaster Management Plan, approximately 488 smaller subdistricts known as Upazilas each with an Upazila Disaster Management Plan and about 4 550 smaller subareas known as Unions each with a Union Disaster Management Plan. At each of these levels there is a disaster management committee that oversees the functions of the management plans

- Pakistan has four main provinces and two autonomous areas (including Kashmir) which have Provincial Disaster Management Authorities and Plans, then there are 149 districts with District Disaster Management Plans and Authorities

- India has 36 state/union territories each with a State Disaster Management Authority and Management Plan, then about 675 districts with District Disaster Management Authorities and Management Plans

Note that these figures have been taken from various sources of information found in the plans, policies and strategies reviewed. As some of these sources are more than five years old these figures may have been subject to change.

5. *Local Community Level*

Disaster risk management at the local community is essential and this is reflected in the Hyogo Framework for Action, stipulating enhanced risk management at all levels. Each country recognises the importance of community based disaster risk management and the mechanisms in place in the selected countries include:

- Bangladesh has implemented community based risk assessments and has undertaken a significant amount of work through the Comprehensive Disaster Management Programme Phase II (run by the Ministry of Disaster Management and Relief at a national level) particularly in the areas of disaster risk reduction plans for floods and cyclones

- The National Disaster Management Authority has conducted several awareness programmes in communities, particularly in coastal regions of Pakistan and it is also a driving force in mock evacuation drills for earthquakes and tsunami. This authority has also produced the guidelines for community based disaster management to be use by instructors when implementing risk reduction mechanisms at the community level

- In India, state and district authorities typically have to role of implementing initiatives at the local community level. There is a significant recognition of the roles that communities play in disaster risk reduction and the Indian government at all levels is working towards the last mile of training requirements for at risk communities

In all three cases the implementation of land zoning and building codes/guidelines is ultimately up to the local authorities to enforce. Responsibility for other initiatives (both structural and non-structural) eventually falls on the local authorities to implement as well.

3.4 Gap Analysis

This section will provide a critical analysis of the gaps between Bangladesh's disaster risk management strategies and the internationally recognised standards. Initially this will focus on the work still to be completed towards the Hyogo Framework for Action, followed by the gaps in addressing the key disaster types. After this an overview of the gaps that are common to South Asia will be provided. This will be based on the review of the disaster risk management strategies and mechanisms of Bangladesh, Pakistan and India as a representation of South Asia in general. Additional gap analysis study details for India and Pakistan can be found in Appendix C: Natural Disaster Risk Management in Selected Countries Gap Analysis section 9.2.1 for India and section 9.2.2 Pakistan.

Due to the broad scope of issues and gaps identified these key disaster type gaps will concentrate specifically on a limited number of engineering related shortfalls in disaster risk management in the specific countries.

3.4.1 Bangladesh

3.4.1.1 Hyogo Framework for Action

This section will highlight the gaps that Bangladesh has in implementing the Hyogo Framework for Action according to each of the Five Priorities for Action. These gaps are based on the documents reviewed for Bangladesh above (see section 3.3.1 Bangladesh), the review completed by the World Bank (2012) and the most recent Hyogo Framework for Action progress report completed by the Government of Bangladesh (2013d).

1. **Ensure that disaster risk reduction is a national and local priority with a strong institutional basis for implementation**

    - While there has been significant progress towards disaster risk reduction made in Bangladesh there remains a disconnection between the policies and structure set at the national level and the implementation of capacity building at the local and community levels. To add to this the actual capacity of the Disaster Management

Bureau is quite weak and as such it is restricted in its capability to implement its mandated roles and responsibilities

- Although resources have been specifically allocated towards disaster management the funding amount is not significant enough for the size of the population and the multitude of hazards experienced. Funding allocations from government to non-government organisations are often delayed and suboptimal due to a lack of coordination. Further, the contingency in budget items for disaster risk is quite small and usually relies on budgetary reallocations from other development programs

- The focus of the media is predominantly on emergency situations as opposed to longer term disaster risk reduction

- At the national level disaster risk management agencies and authorities in Bangladesh lack representation from women and women's organisations

2. Identify, assess and monitor disaster risks and enhance early warning

- More than 12 000 schools and hospitals are not considered safe from natural disasters in Bangladesh, this is comprised of vulnerability to earthquakes in rural areas and from floods and cyclones in rural and coastal areas

- The unavailability of accurate and current geo-spacial data prevents the production and dissemination of flood and storm surge maps to communities

- Risk assessments of key sectors including health, water, sanitation and hygiene, energy and agriculture have not been performed consistently and with enough detail at local levels. adding to this gender, along with disability and aging need to be integrated into community based risk management and hazard analysis

- There are still major constraints with rainfall and water flow data gathering, analysis and sharing between Bangladesh and its immediate neighbours and flood and flash flood warnings will not be at adequate levels until this is rectified

- This lack of cooperation and knowledge sharing extends to all other disaster types between several South Asian countries. There is also a lack of consistent broad scale satellite coverage in Bangladesh and in South Asia in general

3. **Use knowledge, innovation and education to build a culture of safety and resilience at all levels**

- Disruptions to electricity supply and the lack of reliable high speed internet services are major constraints to disaster risk managers, professionals and government/non-government agencies working outside of the major urban areas of Bangladesh

- While there are disaster risk education and awareness curriculum established for all levels of schooling there remain children, women, aged and disabled persons out of the system and thus not reached by these initiatives

- The mechanisms to scale up studies and research programs for public usage, including linking researchers with practitioners, are not readily available and the sharing of the valuable research that has been conducted is not regularly followed through with

4. **Reduce the underlying risk factors**

- There have been numerous successful small scale pilot programmes at the community level in Bangladesh, however there are limited scaling up mechanisms and incentives to drive these initiatives to larger scales

- Natural resource management has not been integrated into disaster risk reduction at local or national levels to an adequate degree

- There are 29 government ministries implementing development programmes to increase the capacity of low socio-economic regions of Bangladesh cope with natural disasters. There is a lack of coordination, overlapping and considerable waste that needs to be addressed

- The absence of risk financing and risk transfer is a major gap in Bangladesh

- There is a lack of resources and authority to monitor the enforcement of the National Building Code in Bangladesh. Johnson (2011) suggests that not only is the code not enforced but the practicality of it in addressing the problems of unsafe dwellings is also in question and simpler, implementable standards should be developed especially for low socio-economic areas.

5. **Strengthen disaster preparedness for effective response at all levels**

- Bangladesh has developed strong disaster risk management mechanisms, policies, regulations and guidelines however it generally lacks the capacity to fully implement them especially in terms of the lack of trained personnel, financial and technical resources

- Bangladesh lacks the contingency planning and financial resourcing to adequately reconstruct and rehabilitate after disaster events. this is a significant gap given that one of the greatest reducers of disaster risk is seizing opportunities to build back better

3.4.1.2 Earthquakes

Despite the fact that seismic risks have been identified as substantial in Bangladesh, the World Bank (2012) believes that seismic risk has been largely neglected. Specific shortcomings have been identified by the World Bank and Earthquakes and Megacities Initiative (2014) and indicate that major stakeholders and decision makers have insufficient knowledge of earthquake risks and risk reduction measures. Even with the work that has already been completed there is a need for further refinement of the methodologies used. For example vulnerability assessments conducted by the Government of Bangladesh (2009f) utilise a deterministic method which is justified, however further work is needed specifically using a probabilistic approach to establish predictive recurrence intervals and exceedance probabilities.

Other specific engineering gaps identified by the Government of Bangladesh (2009b) include:

- The majority of highway bridges in 3 of the largest urban areas (Dhaka, Chittagong and Sylhet) have not taken seismic loadings into account in their designs

- On average more than 80% of railway tracks and railway associated facilities in these 3 centres are not designed to meet expected seismic loads

- On average almost 60% of potable water pipelines in these major urban areas are installed in moderate to very high soil liquefaction areas

- The majority of waste water pipelines in these areas is constructed of brittle pipe (asbestos, cast iron and reinforced concrete) and as much as 43% of this pipe has been laid in high soil liquefaction areas

- On average more than 60% of natural gas piping in these areas has been laid in moderate to very high soil liquefaction areas

3.4.1.3 Floods

One of the key strategies proposed and implemented by the Government of Bangladesh in recent years has been to strengthen existing and install new structural flood proofing, mainly in the form of levees (Brammer 2010). This structural work has a valid place in risk reduction however as identified from previous flooding events in Bangladesh (Government of Bangladesh 2007 and 2013a) there are major risks associated with this work as well. These include:

- The construction of upstream levees and embankments reduces the river's ability to store flood water leading to increased downstream flow and resultant increased risk of flooding downstream

- In several cases the ongoing maintenance of levees and embankments is neglected and embankment breaching during flood events is not uncommon

- People living alongside the embankment/levee are often well aware of the flood risk however remain under a false sense of security and are ill prepared for embankment/levee failure

- Critical flood infrastructure such as bridges and culverts are not routinely inspected and cleared of debris/sediment prior to monsoon season, thus increasing the potential for the failure of levees/embankments and drainage systems

- To compound the problem further, many schools, hospitals, bridges and roads are not designed or built with consideration to building codes and flood proofing, some of which rely on structural measures for protection

- The concept of flood proofing and flood insurance is not commonly practiced in Bangladesh to date, especially in low socio-economic areas

Many of the issues identified above are not restricted to Bangladesh or the South Asia Region. Kundzewicz (2011) describes similar issues experienced in the Mississippi river catchment during the 20th century, leading to recommendations of large scale river flood plain buybacks to allow natural dissipation of flood waters. This paper leads onto describe how certain European countries are moving to implement a combination of natural flood plain areas along side structural measures such as levees and embankments in order to mitigate flood risks.

3.4.1.4 Storms

In 1970 a cyclone in Bangladesh killed more than 500 000 people (EM-DAT 2014), although this is out of the time frame for the scope of this research project it is pertinent here. After this event there was a gradual paradigm shift from a response oriented approach towards disaster management to a system that incorporates more risk reduction and emergency preparedness. A cyclone event with a greater intensity than the 1970 cyclone struck the Bay of Bengal in 1991 resulting in approximately 140 000 lives lost (Government of Bangladesh 2008).

Bangladesh increased its focus on cyclone risk mitigation and by 2007 it had built more than 2 000 cyclone shelters across 15 districts and developed a strong early detection and warning system (Government of Bangladesh 2008). Together with this work has been the construction of over 6 000km of coastal embankments and the recruitment and training of over 40 000 emergency volunteers (The World Bank 2012). The event in 2007 (cyclone Sidr) was the strongest cyclone in recorded history (see Table 5) to hit the Bay of Bengal yet it resulted in a much reduced death toll of 3 800. It is estimated that close to 1.5 million people benefitted from the early warning and cyclone shelter systems in place (The World Bank 2013).

Year	Wind Speed	Deaths
1960	210	8119
1961	146	11466
1963	203	11520
1965	210	20152
1966	146	850
1970	223	500300
1973	122	183
1974	162	50
1985	154	11069
1986	100	12
1988	162	9590
1990	102	132
1991	225	138958
1994	200	170
1995	100	172
1996	70	545
1997	225	410
1998	112	233
2007	250	4234
2008	80	15
2009	95	197

Table 5: Wind Speed and Deaths from Bangladesh Cyclones 1960 - 2009 (Source: Haque et al 2012)

While this is a considerable achievement there are a number of issues still identified with the system implemented in Bangladesh. These include:

- Despite the reduced casualty rate experienced in Bangladesh the financial damage resulting from cyclone events is still increasing. For example the resulting damage from cyclone Sidr in 2007 was more than USUS$4.6 billion (EM-DAT 2014 and UN 2013c). These losses are further compounded by the associated losses in earnings in affected regions, agricultural losses, environmental damage, fish population losses, health and disease related losses and the increased pressure put on surrounding areas due to disaster related migration patterns (Paul and Routray 2013)

- Ingirige and Amaratunga (2013) found evidence indicating that poor infrastructure maintenance, particularly road networks, were major factors in reducing evacuation times and access to cyclone shelters as well as delaying the dissemination of early warnings to the more remote communities in Bangladesh. They also found that the cyclone shelters themselves were oftentimes in a state of disrepair and not in a suitable condition to be occupied by evacuees

- The Government of Bangladesh (2009a) found that approximately 7% of the cyclone shelters are not structurally fit for purpose and that about 65% are not designed to withstand expected seismic loadings

- The World Bank (2013) indicates that there are gender issues as there is evidence that the casualties of women were higher than that of men. It goes further to suggest that this is related to the fact that women felt uncomfortable when staying with men in the shelters and thus a certain number of women chose to stay in their homes

3.4.2 Common Gaps Found in South Asia

The following section provides a list of the gaps identified that are common to the three countries examined in this research project. These are additional gaps to those highlighted in the individual country sections. By providing this summary a general indication of the gaps present in South Asia will be appreciated.

- Despite the significant risks posed by seismic events in the South Asia Region, there is a general lack of acknowledgement towards this risk

- While the South Asian Association for Regional Cooperation (SAARC) has been working towards enhanced unity, there remains a distinct lack of regional cooperation. This encumbers successful disaster risk reduction in many ways including:

    - Reduces the effectiveness of geo-spatial data coverage by individual countries and across the region mainly in the form of satellite coverage

    - Denies effective holistic flood modelling of entire river catchments through non-cooperation of water management data across political boundaries

    - Diminishes knowledge sharing and lessons learned from natural disaster events in neighbouring countries that would provide valuable tools for risk reduction

- Local ideas and community based risk reduction methods are not gaining national/regional momentum

    - There has been an increased effort towards community based risk reduction in South Asia. However it is noted that there is a lack of resourcing, expertise, technical assistance and data sharing at the local level

    - There are many examples of local ideas and small scale successful risk management mechanisms in place. However the institutional mechanisms are often not in place to take these ideas, research them, develop them and expand their application into other districts, states, countries and regions

    - This is a significant area for improvement as it has been identified that in some areas initial disaster response efforts are carried out predominantly by local community groups. For example the Government of India (2008b) found that up to 80% of search and rescue efforts are carried out by local community groups, and that knowledge sharing could drastically enhance the effectiveness of these community centred efforts

- Building codes and land use planning are not effective disaster risk mechanisms

    - The capacity to enforce existing building codes and guidelines is not widely present in South Asia nor is the community awareness of the effectiveness of these codes and guidelines in resilient building

    - Certain building codes and guidelines are unachievable economically and are commonly not adopted for housing and infrastructure particularly in low socio-economic areas

- Lack of reliable services

    - Electricity load-shedding (switching off electricity to meet grid demands) and the unreliability of some internet networks seriously hinder data capture, information dissemination and early warning for natural disasters in a number of South Asian countries

- Limited allocation of disaster contingency in budget items and risk financing

- In the developed world the World Bank (2012) estimates that insurance covers approximately 30% of losses associated with natural disaster events. In South Asia this figure is approximately 1% meaning that the risks are not being shared as much as they could be

- The lack of disaster contingency often results in funds being diverted from other public budgets and development programmes. This increases the existing financial burden on existing budgets, including those associated with existing disaster risk reduction projects

3.5 Chapter Summary and Conclusion

Of the nine countries that make up the South Asia Region, the review of literature and statistics has shown that Bangladesh, India and Pakistan are the three countries most affected by earthquakes, floods and storms. Bangladesh and India have been experiencing decreases in the loss of life from these key disaster types while Pakistan has seen an increase in its casualty rates over recent decades. Each of the focus countries show that the damage caused by natural disaster events is increasing dramatically.

A review of the relevant literature indicates that, due to various reasons including the geographic location, population growth rates and economic development and investment patterns, all three focus countries have significant amounts of infrastructure and assets exposed to natural disaster events. It is a common trait among the three countries that climate change is expected to cause increases in monsoonal rain patterns which have a high potential to cause increase flood related disaster events.

The South Asia Region has a broadly generic disaster risk management structure that involves an overriding disaster act, a governing body and high level management plans at the national level, type specific management plans and sub-national and local governing bodies that ultimately have the responsibility of implementing the various risk reduction mechanisms. Despite a significant amount of work and progressive disaster risk management strategy development in recent years there are key gaps commonly shared across the South Asia Region that are yet to be addressed.

4 Stakeholder Role Study – Restoration of Engineering Services Post Disaster Event

The previous chapter has examined the various mechanisms available to countries in South Asia, the methods utilised by these countries and the gaps identified in the approach these countries take in addressing natural disaster risk. In order to focus the scope of this research further this next section will review, assess and evaluate the roles that various stakeholders play in natural disaster risk reduction, specifically in the restoration of engineering services after a disaster event. This will include:

- Engineering services – which defines the topic, examines the impact to these services and the importance that engineering services play in reducing the impact of natural disaster events

- Specific engineering service recovery roles – which looks at governments, non-government organisations and private enterprise and the common roles that they play, particularly in the key aspects of information and resources. Gaps in the current methods used by these key actors is also discussed

4.1 Engineering Services

4.1.1 Defining Engineering Services

For the purposes of this research project the definition of engineering services will be limited to the discipline of civil engineering and the built environment. A brief review of some of the available literature from Engineers Australia (EA), the Institute of Civil Engineers in the United Kingdom (ICE) and the American Society of Civil Engineers (ASCE) reveals that this includes:

- The physical infrastructure, services and facilities that the public uses (EA, ICE, ASCE 2014)

  Such as:
    - Roads
    - Bridges

- Water infrastructure (pumps, pipes, dams, canals, embankments etc)
- Energy infrastructure (power stations, energy grids, substations etc)
- Telecommunication infrastructure (fibre/cable networks, nodes, towers etc)
- Ports
- Railways
- Airports
- Pipelines (Gas, water, waste etc)
- Towers
- Buildings

4.1.2 Natural Disasters and Engineering Services

4.1.2.1 Intensive vs. Extensive Events

Intensive natural disaster events such as the 2001 Gujarat earthquake, the Indian Ocean tsunami in 2004 and cyclone Sidr which hit Bangladesh on 2007, have the potential to cause significant damage to major infrastructure such as power stations, mass transport systems, ports and airports. However the majority of damages incurred by local infrastructure are caused by more frequent, lower intensity, extensive disasters (UN 2013c). Figure 34 below shows that at least 90% of damage to key infrastructure (water supply, power supply, roads and telecommunications) is a result of extensive natural disaster events.

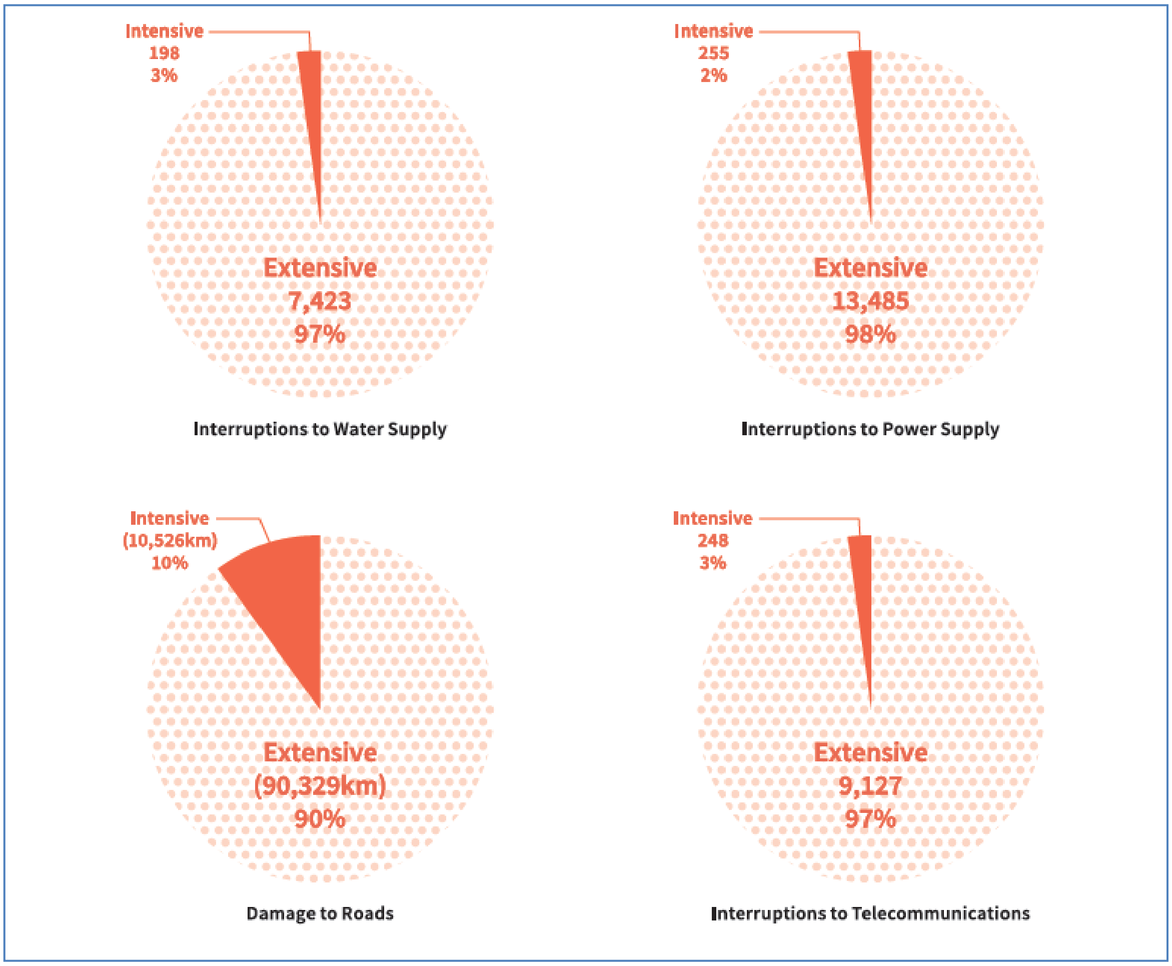

Figure 34: Intensive vs. Extensive Disaster Impacts on Infrastructure from 56 Countries and 2 Indian States (UN 2013c)

4.1.2.2 The Importance of Engineering Services

Two of the key elements of natural disaster risk management that engineering services have direct relevance to are:

1. Disaster Risk Reduction

Appropriate, reliable and resilient engineering services greatly reduce the potential impacts and severity of natural disaster events. For example:

- Resilient roads, built to withstand potential flood/cyclone events, are required to link communities to evacuation routes/shelters so that during an event people do not become stranded in high risk locations

- Reliable and disaster proof communication and power networks are necessary so that essential information may be conveyed to at risk communities

- Water supply and waste treatment facilities and service lines ideally should be able to withstand significant natural disaster events to reduce the impact of disasters and the flow on effects to community health

2. Disaster Recovery – Specifically Financial Recovery

Natural disaster events can have significant impacts on individual country growth and prosperity. For example the cumulative damages as a percentage of GDP from earthquakes, floods and storms resulted in direct financial losses of approximately 9.75% in 1998, 2.8% in 1993 and 5.4% in 2010 in Bangladesh, India and Pakistan respectively (EM-DAT 2014, UN 2013a and the World Bank 2014c).

The ability of a country to effectively respond to natural disaster events (which includes the resilience of engineering services) can reduce the impacts on overall country growth and protect national, state, local and community livelihoods (World Bank 2012). When infrastructure such as power, roads and water networks fail, private and public business experience direct losses as well as indirect losses including:

- Production losses
- Product/service distribution losses
- Local supply chain interruptions
- Regional and global supply chain interruptions

If these losses are too large and recovery (including recovery of engineering services) takes too long to implement there is a potential for industry to never recover. In these cases competitiveness can be affected and the wider impacts of natural disaster events can result in the loss of national and regional productivity (UN 2013c).

4.2 Roles and Responsibilities Specific to Engineering Services – Post Disaster Event

Carter (2008) from the Asian Development Bank (ADB) describes that historical evidence and international experience that the most effective natural disaster response depends on two critical elements:

1. Information; and
2. Resources

Without these essential components all of the plans, policies, expert technical services and other response mechanisms become almost worthless (Carter 2008). It is with regard to these critical elements that the roles of the key stakeholders in the restoration of engineering services post disaster event will be examined.

4.2.1 Governments

The following government roles and responsibilities are based on the information available from the governments of India, Bangladesh and Pakistan. Using this data will provide a representation of the roles and responsibilities for post disaster response, specifically the restoration of engineering services, in the South Asia Region.

- *Overarching coordination of response and recovery efforts*

Each national government of the three investigated countries appoints the overall coordination of disaster response and recovery efforts to a central body. This is in the form of the National Executive Committee in India and the National Emergency Operations Centre in Bangladesh and Pakistan (Government of India 2009b, Government of Bangladesh 2010a & 201b, and Government of Pakistan 2012a). Various roles and responsibilities are delegated to lower level depending on the type, location and severity of the disaster event. These lower levels represent the administrative areas such as states, districts, provinces etc. of the respective country.

- *Collection and dissemination of information*

The collection and appropriate dissemination of information in disaster situations is vital. With specific regard to engineering services this will be in the form of a damage assessment of the specific services. Each country delegates this role to the appropriate authority which will collect this information and supply it to the coordinating authority. For example:

- In Pakistan it is the responsibility of the National/State/Provincial Disaster Management Authority (Government of Pakistan 2012a)

- In Bangladesh the responsibility lies with the National Disaster Response Coordination Group (Government of Bangladesh 201b)

- Similarly in India it is the State Disaster Management Authorities to collect this information (Government of India 2009b)

Ideally the collection of information will be in the form of a coordinated effort of air and land surveys. These surveys need to be made as early as possible after the disaster event (Carter 2008).

- *Analysis of information and the prioritisation and delegation of actions*

The next critical step in the restoration of engineering services involves the analysis of the information supplied and the prioritisation and delegation of actions (Carter 2008). For example:

- Damage assessment of housing may result in the prioritisation of:

  - Houses that are destroyed and thus temporary alternative housing is required

  - Housing that can be repaired

  - Housing that is structurally and functionally sound that may be utilised for shelter by groups of people

- Communication and transportation network damage assessment can also prioritise works including:

    - An assessment of what services remain intact
    - A gap analysis to determine what essential services must be recovered as soon as practicably
    - A lower priority can be given to services that are not essential
- Water and power facilities can often prove more difficult to recover after an event. In certain cases alternative and temporary measures such as portable generators/water purifiers must be implemented to meet immediate shortfalls

In each case the individual government's national level coordinating bodies oversee the decision making processes with regard to the prioritisation of key actions, with roles and responsibilities delegated to sub levels as required.

- *Allocation and coordination of resources*

Similarly to the delegation of actions, the allocation of resources involved with the restoration of engineering services post disaster event in South Asia typically falls with a national body. For example with regard to financial resources:

- Bangladesh:
    - The Ministry of Finance has final approval and overall coordination of budget allocations and the coordination of funding for disaster recovery efforts. The National Platform for Disaster Risk Reduction has the role of allocating financial resources from external agencies (donors, development banks, UN agencies etc) (Government of Bangladesh 201b)
- India:
    - The National Response Fund is allocated and coordinated by the National Executive Committee. Funds are allocated to states who then have the responsibility of coordinating these at their level (Government of India 2009b)
- Pakistan:

- Federal and provincial governments have emergency funds allocated into their respective budgets. There are provisions for emergency accounting and the procurement of funding whereby standard procedures for waiving a tendering process are excluded (Government of Pakistan 2012a)

4.2.2 Non-Government Organisations (NGO's)

Takako and Shaw (2012) suggest that NGO's, with specific regard to disaster recovery, are professionally resourced organisations that have the main role of service providers, often replacing government organisations on the ground especially in remote and rural communities. Some of the advantages of NGO's in providing disaster recovery assistance include reaching lower socio-economic areas and empowering these areas to become more self sufficient, promoting sustainable development and delivering on recovery projects at a lower cost than government or private enterprise.

Lloyd-Jones (2009) further define the role of NGO's, specifically with regard to the restoration of engineering services, as providing technical support and material assistance as well as providing in house training for volunteers in the field. NGO's maintain their level of knowledge and skill sets through partnerships with various institutions including universities and research centres.

The international Register of Engineers for Disaster Relief (now known as RedR) is an example of an NGO directly involved with the restoration of engineering services post disaster events. The Australian branch of RedR is a standby partner for United Nations disaster relief (RedR 2014). Some of the roles and responsibilities of RedR professionals are:

- Civil Engineer (RedR 2014b):
    - Damage assessments of engineering services post disaster event, scoping, costing and management of project proposals for recovery works
    - Prioritising of projects, contractor management, tendering and invoicing

  - Liaison with government bodies, agencies and donors to ensure works are coordinated successfully

- Water Supply &Water Sanitation and Hygiene Engineer (RedR 2014d and 2014e) :

  - Assessment of health risks and water and sanitation needs post disaster events

  - The identification of suitable water resources including the quality, quantity, access and government approval to utilise the source. This also involves community consultation

  - The design and implementation of water, sanitation and hygiene facilities into local communities

  - Design and commission pumping, piping, electrical supply, maintenance and monitoring of water networks post disaster event

- Site Planner (RedR 2014c):

  - Identify, assess and design temporary accommodation facilities for displaced persons post disaster event

  - Manage the implementation of large scale engineering/built environment infrastructure projects including contractor management

  - Prepare contracts and tenders for engineering service restoration projects

  - Coordinate efforts with governments, other non-government organisations, communities and relevant stakeholders in the recovery of engineering services

  - Draw on lessons learned from previous disaster experiences and build on the capacity of local communities by identifying and addressing weaknesses

4.2.3 Private Enterprise

The World Bank (2012) draws attention to the fact that exposure to natural disaster risk is not only associated with public infrastructure but private infrastructure and business as well. Private companies are more frequently recognising that disaster risk management, which includes successful and efficient recovery of engineering services post disaster events, reduces economic uncertainty, builds consumer confidence, reduces costs and enhanced product value (UN 2013c). Thus there is a clear incentive for private enterprise to ensure the timely reconstruction of engineering services after a disaster event.

As opposed to the actual physical restoration of engineering services post disaster event, the most effective mechanism of private enterprise lies in sustainable development and the building of resilient infrastructure. To illustrate this position the following points can be considered:

- The United Nations (2013e) predicts that in the next few decades many trillions of dollars of investment in new infrastructure will occur in highly exposed low and middle income countries. Of these monies, private sector investment will account for approximately 85% to 95%

- As an example Indian Institute of Human Settlements (IIHS) (2012) indicates that Delhi had a targeted growth rate of 9% in 2007. It was estimated that to meet this growth investment in large scale infrastructure and real estate to the amount of approximately USUS$475 billion was needed. The Indian government could only allocate USUS$222 billion due to fiscal deficit. The IIHS suggests that private investment is the only feasible mechanism available to meet this USUS$253 billion gap. This private investment must adhere to building guidelines and must account for disaster risk in its designs if it is to be sustainable. As an example:

    - One of the biggest privately invested infrastructure projects in Delhi recently has been the building of a metro line to connect Delhi to a new suburb. According to the United Nations (2013c) more than 50 stations have been built in high earthquake risk areas and one in a high flood risk area. This risk has been reduced by utilising disaster risk reducing building codes, however other infrastructure and real estate developments surrounding the metro line have not been designed or built with disaster risk reduction considered thus the total disaster risk for the area has significantly increased (IIHS 2012)

4.2.4 Reconstruction of Engineering Services Post Disaster Event – Gaps Found

Despite the advancements in disaster risk reduction and the mechanisms in place to build infrastructure back better and more resilient, gaps remain. For example Johannessen et al (2013) found that after the 2004 tsunami event hundreds of thousands of houses had to be rebuilt in South Asia. Unfortunately due to inadequate planning and investment of resources approximately 250 000 were constructed without toilets and thus had to be retrofitted some time a after. It was found that the private sector could play a more dominant role in water, sanitation and hygiene aspects of disaster risk reduction however there is a general lack of communication and trust between communities government and private companies, impeding the progress.

Takako and Shaw (2012) found that with regard to NGO's the lack of continuance of the actual organisation is one of the major gaps in terms of successful reconstruction and ongoing sustainability of engineering services. Many activities initiated by NGO's in the field fail to stand the test of time once the organisation leaves the area. There is also a lack of linkage between NGO's and local governments meaning that many projects are not provided the opportunity to reach broader areas of implementation.

The International Recovery Platform (IRP) (2012) indicates that very few recovery frameworks around the globe are able to enhance resilience of infrastructure while maintaining fast recovery processes. It finds that communities and governments are essential to promoting resilience in restoration and recovery efforts as well as disaster risk reduction in general. One example that the IRP (2012) found was that some coastal communities in the United States Gulf area will not accept new and updated coastal hazard zoning maps that define where services and housing can be constructed. This is partly due to the fact that a change to zoning has the potential to reduce property prices in those areas. This indicates that vested economic interests are having an impact. This problem could potentially be magnified in certain countries in South Asia.

One final example of a significant gap involves disaster risk reduction funding in Pakistan. The Government of Pakistan (2013c) in their Hyogo Framework for Action progress report indicate that there is a general lack of financial resourcing for disaster risk reduction in the country. The World Bank et al (2010) provide a breakdown of the financial cost of the devastating flooding experienced in 2010. Of the total recovery and reconstruction cost of USUS$10.85 billion:

- Flood relief and early recovery accounted for USUS$ 1.937 billion

- Reconstruction of infrastructure accounted for up to USUS$ 8.915 billion

This strengthens the argument that investment in resilient building and ensuring that opportunities for building back better are seized during reconstruction efforts are critical to infrastructure sustainability as well as financial and economic security.

4.3 Chapter Summary and Conclusion

The engineering services most vulnerable during natural disaster events and therefore the services most commonly damaged include infrastructure specifically related to transport, communication, energy supply and water supply. More often than not it is the more frequent, extensive disaster events that cause disruption and damage to these services. Efficient and timely recovery of engineering services and more importantly building disaster resilient structures are critical to reducing disaster risk and enhancing the capacity for response, especially financial response and recovery, of affected communities.

Government organisations remain central to disaster response and usually have overall responsibility for recovery, collation and dissemination of information, delegation of actions and the allocation and coordination of resources. Non-government organisations typically supply technical support and material assistance during reconstruction processes, while private enterprise are becoming more vital particularly in the role of funding and investment in infrastructure projects. Moving forward a collaborative approach between all stakeholders towards the restoration of engineering services is required in order to fully utilise the resources and expertise available in this vital area of disaster risk management.

5 Case Studies

Previous chapters of this project have looked at the available risk reduction strategies, the actual mechanisms in place in selected countries and the roles that various actors play in response and recovery efforts after disaster events. This next chapter will critically review 3 case studies in order to gauge the success of the risk management frameworks and strategies in place. The following case studies will be examined:

1. 2003 Bam Earthquake in Iran
2. 2004 Indian Ocean Tsunami, Maldives
3. Kathmandu Earthquake Risk, Nepal

5.1 Case Study 1: 2003 Bam Earthquake, Iran

5.1.1 Country Overview

Because Iran was not one of the three focus countries of this report a brief introduction of the statistics of this nation will be provided in Table 6 below:

Data Topic	Statistic
Geographic Area	1 648 000 km^2
Population	74.8 million
Population Density	45/km^2
Percentage Urban Population	70%
Number of Earthquakes since 1980	74
Total Casualties from Earthquakes since 1980	74 388
Total Affected by Earthquakes since 1980	1 905 159
Total Damages from Earthquakes since 1980	USUS$ 11.65 Billion

Table 6: Iran Country and Disaster Statistics (Source EM-DAT 2014 and the World Bank 2014a)

5.1.2 Bam Earthquake Impact Overview

On the 26th of December 2003 at 05:26am a magnitude 6.5 earthquake struck along the Bam fault, located in the south east of Iran. This was the first ever recorded earthquake in Bam city itself and it has been estimated that this was the first major earthquake experienced in the region for more than 2 500 years. This event resulted in the loss of more than 26 500 lives (Ghafouri-Ashatiani 2004). The summary of the losses/damages can be found in Table 7 below.

Damage/Loss Aspect	Damage Experienced	Contributing Factors
Loss of life	More than 26 500 lives lost (25% of the city population)	This figure was increased due to the timing of the event being quite early in the morning when people were still inside their homes Ongoing casualties would have been higher had the airport not been restored in a timely manner
Buildings & infrastructure	More than 85% destroyed throughout the area	Newly built masonry buildings failed due to lack of structural integrity Older masonry buildings proved more resilient due to sound construction techniques employed Most steel building damage was due to lack of compliance to building codes – buildings that had followed the seismic loading design requirements were structurally un-damaged Reinforced concrete buildings were inadequate in many residential cases however essential buildings proved more resilient
Lifelines and special infrastructure	Bridges/roads/railway in the area were largely undamaged – the majority of bridges were still in service after the event	Structural adequacy and seismic considerations followed in design and construction
	Bam airport was closed for a short period of time	The runway was largely undamaged however the tower and buildings sustained structural damage
Water distribution systems	Traditional water systems (typically underground tunnels and well shafts) sustained significant damages	Underground systems were more exposed to seismic risks
	Elevated water tanks and water treatment facilities remained largely intact	Tanks and treatment facilities designed and constructed to engineering standards
Communicati-ons and electrical lines	Minor damages to electrical distributions systems, some substations sustained significant damages	Lines and substations sustained both structural and non-structural damage
	Communication lines were quite resilient with cell services operational after a matter of hours	Adequate designs and construction of resilient towers and networks

Table 7: Damage and Loss Summary of Bam Earthquake 2003 (Sources: Ghafouri-Ashatiani 2004, Sanada et al 2004, Hosseinzadeh 2011, Eshghi & Razzaghi 2011 and Kishore et al 2004)

5.1.3 Key Findings

The following key outcomes and findings resulting from the Bam earthquake are directly related to the implementation of the risk management:

- Ghafouri-Ashatiani (2004) found:
    - The government of Iran needs to fully capitalise on current earthquake expertise both domestically and internationally and draw on the lessons learned from past events to promote disaster risk reduction implementation
    - Scientific and engineering professionals need to establish and implement more socio-economic-cultural solutions to disaster risk management needs
    - The general public needs to become more aware of disaster risk and disaster risk management mechanisms
- Sanada et al (2004) found:
    - In general adobe and simple masonry buildings were structurally inadequate. Some buildings were found to be designed to meet seismic building standards however the final construction did not reflect these designs and thus the buildings failed during the earthquake
- Hosseinzadeh (2011) concluded:
    - Inadequate construction methods are believed to be the main contributing factor to steel structure failure.
    - Very few of the steel structured buildings that were damaged were designed to meet seismic building standards
- Eshghi & Razzaghi (2011) found:
    - Reinforced concrete towers used to support water tanks were found to be structurally adequate during earthquake events

  - Although bridges and rail sustained very little damage, longitudinal movement of the superstructure was a common form of structural inadequacy

  - Damage to industrial and critical facilities caused the most amount of structural damage during the earthquake

- Kishore et al (2004) concluded:

  - There is inadequate emphasis placed on disaster risk management especially in the area of restoration of services and relief in Iran

  - There is a distinct lack of awareness amongst key decision makers in development sectors and there is a lack of a multi-hazard approach to risk assessment and risk management

  - The compliance to and enforcement of building codes and standards is lacking and there is also a gap in the training that masons and construction professionals receive

  - The application of existing knowledge bases and expertise is insufficient in Iran, specifically towards city planning, seismic risk management and disaster risk management in general

5.2 Case Study 2: 2004 Indian Ocean Tsunami, Maldives

5.2.1 Country Overview

Because the Maldives has not been one of the three focus countries of this report a brief introduction of the statistics of this island nation will be provided in Table 8 below:

Data Topic	Statistic
Geographic Area	300 km^2
Population	310 000
Population Density	1 035/km^2
Average Elevation	1.5m above sea level
Maximum Elevation	2.5m above sea level
Percentage Urban Population	38%

Table 8: Maldives Country and Disaster Statistics (Source: the World Bank 2012)

5.2.2 2004 Tsunami Impact on the Maldives

At approximately 09:15am on the 26th of December 2004 a series of tsunami tidal waves travelling at over 700km/hour struck the Maldives. The waves ranged in height from 1.2m to 4.3m and were reported in all parts of the country (the World Bank et al 2005). According to EM-DAT (2014) the resultant impacts from the tsunami event on the Maldives were:

- 102 casualties
- 27 200 people affected – including 2 200 injuries and 13 000 people made homeless
- USUS$470 million in damages

According to Pardasani (2006) the damages to infrastructure and the built environment resulting from the tsunami included:

- Nearly 39 islands suffered significant damage and 14 islands were completely destroyed
- More than 100 islands completely lost key infrastructure relating to health, education, transport and communication
- 10% of all homes in the Maldives were destroyed

Further damage assessments and recovery costings for key infrastructure from the World Bank et al (2005) are contained in Table 9 below.

Sector	Direct Losses (USUS$ Millions)	Indirect Losses (USUS$ Millions)	Cost of Reconstruction (USUS$ Millions)
Education	15.5		21.1
Health	5.6		12.2
Housing	64.8		74
Water & Sanitation	13.1		45.6
Tourism	100	130	100
Transport	20.3		27
Power	4.6		1.9

Table 9: Maldives Tsunami Estimated Losses and Recovery Costs (Source: the World Bank et al 2005)

The total damages amounted to 62% of GDP for 2004 and the total financing needs for reconstruction including revenue loss equates to 48% of 2004 GDP. This was exacerbated by the drastic drop in tourism numbers from 17 000 at end of January 2004 to 7 000 at the same time in 2005 (the World Bank et al 2005).

5.2.3 Response Efforts

According to EM-DAT (2014) before 2004 there had been no recorded natural disaster events in the Maldives. The United Nations Development Program (UNDP) (2006) indicates that as a consequence, despite many years of concern regarding climate change and disaster threats, the Maldives was not prepared for a disaster event of this magnitude and no disaster management system, policies, plans or institutional frameworks were in place. Regardless of this fact, within days of the event the government of the Maldives had established a National Disaster Management Centre. This was not only highly successful but it also became a model to be used by other governments on how to effectively coordinate major crisis response efforts.

The research by Pardasani (2006) describes that under this National Disaster Management Centre the Maldivian government set up the follow organisation divisions:

- The National Disaster Relief Coordination Unit responsible for temporary shelter, repair of damaged homes, rehabilitation of damaged social infrastructure and the management of the displaced persons register

- Transport and logistics unit coordinating all transport and logistical aspects of recovery projects

- Tsunami relief and reconstruction fund was set up to receive, coordinate and disseminate funds from internal and external sources with three priority levels:

    - Immediate recovery

    - Reconstruction and rehabilitation

    - Future disaster risk management mechanisms

According to the UNDP (2006) of the USUS$375 million in funding needs initially identified, USUS$368 million came from the international community.

5.2.4 Key Findings and Challenges

The following findings have arisen since the 2004 tsunami with regards to natural disaster risk management in the Maldives:

- Strong community cooperation in conjunction with decisive and well organised response efforts by the Maldivian government supported by international donors resulted in a fast, efficient and highly effective recovery effort (The World Bank et al 2005)

- There remains a challenge to establish and maintain working partnerships between the government, NGO's, aid providers and local communities, particularly with regard to the improvement of technical expertise in disaster response (Pardasani 2006)

- Enhanced mitigation of the current and potential effects of climate change is paramount to the Maldives becoming resilient to natural disaster events (UNDP 2006)

- The World Bank (2012) highlight the fact that after the initial accelerated implementation of disaster risk management mechanisms of the 2004 tsunami event the Maldivian government has been slow to progress through the remaining important goals. Sufficient human and financial resources are unavailable and the necessary policy and frameworks required for effective disaster risk management are not in place

5.3 Case Study 3: Kathmandu Earthquake Risk, Nepal

5.3.1 Country Overview

This next case study is slightly different in that it examines the risk of a disaster event rather than an event that has already occurred. Because Nepal has not been one of the three focus countries of this report a brief introduction of the statistics of this nation will be provided in Table 10 below

Data Topic	Statistic
Geographic Area	147 180 km^2
Population	28.6 million
Population Density	200/km^2
Percentage Urban Population	17%

Table 10: Nepal Country and Disaster Statistics (Source: the World Bank 2012)

5.3.2 Kathmandu Earthquake Risk Overview

Kathmandu has experienced 4 earthquake disaster events since 1980 (1980, 1988, 1993 and 2011) with a total loss of life of 816 persons, 670 000 people affected and about USUS$ 300 000 worth of damages (EM-DAT 2014). Despite this relatively low frequency and impact of earthquake events, the seismic risk facing the capital city of Nepal is quite significant. Major earthquakes in Nepal occurred in 1255, 1810, 1866, 1934, 1980 and 1988. The 1934 event was an 8.4 magnitude earthquake and largely impacted Kathmandu with 8500 people dying and more than 38 000 buildings collapsing (Government of Nepal 2010).

The World Bank (2012) sourcing information from the Nepalese Government Department of Mines and Geology indicates that this seismic record suggests that a major earthquake event can be expected to impact on Kathmandu every 75 years, making a significant event statistically overdue by 5 years already

Kathmandu today is a vastly different city than it was in 1934. The Word Bank (2012) indicates that the Kathmandu valley is home to more than 5.3 million people and is experiencing a growth rate of about 6.5% per annum. Among the 20 cities around the world situated in high risk seismic zones, Kathmandu is the most at risk. A person living in Kathmandu is about nine times more likely to die in an earthquake than someone living in Islamabad and as much as sixty times more than a person living in Tokyo (GeoHazards International 2001).

5.3.3 Key Gaps Identified

Housing and infrastructure demand has increased rapidly in Kathmandu in line with Nepal’s 3.5% per annum growth in GDP, however while the quantity of infrastructure has increased the quality of construction has been falling away. The World Bank (2012) indicates that in the Kathmandu valley:

- Over 6 000 concrete houses are being built every year with the majority of these not being properly engineered and not considering potential seismic loadings

- 90% of these new houses are designed by tradition masons without reference to design standards and without professional engineering input

- Less than 1% of Nepal's schools and hospitals are designed to withstand expected seismic loadings

- Two thirds of Kathmandu's structures are not designed to withstand an earthquake with a magnitude of 8 on the Richter scale, less than the 1934 event

With regard to the governments strategies toward disaster risk reduction the World Bank (2012) has suggested:

- The government has failed in its duty to adequately manage growth in Kathmandu and almost all development has taken place without considerations towards seismic risk

- Nepal's political instability has created issues for the implementation, enforcement and monitoring of development permits and building codes

- Technical information about seismic risk is not presented in an accessible format and is thus not readily utilised by the general public

- Unless immediate action is taken in a cooperative effort between private and public organisations the next significant earthquake event in Kathmandu will results in significant loss of life, structural and economic damage

According to the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) (2013) indicate that an anticipated earthquake event in the Kathmandu Valley could result in over 100 000 deaths, affect more than 2 million people and destroy up to 60% of the buildings in the area.

6 Conclusion

The title of this dissertation is ‘Natural Disaster Risk Management in South Asia’ with the aim being to critically analyse the natural disaster risk management strategies, emergency preparedness and response readiness of South Asian countries. This was achieved by investigating natural disaster risk management at four levels. Initially a literature and statistical review was undertaken at the global and regional level. The next stage was a narrowed focus of three South Asian countries for a more detailed study. This was further narrowed to a single country with supporting data for the remaining two countries. The last level looked at individual disaster events and risk areas. This final chapter briefly collates the findings attained from this research as follows:

- Completion of Objectives – a checklist for the completion of the objectives
- Conclusions – provides details of the achievements of this research
- Further research – outlines the potential future work related to this topic

6.1 Completion of Objectives

In order to meet the objectives (detailed in section 1.3 Objectives and formally set in Appendix A: Project Specification Document) the following works were undertaken during the process of this research project dissertation:

- The type, frequency and severity of natural disaster events in South Asia from 1980 to present have been examined in a literature review
- The global natural disaster risk management strategies, specifically floods, earthquakes and storms have been reviewed
- 3 countries were selected based on the literature and a detailed study of the disasters and risk management strategies employed was undertaken. This was narrowed further to a single country in the body of the paper with the remaining two being included as appendices

- A review of the risk management protocols in place in the selected countries was undertaken and a detailed gap analysis was carried out. Again a single country was focussed on in the body with the other two included as appendices. The gaps common the South Asian countries in general were also identified

- The roles that governments, non-government organisations and international organisations in disaster risk management and resilience in South Asia was reviewed, assessed and evaluated

- The results of this research were used as the basis to conduct two case studies of recent natural disaster events to focus on the actual implementation of frameworks and protocols. An addition potential risk scenario was also examined

6.2 Conclusions

By achieving the objectives as outlined above, the following conclusions have been able to be drawn.

Conclusion 1

The frequency of natural disaster events experienced around the globe since 1980 is increasing and research suggests that the frequency of these events will continue to increase into the future. The most positive aspect of natural disaster risk presently is that through a significant concerted effort across the globe the number of people killed from natural disaster events has increased at a slower rate than the increase in frequency of these disasters. In the South Asia Region the number of people killed by natural disasters each year is actually decreasing. Despite these positives, development and investment decisions are continually failing to account for the risks posed by natural disasters and as a direct result the losses experienced and the damages to infrastructure are increasing at unprecedented rates.

Since the early 1990's countries across the globe have been driving the development of strategies for natural disaster risk management. This work has evolved into the Hyogo Framework for Action (HFA) which is now the guiding protocol for which individual countries can measure themselves against to determine overall risk management performance. For more type specific disaster management strategies other global organisations exist who work closely with countries and regions to develop cooperative knowledge sharing systems to address specific risk areas and hazard types.

There has been a paradigm shift in recent years from a reactionary approach to a more proactive, risk reduction and prevention stance towards disaster hazards across the globe. Despite these advancements in the approach and strategies available to reduce natural disaster risk there remains a significant and ongoing volume of work to be completed. Within individual disaster types there needs to be a more holistic view taken to manage the risk not only in small community areas but in the districts, states, countries and regions that these communities contribute to.

Conclusion 2

Utilising a statistical data based decision process established that floods, storms and cyclones are the dominant disaster types experienced in the world as well as in the South Asia Region. Through further analysis of the available literature and statistical data Bangladesh, India and Pakistan emerged as being the three countries in South Asia most affected by these dominant types. All three of these countries are vulnerable to significant natural disaster hazards and commonly have a large amount of infrastructure and high volumes of population exposed to these hazards.

These countries follow similar approaches in the way they construct their management strategies, policy arrangements and disaster risk management mechanism implementation. Consequently common gaps have been identified between individual countries that give a strong indication of the shortcomings in disaster risk management approaches taken in South Asia as a region when compared to the relevant global risk management mechanisms available. These common gaps include:

- Under-appreciation and acknowledgement of seismic risk across the region
- A lack of regional cooperation and knowledge sharing that is encumbering regional development
- The appropriate support mechanisms are not established to allow local community level projects and ideas to be fully researched and gain broader application
- Building codes and guidelines have not been established in realistic manner that enables them to be widely utilised and implemented across all socio-economic regions

- Communication and information dissemination services (internet and energy supply systems) are often unreliable and do not function at a level necessary for effective disaster risk management

- Risk financing and budget allocation for disaster contingency are not often incorporated into fiscal planning and therefore when disaster events occur the impacts are more severe economically

For South Asia to continue its growth patterns while ensuring that populations are not exposed to unacceptable levels of risk, and that economic advancement continues, these gaps will need to be addressed.

Conclusion 3

The available literature indicates that, in order to reduce risk associated with natural disasters, infrastructure must be built with improved resiliency to anticipated hazards. This includes planning for new infrastructure as well as taking the opportunity presented after disaster events to build infrastructure back better. Despite the acknowledgement of this need very few disaster recovery systems in place around the world are capable of doing this while maintaining the appropriate level of speed during recovery.

The role of private enterprise in enhancing the resilience of infrastructure and thus ensuring easier reconstruction of engineering service after a disaster event is clearly essential. Private company investment will be paramount to meeting expected economic growth patterns in South Asia. It is because of this fact that careful planning and stringent application of appropriate incentives and risk reduction mechanisms must be in place to ensure that this investment does not increase overall vulnerability, exposure and therefore natural disaster risk.

As the mechanisms for the estimation of losses associated with natural disaster events become more capable, more precise benefits of investment in risk reduction will become clearer. This should be a significant driving force for both governments and the private sector to work cooperatively to ensure that the potential for natural disasters to disrupt economic growth is reduced.

Conclusion 4

By undertaking this study, submitting this dissertation and presenting the works in an oral format the objective of generating discussion amongst engineers and decision makers about natural disaster risks and the importance of integrating disaster risk reduction mechanisms into sustainable development has also been fulfilled.

6.3 Future Research

Based on the findings and conclusions of this dissertation there are a number of avenues available for further research in the field of natural disaster risk management. The review of the plethora of literature available suggests that a significant amount of research has already been conducted in this field of study. However the trends identified by the statistical analysis proves that there is a significant amount of work that remains to be undertaken.

With regards to natural disaster risk management in general perhaps the most obvious point to begin further research with is to apply this to other regions of the globe as well as to apply the research further to other specific countries in South Asia. Furthermore each aspect of this research dissertation could be studied in greater detail as a singular project.

The following list of research areas provides a good starting point for potential future research into this challenging yet rewarding field of study.

- In 2015 the delegates from almost every country in the world will meet to develop and put into motion the next decade of disaster risk management. The development of the Hyogo Framework for Action II will see significant opportunities for improvement, not least of which will involve engineers from varying backgrounds in the determination of solutions. From this work incredible opportunities exist not only for singular research projects, but for the building of very challenging and rewarding careers

- With regards to the role of engineers in natural disaster risk reduction the following avenues of research are available:

    - The study of the roles which engineers play in the provision of public morale during and immediately after natural disaster events

  - Project management techniques employed during the reconstruction phase after natural disaster events. This could involve modified tendering, work scoping and contractor management techniques to be utilised where time is the major constraint in the delivery of efficient and cost effective disaster recovery solutions

  - Design processes for building construction could be created that can be used to ensure construction of housing and small commercial buildings are resilient to multiple hazard types. For example the application of confined masonry and its resistance to seismic loadings as well as wind and water loadings

- The role of technological advancements in several aspects of disaster risk management should also be researched. These could include:

  - Utilising mobile phones in the capture of damage data during the process of damage and needs assessment immediately after disaster events

  - The options for using Unmanned Aerial Vehicles for similar processes during damage and needs assessments

  - Utilising satellite data in combination with ground truthed infrastructure assessments to assess potential vulnerability and exposure risks, particularly in high density urban environments

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7 Appendix A: Project Specification Document

University of Southern Queensland

FACULTY OF ENGINEERING AND SURVEYING

ENG4111 and ENG4112 Engineering Research Project 2014

PROJECT SPECIFICATION

FOR: **Nashua Thomas HANCOCK**

TOPIC: Natural Disaster Risk Management in South Asia

SUPERVISOR: Dr David Thorpe

PROJECT AIM: This project aims to critically analyse the natural disaster risk management strategies, emergency preparedness and response readiness of South Asian countries.

PROGRAMME: **Issue C – 13 April 2014**

1. Conduct a literature review of the type, frequency and severity of natural disasters from 1980 to present, with specific focus on South Asia.
2. Review global natural disaster risk management strategies, with a focus on the dominant types experienced in South Asia.
3. Select up to three (3) South Asian countries for a more detailed study of natural disasters and disaster risk management in those countries.
4. Undertake a review of the risk management framework and protocols in place in the selected South Asian countries, including a gap analysis of the differences between these and world standards
5. Review, assess and evaluate the roles that government, non-government & international organisations play in natural disaster risk management and natural disaster resilience in South Asia specifically the restoration of engineering services following a natural disaster event
6. Use the results of this research to discuss and evaluate case studies of recent natural disaster events in South Asia focussing on the actual implementation of the framework and protocols in place

As Time Permits:

7. Undertake analysis of the global communication techniques for natural disaster risk management strategies and learning from previous events

AGREED:	Nash Hancock (Student)	D. S Thorpe (Supervisor)
	Date: 21/ 02/ 2014	Date: 21 /02 / 2014

8 Appendix B: Selected South Asian Country Data

This data has been acquired from the following sources:

- Deaths, persons affected and financial damage from EM-DAT (2014)
- Population data from the United Nations World Population Prospectus (2013a)
- GDP data from The World Bank Indicators, Data, GDP (Current USUS$) (2014c)

8.1.1 India

Year	Deaths (Actual)	Number Affected (Millions)	Damage (US$ Billions)	Population (Millions)	GDP (US$ Billions)	Total Affected as % of Population	Damage as % of GDP
1980	2,577	32.05	0.32	698.97	189.59	4.59	0.17
1981	1,570	16.13	0.25	715.11	196.88	2.26	0.13
1982	1,676	38.80	1.45	731.44	204.23	5.30	0.71
1983	1,567	1.81	0.59	747.99	222.09	0.24	0.27
1984	1,284	20.35	0.13	764.75	215.88	2.66	0.06
1985	1,834	11.43	0.81	781.74	236.59	1.46	0.34
1986	647	3.70	0.65	798.94	253.35	0.46	0.26
1987	1,480	18.38	0.55	816.33	283.93	2.25	0.19
1988	2,558	44.22	1.03	833.83	301.79	5.30	0.34
1989	1,702	3.70	0.00	851.37	301.23	0.43	0.00
1990	2,067	4.10	2.89	868.89	326.61	0.47	0.89
1991	2,641	8.78	0.32	886.35	274.84	0.99	0.12
1992	917	3.07	0.31	903.75	293.26	0.34	0.11
1993	11,231	128.16	7.88	921.11	284.19	13.91	2.77
1994	2,234	12.49	0.19	938.45	333.01	1.33	0.06
1995	1,736	32.72	0.31	955.80	366.60	3.42	0.08
1996	2,828	16.45	1.69	973.15	399.79	1.69	0.42
1997	2,425	30.42	0.26	990.46	423.16	3.07	0.06
1998	5,602	34.31	1.01	1,007.75	428.74	3.40	0.24
1999	11,032	41.97	2.99	1,025.01	466.87	4.09	0.64
2000	2,086	50.42	0.91	1,042.26	476.61	4.84	0.19
2001	20,685	26.96	2.98	1,059.50	493.95	2.54	0.60
2002	881	42.02	0.05	1,076.71	523.97	3.90	0.01
2003	616	8.10	0.21	1,093.79	618.36	0.74	0.03
2004	17,737	33.86	3.80	1,110.63	721.59	3.05	0.53
2005	3,520	28.51	7.19	1,127.14	834.22	2.53	0.86
2006	1,384	7.38	3.39	1,143.29	949.12	0.65	0.36
2007	2,051	38.14	0.38	1,159.10	1,238.70	3.29	0.03
2008	1,701	13.99	0.15	1,174.66	1,224.10	1.19	0.01
2009	1,663	9.00	2.73	1,190.14	1,365.37	0.76	0.20
2010	1,053	4.79	2.15	1,205.62	1,708.46	0.40	0.13
2011	826	12.83	2.03	1,221.93	1,880.10	1.05	0.11
2012	319	4.28	0.24	1,238.58	1,858.74	0.35	0.01
2013	6,562	16.71	2.38	1,255.45	1,876.80	1.33	0.13
Average	3,550	23.53	1.54			2.48	0.32

Table 11: India Cumulative Impacts from Earthquakes, Floods and Storms 1980-2013 (Source: EM-DAT 2014, UN 2013a and the World Bank 2014c)

8.1.2 Pakistan

Year	Deaths (Actual)	Number Affected (Millions)	Damage (US$ Billions)	Population (Millions)	GDP (US$ Billions)	Total Affected as % of Population	Damage as % of GDP
1980	0	0.00	0.00	79.98	23.69	0.00	0.00
1981	394	0.00	0.00	82.73	28.10	0.00	0.00
1982	68	0.01	0.00	85.60	30.73	0.01	0.00
1983	63	0.06	0.00	88.58	28.69	0.07	0.01
1984	43	0.00	0.00	91.64	31.15	0.00	0.00
1985	5	0.01	0.00	94.78	31.14	0.01	0.01
1986	11	0.00	0.00	98.00	31.90	0.00	0.00
1987	0	0.00	0.00	101.28	33.35	0.00	0.00
1988	232	1.00	0.00	104.58	38.47	0.96	0.00
1989	20	0.14	0.00	107.87	40.17	0.13	0.00
1990	22	0.00	0.00	111.09	40.01	0.00	0.00
1991	324	0.20	0.01	114.23	45.45	0.18	0.02
1992	1486	12.84	1.00	117.29	48.64	10.95	2.06
1993	624	0.26	0.00	120.34	51.48	0.22	0.00
1994	352	0.84	0.09	123.45	51.89	0.68	0.18
1995	1063	1.86	0.00	126.69	60.64	1.46	0.00
1996	111	1.30	0.00	130.08	63.32	1.00	0.00
1997	262	0.86	0.00	133.60	62.43	0.64	0.00
1998	1013	0.20	0.00	137.14	62.19	0.15	0.00
1999	292	0.54	0.01	140.58	62.97	0.38	0.02
2000	0	0.00	0.00	143.83	73.95	0.00	0.00
2001	226	1.31	0.25	146.86	72.31	0.90	0.34
2002	90	0.16	0.00	149.69	72.31	0.11	0.00
2003	317	1.27	0.00	152.42	83.24	0.83	0.00
2004	29	0.01	0.00	155.15	97.98	0.01	0.00
2005	74032	12.66	5.23	157.97	109.50	8.01	4.78
2006	400	0.01	0.00	160.91	137.26	0.01	0.00
2007	768	1.65	1.95	163.93	152.39	1.01	1.28
2008	249	0.37	0.11	167.01	170.08	0.22	0.07
2009	102	0.08	0.00	170.09	167.87	0.04	0.00
2010	2136	20.37	9.58	173.15	177.17	11.76	5.41
2011	511	5.40	2.50	176.72	213.69	3.06	1.17
2012	518	5.05	2.50	180.55	224.88	2.80	1.11
2013	730	1.70	1.60	184.57	236.62	0.92	0.68
Average	2544	2.06	0.73			1.37	0.50

Table 12: Pakistan Cumulative Impacts from Earthquakes, Floods and Storms 1980-2013 (Source: EM-DAT 2014, UN 2013a and the World Bank 2014c)

8.1.3 Bangladesh

Year	Deaths (Actual)	Number Affected (Millions)	Damage (US$ Billions)	Population (Millions)	GDP (US$ Billions)	Total Affected as % of Population	Damage as % of GDP
1980	666	10.00	0.15	82.50	18.11	12.12	0.83
1981	1,085	2.04	0.00	84.76	19.76	2.40	0.00
1982	0	0.31	0.00	87.06	18.09	0.35	0.00
1983	930	7.17	0.00	89.40	17.16	8.01	0.00
1984	1,200	30.00	0.00	91.80	19.67	32.68	0.00
1985	15,155	2.33	0.05	94.29	21.61	2.47	0.23
1986	214	3.12	0.00	96.85	21.16	3.22	0.00
1987	2,292	29.70	1.06	99.48	23.78	29.86	4.45
1988	3,506	55.57	2.14	102.13	25.64	54.41	8.34
1989	996	0.30	0.02	104.78	26.83	0.29	0.06
1990	924	2.07	0.01	107.39	30.13	1.93	0.02
1991	139,252	18.43	1.93	109.93	30.96	16.76	6.23
1992	40	0.09	0.00	112.43	31.71	0.08	0.00
1993	646	16.62	0.00	114.90	33.17	14.46	0.00
1994	321	1.05	0.13	117.37	33.77	0.90	0.38
1995	1,494	17.09	1.18	119.87	37.94	14.26	3.10
1996	681	5.95	0.01	122.40	40.67	4.86	0.02
1997	527	4.70	0.23	124.95	42.32	3.76	0.54
1998	1,371	15.23	4.30	127.48	44.09	11.95	9.75
1999	330	0.61	0.00	129.97	45.69	0.47	0.00
2000	142	2.83	0.50	132.38	47.12	2.14	1.06
2001	247	0.73	0.00	134.73	46.99	0.54	0.00
2002	132	1.60	0.00	137.01	47.57	1.17	0.00
2003	314	0.55	0.00	139.19	51.91	0.40	0.00
2004	1,002	36.89	2.70	141.24	56.56	26.12	4.77
2005	232	1.19	0.00	143.14	60.28	0.83	0.00
2006	154	0.23	0.00	144.87	61.90	0.16	0.00
2007	5,505	22.83	2.41	146.46	68.42	15.59	3.53
2008	55	0.64	0.00	147.97	79.55	0.43	0.00
2009	213	4.45	0.27	149.50	89.36	2.98	0.30
2010	41	0.83	0.00	151.13	100.36	0.55	0.00
2011	23	1.57	0.00	153.23	111.91	1.03	0.00
2012	272	5.58	0.00	155.59	116.03	3.59	0.00
2013	50	1.53	0.02	158.12	129.86	0.97	0.02
Average	5,294	8.94	0.50			7.99	1.28

Table 13: Bangladesh Cumulative Impacts from Earthquakes, Floods and Storms 1980-2013 (Source: EM-DAT 2014, UN 2013a and the World Bank 2014c)

9 Appendix C: Natural Disaster Risk Management in Selected Countries

Due to the scope of this undergraduate research project the evaluation of three countries was not deemed appropriate to include in the main body of the dissertation. Instead this work has been included in the appendices as material referenced by certain sections of the main body of the report.

9.1.1 India

The Government of India (2005b) introduced The Disaster Management Act 2005 which stipulates that the National Disaster Management Authority has the responsibility of laying down disaster management policy, plan and guidelines in order to ensure timely and effective disaster response. The subsequent levels of disaster management according to the administrative boundaries in India are the State Disaster Management Authority, District Disaster management Authority and Local Authorities which include civic services such as town planning (Government of India 2009b)

One of the key documents that the national authority is responsible for is the National Policy on Disaster Management 2009. This document (Government of India 2009b) provides the following mechanisms for disaster risk management:

- Earthquake, flood, wind and cyclone risk zone maps for the entire country
- Disaster management continuum strategy that encompasses a holistic approach of prevention, mitigation, preparedness, response and rehabilitation. One of the important approaches highlighted is undertaking the opportunity in post disaster reconstruction projects to build back better and more resilient buildings and infrastructure
- Detailed institutional and legal arrangements to develop and integrate disaster risk reduction into decision making processes at national, state and local community levels. This is achieved through the National, State and District Disaster Management Authorities
- Financial arrangements including national level disaster mitigation and response funding as well as state and local resource allocation definition requirements in planning and 5 yearly budgets

- The provision of land use planning and safe construction practices, including compliance and enforcement of standards

- Training, knowledge management, research and development and capacity building is highlighted. This policy provides direction for subsequent policies, institutions and programmes to achieve this

As prescribed by the Disaster Management Act 2005 the National Disaster Management Authority, Government of India (2010a), developed the National Disaster Management Guidelines, Incident Response System. These guidelines comprehensively detail the roles, responsibilities, structure, procedures and methodology to be followed during disaster events. When followed they will provide best practice for incident response through maximising the effectiveness of available resources, technologies and disaster management methods (Government of India 2010a)

Another key guideline prescribed under the Disaster Management Act 2005 is the National Disaster Management Information and Communication System (Government of India 2012). This system consists of software and hardware that collects, stores, maps and analyses a range of quality controlled data from the entire country including geographic, demographic, socioeconomic, topographic and infrastructure detail. This data will be disseminated to all relevant stakeholders via a comprehensive National Disaster Communication Network that is currently under construction. Once this is fully operational it is envisaged that this will integrate fully into disaster management at all levels of planning and policy making, as well as response and readiness programmes (Government of India 2012).

Some of the other initiatives implemented under the National Disaster Management Authority include:

- National Disaster Management Guidelines on Ensuring Disaster Resilient Construction of Buildings and Infrastructure financed through Banks and Other Lending Institutions – this guideline proposes changes to current practices of financing of structural and non-structural (infrastructure that includes water, power, communications transportation and urban services) so that safety and disaster resilience is fully taken into account before, during and after construction. This includes design and as built sign off by architects and engineers before funds are fully approved and released (Government of India 2010b)

- The National Disaster Response Force and Civil Defence – each state has 18 self reliant search and rescue teams, each containing 45 personnel including engineers, technicians, electricians, dog squads and medical/paramedic personnel dedicated to disaster response and recovery efforts (Government of India 2014a)

- The National Institute of Disaster Management – this institute has the responsibility for training, education, research and development, and assistance to all levels of government in policy making. This includes a Ph.D. and Masters courses in Disaster Management (Government of India 2014b)

The National Authority of Disaster Management also has a number of initiatives currently in draft for that are due to be finalised in the near future, these include:

- The National Disaster Management Plan – this plan outlines the prevention, preparedness, and mitigation and response measures available for the different types of natural disasters. It provides operational guidance for all types of disasters and defines the appropriate roles, responsibilities and accountabilities for all government departments and external organisations in order to achieve minimal damage and loss of life resulting from natural disaster events (Government of India 2013c)

- National Disaster Management Guideline for Hospital Safety – this is intended to be applicable to all health care facilities and will ensure structural safety of hospital buildings, ensure that health care professionals are capable of responding to natural disasters and to ensure that each hospital has a functioning Hospital Disaster Management Plan (Government of India 2013a)

- National Disaster Management Guideline for School Safety – this guideline strives to ensure that all schools are resilient to natural disasters and that all children can have an education without the risk of injury or death from a natural disaster event. It seeks to achieve this by stipulating structural measures including appropriate siting, increased factor of safety in loading and design for new schools and during retrofitting and repairing of existing buildings. Non-structural measures include the appropriate location and configuration of shelving in classrooms (for earthquake protection), ensuring electrical wiring, chemical storage etcetera is to standard, making sure each school has disaster drills and other disaster management strategies implemented (Government of India 2013b)

With regards to building standards incorporating considerations for disaster related impact design, the National Building Code of India 2005 (Government of India 2005a) is in force. This Act incorporates live loads from earthquakes as well as wind from cyclone and storm events. There are successive standards that supply detailed instruction for analysis and design of structures affected by wind and earthquake live loads. These will be discussed further in subsequent sections of this report.

9.1.1.1 Earthquake

The National Disaster Management Authority released the National Disaster Management Guidelines Management of Earthquakes in 2007. These guidelines set six key pillars for earthquake risk management in India (Government of India 2007). These are:

- Earthquake resistant design and construction of new structures
    - All new construction shall be built as per earthquake design and construction code of practice (Indian Standard (IS) 4326) and earthquake design criteria (IS 1893)
    - This is subject to earthquake risk zoning stipulated in the National Policy on Disaster Management 2009 (see Government of India 2009b)
    - Expert groups and authorities are set up to perform compliance checks to ensure this is being carried out
- Seismic strengthening and retrofitting of lifeline and priority structures
    - Structures to undergo retrofitting are prioritised by individual state governments based on importance factors
    - Methodologies used are based on global best practice in conjunction with the United Nations Development Program and with reference to the Indian guidelines for seismic evaluation, repair and strengthening (IS 13935)
    - Applicable to structural components as well as fittings, furnishings and contents
- Regulation and enforcement

    - A range of codes, guidelines and standards have been produced (some mentioned above) in order to provide a solid legal framework
    - Licensing and authorisation of engineers and architects are to be implemented in the future
    - Promotion of risk transfer through insurance
    - Extending all by-laws and regulations from predominantly municipal regions to rural areas

- Awareness and preparedness
    - Earthquake event safety handbooks, homeowners earthquake safety guides and structural safety manual will be developed in a range of dialects to suit all regions of the country
    - Public buildings such as stadiums, theatres and malls are to conduct drills every 6 months to test preparedness and capacity for earthquake response
    - All public health facilities are responsible for developing their own disaster management plans with specific components for earthquake risk management

- Capacity development
    - This includes targeting individuals (engineers, architects, teachers, builders) and institutions and organisations (NGO's, community groups, schools) through developing and implementing training and awareness packages for relevant groups
    - Part of the process involves making people aware of the risks and the mitigation and capacity building measures that these groups can take to reduce this risk

- Response
    - Response funding has been set at a national level which is distributed to states as required

- The majority of the response mechanisms are nationally organised with some states having their own services available as well

- As mentioned above the National Disaster Relief Force was established as a response mechanism and it is recognised that this force is employed for multiple hazards (flood, storm and earthquake)

As identified above, the Bureau of Indian Standards has released the following standards with regards to earthquakes. This is not an exclusive list however these are the key documents:

- IS 4326 (1993) Indian Standard Earthquake Resistant Design and Construction of Buildings – Code of Practice (Second Revision) – this covers the selection of materials, design features, detailing and construction methods using masonry, concrete and timber (Government of India 1993)

- IS 1893-1 (2002): Criteria for Earthquake Resistant Design of Structures, Part 1: General Provisions and Buildings – this incorporates the assessment of seismic loadings and the design of earthquake resistant buildings, bridges, dams, embankments, retaining walls and stacks (Government of India 2002)

- IS 13935 (2009) Seismic Evaluation, Repair and Strengthening of Masonry Buildings – Guidelines - this covers material selection and technique application for repair and seismic strengthening of damaged buildings. It also incorporates damageability assessment methods and retrofitting of existing masonry buildings (Government of India 2009a)

9.1.1.2 Flood

The Government of India (2008b), under the National Disaster Management Authority, release the National Disaster Management Guidelines: Management of Floods. The flood risk management framework detailed in this guideline is summarised below:

- The existing structural and non-structural measures taken by India to reduce flood risk, which include:

  - Embankment and drainage construction totalling approximately 34000km and 39000km respectfully protecting more than 18 million hectares of land from flooding

  - About 4700 villages have been raised above flood levels

  - Flood forecasting systems comprised of 175 monitoring stations on major rivers

- Institutional framework:

  - The central government controls the legislation and delegates responsibilities accordingly to different agencies at a national level. These include various river catchment commissions, the Indian Meteorological Department, National Remote Sensing Agency and medium range weather and flood forecasting

  - The primary responsibility of flood control in India however sits with the individual states and each state has its own agencies, commissions and management authorities specific to them

- Prevention, Preparedness and Mitigation:

  - The majority of flood protection measures proposed in India are structural measures. This includes:

    - Dams, levees, embankments, weirs

    - Channel improvement projects, desilting, dredging etc

    - Drainage efficiency improvements, flood water diversions, anti-erosion works such as catchment afforestation and engineered structures

  - To a lesser extent proposed non-structural measures also contribute to risk reduction. These include flood zoning, flood proofing incorporated into structural design, a holistic approach to water management taking into account all relevancies such as flooding, agriculture, sanitation, biodiversity etc

  - Medical preparedness is also an important aspect. Specifying flood resilient health care facilities that stock enough supplies to handle an anticipated event has been implemented by some of the states in India

- Flood forecasting and warning:

    - India is employing an increasingly comprehensive approach to flood forecasting and warning. This approach involves:

        - Real time hydrological and meteorological data collection throughout catchments within the country as well as regional development of data collection from neighbouring Nepal, Bhutan and China

        - Utilising historical data with current and real time data to model and predict flood scenario outcomes and provide timely warning for flood events

        - Dissemination of these forecasts via all available means to all relevant stakeholder groups

        - Educating communities about these services and ensuring that they are available and accessible

- Regulation and enforcement:

    - Flood plain zoning requirements are stipulated in these guidelines at a national level and then handed to the states to implement and enforce

    - Similarly by-laws, incentives and disincentives for development in flood prone areas is proposed at a national level and left to the states to implement and enforce

    - National railway and highway authorities exist to ensure that these areas of public works are conducted with flood resilience taken into consideration, and again the development and enforcement of specific mechanisms are left to the individual states to devise

- Capacity Development

    - Flood education is seen as a key capacity building mechanism with target groups including community based organisations, school institutions as well as individual professionals in the fields of engineering, architecture, surveying, planning, project management etc. The media is also being educated in how best proceed during emergency events

  - Research and development is being promoted not only in terms of preparedness planning but also in the capturing of data during and after events in order to learn from these and grasp opportunities for betterment

- Flood Response

  - This guideline recognises that flood response must be carried out as soon as practicable after a warning has been issued, before the flood event occurs

  - Also acknowledged is the fact that in India approximately 80% of immediate search and rescue efforts are carried out by local community groups, before the state and national rescue teams can respond. With this in mind the Indian government recognises the necessity to have these community groups adequately trained in flood response and have appropriate resource available

9.1.1.3 Storm

The Government of India (2008a), under the National Disaster Management Authority, release the National Disaster Management Guidelines: Management of Cyclones. The flood risk management framework detailed in this guideline is summarised below:

- Early Warning Systems:

  - Since 2008 there have been ongoing works to improve land and ocean based observation networks including increasing the number and coverage of automated weather stations, Doppler radars, wind profilers, shallow and deep water ocean buoys and ship based observations

  - There have also been improvements in air and space based observations including the use of unmanned aerial vehicle in situ observation, surveillance and prediction. There are now at least 2 geostationary observatory satellites over the seas surrounding India at any one time

    - Modelling incorporating historical data combined with real time observations is used to predict cyclone formation, track, intensity and associated rainfall and storm surge. This data combined with scenario planning and expectation can provide estimates on expected damage and loss of life

- Communication and dissemination of warnings:

    - The Indian Meteorological Department is the key agency for providing cyclone warning services

    - Cyclone warnings are issued via satellite in the relevant regional language to the regional stations of which there are more than 250 in the country

    - These warnings reach individual communities via a number of means including

        - Direct to home television and radio channels

        - Hand radios and mobile phones which are either individuals or groups such as village information centres from where the information can be passed on in person

        - Internet services including the meteorological department website

- Structural mitigation measures:

    - One important facet of cyclone risk reduction is the design and building of cyclone structures. To this end the Government of India (2006) produced the Guidelines for Design and Construction of Cyclone/Tsunami Structures. This guide covers internal and external design, placement, capacity, maintenance and essential services supplies for cyclone structures in India

    - The guideline specifies that at least one link road (including culverts and bridges) must be constructed and maintained to withstand all weather events (expected wind and water levels). this link road should be positioned to benefit as much of the population as possible and will link to the cyclone shelters to ensure adequate transportation can be maintained before, during and after an event

    - There are also specifications for surface drains, canals and embankments. These specifications are based on Indian Standards which are linked to this guideline

- Coastal zone management

    - The guideline recognises the importance of coastal zone management in reducing cyclone risk reduction. Natural protection barriers such as mangrove forests have been identified as being highly successful in reducing the impact from cyclone events. In other environments, artificial structures such as sea walls have been employed as well

    - In some high risk identified areas plantation shelterbelts have been considered where appropriate tree species are planted from between 500m and 5km from the shoreline to reduce the landfall impact of cyclones

- Awareness generation

    - The two key aspects of awareness generation identified are that it will prepare communities and allow them to become more resilient, and it will enhance knowledge of the governments responsibilities resulting in a stronger political will to act

    - Awareness generation in India is targeted at three levels; Household, Community and Institutional. Community based disaster management is seen an integral component of risk reduction which when enacted correctly can drastically reduce cyclone risk

- Risk management and capacity development

    - This guideline recognises that sustainable development depends on the integration of disaster management into development planning and policy making. It also acknowledges that investment in mitigation and capacity building provide very high returns

    - There is strong emphasis in building capacity at community levels and enhancing communication and data sharing between policy makers through to community groups

- Response

    - There is a clear delineation between pre and post cyclone disaster response. Pre event response involves early warning and intensity prediction while post event response includes relief, rescue, rehabilitation and the restoration of facilities and services

    - One of the key elements identified by this guideline is the need for all stakeholders to understand the risks involved. Once the full appreciation has been achieved, planning and preparedness for cyclone response can take place effectively

Government of India (1987) through the Bureau of Indian Standards released IS 875-3 (1987): Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Part 3: Wind Loads. This standard provides wind forces and their effects (static and dynamic forces) based on wind zone maps of the entire country. This data can then be used in the design of buildings and structures accordingly.

9.1.2 Pakistan

The Government of Pakistan (2010a) legislated the National Disaster Management Ordinance in 2007 which then became the National Disaster Management Act in 2010. Under the ordinance the National Disaster Management Commission was formed which consists of all relevant ministers of government. This commission then appointed the National Disaster Management Authority which is responsible for the facilitation of disaster risk management at a national level in Pakistan, enforcing the act, preparing plans, policy and guidelines. Subsequent levels of risk governance are provided by the Provincial Disaster Management Authorities and the District Disaster Management Authorities to match the administrative division of the country (Government of Pakistan 2010a).

In 2007 there was a National Disaster Risk Management Framework developed by the National Disaster Management Authority in conjunction with the National Disaster Management Act. This framework set priority areas which expanded on the Hyogo Framework for Action (HFA) priorities (Government of Pakistan 2007b).

More recently under the National Disaster Management Act the National Disaster Management Authority in Pakistan has implemented the National Disaster Management Plan. This plan comprises one main volume and three sub-volumes and is summarised below:

- Main Volume (Government of Pakistan 2012a):
    - Risk overview:
        - This includes a broad identification of the hazards present and an acknowledgement and identification of the key vulnerabilities of people, buildings and infrastructure as well as the natural environment
        - The risk assessment process is defined and severity estimates of the various risks are identified in individual regions of the country
        - A methodology is provided for the creation of risk vulnerability maps and risk assessment rankings which is to be implemented in the coming years
    - Institutional systems for disaster management
        - As per the National Disaster Management Act this section defines the state and district disaster management authority roles and responsibilities
        - A brief overview of the non government bodies and individual group responsibilities is provided as well and a system overview of the interactions between agencies and stakeholder groups is also provided
        - The general structure of disaster management and relief funding mechanisms is identified with regards to national, state and district administration
    - National strategies for disaster management and intervention
        - These strategies are adopted directly from the National Disaster Risk Management Framework. Actions and work programs with

departmental responsibilities are assigned to each of the intervention strategies and initial cost estimates and timeframes for implementation are included in this National Disaster Management Plan

    - The remainder of this National Disaster Management Plan main volume is dedicated to the individual disaster hazards, the relevant types (floods, earthquakes and storms) will be discussed further below

- Volume 1 – Human Resource Development Plan (Government of Pakistan 2012b):

    - This volume of the plan recognises the importance of the development of human resources as a key mechanism for disaster risk management and risk reduction. These resources include the various institutions, organisations, private and public groups that interact to address disaster risk

    - There has been a skills assessment and required competencies study undertaken to establish current human resource capacities as well as a challenges and gap identification to highlight opportunities for improvement

    - A large range of proposed actions which include timeframes and responsibilities have been set to be completed by the body known as the National Institute for Disaster Management. These include mechanisms for strengthening community capacity, education, awareness and training and research into disaster risk reduction across all hazards identified in Pakistan

- Volume 2 – National Multi-Hazard Early Warning System Plan (Government of Pakistan 2012c):

    - This volume is intended to enhance overall risk management by identifying and implementing the early warning systems for multiple hazards, which can then be integrated with preparedness and response mechanisms

    - This aspect of disaster risk management in Pakistan is still in the early stages of implementation for example district hazard map are yet to be developed for many areas however there are some timeframes and responsibilities set for short, medium and long term projects relating to early warning systems

- Volume 3 – Instructor's Guideline on Community Based Disaster Management (Government of Pakistan 2012d):

  - This guideline is designed to be used by instructors and facilitators at the community level to enable communities to conduct the following disaster risk reduction items:

    - To decide the disaster risk management strategies for their individual community

    - To prepare a community based disaster management plan

    - To enhance disaster risk management knowledge and conduct emergency drills

    - To be able to act effectively during disaster events

  - The eight modules in this guideline include self assessments for vulnerability and capacity, disaster knowledge enhancement and emergency response coordination. When implemented effectively these modules should reduce disaster risk at an individual community level

The abovementioned National Disaster Management Plan has a broad scope and a wide range of interventions. In order to encourage a more holistic approach the Government of Pakistan (2013b) developed and implemented the National Disaster Risk Reduction Policy. This policy acknowledges the shortcomings of the national plan and is intended to instil a sense of urgency towards disaster risk reduction through incorporating disaster management into development and decision making processes (Government of Pakistan 2013b).

With specific regard to disaster response the Government of Pakistan (2010b) developed and released the National Disaster Response Plan. This plan aims achieve the following:

- Provide a mechanism to classify the scale of individual disaster events, the corresponding response measures to be implemented and procedures to be followed

- Define what constitutes local, provincial and national emergencies, define the process of declaring an emergency and what response measures and procedures should be followed in each case

- Clarify the disaster management roles and responsibilities for all stakeholders and provide a coordination method between them

- Provide standard operating procedures for each relief function and further stipulate government agency function and responsibility

- Provide a consistent methodology for reporting and evaluating disaster events

The Building Code of Pakistan in 2007 (Government of Pakistan 2007a) was first introduced in 1986. After the severe earthquake event in 2005 to code was amended to incorporate seismic provisions. The code is applicable to all reinforced concrete, steel and masonry buildings and structures. Essentially all of these engineered structures built in Pakistan should, when implemented properly, comply with this code and thus take seismic loads into account (Government of Pakistan 2007a).

9.1.2.1 Earthquake

After the massive loss of life and destruction resulting from the 2005 earthquake the Pakistani government established the Earthquake Reconstruction and Restoration Authority with the intentions of maximising the potential opportunities that arise from earthquake events like the 2005 disaster. A focus on building back better is the key mission of this authority (Government of Pakistan 2011). A significant number of National, State and provincial projects relating to reconstruction and rehabilitation were proposed and are being implemented through this authority.

The National Disaster Management Plan provides risk reduction mechanisms specific to earthquakes. Because this plan has been implemented under the National Disaster Management Act the details set in its contents are statutorily binding. This plan includes the following earthquake risk reduction mechanisms:

- Detailed role and responsibilities of all identified stakeholders with regards to pre-disaster, post-disaster and emergency response for earthquake events (Government of Pakistan 2012a)

- Current and expected future required competencies of human resources specific to earthquake events including earthquake resistant design for new structures and retrofitting of existing structures, hazard assessments and seismic analysis. All government levels, community level and private sector resource conditions and the general capacity of these groups are also identified (Government of Pakistan 2012b)

- Seismic observation, analysis and data dissemination methods and capabilities have been identified by the Pakistani government along with current resource capacities. A strategic plan for increasing the effectiveness of these resources has been developed an a number of work projects have been created to address shortcomings of the current system (Government of Pakistan 2012c)

- A comprehensive earthquake hazard education and awareness package has been developed and disseminated for training use to enhance community based disaster management. This training includes (from Government of Pakistan 2012d):

    - A basic knowledge module for earthquakes including plate tectonics and seismicity

    - An historical overview of Pakistan's earthquake occurrences and the current vulnerability and risk outlook for the country

    - Basic means and mechanisms for risk reduction including structural and non-structural methods, evacuation and response

As mentioned above the Building Code of Pakistan in 2007 was amended in 2005 to integrate seismic provisions and as a result the code incorporates various earthquake conditions including (from Government of Pakistan 2007a):

- Seismic zoning and hazard/risk level identification that triggers the requirements of strict design and analysis conditions to be imposed on structures

- Site considerations to be considered including potential faults, liquefaction and slope stability

- A separate design load requirement for seismic loads and earthquake design

- Architectural, mechanical and electrical seismic design allowances

- Concrete, steel and masonry structural analysis and design based on the requirements of the above listed earthquake considerations

9.1.2.2 Flood

The Government of Pakistan (2014) release an annual National Monsoon Contingency Plan which provides an overview of the previous year including lessons learned from previous disaster events and details an outlook for the coming year. The most recent plan, the National Monsoon Contingency Plan 2014, provides to following flood risk management mechanisms:

- A retrospective assessment river catchment conditions, land use changes, surface storage free capacity along with medium and long range meteorological forecasting to provide a projected risk output for the forthcoming year
- Using this combined approach the likely scenario for the pending monsoon is assessed and gaps are rectified as practicably as possible to reduce the incoming risk
- A bottom up approach to contingency planning where the national authority works with provincial disaster managers and communities to ensure that previous outstanding issues are resolved during pre-monsoon periods
- Coordination of the relevant disaster risk actors is assessed based on past experiences and lessons learned to provide the best approach to impact assessment, response, and recovery

The National Disaster Management Plan provides risk reduction mechanisms specific to floods and as per earthquakes the details set in its contents are therefore statutorily binding. This plan includes the following flood risk reduction mechanisms:

- Detailed role and responsibilities of all identified stakeholders with regards to pre-disaster, post-disaster and emergency response for meteorological related events which includes floods and storms (Government of Pakistan 2012a)
- The Pakistan Meteorological Department is the primary group responsible for observation, data recording, analysis, transmission and forecasting of meteorological data and services in Pakistan. This data includes rainfall and key river water levels and is used in conjunction with regional climate models to provide warning alerts for flood hazards. The Flood Forecasting Division is responsible for increasing the capacity of Pakistan's flood forecasting and warning services and hydrological data capture and analysis (Government of Pakistan 2012c)

- With regard to community based disaster risk management the Government of Pakistan (2012d) provides an education and awareness package that incorporates the following modules:

    - Background information on the types of floods and their hazard classification, probability based classification (i.e. 1:5, 1:20 year food levels), flood risk zoning and high risk area maps as well as an historical flood data overview

    - Flow on effects from flooding including landslide risk and water borne disease outbreak

    - Flood risk mitigation strategies including structural and non-structural mechanisms as well as techniques that can be implemented at the local community level which primarily focus on education and awareness of flood risk

The Government of Pakistan (2013a) has released annual reports on flooding since 1998 which compile annual flood event and catchment flow data, discuss lessons learned from previous flood events and seek to anticipate future flood risk management needs. This report is compiled partly by the Federal Flood Commission and has a focus area on an integrated land and water resource approach that aligns sustainable development with flood risk reduction. Key flood risk reduction mechanisms detailed in the 2013 annual report (Government of Pakistan 2013a) include:

- Provincial irrigation authorities operate water infrastructure such as barrages, irrigation and drain networks and collect and share river flow data with relevant stakeholders. The Water and Power Development Authority maintains the flood forecasting telemetric system throughout the country and directly links with the Flood Forecasting Division during the monsoon season

- Each day during the monsoon season each year, usually from 1st July to 15th October, a flood communication cell releases a flood situation report that compiles all available meteorological and hydrological data and communicates current and expected flood conditional reports to all relevant stakeholders

9.1.2.3 Storm

The National Disaster Management Plan provides risk reduction mechanisms specific to storm events and as per earthquakes and floods the details set in its contents are therefore statutorily binding. This plan includes the following storm risk reduction mechanisms:

- As per flood and earthquake management detailed role and responsibilities of all identified stakeholders with regards to pre-disaster, post-disaster and emergency response for storm events is provided (Government of Pakistan 2012a)

- Similarly for cyclones and storms the Pakistan Meteorological Department is responsible for data management. The Tropical Cyclone Warning Centre manages the majority of automated weather stations and works with the meteorological department to cover upper atmospheric observations as well as ad hoc ground based observational projects (Government of Pakistan 2012c)

- Community based disaster risk management regarding storm events is provided by the Government of Pakistan (2012d) in modules that align with those provided for floods and earthquakes and include:

    - Background of the formation and classification of cyclones, an identification of the cyclone vulnerable areas and the cyclone risk in Pakistan

    - An historical analysis of cyclone and the associated impacts of strong winds, storm surges and secondary hazards such as structural damage and the disruption of services and infrastructure

    - A basic overview of the structural and non-structural mechanisms for cyclone risk reduction

9.2 Gap Analysis

This section has been included as per the details given in section 3.4 Gap Analysis.

9.2.1 India

9.2.1.1 Hyogo Framework for Action

This section will highlight the gaps that India has in implementing the Hyogo Framework for Action according to each of the Five Priorities for Action. These gaps are based on the documents reviewed for India above (see section 9.1.1 India), the review completed by the World Bank (2012) and the most recent Hyogo Framework for Action progress report completed by the Government of India (2013d,).

1. **Ensure that disaster risk reduction is a national and local priority with a strong institutional basis for implementation**

- At the national level the development of disaster risk management mechanisms has been quite strong however the implementation of these mechanisms remains with the states. Some states have built on the national initiatives and have very effective strategies in place while others, some more vulnerable, are lacking

- While there have been large scale vulnerability analysis undertaken in many parts of India, there have been very few micro scale risk assessments, which should be conducted to form the basis for larger risk reductions schemes

- In order to fully encourage disaster risk reduction at the local level and to further decentralise the decision making processes there needs to be more distribution of funding from national to state and state to local levels

2. **Identify, assess and monitor disaster risks and enhance early warning**

- There still remains a disconnect between disaster risk understanding and development programmes

- India's capacity to model potential losses from natural disasters remains limited, while there are damage assessments conducted after events there is a need to compare this to predicted losses and implement calibrated loss models

- Significant advances in early warning have been made for hydro meteorological events; the challenge is connecting the remaining states, districts and local areas. This includes data sharing across the entire country

3. **Use knowledge, innovation and education to build a culture of safety and resilience at all levels**

- Data accessibility and public access for the grass-roots local levels of the community needs to be increased

- The incorporation of disaster risk management into school and university courses is increasing in India, however there is a lack of follow through in terms of providing opportunities to implement these ideas into public programmes, policy development and planning mechanisms

4. **Reduce the underlying risk factors**

- There is a strong need to further understand the linkages between environmental vulnerabilities and natural disaster risk including increased risk due to environmental degradation and the reduction of risk through natural ecosystems

- Along with an increasing population comes an increase in the need for food and agriculture. Sound land use management plans need to take into consideration disaster risk to reduce exposure

- There is a strong need to enhance compliance to building codes and to educate communities of the advantages of resilient building methods. To add to this the Indian Institute for Human Settlements (2012) describes the lack of any regulating/governing body for engineers. As such engineers are free of professional risk associated with poor practice

- There is a strong need to enhance the mechanisms of risk transfer. Disaster insurance for housing and business is lacking and an enabling environment needs to be established so that the bearers of risk, mainly insurance companies and banks, become more motivated towards this method of risk reduction

5. **Strengthen disaster preparedness for effective response at all levels**

- The biggest challenge to disaster response if reaching the most vulnerable community groups to enhance contingency planning, preparedness and capacity building

- Damage assessment techniques have been developed as generic tools and do not provide a realistic representation of individual disaster events

9.2.1.2 Earthquakes

After the 2001 earthquake and then the 2004 earthquake related tsunami event, India implemented the Disaster Management Act 2005 and sought to establish a culture of disaster risk reduction and prevention. However the World Bank (2012) indicates that seismic awareness and risk mitigation and reduction have not been fully implemented into management strategies and mechanisms. Some of the shortcomings in India's earthquake disaster risk management strategies include:

- The Government of India (2007) indicate that despite the fact that building codes with seismic guidelines have been developed and implemented the majority of casualties associated with earthquakes are a result of the collapse of buildings. Earthquakes of the same magnitude experienced in other parts of the world (United States and Japan for example) do not generally result in as many lives lost (Government of India 2007)

- Seismic building codes and guidelines in India are usually enforced by local urban bodies/authorities however the Government of India (2010b) recognises that these risk reduction mechanisms are not generally complied with in urban areas and that in rural areas these local urban bodies have no authority. What regularly occurs is that the onus of ensuring compliance is left to the loaning agency or bank resulting in the following shortcomings:

    - Applications for building loans can be made without the building being fully designed, with the design certificate to be provided at a later date

    - Engineers and architects can recommend to the bank that the loan be approved without actually viewing the fully designed structure

    - Independent assessment of the final structure against the certified design is often not followed through correctly by the banks or the engineers which is evident from the damage and financial losses resulting from earthquake and other disaster events

- To add to this the Government of India (2007) acknowledge that there is a general lack of suitably qualified individuals (civil/structural engineers, architects, masons etc) who can adequately assess and design for seismic loadings on structures

- The Indian Institute for Human Settlements (2012) raises concerns that, for engineers who are suitably qualified and can recommend bank loans and sign off on as built civil constructions, there is no regulatory/governing body that can hold engineers to account for irresponsible practices and therefore engineers are free of professional risk.

9.2.1.3 Floods

Based on the data form EM-DAT (2014) floods affect more people and cause more financial damage than any other natural disaster type in India, and are second to earthquakes in the number of resulting fatalities. A significant amount of work has been put into flood risk management strategies in India in recent years, however there are several gaps that remain. The government of India (2008b) identified a number of these, including:

- Contour mapping with enough detail (close contours) has not been completed in many of the flood prone areas, as a result forecasting and warning systems are not adequate in a number of states

- Web-based forecasting and warning has been developed, however many regions have not implemented it fully and rely on wireless radio and telephone networks

- Inflow into reservoirs and the subsequent outflow downstream during flood events is not often stipulated in management plan or standard operating procedures

- Structural flood measures such as levees and embankments are commonly implemented on an ad hoc basis and do not account for a holistic overview of the entire catchment. For example groundwater recharge and the residual risk created from embankments and drainage systems needs to be taken into consideration

- Furthermore the lack of permitting for general public works also causes problems to flood infrastructure. For example earthen embankments may be put into place and at a later stage utilities such as power, water and gas will be installed, cutting through the embankment and decreasing the structural integrity of the infrastructure. Often rehabilitation of these structures is not undertaken and original designs for strength and integrity are not consulted

The Government of India (2010c) has undertaken an assessment of globally used practices for urban flood management including Australia's "Australian Rainfall and Runoff Manual", the United States "Urban Drainage Design Manual" and the World Meteorological Organisation's "Urban Flood Risk Management: A Tool for Integrated Flood Management". The intention was to design India's Urban Storm Drainage Design Manual by 2012, however at the time of this research project this manual has not been available for viewing over the internet.

9.2.1.4 Storms

The World Bank (2012) indicates that over 75% of India's coastline is prone to tropical cyclones and intense storm events. Similarly to the other disaster types, India is increasing its efforts to reduce cyclone related risk and adopt a proactive approach to the management of that risk. As part of the National Disaster Management Guidelines for the Management of Cyclones the Government of India (2008a) has identified a number of gaps in its systems. These include:

- In 2005 the first Indian high altitude Unmanned Aerial Vehicle (UAV) was launched into a tropical storm for a 10 hour data gathering exercise. Despite these early beginnings it was identified in 2008 that there was a significant lack of information available from the cyclone core, creating difficulties for track forecasting a intensity predictions

- Globally the accuracy of track prediction of tropical cyclone has reached a level of about 60-80km for a 24hr forecast. Due to the lack of real time satellite and ground radar data, as of 2008 India was only able to predict within 140km for a 24hr forecast

- With regards to structural methods of risk reduction, about 1450km of the Indian coastline is affected by intense coastal erosion. As of 2008 only about half of this length had structural mechanisms implemented for protection

The Indian Meteorological Department (2012) indicates that a significant amount of work has been undertaken to reduce the errors in cyclone forecasting and pilot trials have been undertaken. Further gaps identified from this work included:

- Ocean buoy networks need significant upgrades
- Satellite data capture needs to be improved
- General funding and consumable item availability should be increased

9.2.2 Pakistan

9.2.2.1 Hyogo Framework for Action

This section will highlight the gaps that Pakistan has in implementing the Hyogo Framework for Action according to each of the Five Priorities for Action. These gaps are based on the documents reviewed for Pakistan above (see section9.1.2 Pakistan), the review completed by the World Bank (2012) and the most recent Hyogo Framework for Action progress report completed by the Government of Pakistan (2013c).

1. **Ensure that disaster risk reduction is a national and local priority with a strong institutional basis for implementation**

- The shift from response based disaster management to a more proactive approach was hindered in Pakistan due to significant disaster events in 2010 and 2011. Moving forward form this mitigation and capacity building needs to be advanced at a greater rate in the coming years, particularly at sub-national levels. This includes further integration of disaster risk reduction into sustainable development programmes.
- There is a broad ranging lack of financial and technical resources available for disaster risk reduction in Pakistan, particularly at province and district levels as this is where the primary responsibility lies in implementing the nationally prescribed mechanisms
- There is a lack of awareness regarding the importance of investment in preparedness and preventative measures of risk reduction, by addressing this need local

governments and institutions can become aware of the provincial and national level responsibilities to provide adequate funding to their local community areas

- In order to address the lack of local resources funds are spent on procuring international sources of expertise, often knowledge from these investments is not adequately captured and thus there is a gap in efficiency

2. Identify, assess and monitor disaster risks and enhance early warning

- As with India and Bangladesh, Pakistan has a lack of reliable data available for carrying out risk assessments. The poor coordination of internal stakeholders in Pakistan combined with restricted South Asian regional cooperation is also an area where improvement can and needs to be made

- Again the lack of resources and technical expertise restrict Pakistan's early warning systems particularly in regards to multiple hazard warnings and the dissemination of these warnings to vulnerable rural and remote areas of the country

3. Use knowledge, innovation and education to build a culture of safety and resilience at all levels

- The facilitation of the dissemination of knowledge and education throughout Pakistan is limited by the lack of reliable information technology services (such as the internet) and a major problem is that vulnerable regional and rural areas are not connected to the larger centres

- Lack of general disaster awareness in government departments including those dealing with education coupled with the lack of resources and expertise is hindering the addition of disaster risk reduction into education curriculum

- Firstly the lack of awareness and expertise in the decision making processes needs to be resolved, this will then lead onto the broader problem of awareness in the general public

4. Reduce the underlying risk factors

- Given that Pakistan is a developing country with fiscal constraints the need to promote economic growth, the environmental sector the appropriate degree of attention. This has the potential to further increase vulnerability to natural disasters

- Poverty and an increasing financial pressure is still one of the major drivers of disaster risk in Pakistan. The sustainable development of low socio-economic regions and the modernisation of existing services (such as gas, water, electricity, communications, transport) tie together poverty reduction, economic empowerment and as a by-product disaster risk reduction

- Similarly with Bangladesh and India, Pakistan has a need to enforce building standards in a manner that is achievable, providing economically viable building options while reducing underlying disaster risk

5. Strengthen disaster preparedness for effective response at all levels

- At the federal level there are several initiatives focussing on local community based risk management, however unless the resources and expertise are in place these will not achieve their potential positive impacts

- Presently the capacities of provincial and local communities are not at desirable levels

- Given that the World Bank and the Asian Development Bank provide expertise with regards to disaster needs assessments Pakistan should be doing more to capture the methodologies and train internal expertise to fulfil these requirements in house

9.2.2.2 Earthquakes

After the devastating effects of the 2005 earthquake, Pakistan sought to implement a more comprehensive approach to disaster management as opposed to the previous reactive and response oriented methods (The World Bank 2012). Despite this shift in paradigm there remain significant gaps in Pakistan's earthquake risk reduction strategies, including:

- According to the Government of Pakistan (2012c) the national seismic network in Pakistan has access to real time seismic data (for both earthquakes and tsunami) from over 150 stations worldwide including Australia, Indonesia and Israel however it lacks live data from its nearest neighbours such as India and Iran

- The Pakistan Meteorological Department operates 21 seismographic stations throughout the country however according to the Government of Pakistan (2012c) 3 of these sites have been nonoperational since 2010 due to power system failures

- Haseeb et.al. (2011) and the Government of Pakistan (2013b) identify significant gaps in the methodology used to develop building codes and standards in Pakistan. Both sources suggest that extensive studies are needed to identify realistic earthquake resistant structural mechanisms that can be implemented in Pakistan via amendments to existing building codes. They go further to say that these codes should be being reviewed at least every three years moving forward

- Syed and Routray (2014) and the Government of Pakistan (2013b) highlight the significant gaps in earthquake risk reduction via land use and seismic risk zoning in rural and low socioeconomic areas. It is identified that poverty and vulnerability are linked not only in terms of immediate damage but also in long term recovery and rehabilitation as well. This is due to building in high risk areas, not designing buildings (both residential as well as public infrastructure) to seismic loadings and the lack of risk financing and insurance

9.2.2.3 Floods

The flood experienced by Pakistan in 2010 has been assessed as the worst recorded since 1929 with the overall financial damage estimated as being up to US$10.5 billion (The World Bank et al 2010). During the 5 year period from 2009 to 2013 the annual damage from flooding has been estimated to be as high as US$6.4 billion (accounting for underestimated reported figures) with more than 6.5 million people affected each year during the same period (EM-DAT 2014). While there has been an increase in the need for investment in flood risk reduction (Government of Pakistan 2013a) there are still gaps, particularly in the level of investment in flood prevention, highlighted below:

- According to the Government of Pakistan (2013a) an investment of around Pakistani Rupees (PKR) 27 Billion (approximately US$450 million USD) has been made towards flood protection infrastructure and forecasting and warning systems in the past 36 years (currency exchange is based on the mean value for PKR vs. USD of 62 PKR to 1 USD from 1988 to 2014 (Trading Economics 2014))

- During this same period the total damages caused by flooding in Pakistan are estimated at up to US$34 billion (EM-DAT 2014)

- For the 2010 floods, the World Bank et al (2010) estimate that the total reconstruction efforts post flood event accounted for more than 80% of the financial expenditure

- The Government of Pakistan (2014) in its National Monsoon Contingency Plan for 2014 describe that a bottom up approach has been adopted by the National Disaster Management Authority where the provincial governments are responsible for needs assessments and the deployment of appropriate resources. However in the progress report towards the Hyogo Framework the Government of Pakistan (2013c) identifies that provinces are lacking in funding compared to the national level, and that what funding is available at the provincial level needs to be increased to allow for effective disaster risk reduction

9.2.2.4 Storms

The Government of Pakistan (2008 & 2012c) recognise that, although there is not a strong history of severe cyclone activity affecting Pakistan, in recent years there has been an increasing trend in cyclonic events and the intensity of these events which likely to continue to increase. They also recognise that the risk of cyclonic events particularly to Karachi city, as an economically important city with an increasing population, is increasing. The following gaps have been identified in Pakistan’s mechanisms to cope with this risk:

- In 2012 the Government of Pakistan (2012c) identified that the Pakistan Meteorological Department’s Karachi Radar was outdated and did not have the coverage required to adequately forecast intensity and landfall location of cyclones in Pakistan

- Unlike neighbouring areas of India and further in Bangladesh, Pakistan has no established cyclone shelters in place despite the fact that the Government of Pakistan (2008) has identified that during a cyclone event a significant portion of the population of Karachi would have to be evacuated

- According to the Government of Pakistan (2008) total waste produced in Karachi city in 2008 was about 8 000 tons and the city had the capacity to treat about 4 000 tons. The remaining waste ends up being disposed of elsewhere with a significant portion finding its way into stormwater drainage, exacerbating the effect of flooding during cyclonic events

10Appendix D: Consequential Effects of This Project

Given the scope and object of this research project it has been deemed appropriate that a section regarding sustainability and ethics will be incorporated into this report. The following points are adopted from the Institute of Engineers Australia (Engineers Australia 1997) and are considered to be associated with this project.

1. **Development today should not undermine the development and environmental needs of future generations**

Natural disaster events can potentially have considerable negative impacts of local, national, regional and global development. In some regions of the world development decisions without the appropriate level of consideration for disaster risk have compounded the vulnerability and exposure intensity of their communities. The future for DRR lies in the integration of disaster risk integration with sustainable development and the facilitation of change within the decision making processes of investment and development.

Part of the objective of this research project is to establish findings and recommendations which help to ensure that the development decisions made today and in the future provide positive results for future generations.

2. **Environmental protection shall constitute an integral part of the development process**

The integration of disaster risk management into sustainable development is one of the key recommendations from UNISDR (2013a) towards the post 2015 DRR guidelines. This includes interlinking DRR with global initiatives such as the Kyoto Protocol and the Millennium Development Goals.

A significant part of sustainable development is natural resource and environmental management; indeed these aspects are already identified as risk reduction measures (specifically the reduction in underlying risks) in the HFA (UN 2014).

Natural environmental mechanisms for the reduction of natural disaster risk include:

- Forests as a means of reducing tsunami and landslide risks (World Bank 2012)

- Excluding existing natural wetlands from future development and restoring development affected wetlands and flood plains as a mechanism of reducing flood risk. The benefit to risk reduction of which is twofold as this process also removes settlements from risk vulnerable flood areas (Kundzewicz 2011)

Such disaster risk mechanisms as these, when implemented, have the potential not only to reduce risk but to increase environmental and sustainability values for entire ecological systems. Part of this project is looking at the holistic approach to disaster risk management that will arise from granting DRR the importance it requires in environmental management.

3. Engineering people should take into consideration the global environmental impacts of local actions and policies

One of the fundamental aspects of this project is that it is analysing natural disaster risk management on a global scale. To achieve this global risk reduction local decision making policies and guidelines have to be developed, implemented and maintained. The learnings form these local decisions can provide important lessons and learnings to be disseminated and adopted in other regions of the globe.

Disaster risk management is a dynamic and evolving system of mechanisms that has seen vast considerable improvements in the past 2 decades. This research project is essentially examining a small portion of what will be analysed as part of the 3rd World Conference of Disaster Reduction in 2015 in Japan. As an undergraduate research project the resulting findings will among many that have been developed over the past decade of the HFA's implementation.

Through these findings and recommendations the future of DRR will be established and have potential global impacts for the next decade (2015-2025) at least.

4. The eradication of poverty, the reduction in differences in living standards and the full participation of women, youth and indigenous people are essential to achieve sustainability

The reduction in natural disaster risk goes hand in hand with the global reduction in poverty and the increase in living conditions. They are mutually supportive global objectives and a collaborative and integrated approach must be taken to ensure they are attainable. Furthermore gender, cultural diversity and age should all be taken into consideration when planning and implementing DRR mechanisms (UN 2014).

As it has been identified in the above report, often the most vulnerable to natural disasters are those living in poverty. If the global strategies and mechanisms discussed above are implemented and maintained then the world will see a dramatic change in local, national, regional and global equality. The findings from this research project may potentially contribute to such strategies and mechanisms.

5. **People in developed countries bear a special responsibility to assist in the achievement of sustainability**

The fundamentals of integrating DRR into sustainable development will have a direct positive effect across the globe. Natural disaster events are not restricted to developing countries, the earthquake disaster in Christchurch, the Queensland floods in recent years and the more recent Washington landslide attests to this fact. Provided that the fundamentals of knowledge sharing and increased global awareness of natural disasters are followed, developed countries will be able to help developing countries and vice versa.

Given that part of this research project is concentrated the SAR, the resulting findings and recommendations have the potential to provide positive outcomes for the developing world as well as provide knowledge and understanding for Australia and other developed countries.