

**DISASTER MANAGEMENT FRAMEWORKS IN SRI  
LANKA AND ITS COMPLIANCE WITH GLOBAL  
STANDARDS**

**Gimhan Pramodith Jayasiri**

**178062T**

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**Department of Civil Engineering**

**University of Moratuwa**

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## DECLARATION

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Names of the supervisors: Prof S.S.L Hettiarachchi

Dr C.S.A Siriwardana

Signature of the supervisor: .....

Date: .....

## **ABSTRACT**

In the recent past Sri Lanka has experienced several significant natural disasters. At present, the DMC and all the line agencies focus on disaster management functions under the ministry of disaster management. The comprehensive disaster management program was prepared in 2014 and it is to be used up until 2018. Furthermore, it was proposed to identify mechanisms to integrate the Sendai Framework into the Sri Lankan national disaster management framework. However, during recent disasters, the DMC and the disaster management framework was under severe criticism from the public as well as the technical community. Therefore, the aim of this study is to investigate disaster management framework in Sri Lanka and its compliance with global standards. Initially an in-depth literature review was carried out to identify the terminology and existing local and international frameworks related to Disaster Management. Then the local frameworks were evaluated against seven criteria, which were identified after carefully analysing the requirements of the Sendai Framework. During this investigations several recent disaster incidents were referred as well. In addition, a case study was carried out to identify the status of some of the key components of coastal community resilience. Interviewing key professionals in the field of Disaster Risk Reduction in Sri Lanka and the focused group and panel discussions provided sufficient data for the analysis. Sri Lanka is in the process of aligning themselves with the Sendai Framework and Even though country lacks proper and efficient resilience mechanisms focused on the coastal communities, national efforts are underway to build up the coastal resilience. Training and public awareness campaigns, efficient funds, properly maintained hierarchy and concern to the coastal ecosystems are some of the enablers associated in building coastal resilience. Developing a multi-hazard map, improving the interagency cooperation, Use of social media to disseminate Early Warnings and focusing more on the development of a people-centered Multi-Hazard Early Warning Systems (MHEWS) are some of the recommendations given.

**Key Words:** Disaster Management; Disaster Risk Reduction; Resilience frameworks; Sendai framework; University Industry Partnerships; Evacuation planning

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## **LIST OF ABBREVIATIONS**

<u>Abbreviation</u>	<u>Description</u>
CCA	Coast Conservation Act
CCR	Coastal Community Resilience
CCD	Coast Conservation Department
CDMP	Comprehensive Disaster Management Plan
CRF	Community Resilience Framework
CZMP	Coastal Zone Management Plan
CSO	Community Service Organization
DM	Disaster Management
DMC	Disaster Management Centre
DoM	Department of Meteorology
DRM	Disaster Risk Management
DRMP	Disaster Risk Management Plan
DRR	Disaster Risk Reduction
DRRPP	Disaster Risk Reduction and Preparedness Plans
EOC	Emergency Operations Centre
EW	Early Warning
HEIs	Higher Education Institutes
HRCM	Hazard Resilient Housing Construction Manual
IUCN	International Union for Conservation of Nature
MDM	Ministry of Disaster Management
MHEWS	Multi Hazard Early Warning System

MoF	Ministry of Finance
NAPCCI	National Adaptation Plan for Climate Change Impacts
NBRO	National Building Research Organization
NCDM	National Council for Disaster Management
NDMC	National Disaster Management Centre
NDMP	National Disaster Management Plan
NDRSC	National Disaster Relief Services Centre
NEOP	National Emergency Operations Plan
NGO	Non-Governmental Organization
NITF	National Insurance Trust Fund
NIPPP	National Influenza Pandemic Preparedness Plan
NMC	National Meteorological Centre
NOSCP	National Oil Spill Contingency Plan
PACC	Paris Agreement on Climate Change
RRA	Reconstruction and Rehabilitation Act
SLCDMP	Sri Lanka Comprehensive Disaster Management Programme
SLDRMP	Sri Lanka Disaster Risk Management Plan
SLNDMP	Sri Lanka National Disaster Management Policy
SoR	Scheme of Recruitments
TAC	Technical Advisory Committee
UNISDR	United Nations International Strategy for Disaster Reduction
UNFCCC	United Nations Framework Convention on Climate Change
UIP	University Industry Partnerships

# 1 INTRODUCTION & STRUCTRE OF THE THESIS

## 1.1 Research Problem

During recent past, Sri Lanka has experienced several natural disasters. Out of them Indian Ocean Tsunami in 2004, made a devastating damage affecting more than one million people. 2016, 2017 Floods and landslide in Aranayake can be considered as the most recent natural disasters. With the aim of effectively managing all phases of disaster risk & disaster management and to enhance the resilience of the community, in 2005 disaster management act was passed to provide the necessary legal provisions which was revised into a national policy later. Furthermore, Disaster Management Centre (DMC) was also established. At present, all the line agencies focus mainly on Disaster Management function under the Ministry of Disaster Management.

However, they have made every effort to encourage DRR measures with the assistance of line agencies who are responsible for the monitoring & warning of hazards. This task cannot be done purely by Ministry of Disaster Management in view of the fact there are designated line agencies who have responsibilities for the hazards (Ex: Irrigation Department for monitoring & forecasting of river flooding). The line agencies themselves have to work in collaboration with the agencies such as Department of Meteorology, for rainfall predictions. Therefore, this demands close cooperation among many agencies.

The Comprehensive Disaster Management Program was prepared in 2014 and it is to be used up until 2018. Furthermore, after 10 years of the implementation of Hyogo Framework the Sendai Framework was adopted by the member states in February 2015. It was proposed to identify mechanisms to integrate Sendai framework to the national disaster management framework.

As mentioned previously, although the Ministry of Disaster Management can respond at the time of national disasters they on their own cannot implement DRR measures relating to hazards. This has to be done after an effective dialogue with the relevant line agencies responsible for the said hazards. When looking at the current disasters occurred in Sri Lanka it is visible that DMC is more into the management of the

response stage of a disaster rather than the Disaster Risk Reduction and Post Disaster Management.

It is also observed that risk is a function of hazard, vulnerability and capacity (Preparedness). There is no national agency, which is responsible to prepare a vulnerability profile in relation to human population, physical infrastructure, food and crops and ecosystems. The Ministry of Disaster Management achieved the first attempt of a national hazard profile with the assistance of United Nations Development Programme (UNDP). This document is a benchmark document, which has to be periodically upgraded and expanded. It is important that a similar vulnerability profile has to be prepared under the leadership of appropriate state institutions and stakeholders must reach agreement on the best approach to this national problem. Sri Lanka is very fortunate to have a very strong Census & Statistics Department, which can provide most of the information. The said stakeholders can request the Census & Statistics Department to collect the additional information if necessary which is required for DRR.

## **1.2 Objectives**

Given the above background the objectives of the study are

1. To identify and understand the existing frameworks for Disaster Risk Reduction (DRR) and Disaster Management (DM) in Sri Lanka
2. To identify the Global standards and frameworks for Disaster Risk Reduction and Management and to check whether the local frameworks are aligned with them
3. Conduct case studies on improving coastal community resilience using relevant methods
4. To provide recommendations for the improvement of existing frameworks

## **1.3 Research Methodology**

In order to reach the specified objectives mentioned above, in-depth literature surveys were carried out during the initial stage of the research to collect data. Online databases, JSTOR, EBSCO, and Google Scholar was used, to search for peer-reviewed articles, reports, and white papers on Disaster Management in Sri Lanka.

Combinations of the following keywords was employed: Sri Lanka, early warning systems, hazards, disaster risk management, disaster resilience, coastal resilience, and climate change. In instances where searches including ‘hazards’ as keywords yielded limited results, we further specified the types of coastal hazards that are relevant to the country. In addition, regional, national, and subnational plans, sectoral reports, guidelines, policies acts and laws were downloaded from government websites. These preliminary materials were further screened for relevance by comparing their abstracts and executive summaries with the objectives. Then close examination was given and synthesized the shortlisted materials related to this research. The shortlisted materials was also used as starting points for snowball sampling to find other relevant literature.

To achieve the objective 1 and 2, the found literature provided sufficient evidence and the methodology to reach the 3<sup>rd</sup>Objective is explained in detail in Chapter 5. As a summary the methodology adopted is listed below.

1. Determining important aspects of Disaster Risk Reduction and Disaster Management
2. Reviewing existing disaster management frameworks in Sri Lanka
3. Ascertaining the alignment of national frameworks with international frameworks and identifying gaps
4. Finding merits and demerits in implementing DRR and DM under existing frameworks
5. Conducting interviews and field studies to identify the existing knowledge within different community groups and successful mitigation measures adapted for improving coastal resilience
6. Providing suitable recommendations

#### **1.4 Organization of the thesis**

This study strictly follows the said objectives and methodology. It is also observed that no dedicated chapter on literature review in this thesis. However each chapter incorporates the relevant reviewed literature to the subject under discussion.

Chapter two identifies the terminology, which is commonly used in DRR activities. Furthermore, it gives brief descriptions about how the hazards, vulnerability and risks



can be assessed. Chapter three gives a detailed description about the existing Disaster Management Frameworks and relevant functions are described and discussed. Chapter four refers to the global standards & frameworks & identifies the need to align the local frameworks with global standards.

Chapter five refers to a case study on improving coastal community resilience. The approach adopted is a questionnaire survey with multiple stakeholders who have contributed in formulating policies and implementation of coastal community resilience programmes. In addition, the resilience frameworks adopted in Sri Lanka are analysed and identified the important components in measuring resilience. Chapter six provides detailed recommendations for the improvement of existing frameworks and related issues.

It is observed that the relevant chapters described the works as identified in the objectives of the study strictly follows the objectives and methodology and the two case studies, which reflect the multiple aspects of coastal community resilience, were designed to cover item five of the methodology in sufficient details with the help of multiple stakeholders. A mind map of the entire research is shown in Figure 1.

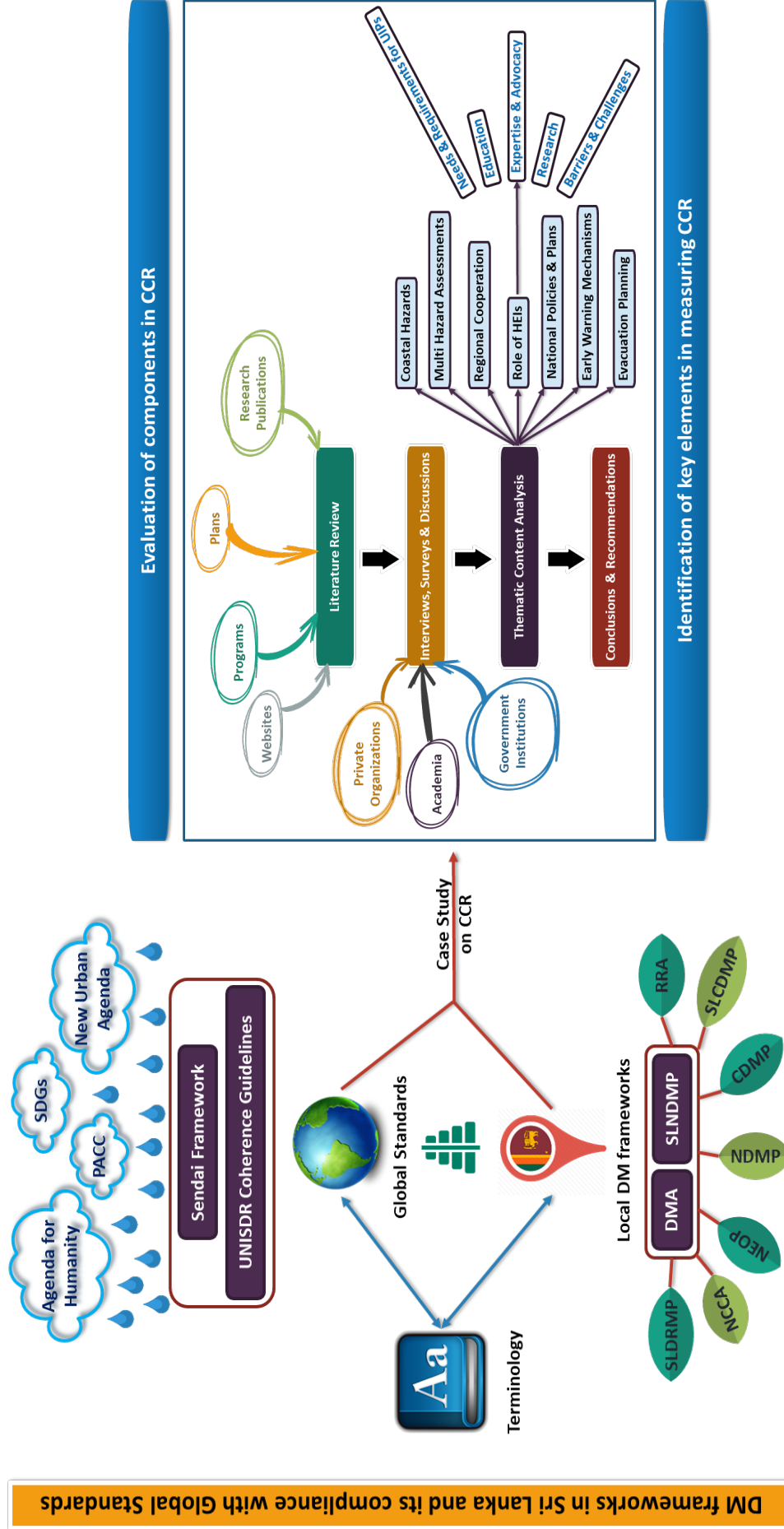


Figure 1: Introductory mind map for the research

## **2 IMPORTANT ASPECTS OF DISASTER MANAGEMENT**

### **2.1 Terminology**

#### **2.1.1 Hazard**

Hazard can be a dangerous phenomenon, substance, human activity or a condition that may cause light or severe impacts to people, infrastructure and natural environment [1]. It also signifies the potential for a major incident [2]. They represent the occurring possibility of a natural/human induced event of a considerable magnitude that includes a relevant area of exposure. The communities must know the types of hazards and characteristics. They should be educated on the importance of resilience to potential disasters particularly when faced with the rapid onset extreme events. When looking at the history of Sri Lanka it is visible that floods and landslides occur frequently. Hence, geological hazards and hydro meteorological hazards should be given priority when preparing hazard maps for Sri Lanka.

#### **2.1.2 Vulnerability**

The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard is defined as the vulnerability [1]. It also refers to the community's high exposure and socio cultural factors [2]. Physical, social, economic, and environmental factors affect the vulnerability of a community as it varies with the community and time.

Physical vulnerability refers to sensitivity of the built environment. Social factors of vulnerability include levels of education, health facilities, peace and security, access to basic human rights, systems of good governance, social equity, traditional values, customs and ideological beliefs and overall collective organisational systems [3],[4]. Economic vulnerability highlights people less privileged in class or caste, ethnic conditions, the very young and old, the disadvantaged, and women who are primarily responsible for providing essential shelter and basic needs. Environmental vulnerability refers to the degradation of natural resources [5]. However the word is used broadly to include the element's exposure. With respect to the Sri Lankan context poor design and construction of buildings in rural areas, lack of public information

and awareness and disregard for wise environmental management are some of the factor which make the local communities more vulnerable to hazards.

Vulnerability is multi-dimensional, differential, time dependent and dynamic. It's partially determined by the type of hazard as well [3].

### **2.1.3 Capacity & Preparedness**

Preparedness refers to the state of being prepared with the knowledge and capacities developed by governments, professionals and recovery organizations, communities and individuals to face the impacts of likely, imminent or current hazard events or conditions [1]. Capacities mainly focus on group measures in place to assist the community to cope with the event.

It is necessary to build the capacities to manage all types of emergencies effectively from response to recovery process. This includes early warning mechanisms, emergency planning, hoarding of equipment and supplies, coordination strategies, evacuation management, public information, and associated training and field exercises. Communities should have a sound knowledge of the hazards, their exposure, vulnerabilities and the importance of capacity building and preparedness which eventually leads to hazard resilient communities[5].

### **2.1.4 Disaster**

A serious disruption of the functioning of a community involving widespread losses in and impacts to human life, infrastructure and environment which exceeds the ability of the affected community or society to cope using its own resources is defined as a disaster [1]. The actual historic event is referred as a disaster [2].

The nature of disasters vary and several classifications of disasters are observed in literature. Disasters have distinct phases of onset, climax and withdrawal. As a result, disasters are classified into three groups referring to the spatial dimensions of disasters as small, localised or large and regional disasters [5].

### **2.1.5 Risk**

A Risk can be defined as a combination of the probability of an event and its negative consequences. When considering the disaster risk it mainly focuses on the losses of

lives, health status, assets and services, which occur for a specific period of time due to a disaster [1].

### 2.1.6 Resilience

Resilience denotes the ability to “resile from” or “spring back from” a shock [1]. It also shows the ability of a system to adjust [6] and sustain a certain dynamic regime [7]. The necessary resources and the communities’ capability of organizing itself during several phases of a disaster show the potential of the community with respect to resilience [8]. Figure 2 shows the community response during a hazard event which depicts their status of resilience [9].

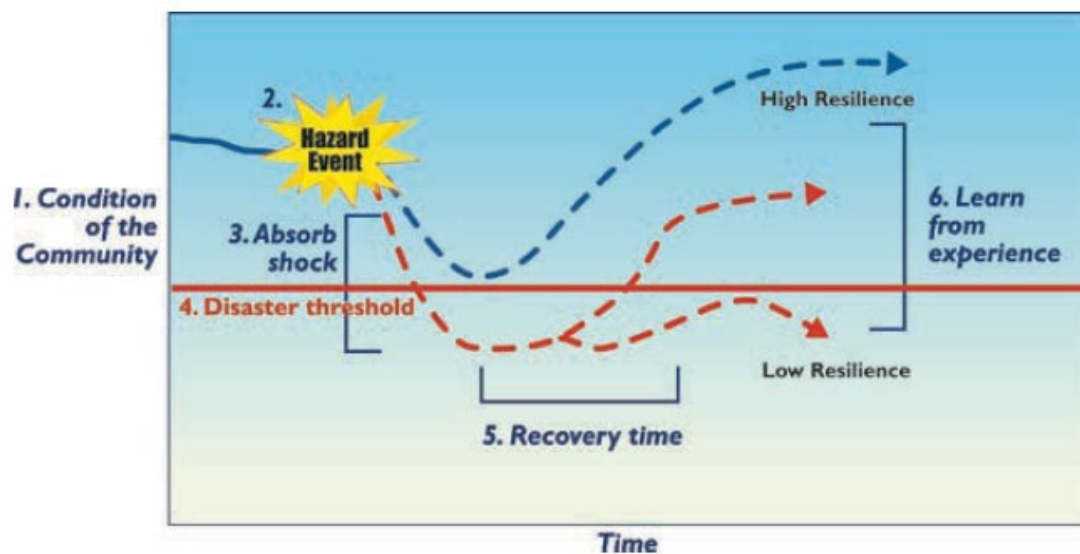


Figure 2: Role of resilience in determining community response to a hazard event  
(Source: How Resilient is your coastal community? A Guide for evaluating coastal community resilience to tsunamis and other hazards)

### 2.1.7 Disaster Risk Reduction

The concept and practice of reducing disaster risks through systematic efforts by lessening vulnerability and improving preparedness. Reduced exposure to hazards, wise management of the land and environment and strong preparedness for adverse events will help to manage the casual factors of disasters. This provides a better understanding of the ongoing nature of disaster risks and the potential to reduce these risks [1].

### 2.1.8 Disaster Risk Management

Disaster Risk Management refers to a defined process of using administrative directives, organizations, and operational skills and capacities to execute strategies and policies in order to lessen the impacts of hazards and the possibility of occurring a disaster [1]. This aims to avoid, lessen or transfer the said adverse effects of hazards through measures for mitigation and preparedness.

### 2.2 Disaster Management cycle

Three main stages of the DM cycle are the pre disaster, response stage and the post disaster stage. DRR and DRM comes under pre disaster while rescue and relief operations fall into response stage. Rehabilitation and future risk mitigation methods come under the post disaster stage. Figure 3 shows the individual elements within each stage which gives an overall image of the cycle [10].



Figure 3 Disaster Management Cycle  
(Source: DM in General [10])

### 2.3 Hazard Assessment

Prioritizing hazards are necessary in the DRR process. Community involvement is necessary for this process where consultative and participative processes are

necessary. The commitment of those required to take action and those who may be affected by hazards is necessary. As the initial step we should involve the relevant people. Only some people are protected from different hazard mitigation, response strategies, and others may not address the needs of the most vulnerable. The whole community should make the decisions as to who and what should be protected, and to what extent.

The second step is to identify a proper criteria which should include factors such as the probability of an emergency, the level of vulnerability of people or property or both, the degree of manageability, and whether the hazard may worsen and how quickly. There are several methods that use this criteria, including the FEMA (the United States Federal Emergency Management Agency) model and the SMUG (“seriousness”, “manageability”, “urgency”, and “growth” - developed by the Tasmania State Emergency Service) hazard priority system, which are described below. [11]

### **2.3.1 The FEMA Model**

The FEMA model uses four criteria in an evaluation and scoring system.

#### **1. History**

Past occurrence of a certain type of emergency, it can be identified that there were sufficient hazardous conditions and vulnerability to cause the event. Unless these conditions no longer exist, or reduced considerably, a similar emergency may occur again.

#### **2. Vulnerability**

This determines the number of people and the value of property that may be vulnerable, based on factors such as vulnerable groups (aged, disabled, and children), population densities, location of population groups, property and vital facilities.

#### **3. Maximum threat**

Most serious event possible with the greatest impact is assumed here, which is expressed in terms of human casualties and property loss.

#### 4. Probability

Probability is the likelihood of an event occurring, expressed in terms of chances per year that an event of a specific intensity (or greater) will occur. Even though there is some link between probability and history, some hazards are without historical precedent. To get a complete score for each hazard points and weights are given for the evaluation criteria (Figure 4).

<i>Criteria</i>		<i>Evaluation</i>
History: whether an emergency event has occurred:	<2 times in 100 years	Low
	2–3 times in 100 years	Medium
	>3 times in 100 years	High
Vulnerability: of people	1%	Low
	1–10%	Medium
	>10%	High
of property	1%	Low
	1–10%	Medium
	>10%	High
Maximum threat: area of the community affected	5%	Low
	5–25%	Medium
	>25%	High
Probability: chances per year of an emergency	<1 in 1 000	Low
	1 in 1 000–1 in 10	Medium
	>1 in 10	High

Figure 4: Evaluation criteria in FEMA Model  
(Source: Emergency Preparedness : a Manual for Policy-Makers [11])

- Low – 1 point
- Medium – 5 points
- High – 10 points
- History – 2 (Weight)
- Vulnerability – 5 (Weight)
- Maximum threat – 10 (Weight)
- Probability – 7 (Weight)

#### 2.3.2 SMUG hazard priority system

This allows a direct comparison of a number of possible hazards, through ratings of high, medium, or low, against four separate criteria common to all hazards.



**1. Seriousness** - The relative impact of a hazard, in terms of financial cost or number of people affected or both. They are rated as “high”, “medium”, or “low”, in terms of seriousness. If the group cannot agree, the highest rating should be given.

**2. Manageability** - If the impact of the hazard can be lessened, the rating for manageability would be “high”. If it were manageable only after it had occurred, the rating would be “low”.

**3. Urgency** - “High” means that something should be done now, “medium” means something should be done in the near future, and “low” means there is no urgency and action can be deferred.

**4. Growth** - If nothing is done about the hazard, will it grow worse or remain as it is? If the hazard would increase quickly, it is rated “high”, if it would grow gradually, “medium”, and if it would stay static, “low”.

The FEMA provide more satisfying results than the SMUG system because it gives a numerical output, if there are sound numerical data on the hazards in question. The SMUG system, on the other hand, allows close comparison of each hazard with others, which allows a close comparison.

#### **2.4 Vulnerability Assessment**

Detailed assessment of vulnerability is a complex area in view of the widely varying parameters, which have to be analysed, and in view of the difficulties in defining and quantifying certain parameters.

According to Pressure and Release (PAR) model the progression of vulnerability is influenced by three dimensions namely root causes, dynamic pressure and unsafe conditions combined with hazard cause disaster. Root causes comprise with economic, demographic and political processes which determine the access to and distribution of power and various resources. All processes and activities that transform and channel the efforts of root causes into unsafe conditions such as epidemic diseases, rapid urbanization and violent conflicts are included in dynamic pressure. Unsafe conditions are the specific forms which human vulnerability is expressed in a temporal and spatial dimension

### 2.4.1 Single dimension of susceptibility approach to vulnerability

A simplified approach for vulnerability assessment would focus on critical parameters of interest, which characterizes vulnerability by addressing the susceptibility dimension covering the broader components as mentioned below.

- 1. Physical** - This targets the susceptibility of the infrastructure to be damaged by an event such as an earthquake, a landslide, etc.
- 2. Human** - Targets the differential vulnerability of different groups such as children, the elderly and women.
- 3. Economic** - The susceptibility of income of communities or of the resources allocated to each sector to carry out its tasks is an example.
- 4. Environmental** - This is related to the environmental systems and services, which affect development.
- 5. Functional** - Targets the processes, tasks and operations that need to be conducted.
- 6. Administrative** - Targets the managerial processes required to conduct those processes, which are required for development

### 2.4.2 Sector approach to vulnerability

The sector approach extends vulnerability in three dimensions, namely dimensions of susceptibility, sectors and scale of consideration. Figure 5 illustrates the concept graphically.

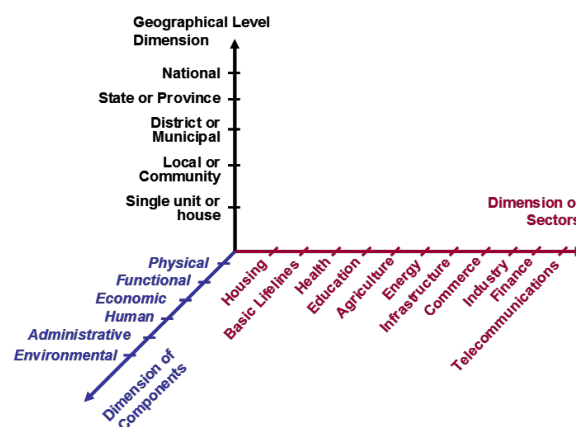


Figure 5: Sector approach to vulnerability

(Source: Important aspects of Vulnerability and Preparedness for Risk Management in coastal cities Case Study-Port City of Galle 2016)

The framework proposes the differentiation within each sector in terms of six areas related to susceptibility, namely human, physical, socio-economic, environment functional and administrative. These areas can be linked to the factors identified by UN-ISDR as increasing the susceptibility of communities to the impact of a hazard. Third dimension targets the scale of consideration from a household to national level. The advantage of this approach, in particular from a policy point of view, is that it promotes the effective assignation of responsibilities relating to the reduction of vulnerabilities.

The application of this method requires vast amount of data and consumes time.

## **2.5 Risk Assessment**

Risk is primarily a function of hazard and vulnerability. There are several expressions for risk, which involves the effect of hazard and vulnerability [5].

$$\mathbf{Risk = Hazard \times Vulnerability} \quad (\text{eq.1})$$

In this form, risk is quantified with hazard being associated with the probability of occurrence and vulnerability with potential damage.

$$\mathbf{Risk = (Hazard \times Vulnerability) / Capacity} \quad (\text{eq.2})$$

In this equation, inclusion of capacity highlights that the strengthening of coping capacities usually builds resilience to withstand the impacts of hazards both natural and human-induced.

$$\mathbf{Risk = Hazard \times Vulnerability \times Deficiencies in Preparedness} \quad (\text{eq.3})$$

By including the factor deficiencies in preparedness, the importance of preparedness was identified. If there is no any efficient preparedness, it will lead the loss of human lives and property in the specific interval of time during which the event is taking place. This is also known as the inverse of capacity.

The risk calculated by Equation 3 equals zero if one of the three dimensions above is zero. Furthermore, there is no risk if there is no likelihood of a flood to occur or/and the hazard zone is not populated or/and if the population is not vulnerable. Hence risk

should be more sensitive to the Vulnerability and the Deficiencies of Preparedness dimensions.

$$\text{Risk} = \text{Hazard}^{1/3} \times \text{Vulnerability}^{1/3} \times \text{Deficiencies in Preparedness}^{1/3} \quad (\text{eq.4})$$

This approach allows slight variations in the Vulnerability and the Lack of Coping Capacity indexes amongst countries with similar exposure [12].

There is no standard technique for assessment of risk and researchers including quantitative and qualitative methods have used a number of methods. Quantification based on ranking methods and detailed analysis of respective parameters has been successfully adopted in the past few years. Currently in order to interpret and describe hazard, vulnerability and risk experts are using maps.

Hazard maps shows the type of hazard, spatial scope of processes, highlighting areas possibly affected by an extreme event. The maps provide an overview of the hazardous situation and enables respective planning measures to be adopted efficiently. Regular upgrading of the maps help to monitor the hazard profile in specific regions.

Vulnerability maps highlight various aspects of vulnerability including geographical location of places with vulnerable groups such as children, elderly and women, buildings and other infrastructure, the location of processes equally susceptible to damage and access to public services. These maps serve as a tool to identify measures and implement them to reduce the vulnerability of communities and to improve early warning efforts.

The superposition of the hazard and vulnerability maps lead to risk maps where the outcome will depend on the assumptions made in establishing criteria for the superposition of hazard and vulnerability levels leading to risk levels.

Consider hazard and vulnerability maps, each comprising four levels of classification, namely, high, medium, low and very low (zero) which have been prepared for the purpose of risk assessment. Establishing the criteria for risk levels is important for superposition. An example is presented in the Figure 6 , which illustrates the Risk

Matrix adopted for superposition of hazard and vulnerability for the risk assessment [5].

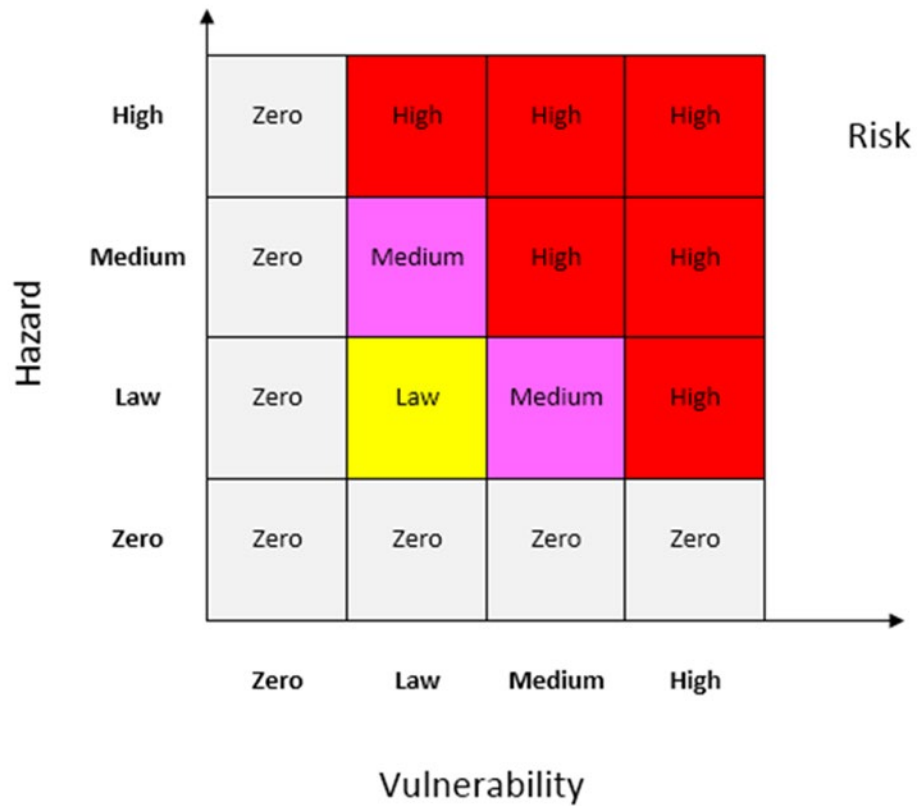


Figure 6: Risk matrix

(Source: Important aspects of Vulnerability and Preparedness for Risk Management in coastal cities Case Study-Port City of Galle 2016)

### 3 EXISTING DISASTER RISK REDUCTION & DISASTER MANAGEMENT FRAMEWORKS IN SRI LANKA

#### 3.1 Background

The institutions and legislations related to DM and DRR have undergone several changes since 1977. A dedicated body to manage disasters was first recognized through the establishment of a National Disaster Management Centre (NDMC) under the Ministry of Health, Highways and Social Services during 1996. Then until the establishment of the Disaster Management Act in 2005 National Council for Disaster Management led the preparedness activities while the Department of Social services led the relief assistance [13]. Figure 7 shows how the DM authorities evolved from 1977 to 2005.

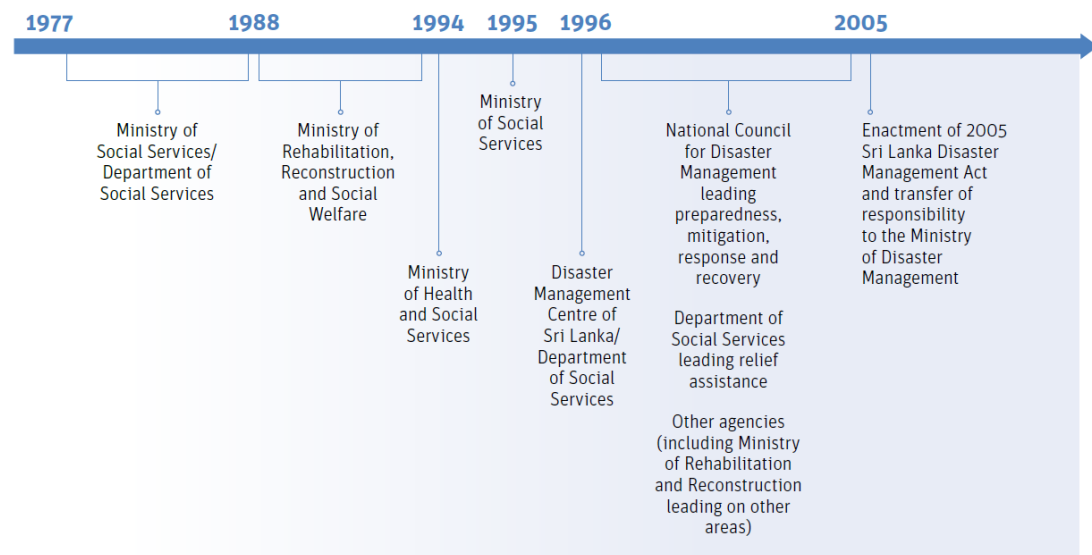


Figure 7: DM authorities in Sri Lanka (1977-2005)

(Source: Fiscal Disaster Risk Assessment and Risk Financing Options Sri Lanka 2016)

The widespread destruction caused by the 2004 Tsunami prompted the government's commitment to devising a DRM framework that was multi-sectoral, inter-institutional and multi-disciplinary. Then in May 2005, the Sri Lanka Disaster Management Act (DMA), No. 13 of 2005 was enacted. The Act provides a framework for DRM in the country. Subsequently National Council for Disaster Management (NCDM) and Disaster Management Centre were established as per the act [14]. In order to strengthen the said institutions Ministry of Disaster Management and Human Rights was established in 2006 which was renamed in to Ministry of Disaster Management

(MDM) later on 2010 [15]. National Disaster Management Centre which was established in 1996, became the umbrella agency of the Ministry of Resettlement and Disaster Relief Services in January 2007. In April 2010, the Centre was renamed as National Disaster Relief Services Centre (NDRSC) and came under MDM [16].

At present National Disaster Relief Services Centre, Department of Meteorology, National Building Research Organization and Disaster Management Centre are under the purview of MDM to implement the assigned tasks during the tri phases of a disaster in an effective manner [15].

## **3.2 National Legal frameworks, policies and plans**

### **3.2.1 Disaster Management Act**

The Disaster Management Act No. 13 of 2005, providing for the institutional structure to be adopted to facilitate disaster management activities, governs the DM structure. The DMA classifies disasters in Sri Lanka as being geological, hydro-meteoroidal, technological, biological, or man-made. It also provides the legal framework to establish the NCDM and DMC. According to section 3 of DMA NCDM should include the President (Chairman), the Prime Minister (Vice-Chairman), the Leader of the Opposition, and Ministers in charge of areas such as social welfare, rehabilitation and reconstruction, the environment, and home affairs [14]. The DMA assigns the NCDM three broad functions,

- Policy formulation and planning on the management of disasters (Preparation of the National Disaster Management Plan)
- Monitoring and oversight (Monitoring the implementation of the National Disaster Management Plan, and the activities of the Disaster Management Center)
- Ensuring disaster preparedness and information sharing (Conducting public awareness campaigns, and running programs to promote community self-reliance in the event of a disaster)

Section 8 of the Act states that DMC should assist NDMC in the implementation of the above functions. The DMC must also ensure that the Ministerial (or Departmental) Disaster Management Plans conform to the National Disaster Management Plan.

Furthermore, DMC is mandated to promote research and development programmes on DRM.

In addition, the DMA authorises the President to declare a ‘State of Disaster’ in the event of an existing or an impending disaster which cannot be counteracted with resources normally available to the administration. This can be declared in respect of a particular area or areas by way of a Proclamation issued by the President. Section 11(2) of the DMA states that a ‘State of Disaster’ can remain in force for a period of two months, with an option to extend the Proclamation for further periods not exceeding two months at a time.

### **3.2.2 Reconstruction and Rehabilitation Fund Act, No. 48 of 1993**

Under section 4(o) of the DMA, the NCDM is permitted to recommend the allocation of funds for disaster management from the relevant authorities. The NCDM is also permitted to recommend the allocation of funds from the Reconstruction and Rehabilitation Fund. This Fund was established under the Reconstruction and Rehabilitation Fund Act, No. 48 of 1993, and can be used to provide relief to persons affected by any disaster, reconstruct property affected by any disaster, and provide for the rehabilitation of persons or property affected by any disaster [17].

### **3.2.3 Ministry of Finance and Planning – Budget Circulars No. 152 (I) (II) and (III)**

These were issued on 2013 and 2014 in order to eliminate duplication of functions in responding to disasters. Provision of disaster relief and short term, small-scale rehabilitation work were assigned to MDM and the reconstruction of utilities and other services were assigned to other respective ministries [18].

In the event of a disaster, funds for the provision of emergency relief will be disbursed by the treasury to MDM. Such relief will then be distributed to the relevant District Secretariats (DS) based on their requests. The procedures to be followed in receiving and distributing relief and the relevant documents to be submitted will be notified by the Ministry [18]. The emergency relief will vary based on the nature and extent of the natural disaster involved. The maximum amount of relief to be granted under each situation is listed in the circulars [19],[20].



Grants for the restoration of the short term small scale rehabilitation efforts will be provided by the Ministry. Based on the damage estimates of the relevant districts, additional funds will be released by the treasury. These funds must be made available to the district secretaries based on their requests. The amounts for the activities such as restoration of self-employment activities, cultivation relief, restoration of homes and reconstruction of small roads, tanks, culverts etc, on a small scale are mentioned in the circulars [18].

In restoring self-employment activities, based on the relevant occupation, related ministries such as agriculture, fisheries etc. should be involved, along with the Provincial Councils. Grants for such activities must be released to the District Secretaries and identifying beneficiaries should be based on the DS' advice [18].

When cultivations are affected by extensive disasters, the district secretary shall look at factors such as the nature of the crops, the expected revenue from the harvest and the size of the land, and the recommended beneficiaries are to be paid. The Ministry is to release funds to the DS for this purpose. Relief for housing will be released to the Ministry. The DS is to get work with the Ministry of Housing Development and its programs in this regard. Based on the ownership and nature of the house concerned, and on the recommendation of the DS, payments shall be made within the proposed upper limit [18].

Remedying large scale damage to infrastructure in each district is the responsibility of the relevant line ministries. This will be done based on the damage assessments of each district. Where possible, it will be done with existing funds, failing which additional funds may be obtained from the treasury. This is the responsibility of the relevant ministries. In the event of a disaster not covered by this circular, the treasury will issue instructions based on the nature of the event [18].

#### **3.2.4 National Disaster Management Policy**

The SLNDMP's vision is to make "a Sri Lanka safe from disaster" and the objective statement is "to protect Sri Lanka's people, property and environment from disaster". SLNDMP which was initiated in 2010 is intended to compliment the other elements including National Disaster Management Plan (NDMP), National Emergency

Operations Plan (NEOP) and other plans and guidelines related to DM. The SLNDMP is prepared according to the Hyogo Framework for action 2005: 2015 which is the predecessor of the current global standard; the Sendai framework [21]. Policy is structured in to two sections namely cross cutting principles and policy statements as mentioned in Figure 8 [22].

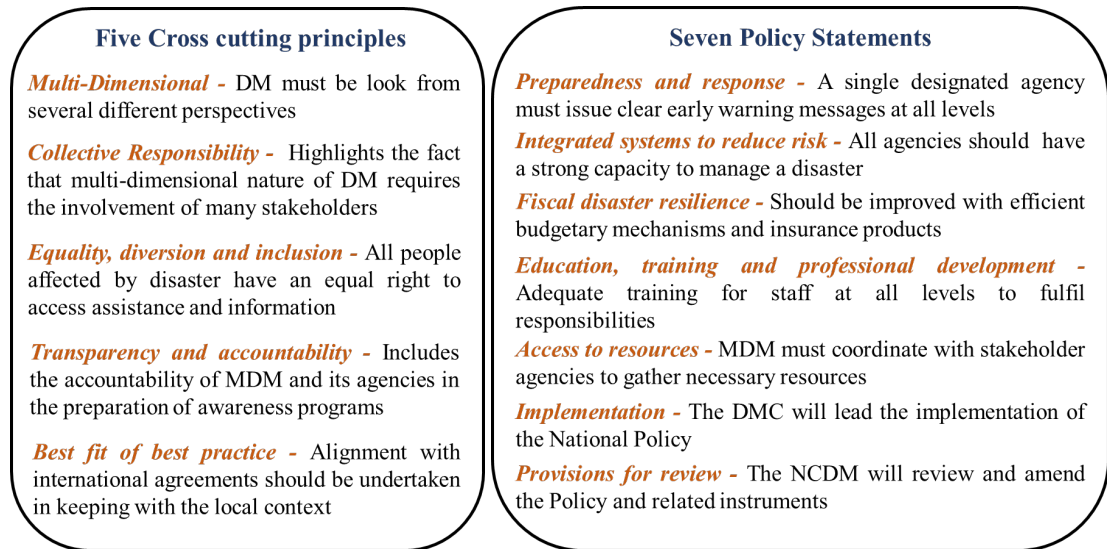


Figure 8: Cross cutting Principles and Policy Statements in NDMP

### 3.2.5 National Disaster Management Plan

The NDMP is prepared for the years 2013 – 2017 which incorporates all aspects such as: institutionally mandated and institutional development, hazard, vulnerability and risk assessment, multi-hazard early warning systems, disaster preparedness and response planning, disaster mitigation, and integration into development planning [23]. NDMP provides guidance to the formulation of the disaster management plans in each administrative level and each sector and the establishment of various committees [16].

### 3.2.6 National Emergency Operations Plan

NEOP which came out in 2015 provides the guidelines for emergency preparedness in Sri Lanka. The NEOP is under MDM review prior to submission to Cabinet for approval. NEOP identifies the role of agencies in-charge and the coordination mechanism of emergency response before, during and post disaster phases. It also gives Standard Operating Procedures (SOPs) of all the government organizations who are responsible to act accordingly during an emergency situation [24].

NDMP and NEOP combined together directs each administrative level and sector to prepare disaster management plans as shown in Figure 9 [23].

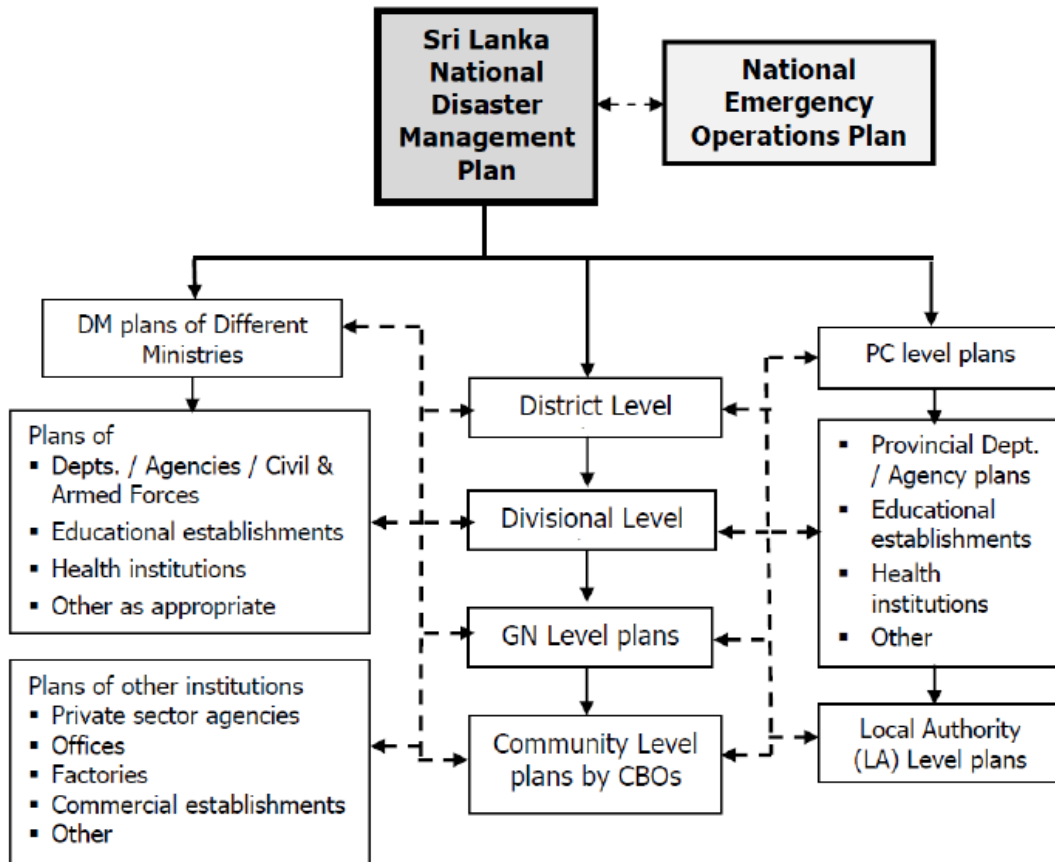


Figure 9: Disaster management plan in each administrative level and sector  
(Source: National Disaster Management Plan 2013 - 2017)

### 3.2.7 Sri Lanka Comprehensive Disaster Management Programme

CDMP (2014 - 2018) is the action plan of the above mentioned NDMP dealing with the issues and solutions in implementing NDMP, the agencies in charge, the budget required, the period of implementation and the evaluation indicator. CDMP will be revised in line with the revision of NDMP. Some of the main objectives are to set up legal and institutional systems, prepare vulnerable communities for disasters, and enhance efforts to minimize disaster risks [25].

### 3.2.8 National Adaptation Plan for Climate Change Impacts in Sri Lanka

NAPCCI is prepared for the years 2018 – 2025 in line with the set of guidelines set forth by the United Nations Framework Convention on Climate Change (UNFCCC), which covers adaptation needs at two levels, namely; adaptation needs of key

vulnerable sectors and cross-cutting national needs of adaptation. Nine vulnerable sectors were identified during the advisory process (food security, water etc). Extensive stakeholder consultation adopted when preparing the NAPCCI helped to identify the adaptation needs of each vulnerable sector based on logical criteria [26].

### 3.2.9 Sri Lanka Disaster Risk Management Plan

DRMP is prepared in accordance with the Sendai Framework for the years 2018 – 2030 with four main goals which are prepared for the communities to understand the disaster risk, to establish a proper governing mechanism, invest in disaster resilience and enhance capacity and preparedness [27].

### 3.3 National Institutions and Organizations

Existing coordinating mechanisms of relevant agencies is described in this section. Figure 10 shows the current organizational chain of command in Sri Lanka.



Figure 10: Organizational Structure of main National Institutes related to DM

(Source: Data collection survey on disaster risk reduction [16])

#### 3.3.1 National Council for Disaster Management

NCDM remains the supreme body governing disaster management, and the DMC is the central coordinating body for disaster management as per the DMA. The two main implementing bodies of the NCDM are MDM and DMC [25]. DMA stipulates the holding of NCDM quarterly meetings. However, no NCDM meeting has been held since May 11, 2012. It shows that the meaning of existence of NCDM is becoming

unclear and different from what was originally envisioned [16]. Figure 11 shows the structure of current NCDM.

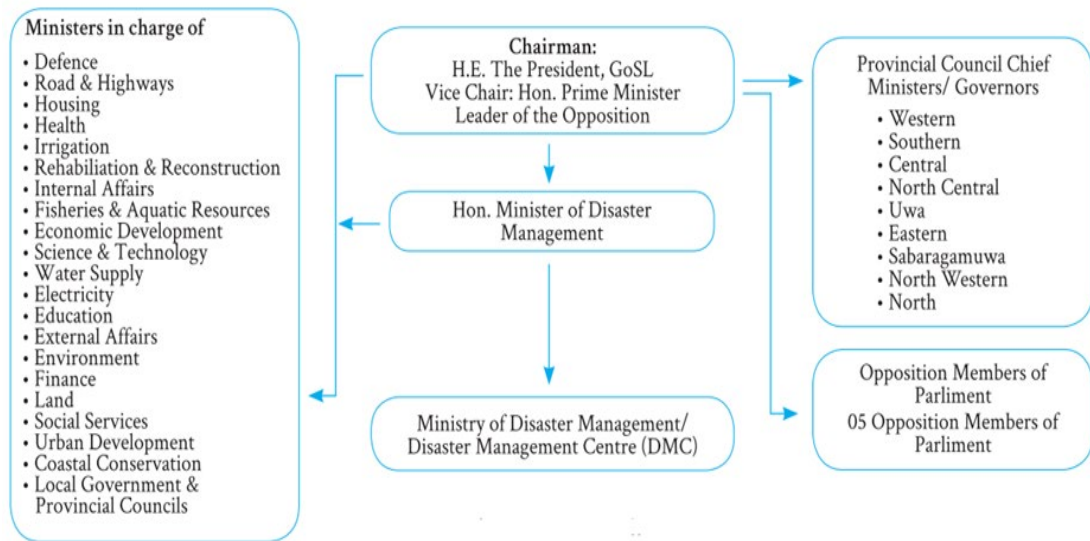


Figure 11: Structure of NCDM (Source: CDMP)

Responsibilities of NCDM can be broken down into four main areas as mentioned below [14].

- Policy Formulation and Planning - Formulating a national policy and programs for DM activities, NDMP and the NEOP and denote guidelines to be followed by every Ministry, Government Department and public corporation when preparing Disaster Management plans.
- Oversight - Monitor implementation of the NDMP and NEOP and to direct, coordinate and monitor implementation of the DMC.
- Active operational functions - Facilitating emergency response, recovery, relief and rehabilitation in the event of a disaster, implementing action programs on hazard, vulnerability and risk reduction, assigning functions and responsibilities to the DMC, declaring a state of disaster by way of a Proclamation.
- Public Awareness and Education - Promoting public awareness campaigns relating to disaster management and initiating programs related to prevention and mitigation of disaster.

### 3.3.2 Ministry of Disaster Management

The principal objective of the MDM is the protection of the community from Disasters. Four institutions function under the Ministry for the implementation of government policies to achieve these objectives:

- Disaster Management Centre (DMC)
- National Disaster Relief Services Centre (NDRSC)
- Department of Meteorology (DoM)
- National Building Research Organization (NBRO)

The MDM, both in its day-to-day operations and during emergencies, has to coordinate within its own Ministry, with line institutions in other ministries, and with the armed forces [16]. During emergencies, the MDM is a centre of public attention, which performs a coordinating role in assisting other agencies, government, non-government, and private to contribute to response, relief, and rehabilitation. Figure 12 shows the organizational structure within the main office of MDM.

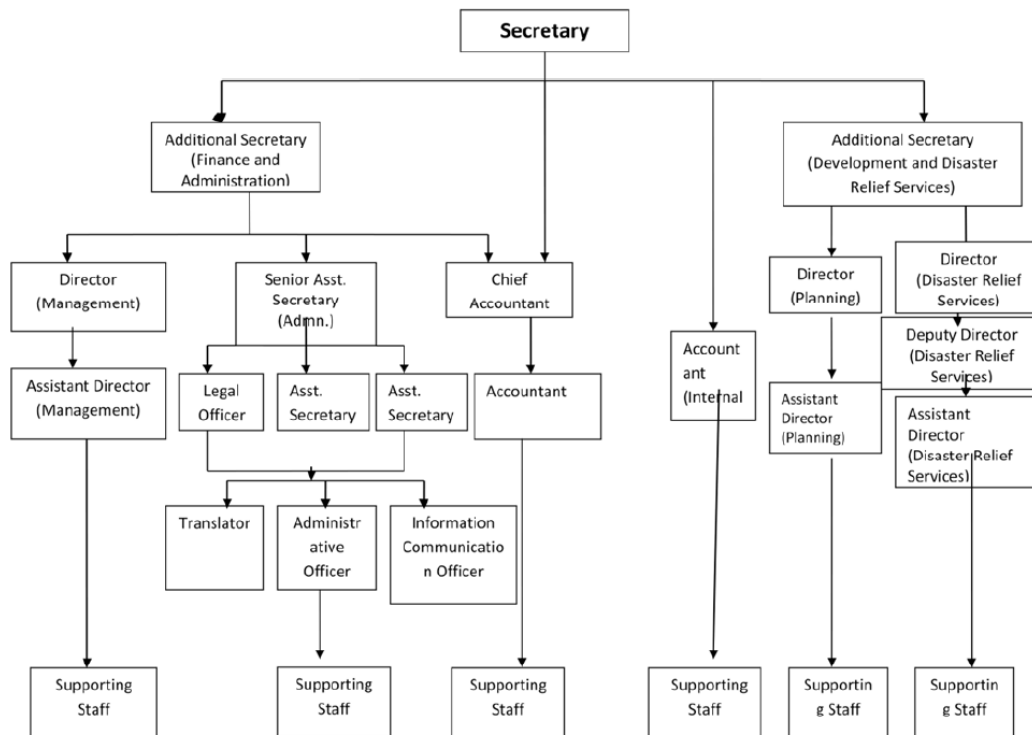


Figure 12: Organizational structure within the main office of MDM  
(Source: Data collection survey on disaster risk reduction [16])

### 3.3.3 Disaster Management Centre

DMC is composed of several divisions namely; Preparedness & Planning Division to promote the Disaster Management Plan in each level, Mitigation, Research & Development Division to conduct the projects and research related to DRR, Public Awareness Division to conduct awareness campaigns and Emergency Operation Centre (EOC) is in charge of emergency response and early warning [16]. The MDM Annual Report 2012 [28] accords some of the following functions to the DMC namely

- Formulation NDMP and NEOP based on SLNDMP
- Hazard mapping and risk assessment
- Coordinating and conducting training and awareness programs
- Preparedness to respond to disasters including assisting government agencies
- Develop Preparedness Plans
- Early warning and dissemination
- Emergency operations management and coordination of search & rescue operations
- Coordination of post disaster activities including relief
- Mainstreaming DRR into development

The organizational structure of DMC is shown in Figure 13.

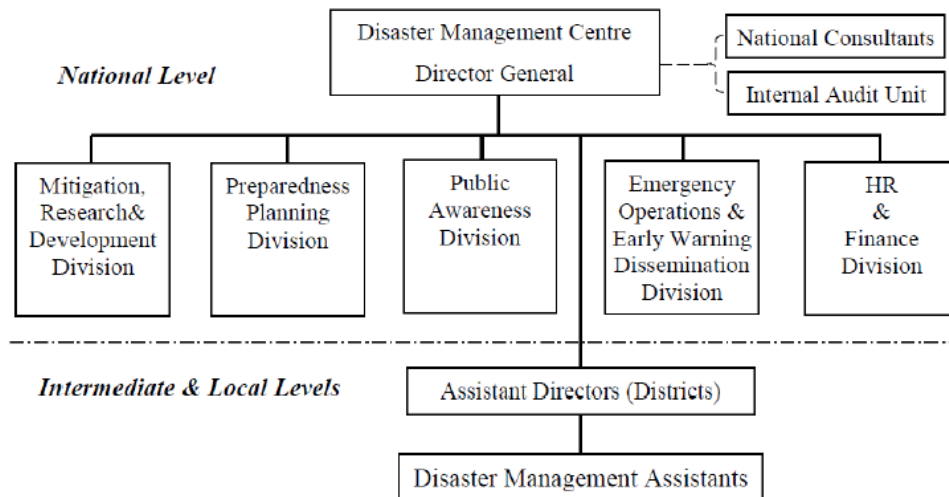


Figure 13: Organizational Structure of DMC  
(Source: Annual Performance Report 2014 by DMC)

### **3.3.4 National Disaster Relief Services Centre**

NDRSC is responsible for the support of disaster affected people. It has dispatched Disaster Relief Coordination Officers to all the District Secretariats and Disaster Relief Officers to all the DS Divisional Secretariats. NDRSC has the ability to access the field disaster information immediately during a disaster with the information collection and recording system established [16].

The MDM Parliamentary Performance Report 2015 [29] attributes the following disaster management activities to the NDRSC.

- Providing expeditious relief to the appropriate beneficiary through an efficient disaster relief service.
- Renovating houses affected by disasters and building resilient houses that can stand disasters.
- Developing infrastructure for damages to cultivation, losses in self-employment and rural small-scale industries. Mobilizing Disaster Relief Service Officers on post disaster management processes
- Empowering the communication process by providing information online in a short period and strengthening the communication network.
- Establishing good governance through the supervision, monitoring and evaluation of the provision of relief services.
- Implementing community awareness programs to face post-disaster situations and minimize damage.

### **3.3.5 Department of Meteorology**

DoM is responsible for meteorological observation which became an affiliated semi-governmental agency MDM in February 2006. DoM issues the early warnings on heavy rainfall and cyclone and is in charge of issuing the tsunami warning based on international meteorological information [16]. Forecasting and Decision Support unit operates their 24/7 operation room while Katunayaka airport office functions as the backup of Colombo main office in case of the breakdown of Colombo office [16]. DoM also has 37 automatic Weather systems which are deployed at regional



Meteorological Stations and collaborative stations [30]. DoM offers weather forecasts which includes expected rainfall, temperature and relative humidity.

### 3.3.6 National Building Research Organization

NBRO is the responsible agency for landslide countermeasures. Automatic rain gauges and alarm systems installed by NBRO in landslide prone areas help vulnerable communities living to evacuate in the event if the centrally issued early warnings fails [25]. Landslide related forecasting based on rainfall, geological factors and other data are also used when issuing early warnings. NBRO also implements the early warning, hazard mapping and structural and non-structural measures on landslides. NBRO has 9 district offices with 346 staff [16].

### 3.3.7 Other line agencies

There are several technical agencies which are mandated to provide early warnings for various hazards which are mention in the Figure 14.

Disaster		Responsible Technical Agencies
(a)	Landslide	National Building Research Organization (NBRO)
(b)	Cyclone	Department of Meteorology
(c)	Flood	Department of Irrigation (DOI) / Mahaweli Authority/Agrarian Services Dept./CEB/ NWSDB
(d)	Drought	DOI, Dept. of Meteorology, Dept. of Agriculture, Mahaweli Authority
(e)	Industrial hazard	Central Environmental Authority (CEA), NACWC
(f)	Tsunami (seismic wave)	Dept. of Meteorology
(g)	Earthquake	Geological Survey & Mines Bureau (GSMB)
(h)	Air hazard Aircraft Accidents	Met. Dept., CEA Airport and Aviation Authority
(i)	Maritime hazard	Marine Environment Protection Authority (MEPA)
(j)	Fire	Local Authority (Fire Brigade), Police
(k)	Epidemic	Ministry of Health
(l)	Explosion	Ministry of Defense, Police
(m)	Air raids	Sri Lanka Air-Force
(n)	Civil or internal strife	Ministry of Defense, Police
(o)	Chemical accident (Land and Sea)	Ministry of Industries, CEA, BoI, NACWC, Ministry of Defence
(p)	Radiological emergency	Atomic Energy Authority
(q)	Oil spills including inland & marine oil spills	MEPA , Ministry of Defence
(r)	Nuclear disaster	Atomic Energy Authority
(s)	Forest fire	Forest Department
(t)	Coastal erosion	Coast Conservation & Coastal Resource Management Department (CC&CRMD)
(u)	Tornado, lightning strikes and severe thunder storms	Department of Meteorology

Figure 14: Responsible Technical Agencies for various hazards (Source: NEOP)

## **4 ALIGNMENT OF LOCAL FRAMEWORKS WITH GLOBAL STANDARDS**

Some of the sections written under this chapter was published by me in the International Conference on Building Resilience 2017 under the title “Investigation of efficiency and effectiveness of the existing disaster management frameworks in Sri Lanka”.

### **4.1 International frameworks related to DM**

The main international framework related to disaster management is the Sendai Framework, which was adopted during the Third United Nations (UN) World Conference on Disaster Risk Reduction (WCDRR) held in Sendai, Japan on 14-18 March 2015. It is the first major agreement of the post-2015 development agenda, with seven targets and four priorities for action. The Sendai Framework is the successor of Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters.

The Sendai Framework mainly focus on risk reduction and resilience which is a common element highlighted in all the 2030 development agendas adopted by all member states of the United Nations. Addis Ababa Action Agenda on Financing for Development, the Sustainable Development Goals, the Paris Agreement on Climate Change, the Agenda for Humanity and New Urban Agenda are some of the said agendas which focus on resilience.

The Sendai Framework introduces seven global targets which represent a means to quantify and qualify the “substantial reduction of disaster risk and losses in lives, livelihoods, and health, and in the economic, physical, social, cultural, and environmental assets of persons, businesses, communities and countries ” indicated in the expected outcome [21].

The Framework’s seven Targets are to:

- Substantially reduce global disaster mortality rates by 2030, aiming to lower the average per 100,000 global mortality rate in the decade 2020-2030, compared to the period 2005-2015.

- Substantially reduce the number of affected people globally by 2030, aiming to lower average global figures per 100,000 in the decade 2020-2030 compared to the period 2005-2015.
- Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030.
- Substantially reduce disaster damage to critical infrastructure and reduce disruption to basic services, such as health and educational facilities, by developing their resilience by 2030.
- Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020.
- Substantially enhance international cooperation to assist developing countries through adequate and sustainable support to complement their national actions for implementation of this Framework by 2030.
- Substantially increase the availability of, and access to, multi-hazard early warning systems, disaster risk information, and assessments, to the people by 2030.

The principles within the Sendai Framework focus on DRR through mitigation and preparedness by ‘enhancing disaster preparedness for effective response’ and rehabilitation and reconstruction, in order to ‘Build Back Better’ in recovery. The Sendai Framework’s predecessor, the HFA, prioritized action was aimed at response measures. DRR and the principle of ‘Build Back Better’, which is necessary to increase resilience to disasters, will require the adoption of a more strategic approach to national planning by Sri Lankan authorities through a process of wide stakeholder consultation.

The thirteen principles present some common themes that can be summarized into seven key guiding principles for the purposes of assessing policy and legislation. It is against these seven principles that SLNDMP and DMA are assessed in this chapter. The key principles are as follows.

- 1) States have the primary responsibility to prevent and reduce disaster risk →  
**Whole of Government Response**

- 2) Emphasis on coherence among agreements is necessary if sustainable development and growth is to be achieved → **Coherence and integration**
- 3) Local authorities should play a key role in DRR. National governments are required to facilitate this through incentives, decision-making responsibilities, and resources → **Resource allocation**
- 4) The responsibility for DRR within a state is required to be shared by the central government, relevant national authorities and key stakeholders. States may fulfil this responsibility through international, regional, sub-regional, trans-boundary and bilateral cooperation. In addition, DRR is required to be inclusive of vulnerable groups and should be facilitated through multi-sectoral and multi-institutional coordination → **Multi-stakeholder approaches**
- 5) Disaster risk reduction should risk-informed decision-making based on the open exchange and dissemination of disaggregated data complemented by traditional knowledge → **Localized approaches to DRM**
- 6) The decision-making associated with DRR should be an inclusive, multi-hazard, data-driven approach → **Data-driven approach**
- 7) Public and private investments should be safeguarded through application of mitigation measures and in the event of a disaster; assets should be further safeguarded through ‘Building Back Better.’ → **Safeguard investment through preparedness and ‘Build Back Better**

It is now more than two years since the adoption of the Sendai Framework and over a year since the adoption of Sustainable Development Goals (SDGs) in September 2015, making the current period significant for disaster management globally.

In this context, the United Nations Office for Disaster Reduction (UNISDR) has developed Coherence and Integration Guidelines in recognition of the need to reinforce these international agreements [31]. The Guidelines advocate for successive international agreements to build on existing policies and mechanisms through:

- Developing coherence and mutual reinforcement of international agreements through national policy and legislative frameworks.
- Linking monitoring and reporting mechanisms of related goals and indicators.

- Promoting cooperation through implementation.

SLNDMP will be checked its alignment with these guidelines as well. Furthermore, four disaster incidents namely; Collapse of the Meethotamulla garbage dump, Aranayake landslide 2016, Colombo floods in 2016 and Floods in 2017 which affected Kalutara, Matara and Galle districts were selected to justify the need of aligning local frameworks to global standards. Study which is done in this chapter is explained pictorially in the Figure 15 below.

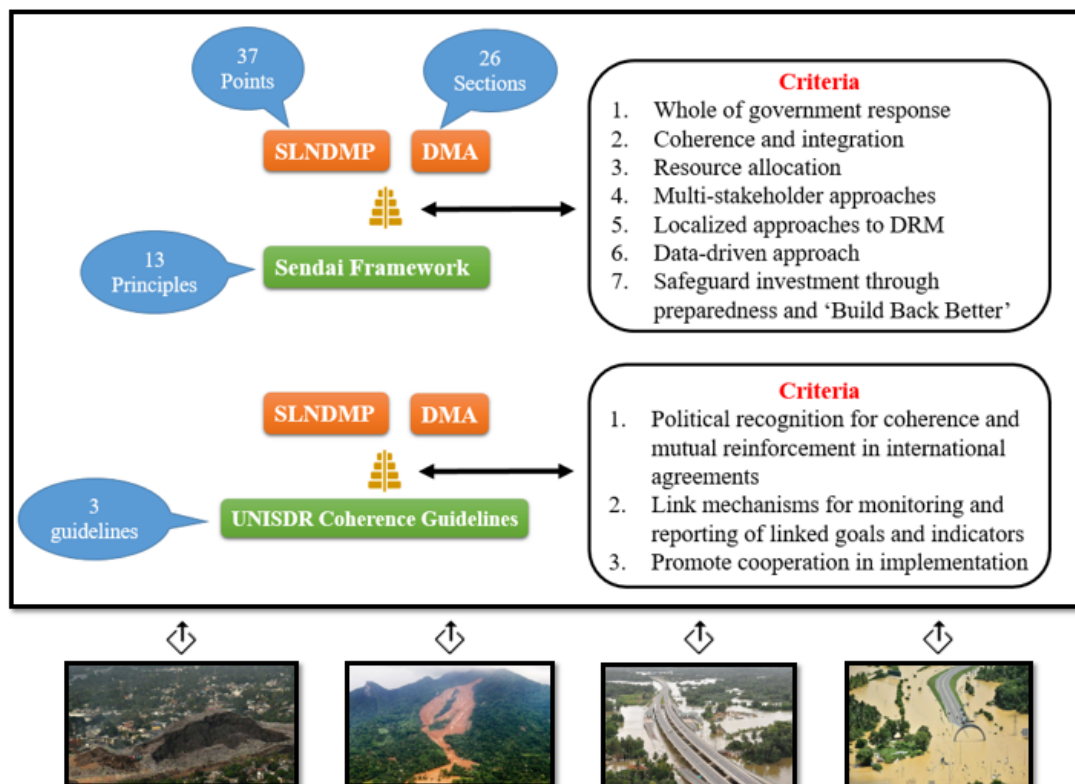


Figure 15: Methodology followed in aligning frameworks

## 4.2 Alignment of DMA and SLNDMP to Sendai Framework

The DMA and SLNDMP will be evaluated against seven criteria, flowing from the requirements of the Sendai Framework as shown in Figure 15.

### 4.2.1 Whole of government response

The Guiding Principles of the Sendai Framework require the state to manage the risk of disasters in a manner that protects persons and their property, health, livelihoods and productive assets. The principles highlights that the central government should promote and protect all human rights, including the right to development in

administering DRM. Therefore, the above requirements indicate that alignment with the Sendai Framework will require a country to adopt a DRM approach that is comprehensive, integrated and proactive in terms of its ability to lessen the socio-economic and environmental impacts of disasters. Moreover, the country will need to ensure that DRM is perceived government priority, and not as a stand-alone responsibility of nodal DRM institutions or technical agencies.

The DMA does not make explicit reference in promoting a DRM approach that is holistic, proactive and integrated across different sectors. Notwithstanding this gap, the cross-sectoral linkages to issues such as development planning and environmental and resource management are facilitated through the composition of the NCDM. The Council is required to consist of ministers overseeing a broad range of subjects and functions such as Urban Development, Coast Conservation, the Environment and Health.

The SLNDMP recognizes that disaster management is a shared responsibility, as enshrined in the principle of Collective Responsibility (point 12). As mentioned above, Sendai Principle 1 acknowledges that primary responsibility for disaster risk reduction lies with the State. This is in addition to the state responsibility for creating a system and a process for the inclusive participation of all stakeholders.

Before the Meethotamulla disaster Western region Mega polis planning project suggested a waste to energy process during the risk identification process [32]. Also before the Colombo floods, several studies were done for the flood inundation mapping along the Kelani river basin and vulnerable areas were identified as shown in Figure 16 [33].

During the rescue and relief processes, armed forces and voluntary organizations like Red Cross and Sarvodaya provided aid. In addition, in the rehabilitation processes, it is seen that the involvement of the central government is high, as they have provided funds from the National Insurance Trust Fund (NITF) [34]. However, during the DRR processes even though the professionals had identified several risk mitigation measures, the central government had not taken further actions. Even though DM is a

shared responsibility, it is visible that the primary responsibility lies with the state for proper execution of the plans.

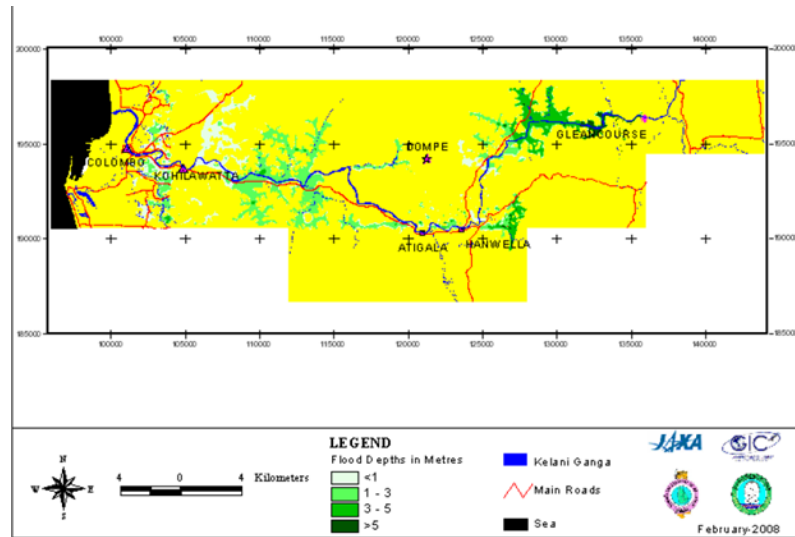


Figure 16: 10 year flood map for lower reach of Kelani River

#### 4.2.2 Coherence and integration

At present, SLNDMP and DMA do not refer to the Government’s Sustainable Development agenda and the important role DRR plays in helping to achieve Sustainable Development and growth. Creating linkages to the NAPCCI in Sri Lanka (2016 – 2025) in the SLNDMP is necessary in order to strengthen coherence with Sustainable Development and climate change agendas.

The UNISDR has placed a strong focus on coherence and integration because of the strong synergies that exist among these agreements. Climate Change Adaptation can be considered as DRR over the medium to longer term. Sustainable development also internalizes the multi-dimensional interactions of various sectors and their impacts to society, environment and the economy, as does disaster management.

SLNDMP only refers to the Hyogo Framework currently. Given the tone of the Sendai Framework to lead the international community towards DRR and ‘Build Back Better’ to set the nation on a more disaster resilient and therefore sustainable path, the preamble to the SLNDMP should include a strong statement reflecting this intent. Moreover, the preamble should recognize the common goals of Sustainable Development Goals (SDG) and Climate Change Adaptation to DRR, with direct

reference to the relevant policies and plans for each of these agenda at the time of revising the SLNDMP.

According to the Sustainable Development Goal (SDG) 12, by 2030 halving per capita global food waste at the retail and consumer levels is necessary. When considering the Meethotamulla disaster it is visible that if the generation of food waste was reduced the risk of collapse would have been easily minimized. Furthermore, NAPCCI clearly highlights to improve the existing systems of DRM to minimize the vulnerabilities and increase the preparedness. After the lessons learnt from Colombo floods 2016 and floods in 2017 which affected Kalutara, Galle and Matara districts identifying and mapping areas vulnerable to droughts and flood hazards to prepare disaster risk management plans has become a priority action. According to the literature, there were several flood inundation maps in the Kelani river basin but the risk reduction measures were taken too slowly to prevent damage during an extreme flooding event. If the Government's sustainable development agenda and SLNDMP were integrated considering the provisions of DMA before these disasters the impact and the damage could have been minimized by improving disaster resilience via sustainable measures.

#### **4.2.3 Resource allocation**

For the successful implementation of DRM systems, sufficient resources are necessary. Under section 4(o) of the DMA, the NDMC is permitted to recommend the allocation of funds for disaster management from the relevant authorities. The NDMC is also permitted to recommend the allocation of funds from the Reconstruction and Rehabilitation Fund.

Additionally, the DMA provides for the creation of the NDMC's own Fund, which includes the initial capital of the NCDM (10 million rupees), all money received by the NDMC in the discharge of its functions, and all sums received by way of grants and loans.

The Sendai Framework notes that the DRR should be administered in a manner that protects people and their health, cultural and environmental assets, property, and livelihoods. The SLNDMP refers to meeting the needs of people, economy,



infrastructure, livelihoods through legislation (legal Basis, point 9). When responding to disasters, adequate relief services are provided, (point 20) and provision or reconstruction of infrastructure and housing that incorporates DRR to reduce risks (points 24 and 25), obtaining financial assistance on concessionary terms and risk transfer (point 26), and integration of DRR and DRM education to schools and universities (points 30 and 32). However, the SLNDMP fails to address the protection of environmental assets under the Policy Statements adequately. Aside from a reference to the environment in its objective statement, which is reiterated under the section Legal Basis (point 9.a), reference to managing the prevention of environmental degradation and post-disaster environmental restoration should be included as a policy statement.

Looking at the disasters mentioned previously, it is visible that resource allocation for DRR measures was not adequate. During the Aranayake landslide the threats were identified before the event but no preventive measures were taken as shown in Figure 17 [35].

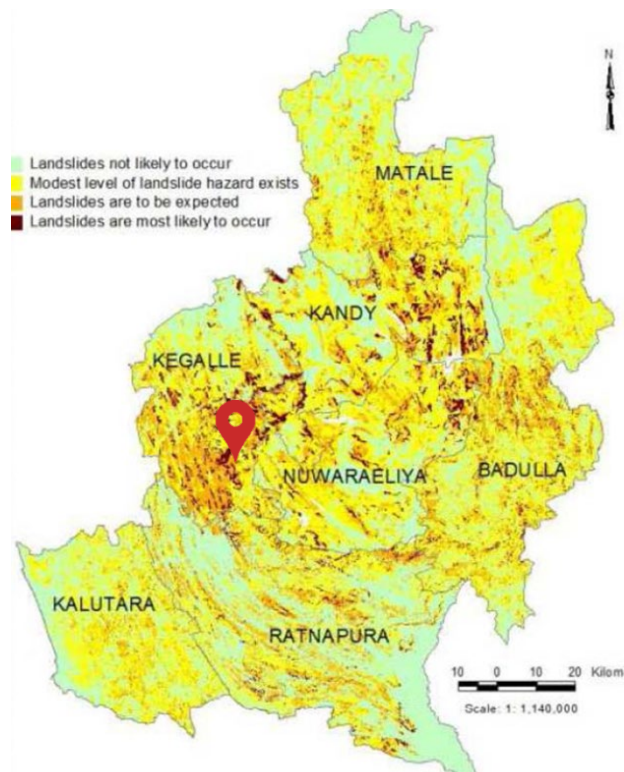


Figure 17: Location of Aranayake in landslide hazard map  
(Source: National Hazard Profiles Sri Lanka 2012)

Since the Kegalle district is a landslide prone area proper environmental measures must be taken in order to prevent landslides. Issuing warnings during a heavy rainfall is necessary for proper evacuation but the damages to infrastructure remain.

Before the collapse of the garbage dump in Meethotamulla, unauthorized dwellers in the area were transferred to the nearby housing scheme, Sudu Nelumpura, and government offered Rs. 1.5 million as an incentive for others to find alternative housing [36].

During the rescue, relief and rehabilitation phases of the disasters, the allocated resources by the government were not enough to satisfy the needs of victims. Allocating resources quickly depends on the efficiency of the respective agencies. Several organizations and the community in Sri Lanka helped in this processes in order to provide better facilities for the affected people. Considering the future risk reduction measures after the Colombo floods in 2010 Metro Colombo Urban Development Project (MCUDP) was initiated in order to convert the city into a flood free zone [37]. During the 2016 floods, still Colombo city flooded where the project was partially completed. Though all the funds are provided by the World Bank, other relevant resources like professionals and labour force should be constant in order to complete projects on time and reach targets. The Post Disaster Needs Assessments done by DMC shows that disaster recovery needs are above LKR 100 billion for both the floods and landslides in 2016 and 2017 [38], [39]. This shows the need of allocating resources for DRR in order to reduce the recovery needs. Furthermore, the number of affected people being doubled in 2017 compared to 2016 justify the need of adequate resource allocation [40].

#### **4.2.4 Multi-stakeholder approaches**

The Sendai Framework states that disaster risk reduction requires an ‘all-of-society’ engagement, which denotes that DRR is a multi-stakeholder initiative. It also highlights the fact that the state should assign, as appropriate, clear roles and tasks to community representatives through the relevant legal frameworks.

The DMA contemplates partnerships with CSOs and technical experts in the administration of DRM. For instance, under Section 13(1) of the DMA, the NCDM is

entitled to obtain the assistance of CSOs to facilitate disaster responses in the event a State of Emergency is declared. Additionally, Section 9(1) of the DMA permits the NCDM to appoint TACs, which consists of Professionals and experts having expertise in relation to the respective functions and responsibilities to assist with the discharge of its functions. In addition, the DMA does not specially provide for CSOs and community representatives to be consulted in the formulation of the NDMP and the NEOP.

Inclusive decision-making, multi-sectoral and multi-institutional coordination are addressed in the SLNDMP by four principles, namely: Multi-dimensional (point 11); Collective responsibility (point 12); Equity, diversity and inclusion (point 13); and Transparency and accountability (point 14). The clauses under the policy statement ‘Integrated approach to reduce disaster risks’; clauses supporting a multi-stakeholder approach include education training and professional development (Point 30 – 31); and participation of NGOs, civil society and private sector in implementing the DMP. In addition to government agencies (point 34), other organizations support a multi-stakeholder approach to DRR and DRM. As such, the current SLNDMP adequately addresses the need for a multi-stakeholder approach to DRR.

During all the disasters mentioned above, a multi – stakeholder approach was visible where both government officials as well as NGOs provided their full support in the post-disaster management processes. Even though no special consideration was given to the general public to share the responsibility, people provided aid by providing relief items and assisting in rescue operations.

Furthermore, Community Based Organizations (CBOs) need to be formally liaised with the state sector agencies for developing and implementing DRR plans, raising public awareness, DRR education, etc. This enables synchronizing synergies of the state and non-state sector agencies to achieve the common goal of DRR. In this regard children and youth need to be recognized as the agents of communicating and disseminating DRR concerns, thus strengthening education systems making them DRR sensitive become pivotal. In addition, identification of needs for disable persons

and making tailor made DRR programmers to cater their needs is important to synchronize the capacities of all members in the community.

Private, Public and People (PPPs) partnerships also can supplement/fill knowledge and resource gaps. For example, development of technologies for strengthening DRR capacities and preparedness of the people at risk that demands for large investments. Hence business case for DRR should be clearly defined while proper guidelines, agreements, standards need to be put in place improving the shared understanding of the partners involved.

Media is a key stakeholder who can immensely contribute for strengthening the knowledge on DRR by disseminating relevant information to the people at risk. As media networks are spread beyond any administrative and political boundaries, systematic engagement of them in DRR efforts will be useful. At the moment media plays an impressive role in early warning saving many lives of the people at risk. At present most of the people are actively involved in Social media which also plays a huge role during a disaster. Most of the early warnings and relief requirements are spread via social media like Facebook and twitter as shown in Figure 18. In addition, proper regulations should be in place to stop spreading false rumours as well.

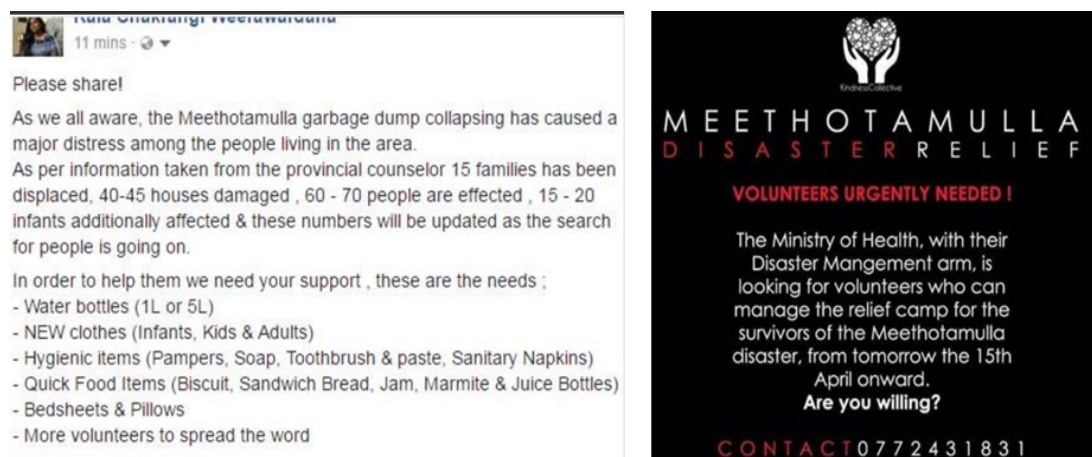


Figure 18: Posts in Facebook (left) & Twitter (right) regarding relief work during Meethotamulla disaster

Publishing of roles and responsibilities of the DRR stakeholders such as, Ministries, Departments and Agencies/Authorities, Military, Police, Paramilitary, NGOs, CBOs, Universities, Research Institutes and Professional Bodies, Development partners,

Private sector, and Media at strategic and operational levels become pivotal for a sustainable and strong multi stakeholder approach provided that tangible or intangible incentives/benefits to the above stakeholders are present.

#### **4.2.5 Localised approaches to DRM**

DMA does not specifically refer to any localized approaches but it assigns the NCDM the responsibility of facilitating and supporting local and community self-reliance in the event of any potential or actual disaster. This denotes that local communities can have several approaches depending on their locality to be resilient which can be strengthened with the assistance of NCDM.

When looking at the SLNDMP, the principle of ‘Best fit of best practice’ (point 15) refers to the need to draw on indigenous knowledge and traditional methods, and for approaches to be socially acceptable. The SLNDMP recognizes the need to engage local authorities in making direct references to the participation of Local Government agencies under the policy statement, ‘Integrated systems to reduce disaster risk reduction’ regarding supporting legal mandates, adequate capacity and ICT, land use planning and building codes (points 22 and 25).

When looking at floods and landslides, small water tanks must be built and these smaller tanks must be connected to reservoirs. This will stop upstream water being dispersed quickly to downstream which will eventually stop the floods [21]. During ancient times, the irrigation network in Sri Lanka was designed to save water and prevent floods. Currently, most of the irrigation networks are not working properly and it is necessary to repair them in order to maintain a proper water management system. If these traditional methods are incorporated with modern technology then it would help to reduce disaster risks. The DMC must always identify the unique features and technologies Sri Lankan ancestors used which can be implemented in the future as DRR measures. Since they are traditional methods they would be socially acceptable as well.

#### **4.2.6 Data driven approach**

Section 8 of DMA assigns DMC to promote research and development programmes in relation to disaster management and to setup a database on disaster management.

At present DMC has the “Desinventar” disaster information database (<http://www.desinventar.lk/>), which was setup with the assistance of UNDP [41]. It provides disaster data such as number of affected people, deaths for various disasters.

The SLNDMP notes that a multi-dimensional approach to disaster management is necessary and that the sharing of disaster risk information, provision of information to those impacted, alongside accountability and transparency in the decision-making process, and handling of resources are all necessary (point 14). The SLNDMP notes that scientific research tools and methods should be available to develop risk profiles and maps (point 23). Promotion of research and development in DRR is also supported in the policy (point 32). However, the SLNDMP fails to include monitoring and evaluation, which is a necessary tool to collect the data necessary to support an informed, scientific, and multi-hazard approach. Line agencies (table 3) such as the NBRO and the Meteorological Department carry out research and gather data to provide relevant disaster related information for the DMC to give early warnings to the public.

There are merits and demerits of the data driven approach of SLNDMP. During the Meethotamulla disaster, the risk of the landfill exploding was identified by referring to the previous event which occurred in the Bloemendhal dumpsite [36]. With this information, the community began to react via protests to remove the garbage from Meethotamulla. However, the DMC was unable to evacuate the vulnerable community in time. Furthermore, proper flood and landslides modelling must be done by the line agencies of the DMC as DRR measures. For example, the rain gauge system in Sri Lanka were not technologically updated and do not have the capability to provide data when necessary.

#### **4.2.7 Safeguard investment through preparedness and ‘Build Back Better’**

DMA assigns NCDM to formulate the SLNDMP which will effectively use resources during reconstruction but it does not refer to build back better. Furthermore, Section 4 of DMA states that NCDM is responsible to prepare the NDMP and NEOP which will act as guidance materials to build capacity and preparedness for disasters.

The safeguarding of investments through preparedness is covered under the policy statements named preparedness and response (point 16) and integrated systems to reduce disaster risk (Point 22). The 2010 version of the SLNDMP made a direct reference to ‘Build Back Better’. SLNDMP operationalizes the concept in a more detailed manner (policy statement – Integrated systems to reduce disaster risk). As the term ‘Build Back Better’ is internationally synonymous with DRR and resilient reconstruction, and with direct reference to it under the Sendai Principle 11 and Sendai Priority Action 4, the next iteration of the SLNDMP should seek to incorporate the term into the text.

The SLNDMP fails to refer to the need to conduct Post Disaster Assessments. Post Disaster Assessments are an important tool through which the DRR actions and the performance of institutions involved in the response operations, can be assessed. Post Disaster Needs Assessments were carried out after the floods in 2016 and 2017 even though it contradicts the fact mentioned above [38],[39]. This shows that the DMC and relevant authorities have identified the said need. The findings are invaluable with respect to addressing the principle of ‘Build Back Better’; providing the most up-to-date findings that may influence new investment; and continuously improving disaster management services to the community. The findings would also inform mitigation activities and help to close the loop between Reconstruction and Mitigation in the disaster management cycle.

After the Garbage dump collapse in Meethotamulla, post disaster assessments were done only to identify mitigation measures and future risks. Proper post disaster assessments are needed after every disaster, which will critically evaluate the DRM and DM strategies and identify the inefficiencies in processes.

### **4.3 Alignment of SLNDMP with UNISDR Coherence and Integration Guideline**

Following section provides a more detailed analysis on how the SLNDMP can align with the Guideline. Three components of the guidelines mentioned in section 4.1 will be used during analysis.

### **4.3.1 Coherence and mutual reinforcement**

While there is recognition for the need to adopt international agreements (6.1.9), coherence is not a principle that is recognized in the SLNDMP.

The SLNDMP does note that ‘Plans and Programs in Disaster Management should reflect national and international commitments’ (5.1.6). Therefore, in effect, coherence is implied. However Sendai framework notes that explicit reference to these objectives should be made where possible, in order to avoid ambiguity.

The Guidelines call for an ‘Explicit reference of SDGs and UNFCCC in national policies and implementation’. There is no reference to SDGs at present and SLNDMP would need to be updated to reflect this guidance.

Two references to Climate Change can be found in the SLNDMP under Multi-sectors (point 11.c) and under the policy statement ‘disaster risk reduction activities should integrate climate change adaptation’ (point 22.c) which refer hazard profiles, vulnerability and risk assessment. However, there is no explicit reference to the UNFCCC and its agreements. Hence due consideration should be given to this matter.

The Guidelines refer to a multi-hazard approach and inclusive, risk-informed decision-making. The principles of multi-dimensional (point 11), collective responsibility (point 12), equity, diversity and inclusion (point 13), transparency, and accountability (point 14), comprehensively address this requirement.

### **4.3.2 Link mechanisms for monitoring and reporting of linked goals and indicators**

There is no policy statement within the SLNDMP in support of monitoring. Hence it should consider inclusion of a policy statement around linking goals and indicators (in support of a coherence and integration agenda), the SLNDMP should first acknowledge the importance of monitoring & evaluation, and reporting for DRR and response. While the principle of transparency and accountability (point 14) may imply the need for monitoring, an explicit reference for monitoring and reporting to be undertaken by the relevant agencies should be included.



Within the context of the Sendai Framework, reference to monitoring and reporting extends to the coherence of indicators and harmonization of reporting. For this purpose, the coherence guidelines recommend the alignment of targets and indicators across agreements, harmonization of national reporting systems of Sendai, SDG and UNFCCC. After 2015 it's visible that DMC has produced several reports after the disaster which shows that they have understood the importance of monitoring and reporting which will lead to identify the necessary components to make sri lanka a resilient country to disasters.

### **4.3.3 Promote cooperation in implementation**

Cooperation is a strong theme throughout Sendai. The Guideline calls for explicit reference to coordinate within existing mechanisms for DRR, in order to maximize partnerships within and across sectors. The SLNDMP upholds coordination and inclusivity in its principles.

The Guideline adds that in order to promote coordination and inclusive governance, a clear delineation of stakeholder roles in planning and implementation is required. As coordination is integral to providing disaster management services to the community, the MDM should update SLNDMP to include reference to all peak coordination bodies that should be consulted in addition to a high-level summary of stakeholder commitments as recommended above.

The roles of the private sector and local governments are emphasized within the Guideline. The Guideline notes that 70-85% of total investments for a nation are decided by private business. It is therefore necessary to engage closely with the private sector. Two references are made to partnerships with the private sector. First, '5.1.4 Public Private Partnerships in disaster management will be encouraged', and second, '6.1.10 Encourage innovative use of private sector Corporate Social Responsibility (CSR) programs to reduce social vulnerability'. The nature of partnerships with the private sector is not specified. As the Guidelines encourage clearly delineating the roles and commitments of all major stakeholders, the role and contribution that the private sector should perform should be considered in consultation with the sector.

Ensuring the visibility and accessibility of risk information is also another important recommendation to promote cooperation. The SLNDMP does refer to the sharing of information. As such, the SLNDMP adequately covers the need to share information, and refers to share multi-hazard maps and risk profiles with the stakeholders and the communities (point 14.f).

#### **4.4 Merits and demerits**

##### **4.4.1 Merits**

- After DMA was introduced several plans and programs were introduced which are related to DRR. These helped relevant authorities both at national level and local level to increase preparedness and capacity of the communities.
- Establishment of several line agencies like NBRO and DoM helped the DMC to issue accurate early warnings rather than taking the whole responsibility by themselves.
- During the disasters, DMC and other line agencies engage in rescue, relief and rehabilitation work in a satisfactory level while getting the assistance of NGOs and other volunteer services. Normally army forces come in to the aid of the affected people with the coordination of DMC.
- Considering the multi-dimensional approach in DM frameworks in Sri Lanka preparedness and capacity building is necessary as a DRR measure. Hence, DMC and other related agencies carryout awareness campaigns as well as training of both community and stakeholders.

##### **4.4.2 Demerits**

- There are several overlaps in functions of NCDM and DMC. One example is both NCDM and DMC are tasked with promoting public awareness campaigns relating to disaster management; and initiating programs relating to preventing and mitigation of disaster and provision of relief, rehabilitation and reconstruction. This shows that clarification is necessary in order to prevent duplication of activities or prevent instances where one of the institutions tries to absolve itself from responsibility on grounds that the other institution is required to carry out this activity.

- Local governments do not involve much in DM. Hence it is necessary to establish links between disaster management activities on a national and local scale. This would require involvement of local institutions within policy formulation and guidance of activities through the main disaster management coordinating bodies.
- The issue with the existing Act is that while provisions are in place for the establishment of these policies, there is no period set in place for submission of these plans, nor is there any provision for regular updates of these plans. Hence proper time frames and deadlines are required
- Mandate confusion, management challenges and lack of accountability are some gaps in institutional framework for DM.

## **5 EVALUATION OF COASTAL COMMUNITY RESILIENCE – CASE STUDY**

Some of the sections written under this chapter was published by me in the International Conference on Disaster Management 2018 under the titles “Important aspects in building community resilience of coastal districts in Sri Lanka” and “Need of Strong University-Industry Partnerships: A Case Study in Sri Lanka”. In addition, an abstract with the title “Role of Higher Education Institutes in Coastal Community Resilience & Risk Management” was accepted for Oral presentation at the International Conference on Building Resilience 2018.

### **5.1 Why Coastal Community Resilience**

Sri Lanka being a tropical island has a coastal belt around the country comprising primarily congested communities, infrastructure, and fauna and flora, which are exposed to various hazards caused due to natural occurrences and human-induced phenomena. Cities in the coastal belt are rising the ladder of economic development and are under severe pressure resulting from various scenarios of development, population growth, human-induced vulnerability, frequently increasing coastal hazards of larger magnitudes and impacts of global climate change. These unrivalled changes are placing coastal communities at increasing risk from various hazards such as severe storms, storm surges and tsunamis leading to coastal erosion, flooding and environmental degradation.

Indian Ocean Tsunami of 2004 is the major coastal disaster, which devastated the infrastructure and livelihood in most of the coastal belt of the island. Then DMC and together with other agencies implemented several programmes to improve the community awareness and resilience with the increased capacity in tsunami-prone districts [25]. Furthermore, 2016 floods and landslides affected Colombo, Puttalam and Gampaha districts severely, while the number of affected families raised up to 800,000 in total [39]. 2017 floods and landslides, which occurred a year later, affected Kalutara, Galle, Matara, and Hambantota districts in the southern coastal belt of the island [38]. These events show that risk perception of the communities should be changed to encourage protective action against multiple hazards.

Hence above information show that necessary actions are required to increase coastal community resilience, which led in selecting the coastal districts as the case study.

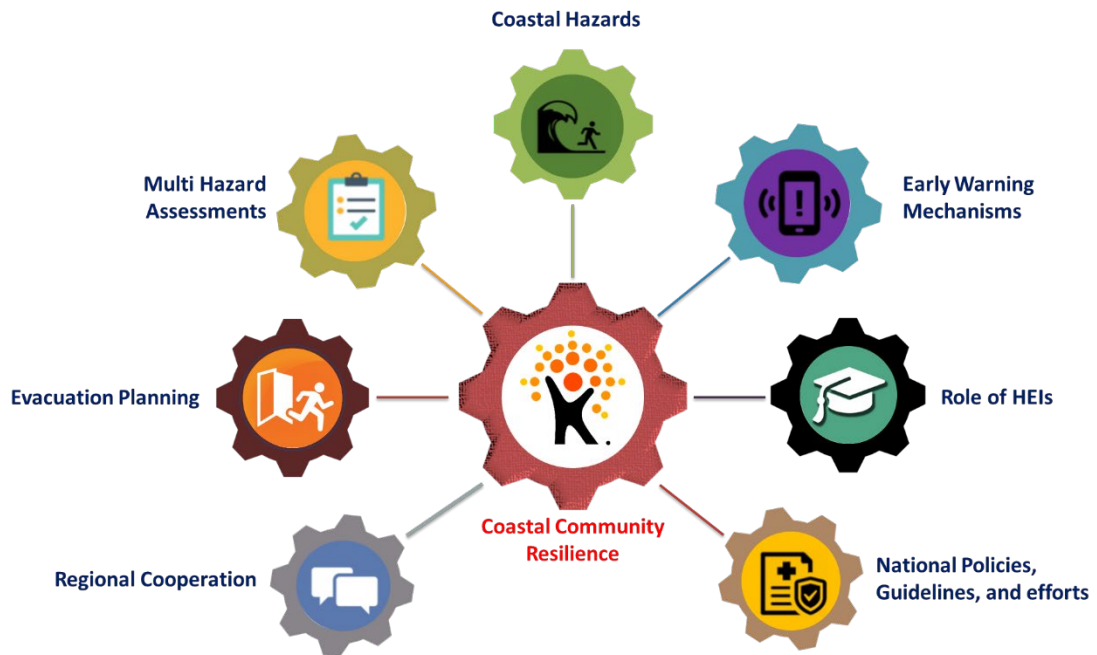


Figure 19: Components selected to assess CCR

The lack of awareness about hazards, vulnerability, and deficiencies in capacity and response has led to address the intellectual and normative challenges in placing multi-hazard assessments, early warning and preparedness in the broader trajectories of societal behavior in coastal communities at risk. When assessing the Coastal Community Resilience (CCR), several components come in to account. Out of them seven key components were selected as shown in Figure 19.

## 5.2 Methodology

In addition to the information found in chapters 2,3 and 4 , to assess the condition of the community resilience of the coastal districts in the island, an in-depth literature survey was executed to find out the plans, policies, assessments, and programmes prepared by several government bodies, research institutions, and nongovernmental organizations. Then the study was strengthened by a set of interviews and roundtable discussions.

Initially several key professionals and experts who are actively involved in Disaster Management (DM) activities including academic staff of several Higher Education

Institutes (HEIs) were identified and they were presented with a detailed questionnaire followed up by a discussion to gather information and knowledge. Interviewee data is shown in Table 1 below.

Table 1: Participant data for interviews

<b>Summary &amp; Coding</b>	<b>Level of experience in terms of involvement in Coastal Resilience</b>
Academia [A1]	A Senior Professor at the Department of Agricultural and Plantation Engineering, Open University of Sri Lanka who has involvement in coastal flooding
Academia [A2]	A Senior Professor at Department of Sociology, University of Colombo who has experience in social aspects related to coastal community
Academia [A3]	A senior lecturer in the field of sustainability in National School of Business Management (NSBM)
Academia [A4]	The Emeritus Professor working in the Department of Physics in University of Peradeniya involved in DM
Government [G5]	The current media spokesperson of DMC who is actively involved in MHEW in coastal resilience
Government [G6]	The Chief Engineer of Coastal Research & Design Division in CCD
Government [G7]	The Director (Mitigation, Research & Development) of the Disaster Management Centre
Government [G8]	The Head - Human Settlements of NBRO
Government [G9]	The Senior environmental professional- water resources management of National Building Research Organization
Government [G10]	The Director General of the Department of Meteorology (DoM)
Private [P11]	The head of IUCN – International Union for Conservation of Nature

The interviews lasted for approximately 1.5 to 2 hours and were recorded using the Voice Memos application for iOS or other audio recorder. We then transcribed these recordings manually. The transcribed data were then analysed thematically, looking at themes in Figure 17. Altogether eleven expert data were collected.

Then expert stakeholder roundtable discussions were held during a Symposium on ‘Creating University-Industry Partnerships’ held on the 12th of March 2018 with the Ministry of Primary Industries. The symposium brought together more than 60 academics, policy makers, industry professionals and financial institutions involved in UIPs. The event consisted of several inaugural speeches from distinguish invitees, thematic presentations of related to university – industry links and a final roundtable discussion to identify the needs and requirements to establish strong UIPs.

Finally an online questionnaire survey was distributed to gather the community perception on evacuation planning in coastal communities. This questionnaire was sent to more than 500 people via social media and email. Random sampling technique was used to select them. The main reason to send this online survey was to gather the information from the younger generation (below 35 years of age) who may have a different view on Disaster Management. Around 100 filled questionnaires were collected which led to assess the existing problems and challenges in evacuation planning.

These interviews, discussions and surveys provided sufficient information to come to a proper conclusion and provide necessary recommendations. Some recommendations were targeted for specific sectors of the population and some are for the whole country. The thematic content analysis was used to analyse the data under the key themes identified as shown in Figure 19. Graphical view of the methodology followed is shown in Figure 20.

In addition to the evaluation of the components of CCR, identification of key elements in measuring CCR was done. This was done by analysing the existing resilience frameworks in Sri Lanka with the literature available.

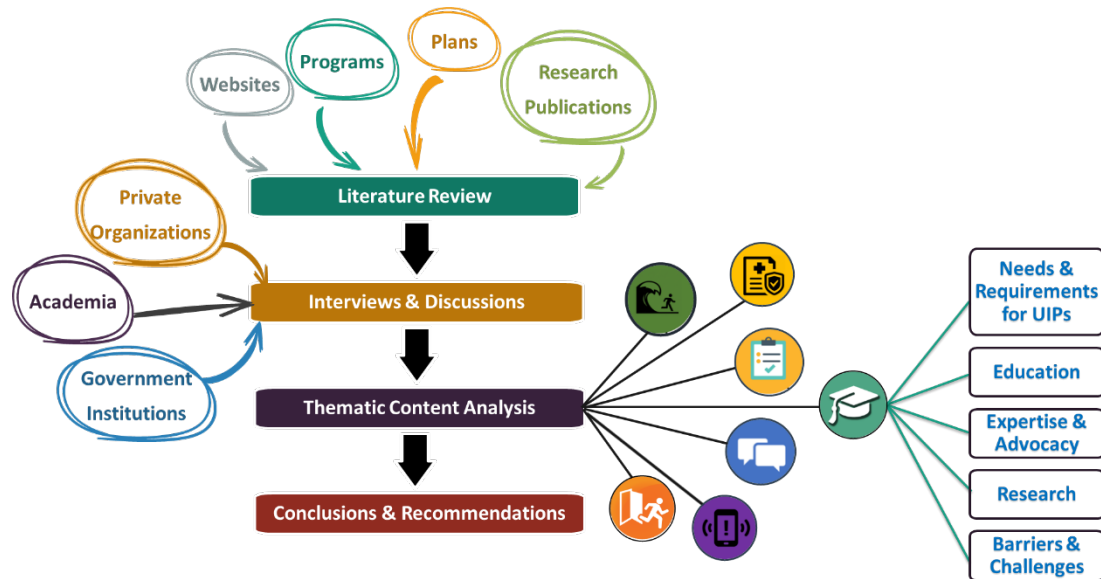


Figure 20: Summary of the methodology followed

### 5.3 Coastal Hazards

Coastal districts of Sri Lanka are vulnerable to several hazards including floods, sea level rise, coastal erosion, storm surges, tropical cyclones, oil spills, droughts, landslides and Tsunamis [42]. Variability of the return periods associated with respective hazards is the main characteristic to be considered in the coastal multi-hazard approach. When considering Sri Lanka, erosion and storm surge set off by the North East & South West monsoons have an annual return period, storm surges unleashed by cyclones are multi-centennial, and a significant tsunami can be even multi-centennial to millennial [43]. Floods are the most frequent disaster in Sri Lanka (37%) followed by strong winds, landslides, and cyclones [16]. Furthermore, when looking at the disasters in a percentage of a number of deaths point of view Indian ocean Tsunami has the highest number of deaths with 39,143, which is a significantly higher value compared to all other disasters combined [42]. In addition, it has led to the decrease of a number of people who are involved in fishery-related industries and coir industry in the coastal belt of Sri Lanka [44]. Colombo floods, which occurred in May 2016 affected 54,248 families [39], and the floods in 2017 caused significant damages to the city of Galle where 40184 families have reportedly been affected [38]. Furthermore, coastal erosion has been identified as a major hazard along the densely populated southwest coastline of the country [45]. Moreover, Salinity intrusion in Colombo and Gampaha districts is becoming a primary concern at present [46].



The number of affected people due to various disasters from 1965 to 2017 shown in Fig 19 provides sufficient evidence that a significant impact was made to the coastal districts as well as to the country as a whole.

Also, M V Meliksha Incident was one of the leading oil spill events occurred near the Bundala coast which released fuel and fertilizer damaging the marine environment [47]. Furthermore, due to the sea level rise, National Hazard Profile shows that the Puttalam district will have additional 1113 ha inundated in 2037 [42]. The distribution frequency of the events, number of people affected, and loss of life due to disasters throughout the islands show that coastal districts are the most affected [48].

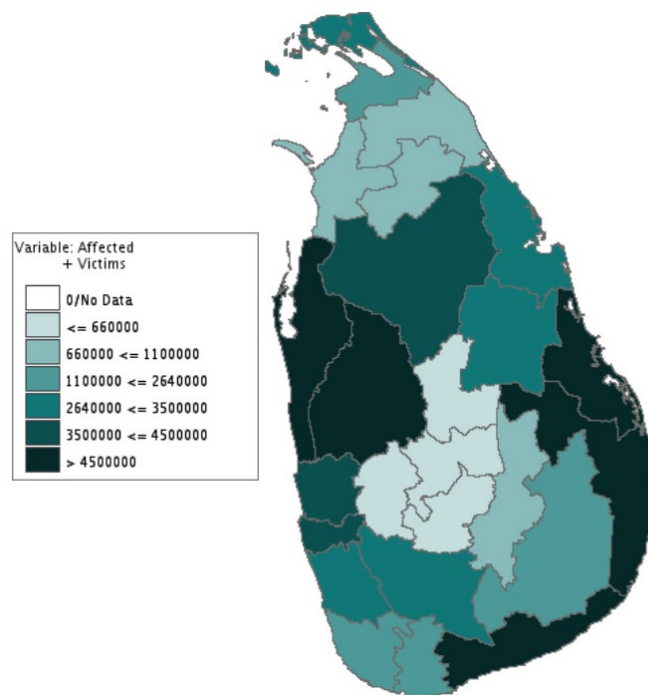


Figure 21: Affected people from disasters (1965 - 2017)  
(Source: <http://www.desinventar.net/DesInventar/profiletab.jsp>)

Information gathered throughout the interviews show that economic loss, displacement of the coastal communities, the effect on the water quality, and loss of habitats in estuaries are some of the critical impacts of the coastal disasters. Also, drought and saltwater intrusion, loss of beachfront properties, damage to the population, and rapid loss of land have also made a significant impact on the coastal belt of Sri Lanka. Additionally, the importance of handling Sri Lankan coastal hazards

at both national and local levels was identified during the literature survey and interviews which is summarized in Figure 22.

	National Level	Local Level
Early Warning	To <u>issue accurate early warnings</u> for the people to evacuate in time.	To <u>evacuate and go for shelter</u> during a disaster to reduce the loss of lives
Policies	By <u>introducing proper policies</u> , and legislation can protect the coastal communities from several hazards	<u>Community leaders can educate and guide people</u> on policies and guidelines to be followed to make them resilient
Tourism	The <u>tourist attraction can be increased</u> to improve the economy of the country	Opportunities which will arise from tourism will ensure the <u>development of the economy of the local villages</u>
Technology	<u>Can introduce advanced technology</u> which will also assist the research and development work in the coastal hazards sector	Fishers, in local communities, <u>can get early warnings in time for them</u> to not to go fishing during storm surges or heavy rains
Awareness	To <u>make coastal communities aware of the hazards</u> which they are vulnerable	Risk awareness and knowledge will help local communities to <u>increase the preparedness and capacity</u>

Figure 22: Importance of Handling Coastal Hazards

#### 5.4 Multi Hazard Assessments

At present, there are no any specific multi-hazard assessments being done for the coastal hazards in Sri Lanka. A multi-hazard map for the whole country by combining the individual hazard indexes for droughts, floods, cyclones, and landslides, with weighing hazards in different ways was developed in 2006 as shown in Figure 23, which is outdated now due to the climate change, potency and frequency of the disasters [49].

In the National Policy on Disaster Management under the section “Multi-dimensional approach,” it has been highlighted that multi-hazards should be given consideration [22]. At present individual natural hazard mapping and assessments are finalized, and hazard profiles for coastal erosion, floods, drought, sea level rise, storm surge, tropical cyclones, and Tsunami were produced [42]. Furthermore, the deterministic analysis undertaken for Tsunami hazard focusing on the south-west coast of Sri Lanka [50], GIS-based flood risk analysis was done for a 50 year rainfall to develop an information systems for flood forecasting in the Kalu river [51] and the flood hazard mapping done for the lower reach Kelani river basin [52] are some of the hazard assessments done considering individual impacts of the hazards. The hazard prediction calendar in Sri Lanka prepared by Disaster Management Centre and other line agencies identifies the

monthly variation of several hazards which provides a guideline for stakeholders to prepare for impending risks [24].

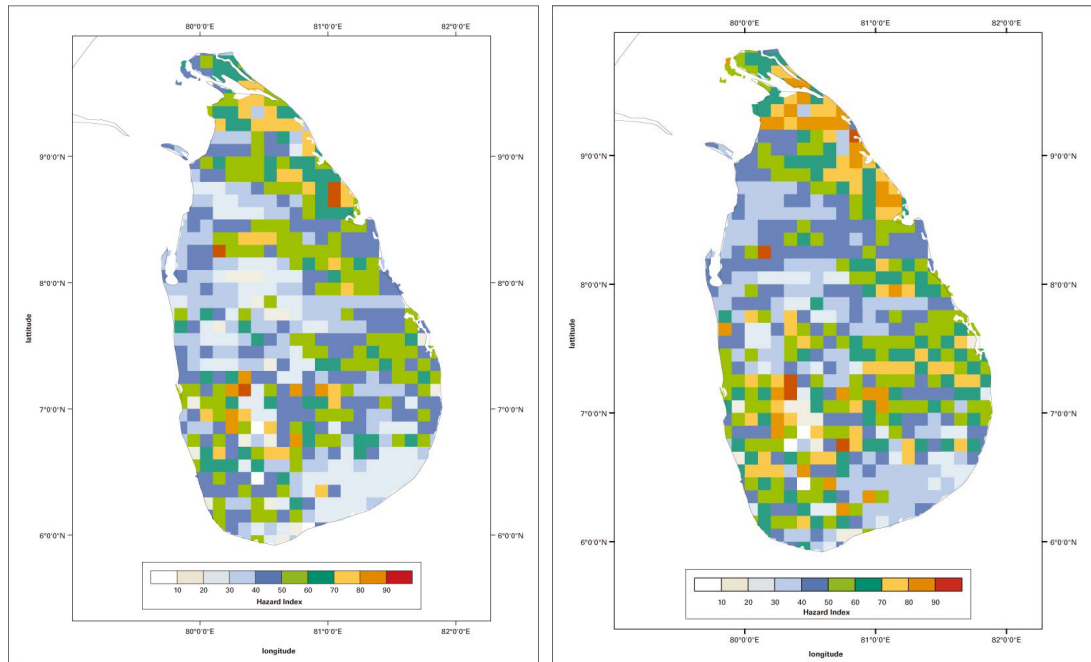


Figure 23: Multi Hazard Maps, Equally weighing hazards (Left) & by incident frequency (Right)

During the interviews, it was noted that Disaster Management Centre (DMC) and relevant technical agencies at National level carry out the hazard assessments. Sri Lanka as a country can carry out the hazard assessment work but what lacks is the advanced modelling software [G10]. Hence, most authorities work with the international agencies to carry out the assessments. Making hazard maps for selected districts available online assist the authorities and other interested parties to update and use them [53].

### 5.5 Early warning mechanisms

When handling a coastal disaster, Early Warnings (EW) play a crucial role to reduce the impact on the vulnerable communities. Dissemination of the said early warnings from National level up to the grass root level is divided into four layers as shown in Table 2 [17].

Table 2: Early Warning Dissemination levels

Level	Description
National	EW messages from International and Regional Technical Agencies are received by the Emergency Operation Center (EOC) of the DMC. A national level EW message is sent to the emergency response committees where they have to pass the messages to the relevant organizations. Intra Governmental Network (IGN), Satellite and Radio Communication are some of the dissemination methods used
District	EW is conveyed via District Disaster Management Centre Units (DDMCU) to the District Secretariat, stakeholder agencies, and political authorities
Divisional	DDMCUs pass the EW messages to the Divisional Secretariats who will send the message to Search and Rescue teams, police and relevant local authorities
Grama Niladhari (GN)	Last mile communication tools such as sirens (Hand and Electric), temple and church bells, riders/ push bicycle and motorcycles/messengers and Early Warning Committees (Door to door) are used to send the EW messages to the vulnerable communities

Department of Meteorology (DoM), Irrigation Department (ID) and National Building Research Organization (NBRO) are the leading technical institutions which are mandated to provide early warning messages to DMC. When severe weather conditions like heavy rainfall are expected, officers of National Meteorological Centre (NMC) and directors share the information, and a warning signed by the forecaster is issued to relevant agencies and media. The warnings are disseminated to DMC and pertinent other stakeholders [16]. DoM also gives marine forecast and city forecast on their web page so that users can quickly get the weather forecast online [54]. The ID informs the DMC the observed water level and rainfall by using FAX. The frequency of data transmission is once a day during normal times or every 3 hours during flood situation [16]. Also, flood warnings are issued based on the observed water level at 34 gauging stations [16]. NBRO manages over 100 rain gauges throughout the

country. Based on rainfall data collected in these rain gauges, NBRO issues landslide warnings to DMC and public through the NBRO homepage [16]. Sometimes the vulnerable community can become the primary source of information to the responsible agency regarding an impending disaster.

Role of media is also significant as they cover the entire island easily through television and FM radios with more than 50 channels. During disaster situations, mass media notify the public with timely and factual information including guidance for the actions to be taken [24]. Furthermore, Technical Advisory Committees (TACs) which are appointed by National Council of Disaster Management (NCDM) must establish a proper chain of early warning of the disaster.

Disaster and Emergency Warning Network (DEWN) is the first GSM-based EW system which generally uses accessible mobile communications technologies like short messages service (SMS) for early warning and cell broadcast (CB) to provide an efficient and reliable mass alert system. DEWN links relevant stakeholders including the general public to the EOC at DMC as shown in Figure 24 [55].

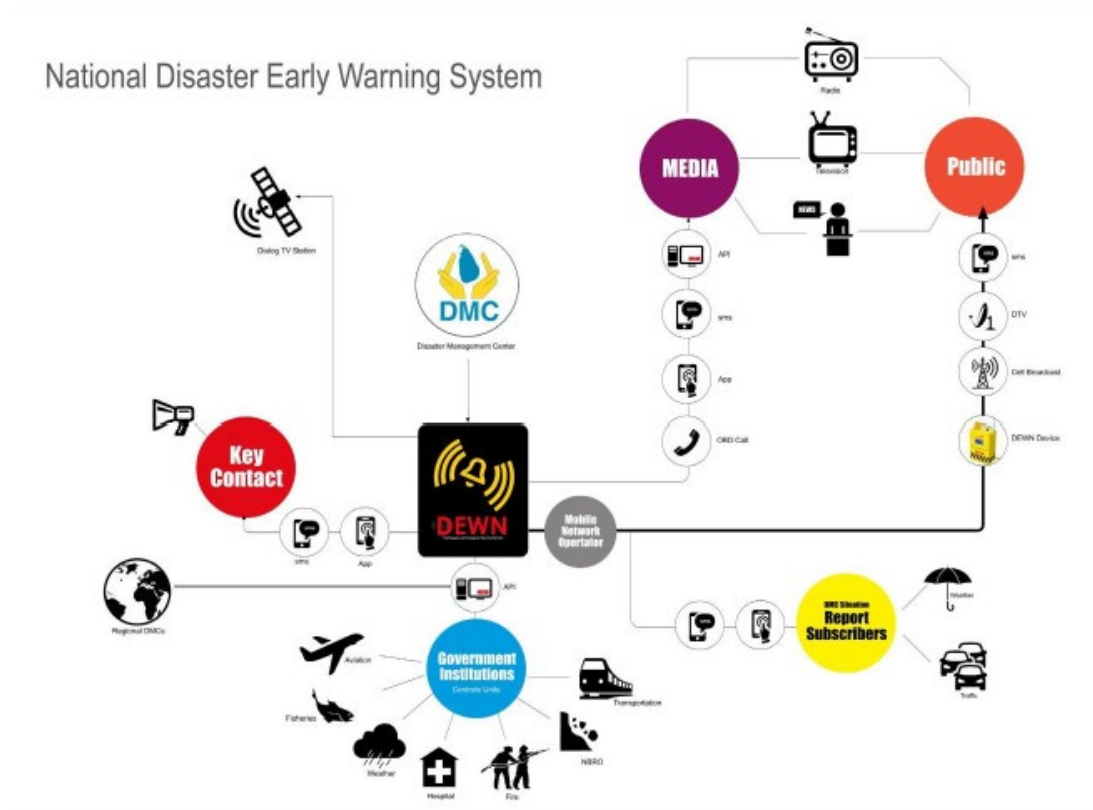


Figure 24: National Disaster Early Warning System

The existing early warning mechanism shows an increased response capacity where entire Eastern coastal community was evacuated within 55 minutes (March 2006) and 90% of the coastal communities were evacuated in 1.5 hours (April 2012) after issuing the Tsunami early warning [56].

Even though the Tsunami early warning mechanisms are strengthened the Post Disaster Needs Assessment of floods and landslides which occurred in May 2016, apparently identifies poor early warning and lack of flood modelling resulted in the almost total loss of household assets of the affected households [39]. Furthermore, Dodanduwa and Hikkaduwa fishery harbors not receiving the official red warning in time during the devastating weather hit on 29th November 2017 provides sufficient evidence of severe gaps in EW system [54].

Even though there are several pros and cons the existing Multi Hazard Early Warning System of the country (Figure 25) performs at its best to disseminate early warnings in time [57].

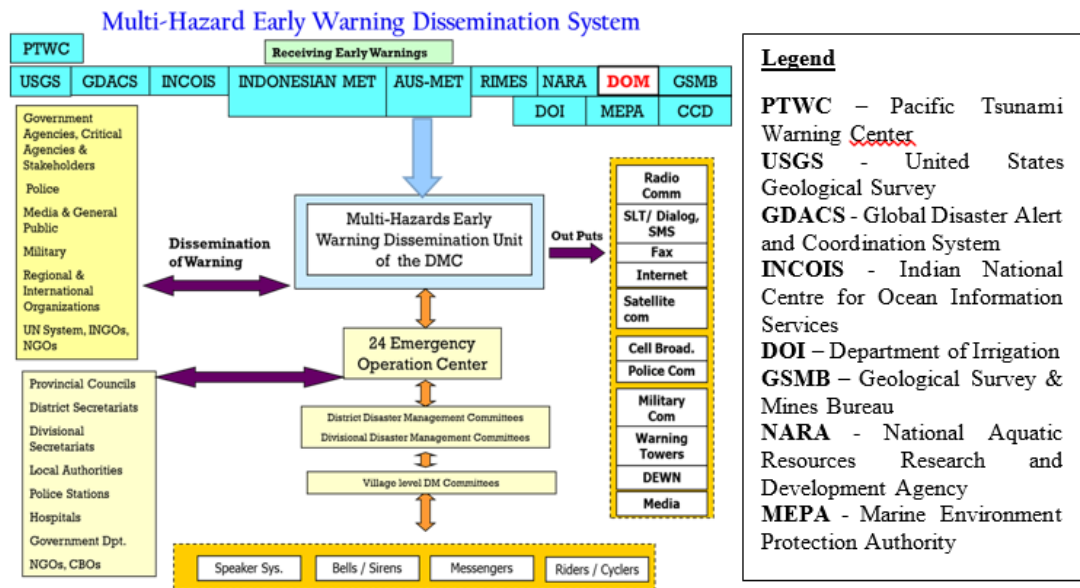


Figure 25: MHEWS of Sri Lanka

The threshold levels of various technical agencies during early warning mechanisms are mentioned in the Table 3 below [16].

Table 3: Threshold levels for various hazards

Hazard	Threshold Level
Tsunami	The lower boundary can be identified as the time at which the earthquake occurred
Flood	Time at which the water level reaches the flood level in rivers or reservoirs declared by relevant identified technical agencies
Landslide	Time at which the rainfall received reaches the saturation level.
Cyclone	Alert level of a cyclone can be defined well in advance by predicting the expected path of the cyclone. Boundary for alert is set 72 hours before the cyclone enters into Sri Lankan coast
Drought	Slow on-set; duration may vary depending on the terrain, environmental condition and geographical area, etc.

During the interviews, it was noted that the locally available techniques and methods could be used effectively to manage village level early warning systems. In addition, providing training to community leaders in early warning mechanisms is also highlighted [G5].

### 5.6 National Policies, Guidelines, and efforts

In addition to the policies and guidelines mentioned in chapter 3 there are several other plans and frameworks focused on coastal zone of the country. Some of the important plans and programmes are shown in Table 4.

Table 4 : Plans and programmes focused on Coastal Zone

Name	Description
Coast Conservation Act (CCA)	Provide the legal guidance to formulate and execute strategies and plans for coast conservation within the coastal zone [58]
Coastal Zone Management Plan (CZMP)	Provides for Capacity building for management, control coastal erosion, facilitate integrated management of coastal resources, operating permit system and setback standards, monitor coastal water quality [59]

The Sri Lanka National Oil Spill Contingency Plan (NOSCP)	Gives the scope, geographical coverage, and responsibilities related to the emergency response which may result due to an oil spill event which can harm the coastal belt of Sri Lanka[60]
Hazard Resilient Housing Construction Manual (HRCM)	The purpose is to promote the use of engineering design and correct construction practices to build hazard resilient houses. It is aimed at the national level [61]
National Guidelines for School Disaster Safety	Gives a detailed School Disaster Safety Plan which includes identification of hazards and resources, hazard assessments and awareness and training [62]

In addition to the above District Disaster Response plans and divisional disaster response plans are also available. All the documents are available online for the public to access whenever they need to gather information.

Furthermore, Disaster resilient city development strategies for Sri Lankan cities have been introduced by UN-Habitat program to strengthen the community resilience of the cities and townships in disaster-prone regions of Sri Lanka. Mannar [63] and Batticaloa [64] are such two coastal towns, which will be made resilient under those strategies. Improving the physical environment of the city by developing sustainable urban drainage systems and adapting to the built environment as well as integrating social and economic development by enhancing community networks are necessary for city resilience [63].

Furthermore, Community Resilience Framework developed by DMC identifies governance and risk knowledge as the two main essential aspects of a resilience community [65]. In addition, a guide to assess the community resilience to coastal hazards which was developed by the US – IOTWS identifies several benchmarks for the resilient components mentioned in the guidelines for Sri Lanka [9].

Summary of the said plans and programmes mentioned above is explained pictorially in the Figure 26 below.



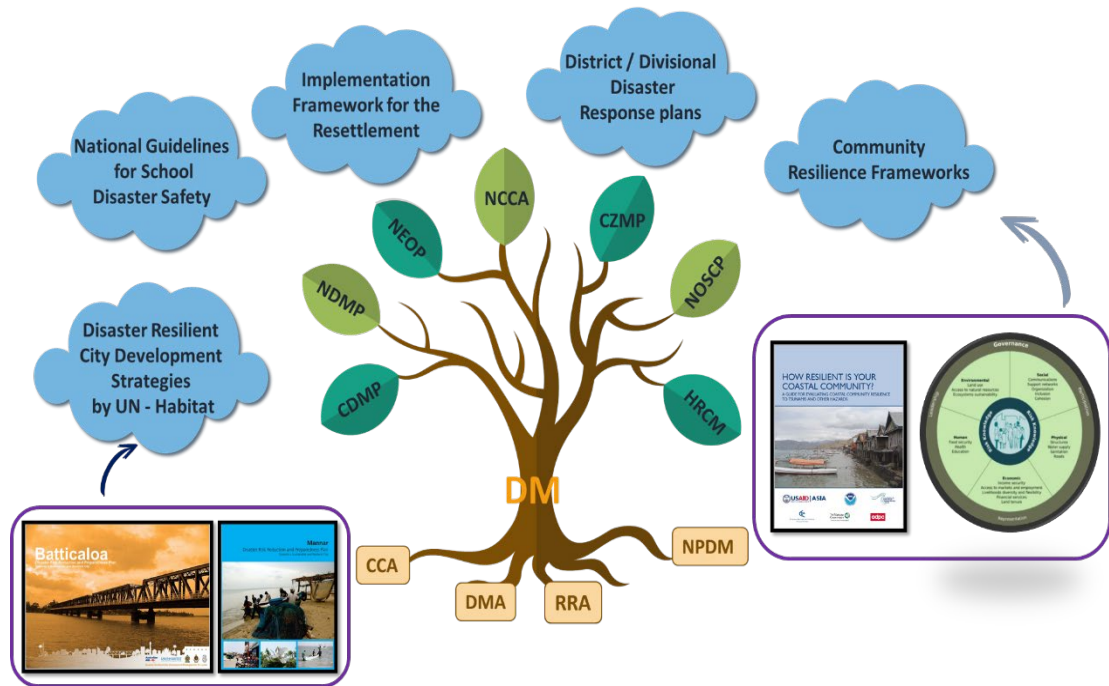


Figure 26: National plans and programmes for CCR

Community awareness programmes which include mock drills, community debriefing, participatory hazard mapping, boat handling, swimming and lifesaving, first aid, search and rescue missions and camp management, establishment of last mile communication methods and early warning mechanisms, implementation of rescue, relief and rehabilitation methods during a disaster are some of the positive outcomes of the said policies and plans.

When looking at the integration of these policies, guidelines, and frameworks to improve EW and coastal community resilience, interviewees mentioned that it is at a minimum, but provisions do exist [A1]. Considering the present status, Sri Lanka is mostly involved in post-disaster activities while the authorities must be proactive and focus more on Disaster Risk Reduction [A2]. Furthermore, DoM believes that for specific weather forecasting local area modelling is required [G10]. High-performance computer systems are needed to do said local area modelling to run high-resolution models. At least one model is needed for each province for better performance. Sri Lanka is included in the Regional Models and forecasting, but downscaling is required to give a localized prediction. Furthermore, weather

dynamics in the tropical areas are not understood very well thus forecasting has become difficult to greater accuracies [G10].

DoM believes that the application developed by DoM is said to be more accurate for weather forecasting in Sri Lanka compared to the “Accuweather” which is used worldwide. However, DoM needs to make it more attractive and user-friendly. DoM also have developed a High Heat Index (HHI) with the Ministry of Health that can be used efficiently in months April and May [G10].

National Insurance Trust Fund (NITF) covers lives and properties up to LKR 2.5 million each in respect of damages (per event) caused to their property and contents due to cyclones, storms, flood, landslide, hurricane, earthquake, Tsunami and any other similar natural perils, excluding drought [34]. CCD believes that even though NITF is present, a focused insurance method for coastal hazards does not exist [G6]. Furthermore, National Planning Department (NPD), has not given priority to the coastal zone when making plans for public hazards [G6]. The professionals involved in Disaster Management sector believes that the release of dams and resulting sudden additions of water to the coastal area due to climate-induced floods; ocean acidification due to climate change and temperature relationship with EW must be considered when designing the Early Warning systems for Sri Lanka [P11].

### **5.7 Regional Cooperation**

There are several regional stakeholder partnerships to support effective EW systems and increase the disaster resilience of coastal districts in Sri Lanka. The island is one of the member states of Indian Ocean Tsunami Warning and Mitigation System (IOTWMS) where DoM acts as the National Tsunami Warning Centre for the country [66]. Furthermore, Sri Lanka is one of the twelve member states of The Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) which aims to establish a regional early warning system within a multi-hazard framework to initiate and convey early warning information, and build capacity to prepare and respond to trans-boundary hazards [67]. In addition, the country is also a partner of Regional Specialized Meteorological Centre (RSMC) for cyclones over North Indian Ocean, which will issue tropical weather outlooks and tropical cyclone adversaries in

the WMO/ESCAP panel region [68]. The Coastal Community Resilience (CCR) is a focused initiative funded by Asian Disaster Preparedness Center (ADPC) that promotes tsunami and other hazard readiness via the dynamic cooperation of state and provincial emergency management agencies, coastal managers, training institutions, and local communities [G6]. Sri Lanka being a part of it will increase public awareness, create required standards and promote sustainable livelihood in the country [69]. Furthermore, Sri Lanka is a member of the Asia Pacific Alliance for Disaster Management (APADM), which is an agreement among the stakeholders in order to implement effective and efficient relief and recovery activities [70].

Sri Lankan experts also contributed in preparing the Tsunami Risk Assessment and Mitigation for the Indian Ocean to inform and assist relevant stakeholders at both local to national levels in assessment of the tsunami risk [71]. Coast Conservation Department (CCD) has taken part in several workshops where most of them were focused on Coastal and Marine Risk Mitigation Plans [G6]. During some these workshops, it was identified the fact that low-lying areas of Sri Lanka which are just above the sea level are likely to be hard hit by a sea level rise [72]. CCD is also working with the Indian Ocean Ring Association (IORA), which has Disaster Management as one of the priority areas. Its member States are considering the cooperation in three main areas namely; early warning, disaster risk reduction and the establishment of regional response capabilities. Figure 27 shows the summary of Sri Lanka's involvement in different international organizations.



Figure 27: Sri Lankan membership in international organizations

Some of the primary objectives of the regional cooperation of CCD is erosion maintenance, management of river outlets, Implementation of Coastal Zone Management Plan (CZMP) and obtaining assistance in the preparation of CZMP and guidelines [G6]. Sri Lanka should engage in regional dialogue and have mechanisms to incorporate geographical knowledge into the national efforts [G9]. Regional stakeholder partnerships can be efficiently used in capacity building and disaster response as well. Oil spills are one specific example that requires regional alliances and corporation. During the interviews, it was further noted that for slow-onset disasters like water or air pollution, efficient information sharing and related capacities are needed [P11].

## **5.8 Role of Higher Education Institutes**

There are several government and private universities in Sri Lanka, which provide their knowledge and expertise for to build capacity and preparedness of coastal communities. Most of the involvements are through education and awareness programmes, providing expertise and advocacy in policy planning, research and university industry partnerships.

### **5.8.1 Education and awareness programmes**

University of Moratuwa [73] and University of Peradeniya [74] offers several modules in their Masters programmes which are directly related to Disaster Management. In addition, Open University of Sri Lanka conduct courses on Disaster Management, climate change and ground water resources management and pollution control [A1]. These courses focus on the coastal communities up to a certain extent.

Some of the interviewees mentioned that they are not much aware about the education and awareness programmes which are available for coastal hazards. But according to DMC, they are currently conducting several EW awareness and training campaigns for the coastal communities in collaboration with university experts [G5]. The capacities need to be enhanced to achieve the target outcome from them.

In addition, 5<sup>th</sup> Asia-Pacific Climate Change Adaptation Forum was held in Sri Lanka which included a separate session on climate resilient development. Ministry of

Mahaweli Development and Environment was one of the key organizers of this event which included the participation of experts from universities as well.

Education curriculums could integrate social learning processes that deals with coastal resilience to hazards. Integrating the topic to student projects in fields such as Civil Engineering, coastal and environmental engineering, sustainable development would enrich engineering education with other useful topics such as social designs, long-term perspective, resilience, vulnerability etc [G7]. In addition, Open University of Sri Lanka states that the courses are open for government employees as well but participation is a problem due to lack of motivation [A1]. Most of the certificate programs cost around LKR 10,000 and 100 hours of education for one year. Sponsorships are required to enhance the participation. Private sector and NGOs participate willingly. Furthermore, IUCN believes that HEI's need to update the curricula to adopt to new technologies, changing climate and resulting new/enhance hazards etc [P11]. At the same time HEIs needs to make Disaster Management attractive to be taken as a profession or major component of other professions.

### **5.8.2 Expertise and advocacy**

As already happening in Sri Lanka, the experts could engage in policy advocacy. Organizing such expert consultancy by interdisciplinary groups of experts may support well in addressing complexities of coastal resilience. In addition, they should take part in the National Disaster Management Committee and the plans must be more people oriented. In addition, professional advocacy needs to be based on global and local knowledge based on facts [P11].

### **5.8.3 Research**

Cross-disciplinary and transdisciplinary research on MHEWS should be encouraged [A3]. In addition, the innovations must be low cost and community focused with the ease of implementation. Research dissemination should be web based even though it is not the current trend in Sri Lanka [A4]. Furthermore, during the data collection stages more focus should be given to the communities and village level involvement rather than the officers in national levels as well as more partnerships with practitioners is the key for applied research [P11].

#### **5.8.4 Need of Strong University Industry Partnerships**

University Industry partnerships play a vital role when assessing various problems and situations which occur in Sri Lanka. The expertise within the universities combined with the funding and management capabilities of the industry always lead to strategic partnerships in creating effective programmes for the benefit of the communities and other stakeholders. This information provides a detailed description of the needs and requirements identified from the Symposium on ‘Creating University-Industry Partnerships’ mentioned in the methodology.

The discussions in the meetings yielded that the most important requirement would be the need of research topics, research problems and ideas. This was seen as a requirement which should be addressed by the industry, as the industry knows the problems they are encountering better. If the requirement is made from the industry side, the academia will be able to align their research to answer the problems, hence produce results which could be used by the industry.

Another important fact that risen was that the industry needs to be confident of the capabilities of the universities. It was raised that academia could be slow in producing results as the resource persons are busy with teaching, administrative work and other consultative work and with the hierarchical processes. Nevertheless, according to a study done in Australia, it should be noted that the universities could be holding the best and up to date knowledge on the subject, and multi-disciplinary approaches will be much enhanced with working with universities [75]. Therefore, the confidence of the industries towards universities has to be enhanced. Another point considered in the discussion was the availability of subject expertise and a mechanism to identify the subject expert.

Looking at an industry perspective, there is a limited number of links with universities which are not widespread. Most of the organizations tend to contact the same expert from the university since they have gained trust or has a good work history with them. But sometimes this expert may get busy with other projects and there can be several other experts who are yet to emerge. Hence if there is a good mediator who knows

very well about the expertise of the universities, he can coordinate properly with the industry to get everyone involved in the projects without any confusions.

Furthermore, Science and Technology Management Information System (STMIS) is a computerized information system which creates a working network among academic institutes, Research & Development Centres and industry which is developed by the National Science Foundation (NSF) of Sri Lanka [76]. STMIS enables the professionals from industry to get registered in the database which will give them access to identify the required expert for their projects.

One final requirement would be the transparency in the policies and agreements. Many literature have shown that many questions rise with regards to the ownership of the intellectual property (IP) and with the transfer of knowledge [77] and complications rise along with the rules and regulations [78]. The discussions strongly highlighted the delays and miscommunications took place due to the inefficient policies and regulations, which could be summarized as the discrepancies due to bureaucratic issues.

Furthermore, it was emphasized that the auditors should be more aware and educated with the auditing processes within the universities, as the funding cycles are present within the universities. It was considered that the policies and regulations should be more transparent to the industry as well as to the academia.

### **5.8.5 Barriers & challenges**

The mismatch of expectations by diverse stakeholders such as the academic experts, funding organizations, policy networks, affected communities, general public etc, hinders successful coordination of projects, and hinders the social impact [A3]. HEIs often face the challenge of their research findings are overlooked in the policy formulation process.

In addition, less attendance for the programmes and duplicate innovations are some of the problems, which exist in HEIs was also highlighted [G5]. Furthermore, exposure for the local graduates is less in the field of Disaster Management.

In adequate resources; lack of capacity to think beyond the main subject area or expertise and developing integrated solutions by partnering with other entities/agencies; in country issues during obtaining patents for new technology developments and poor recognition are some of the main obstacles faced by HEIs [P11].

## **5.9 Evacuation planning in coastal communities**

Evacuation planning is getting more complexed due to the increase of population as well as the natural disasters. It has several consecutive phases which eventually leads to the successful evacuation of all the affected victims while reducing the number of deaths [79]. When looking at the Sri Lankan context, successful evacuation scenarios is handful compared to the occurred disasters. Since this has a broader trajectory in assessments coastal communities were selected.

As mentioned in section 5.2 an online questionnaire was distributed. This was done particularly to target the community who are using internet in the urban areas. Surveys were distributed mostly via social media and emails. 102 questionnaires were collected during this survey. Next sections provide the analysis carried out to provide suitable recommendations.

### **5.9.1 Demographic information**

Out of the 14 coastal districts, information from 9 districts were being able to collect. Most of the data is concentrated to Western province and Southern province as in (Figure 28) hence the conclusions will be more focused to those two provinces. Most of the people who are responded were from the engineering & higher education sector. 34% were female respondents as well. More than 70% of the families consists of 4 to 5 members and at least one person has a mobile phone.

Furthermore when looking at the education level of the families responded more than 90% of them has at least one member who has diploma level or university level education. Facebook is the most commonly used social network by the respondents. In addition more than 50% of the respondents believe that the road conditions and the public transport facilities in their area is satisfactory.



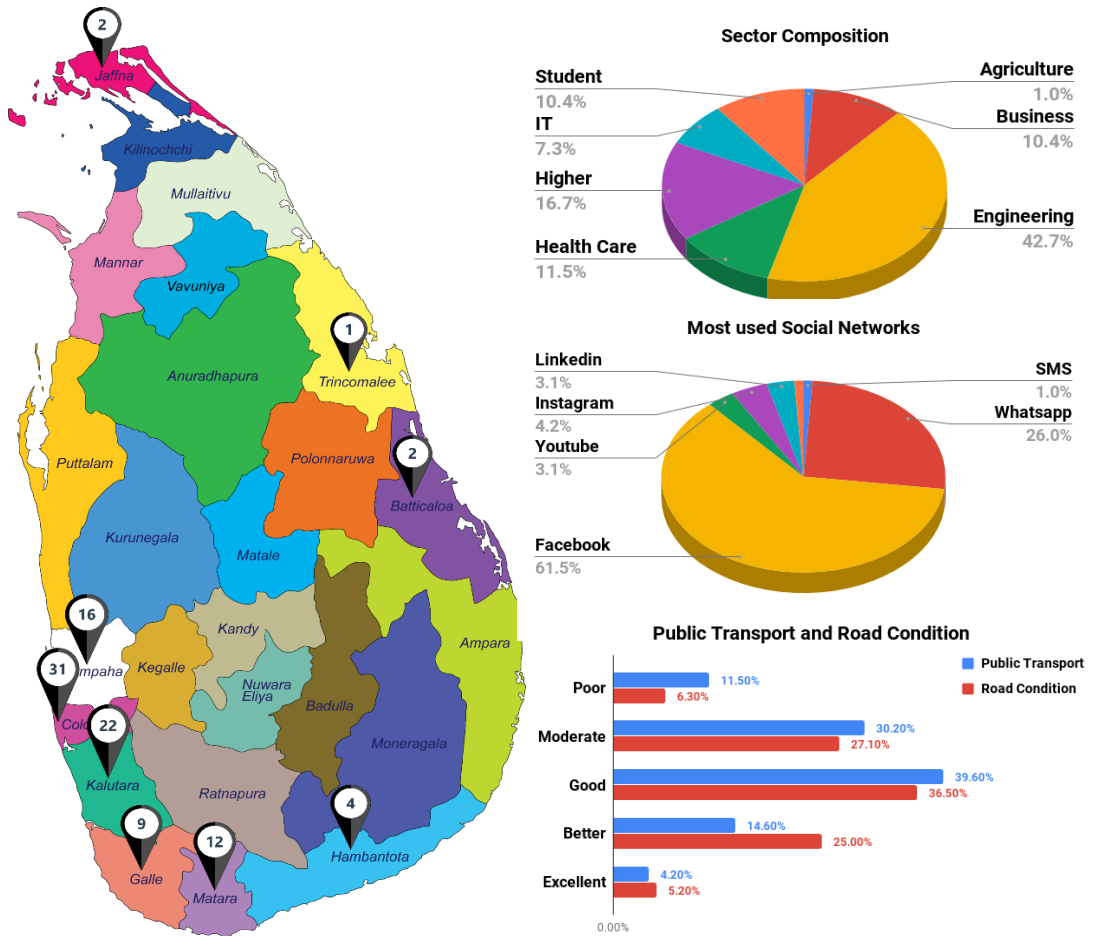


Figure 28: Demographic information of the respondents

### 5.9.2 General opinions related to hazards

More than 40% of the respondents think that storms, floods and lightning strikes will affect their area while 15% were confident that their area is hazard free (Figure 29). This might be due to lack of awareness of the terminology.

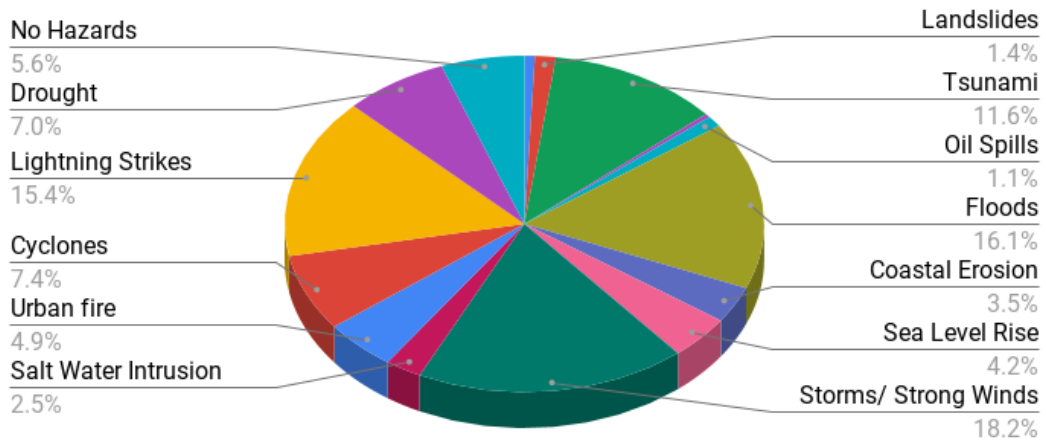


Figure 29: Hazards which will affect the respondent's areas

### 5.9.3 Trust on authorities

When rating the trust placed on the authorities towards the notices issued by the authorities to evacuate for a disasters more than 70% rate it below 3, on a scale of 1 to 5. This is a critical issue which needs to be addressed which shows that communities will not take the evacuation notices seriously. Some of the reasons stated are mentioned below.

- *“Announcements by local authorities are reliable as those are issued right prior to the disaster, but the predictions issued by Met department is inaccurate”*
- *“We didn't get any prior notice in the case of 2004 tsunami”*
- *“Authorities inform NEWS regarding natural disasters using national media services. But sometimes their notices are untimely and in some other cases, unnecessarily exaggerated. Therefore I rated as 3 above.”*
- *“I think it is very important to respond to disaster warnings from the respective authorities even though the level of trust is low, because otherwise if something happened the loss will be severe.”*
- *“Did not received any warning on strong winds passed recently”*
- *“Even if a warning is issued, it takes a significant amount of time to reach the general public, when by which the disaster might have already happened. and the accuracy of predictions I don't trust”*
- *“For an example if you take the weather forecast, it's never forecasted correctly. So I don't really believe in any notices issued regarding weather. But if the nature/environment itself warns out, then such situations will be taken seriously and evacuate as necessary.”*
- *“Sri Lanka has improved surveillance and other facilities regarding disaster management. Developed communication abilities. Increased awareness and knowledge on disasters and management. Since living an area close to the capital city, authorities may be having special attention to these areas.”*

When analysing the comments it is visible that most respondents do not believe in warnings issued by DoM. Some have noted that since they haven't faced any disasters

yet they do not have any experience related to evacuation notices. This shows that training drills are necessary to make the communities aware about the evacuation notices.

#### 5.9.4 Way of receiving Early Warning messages

Way of getting early warnings also play a pivotal role during evacuation. Most of the respondents get early warnings via Facebook, TV and Mobile phone SMS. (Figure 30). During a disaster sometimes access to internet might not be possible.

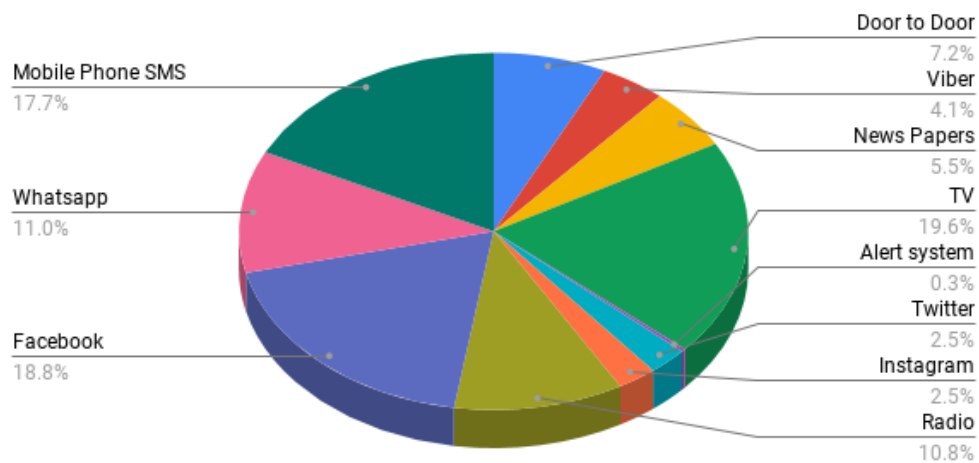


Figure 30: Ways of receiving early warnings by the respondents

According to the Shapiro – Wilk normality analysis done to find a correlation between the respondent’s district and social media, all the selected variables have a significance less than 0.05 which depicts that the data significantly variate from normal distribution. Furthermore, there are some outliers as well. In addition, way of getting EW messages are ranked from ineffective to most effective where the variables will be ordinal. Hence it can be concluded that we have to go with spearman correlation method.

From the analysis and the results shown in Figure 29, it was visible that there aren’t any correlation between the respondent’s districts and preferred way of getting EW messages. But it was visible that there are weak positive correlations between Facebook, WhatsApp, Twitter and other social media. This shows that a selected individual respondent has a slight similarity on their opinion of social media.

			Correlations							
			District	SMS	Facebook	Whatsapp	Twitter	Other_SM	Media_channels	Printed_media
Spearman's rho	District	Correlation Coefficient	1.000	-.051	.012	-.073	.005	-.210*	.047	.013
		Sig. (2-tailed)	.	.621	.911	.478	.959	.040	.649	.902
		N	96	96	96	96	96	96	96	96
	SMS	Correlation Coefficient	-.051	1.000	-.027	.063	.103	.199	.125	.009
		Sig. (2-tailed)	.621	.	.795	.544	.319	.052	.223	.931
		N	96	96	96	96	96	96	96	96
	Facebook	Correlation Coefficient	.012	-.027	1.000	.243*	.263**	.105	-.084	.006
		Sig. (2-tailed)	.911	.795	.	.017	.010	.308	.414	.950
		N	96	96	96	96	96	96	96	96
	Whatsapp	Correlation Coefficient	-.073	.063	.243*	1.000	.418**	.341**	-.296**	-.101
		Sig. (2-tailed)	.478	.544	.017	.	.000	.001	.003	.329
		N	96	96	96	96	96	96	96	96
	Twitter	Correlation Coefficient	.005	.103	.263**	.418**	1.000	.286**	-.007	.025
		Sig. (2-tailed)	.959	.319	.010	.000	.	.005	.950	.809
		N	96	96	96	96	96	96	96	96
	Other_SM	Correlation Coefficient	-.210*	.199	.105	.341**	.286**	1.000	-.045	.047
		Sig. (2-tailed)	.040	.052	.308	.001	.005	.	.662	.650
		N	96	96	96	96	96	96	96	96
	Media_channels	Correlation Coefficient	.047	.125	-.084	-.296**	.007	-.045	1.000	.034
		Sig. (2-tailed)	.649	.223	.414	.003	.950	.662	.	.741
		N	96	96	96	96	96	96	96	96
	Printed_media	Correlation Coefficient	.013	.009	.006	-.101	.025	.047	.034	1.000
		Sig. (2-tailed)	.902	.931	.950	.329	.809	.650	.741	.
		N	96	96	96	96	96	96	96	96

\*. Correlation is significant at the 0.05 level (2-tailed).

\*\* . Correlation is significant at the 0.01 level (2-tailed).

Figure 31: Spearman Correlation results for districts vs EW messages

Furthermore, WhatsApp and media channels have a weak negative correlation which shows a tendency for the respondents to prefer either one of them to get EWs.

In addition, from the District & Social Network cross tabulation it was observed that more than 80% of the respondents either use Facebook or WhatsApp as a social media network.

During the 2018 rains several early warnings were disseminated via Facebook as shown in the Figure 32.

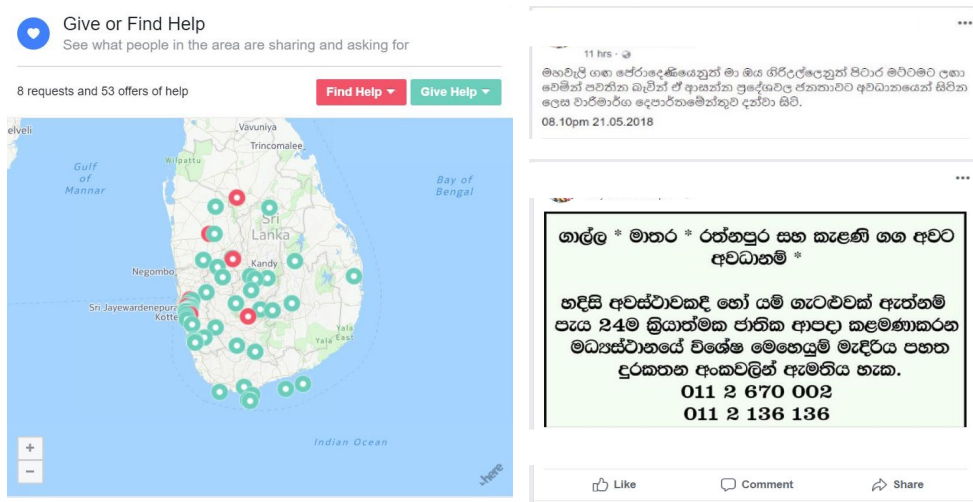


Figure 32: Early warnings via Facebook during 2018 rains

Respondents also have mentioned that conveying early warnings via Mobile Phones and door to door methods are very effective while use of newspapers to distribute early warnings was not as an ineffective way.

In addition, around 70% of the respondents are capable of passing the early warning messages they get to more than 10 people.

### 5.9.5 People with reduced mobility

During an evacuation protective care of people with a higher vulnerability is necessary. These include infants and kid who are below the age of 5 years, elders who are older than 60 years and disable people. During the study only 6% had children below age 5 in their families. In addition, more than 50% of the families had elders who are older than 60 years. This shows that these respondents should take special precautions during evacuation in concern with their family members. Since only 7 respondents mentioned that they have someone with disabilities, data was not enough to come to a proper conclusion.

### 5.9.6 Evacuation drills and training

74% of the respondents have not undergone any evacuation drills. Most of them were from Colombo, Galle, Gampaha, Kalutara and Matara districts. 26% of the respondents who said that they have experience of drills noted that it was mostly Tsunami evacuation drills, fire drills at their work places and first aid drills. It also shows that some of them have not understood the question carefully when looking at the responses like first aid drills. It was also noted that almost every sector responded have at least 10% of respondents with evacuation drill experience as in Figure 33.

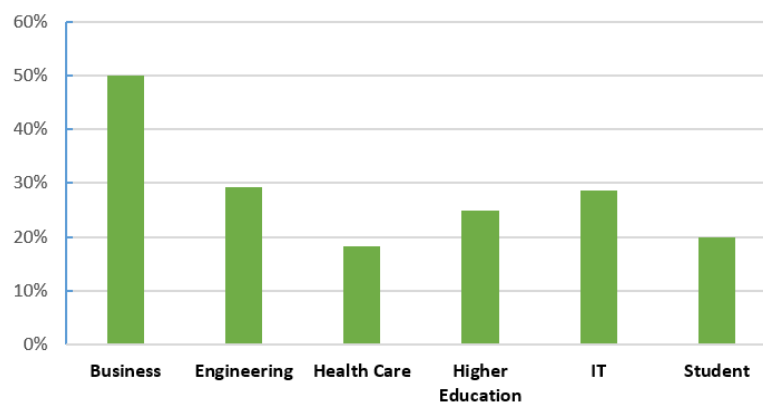


Figure 33: Experience of Evacuation drills

### 5.9.7 Family Vehicle

Sometimes having a family vehicle helps a speedy evacuation for the residents except during a flood. 81% of the respondents said that they have a family vehicle and most of them were cars which has the capacity to carry around 5 five passengers. In comparison to the total number of family members of the respondents only 60% of them have the capability to carry their entire family at once during an evacuation by their vehicle.

### 5.9.8 Domestic animals

Some people who has pets and other domestic animals (people with farms) will always tend to care about them. During this survey the importance of this issue was analysed and out of the respondents 47% had domestic animals and 78% mentioned that they will put an extra effort to carry their pets during an evacuation while the others believe that the animals can survive by themselves.

### 5.9.9 Evacuation routes and shelters

Knowing the safest and fastest ways to the evacuation shelters helps the residents to get out of their houses and reach a more convenient place in time. In addition identification of the safest place in the relevant area which can provide shelter is important. According to Figure 34, 37% of the people said that they know the evacuation routes while others were either not sure or thought there aren't any.

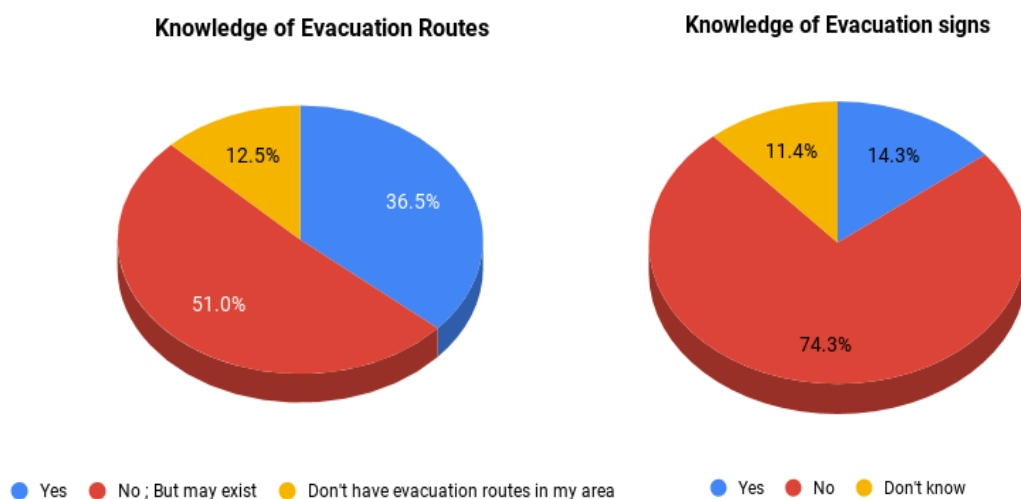


Figure 34: Knowledge of Evacuation routes and signs

Out of the 37% who said they know about the evacuation routes, 74% firmly said that there are no any evacuation signs along the routes. 14% who said there are evacuation routes were keen enough to send some of the signs of evacuation routes in their area. Most of the evacuation signs in the country are for Tsunamis as shown in Figure 35. But for the other disasters there are hardly any.

In addition, only 18% of the respondents know the evacuation shelters in the area. This is significantly a low value which the authorities should take immediate action by conducting awareness programmes. Religious places, schools and hospitals can be taken as evacuation shelters since most of them are in a higher ground. According to the survey, respondents said that it will take around 5 – 10 minutes to reach the nearest shelter in their areas. All of the 18% who said they know the evacuation shelter were confident that they know the shortest routes.

Furthermore, 60% of the respondents said that they don't have any personal experience of a disaster. Most of the remaining 40% has experience related to Tsunami, strong winds and floods. More than 70% of them rated their evacuation experience by giving a value greater than 3 within a scale of 1 – 5 where 1 been poor and 5 been excellent.



Figure 35: Evacuation signs in coastal area

### 5.9.10 Relatives and neighbours

During an evacuation looking after the relatives and neighbours become sometimes priority rather than evacuating your own self. As shown in Figure 36, 80% of the respondents said that they will put an extra effort to take their neighbours with them if they are not capable. 6% of the respondents believed that they do not have enough space in their vehicles to carry them while 12% believe that they are capable to evacuate by themselves

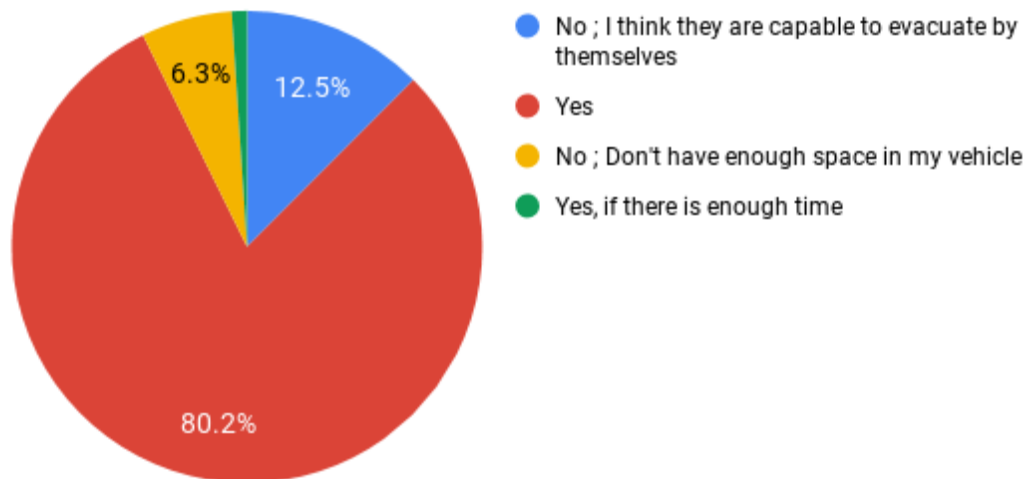


Figure 36: Responses giving opinions about relatives and neighbours



### 5.10 Identification of key elements in measuring CCR

Measuring CCR can be very important for decision makers and city planners to assess the capacities and preparedness of their cities. By referring to the documents, plans and programmes mentioned under section 5.3.4, at present Sri Lanka has two resilience frameworks which gives abundance of information on how to measure resilience. Figure 37 shows some of the similarities of the concepts given in both of them.

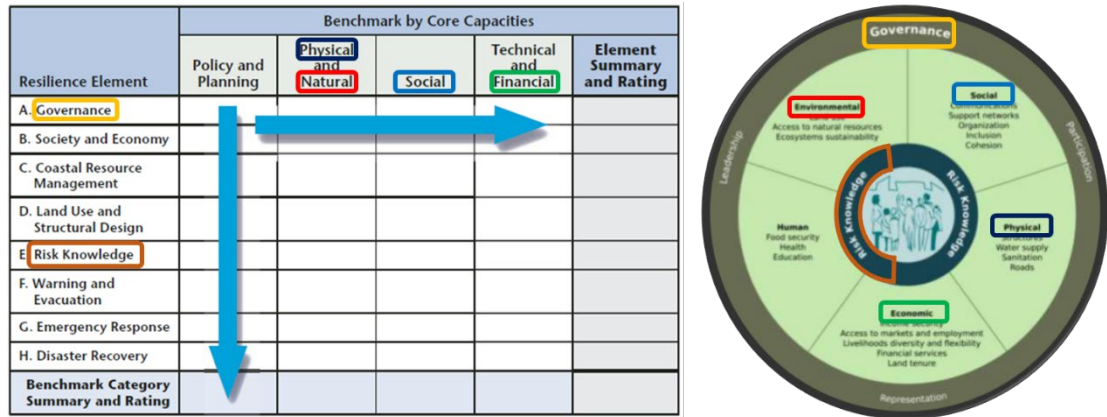


Figure 37: Benchmarks given in “How Resilient is your coastal community” guide (Left) and elements in Community Resilience Framework in Sri Lanka (Right)

Since Community Resilience Framework (CRF) is the more recent one, measuring criteria for the main five elements namely; Human, Social, Environmental, Economic and Physical mentioned in CRF will be assessed with reference to literature. In this framework DMC Disaster Risk Reduction and Preparedness Plans (DRRPP) developed by UN-Habitat for Kalmunai, Batticaloa, Rathnapura, Akkaraipattu, Vavuniya, Balangoda and Mannar cities give various information on parameters to assess vulnerability and preparedness which directly affects community resilience. In addition, National Influenza Pandemic Preparedness Plan (NIPPP) gives additional information related to health sector as well [80].

Most of the measuring criteria for the elements identified can be measured qualitatively rather than quantitatively which are mentioned below. The components, which were not highlighted in the literature, were referred as NM.

### 5.10.1 Physical element

According to definitions, physical elements are defined as the basic infrastructure that people use to function more effectively. Some of the measuring criteria identified are shown in Table 5.

Table 5: Physical elements

Type	Methodology		Source
	Qualitative	Quantitative	
% population with access to cell phones, radio, Internet		x	CRF
% households with electricity supply		x	CRF
% households with access to clean water		x	CRF
No of community productive assets (e.g., roads, markets, grain banks, irrigation, water storage tanks)		x	CRF
No of Structures within a community		x	CRF
Quality of Public transport	x		CRF
Resilience of the existing structures	x	x	HZRM
Building and maintenance of public goods structures	x		NM
Topography & soil conditions of the lands	x		HZRM
Accessibility to the structures	x		HZRM
Conflict management structures	x	x	NM

### 5.10.2 Human element

The sum of skills, knowledge, labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood outcomes belong to the human element in a resilience framework. Some of the measuring criteria identified are shown in Table 6.

Table 6: Human elements

Type	Methodology		Source
	Qualitative	Quantitative	
School enrolment, school completion (primary, secondary)		x	CRF
Literacy rate		x	CRF
Health status and trends (presence of infectious disease, chronic disease)		x	CRF, NIPPP
Immunization coverage		x	NM
Nutrition status		x	NM

% Population with convenient access to health care		x	NM
% Global and severe acute malnutrition rates		x	CRF
Attitudes toward change	x		NM
Attitudes toward the value of education	x		NM
Gross / net enrolment rates		x	CRF
Health Education	x		NIPPP

### 5.10.3 Economic element

The cash that enables people to adopt different livelihood strategies, which is in the form of savings or a regular source of income, belongs to the economic element. Some of the measuring criteria identified are shown in Table 7.

Table 7: Economic elements

Type	Methodology		Source
	Qualitative	Quantitative	
Opportunities for new businesses to be developed; business support networks and services	x		NM
% of population covered by formal or informal banking /credit groups		x	NM
Savings groups		x	NM
% of population covered by hazard insurance (e.g., crop insurance, weather-based index insurance)		x	NM
Income level		x	CRF
% of households with secure access to land for livelihood purposes		x	CRF
Livestock numbers and value		x	CRF
Crop production / value		x	CRF
Access to functioning markets	x		CRF, DRRPP
Access to saving and credit facilities	x		CRF, DRRPP
Agricultural employment		x	DRRPP
Access to agro / livestock extension services	x		CRF
% population with contingency/emergency funds		x	NM

#### 5.10.4 Social element

Access to and participation in networks, groups, formal and informal institutions belongs to the social element. Some of the measuring criteria identified are shown in Table 8.

Table 8: Social elements

Type	Methodology		Source
	Qualitative	Quantitative	
% Population participating in traditional self-help groups (e.g., informal insurance groups, funeral associations, others as defined locally)		x	NM
Attitudes toward sharing food and other resources within community	x		NM
Presence of formal and informal conflict resolution mechanisms	x		NM
Knowledge-sharing by different stakeholder groups	x		NM
Satisfaction with the way decision-making is assigned	x		CRF
Subjective levels of trust and support	x		CRF
% of land use for cultivation within community boundaries		x	NM
Valuation of knowledge from older generation	x		NM
% Membership in community organizations		x	NM
Presence of community-based organizations representing diverse constituencies	x		CRF
Residential Population (Density & No of households)		x	DRRPP
% Population living in peace and security		x	CRF
% year there are no incidences of conflict / insecurity		x	CRF
% population covered by hazard mitigation plan		x	NM
% population covered by emergency response plan		x	NM
Condition of buildings (% Semi permanent and permanent houses)		x	DRRPP
Families receiving 'Samurdhi'		x	DRRPP

### 5.10.5 Environmental element

The environmental resources and associated services upon which resource based activities depend highlights the components in the environment element. Some of the measuring criteria identified are shown in Table 9.

Table 9: Environmental elements

Type	Methodology		Source
	Qualitative	Quantitative	
Wetlands acreage and loss		x	NM
Erosion rates		x	NM
% impervious surface		x	NM
Biodiversity		x	NM
Presence/coverage of communal resource management structure	x		NM
Water quality	x		NM
Quality of terraces, berms, drainage channels, etc.	x		NM
Main type of land tenure (own, rent, sharecrop)		x	NM
Extent of natural tree cover		x	CRF
Policy & Legal support	x		CRF
Rate of deforestation		x	CRF
% time quality pasture available		x	CRF
No of Paddy lands		x	DRRPP

There can be several other parameters which are not mentioned above. This initial assessment can be used to develop a Community Resilience Assessment tool which can be updated later.

## **6 CONCLUSIONS & RECOMMENDATIONS**

### **6.1 Conclusions**

1. The alignment of the DMA and SLNDMP with the Sendai framework is poor. Resource allocation and Multi – stakeholder approach is visible up to a certain extent while localized and data driven approaches, preparedness and building back better are the lacking key elements.
2. The alignment of the DMA and SLNDMP with UNISDR coherence and integration guideline is also in a poor form. Link mechanisms for monitoring and reporting of linked goals and indicators is not visible while interagency cooperation in implementation of DM frameworks exists to a certain extent.
3. Due to the implementation of DMA and SLNDMP, Sri Lanka as a whole had been able to face the disasters up to a certain satisfactory extent by introducing several plans and programs for DRR, developing early warning systems, providing funds to carryout rescue, relief and rehabilitation work and carrying out awareness campaigns.
4. Overlaps in functions of NCDM, DMC, NDRSC, lack of involvement of local governments in DM activates and proper time frames and deadlines and several gaps in institutional frameworks are some of the demerits of implementation of DM frameworks in Sri Lanka.
5. When looking at the DM frameworks in other countries there are several practices, which can be included in Sri Lankan frameworks in order to strengthen the DRR measures in Sri Lanka.
6. Upgrading the national hazard profile and developing a vulnerability profile for the whole country is necessary to produce a risk profile for the country, which will assist DMC and other line agencies to issue more consistent early warnings.
7. Developing proper guidelines for the building and construction infrastructure is essential to build disaster resilient structures and increase the preparedness of the vulnerable communities.
8. Identifying the impacts of coastal hazards at all levels is important before developing a Multi Hazard Early Warning System for coastal resilience.

9. Sri Lanka has a detailed Early Warning Dissemination System where the productivity and efficiency is questionable considering the recent disasters
10. Sri Lanka has done hazard assessments for the coastal hazards individually, but has not carried out detailed multi – hazard assessment focusing on the coastal zone.
11. After the 2004 Indian Ocean Tsunami Sri Lanka has put lot of effort in Tsunami Early Warnings while the focus on other disasters like adverse weather conditions
12. At present the lack of inter-agency cooperation and advanced technology has generated inefficiency in the existing early warning systems.
13. Some of the policies which exist do not focus directly on coastal hazards but the ones which do, are not getting updated in a recurring manner.
14. Both soft and hard resilience mechanisms for coastal hazards must be upgraded to build the capacity of the coastal communities.
15. Sri Lanka has involved in regional efforts for coastal resilience in a satisfactory way.
16. Training and public awareness campaigns, efficient funds, properly maintained hierarchy and concern to the coastal eco systems are some of the enablers associated with effective coastal resilience.
17. Role of Higher Education Institutes in coastal resilience is very important in education and awareness programs as well as on research work for new inventions.
18. UIPs in DRR segment in Sri Lanka are not a common and popular phenomenon for most universities and for most industries, on contrary of the urging need of both universities and industry getting together.
19. In order to implement an effective university industry landscape, well defined transparent policies and regulations are needed.
20. Mismatch of expectations of the stakeholders and lack of participation in the awareness programs are some of the barriers HEIs face in their role of building community resilience.
21. Most of the people lack their trust in authorities (mainly DoM) during early warnings.

22. Facebook and WhatsApp can be used to disseminate EWs effectively during a disaster
23. Experience on evacuation drills and knowledge about evacuation routes and shelters are very minimum in the coastal communities

## **6.2 Recommendations**

1. Clearly define roles of and demarcate functions between main institutions responsible for disaster management activities.
2. Increase the accountability of main institutions by holding regular meetings of DMC, and minutes of the meetings should be presented to Parliament in order to keep the legislature updated on disaster management activities and ensuring legislative oversight over the executive.
3. Facilitate participation by multiple stakeholders by amending the existing act, while including provisions for establishment of disaster management coordination units.
4. Refer to strengthening the State's accountability as paramount in delivering disaster management services to the community.
5. Update the Preamble to refer the Sendai Framework in place of the Hyogo Framework and include a supporting paragraph that drives the message of DRR and Build Back Better, and the UNISDR message on coherence and integration of the SDG and climate change agreements. Make direct reference to the government's Sustainable Development and CCA agenda, policies and plans so that DRR and DRM activities are designed and prioritized for mutually beneficial outcomes.
6. Language around data collection, monitoring and evaluation, and the availability of data in an accessible manner.
7. Upgrade National Hazard Profile: The Sendai Framework adds biological and man-made hazards to Hyogo Framework for Action (HFA) and increases the scope of action in recovery, rehabilitation and reconstruction. The focus on different types of hazards demands understanding the key characteristics of hazards, which includes their magnitude, active time, and frequency. Such an



effort may require upgrading the National Hazard Profile developed by the DMC, with UNDP assistance.

8. Develop vulnerability Profile: Sri Lanka initiated the drafting of hazard maps. However, authorities should endeavor to prioritize the development of a vulnerability profile, without which Sri Lanka is unable to have a clear understanding of exposure to risk. This data is also necessary to develop Risk Maps. The progress of DRR activities will be stifled without the presence of this baseline information.
9. Develop guidelines for the design and construction of infrastructure: Infrastructure loss and damage accounts for a significant proportion of financial resources following a disaster, as well as posing a safety risk for inhabitants. To 'Build Back Better' requires developing guidelines for design and construction of infrastructure in hazard prone areas. On this front, a proposal to develop building codes for Sri Lanka is being led by the National Building and Research Organization (NBRO). It is important that the MDM and DMC provide strong support for this activity.
10. Integrate soft and hard resilience mechanisms for coastal hazards.
11. Carryout training and public awareness campaigns in an effective manner to increase the participation of the villagers, target communities and the relevant officers.
12. Increase the input from HEIs in decision making and provide sufficient funds to carry out research work and produce sustainable inventions.
13. Involve in regional efforts on coastal resilience and early warnings and take a leading role to improve the performance of existing early warning systems.
14. Improve the data availability for investigating, forecasting/predicting and managing risks on different time scales.
15. Introduce mechanisms for sustaining the early warning dialogue and supporting the development.
16. Entrepreneurial leadership should exist in creating sustainable UIPs with the inclusion of an experienced mediator.

17. Develop a proper community resilience measurement tool starting from qualitative measurements leading up to quantitative measurements which will help the decision makers focus more on vulnerable components during urban planning.
18. Focus more on the development of a people-centered Early Warning systems as shown in Figure 38.

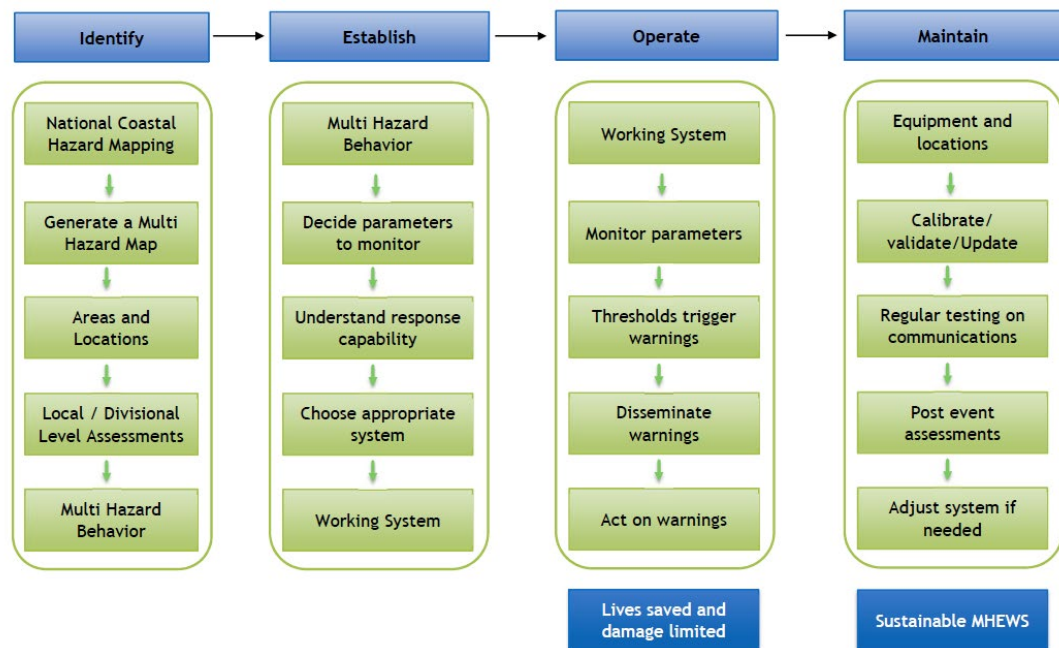


Figure 38: People centred Early Warning Mechanism

19. Authorities can look forward to disseminate EW messages via commonly used social media like Facebook and WhatsApp during a disaster.
20. Awareness of coastal communities related to evacuation planning should be given more focus to increase the reactive capacity to disasters.

In addition to the above recommendations some of the enablers which enhance the role of HEIs in the field of DRR is mentioned in Figure 39 below.

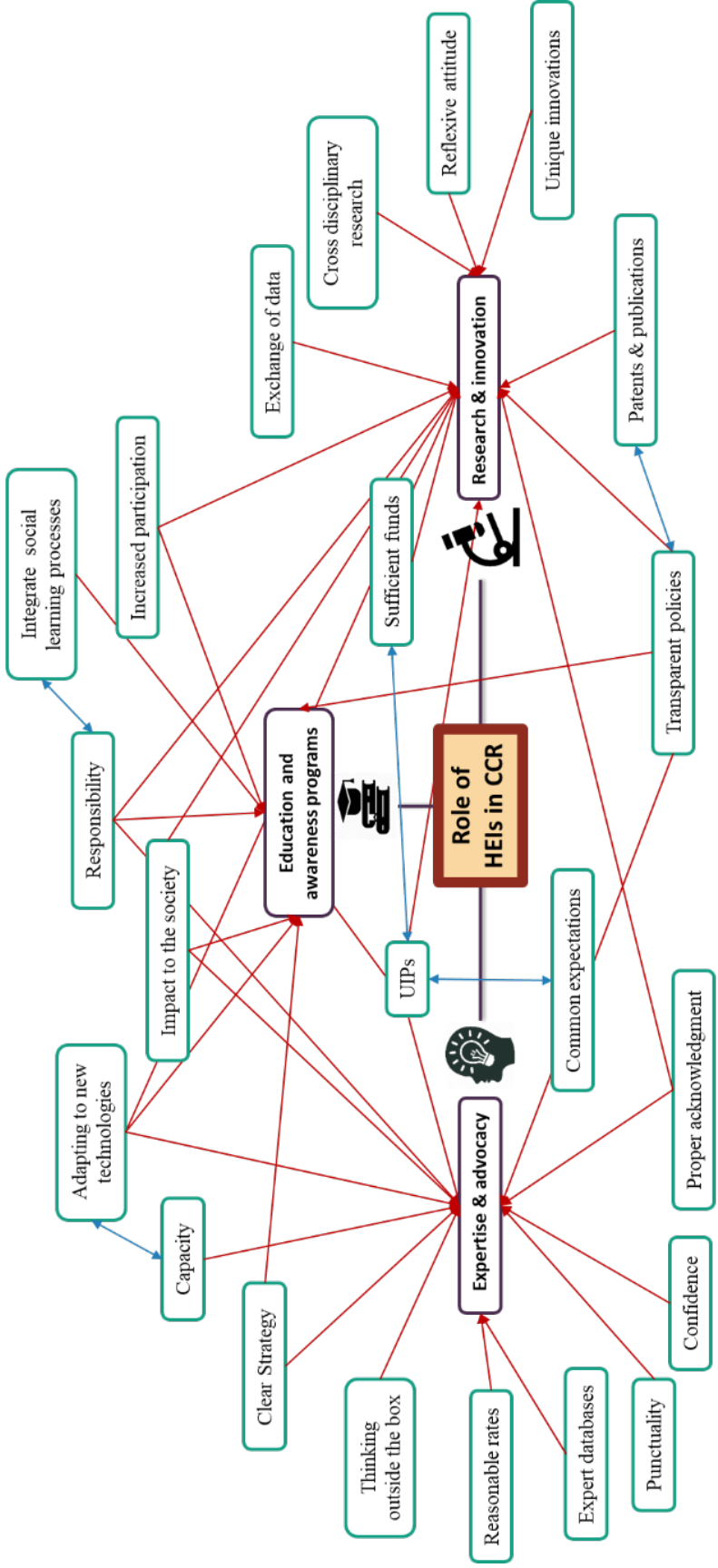


Figure 39: Some of the enablers and their linkages to enhance the role of HEIs

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**Appendix 1 – Scopus Indexed Journal Paper – Procedia  
Engineering online journal**

**“Investigation of efficiency and effectiveness of the existing  
disaster management frameworks in Sri Lanka”**

**International Conference on Building Resilience**

**2017**

**Thailand**



7th International Conference on Building Resilience; Using scientific knowledge to inform policy and practice in disaster risk reduction, ICBR2017, 27 – 29 November 2017, Bangkok, Thailand

## Investigation of efficiency and effectiveness of the existing disaster management frameworks in Sri Lanka

Chandana S.A. Siriwardana<sup>a\*</sup>, G.P Jayasiri<sup>a</sup>, S.S.L Hettiarachchi<sup>a\*</sup>

<sup>a</sup>*Dept. of Civil Engineering, University of Moratuwa, Moratuwa, Sri Lanka*

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### Abstract

In the recent past Sri Lanka has experienced several significant natural disasters. Above all others, the Indian Ocean Tsunami in 2004 had a devastating effect on more than one million people. With the aim of effectively managing all phases of a disaster and to enhance the resilience of the community, the Disaster Management Act was passed in 2005 to provide necessary immediate legal provisions, and was later revised into a national policy. Furthermore, the Disaster Management Centre (DMC) was also established. At present, the DMC and all the line agencies focus on disaster management functions under the ministry of disaster management. The comprehensive disaster management program was prepared in 2014 and it is to be used up until 2018. Furthermore, it was proposed to identify mechanisms to integrate the Sendai Framework into the Sri Lankan national disaster management framework. However, during recent disasters, the DMC and the disaster management framework was under severe criticism from the public as well as the technical community. Therefore, the aim of this study is to investigate the efficiency and effectiveness of the existing disaster management framework in Sri Lanka in managing all phases of a disaster. Since the main governing policy for the DM and Disaster Risk Reduction in Sri Lanka is the Sri Lanka National Disaster Management Policy (SLNDMP), it was investigated whether the policy is applied effectively and efficiently. In addition, alignment with comprehensive global frameworks like the Sendai Principles was checked in parallel to identify its alignment with global standards. SLNDMP was evaluated against seven criteria, which were identified after carefully analyzing the requirements of the Sendai Framework. Applications of the SLNDMP was evaluated with respect to three disaster incidents which occurred recently; the collapse of the garbage dump in Meethotamulla on April 2017, the Colombo floods and the Aranayake landslide during May 2016. In addition, some of the 37 points indicated in the SLNDMP were also considered in this study. Finally, recommendations were provided for improvements to the policy.

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*Keywords:* Disaster Management; Disaster Risk Reduction; Resilience; Sendai framework

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\*Corresponding author: Tel: +94777555655  
Email: [chaasi@yahoo.com](mailto:chaasi@yahoo.com)

## 1. Introduction

Major disasters such as floods, storms, droughts, earthquakes, landslides and Tsunamis leave devastation around the globe with significant impacts to both the economy and the social lives of those affected. Global natural disasters in 2016 combined to cause economic losses of USD 210 billion, an amount 21 percent above the 16-year average of USD 174 billion. The number of human fatalities caused by natural disasters in 2016 was approximately 8,250. Seven of the top ten events occurred in Asia; the deadliest event being the April earthquake in Ecuador that claimed at least 673 lives [1]. The World Economic Forum's ranking of global risks for 2017 states that "extreme weather events" is the global risk most likely to occur this year [2]. International efforts to prevent, curb or adapt to extreme weather events carry grave importance to protect the health and safety of people, the environment, and economic stability of nations. Such efforts are being pursued through agreements such as the Sendai Framework, United Nations Framework Convention on Climate Change (UNFCCC) and Sustainable Development Goals.

Hence, this period is particularly significant for disaster management. Efforts to implement these agreements, alongside the UNFCCC COP21 Paris Agreement, are gaining momentum. It is now almost two years since the adoption of the Sendai Framework and over a year since the adoption of Sustainable Development Goals (SDGs) in September 2015. In this context, the United Nations Office for Disaster Reduction (UNISDR), the focal point for disaster risk reduction in the United Nations, has developed coherent and integrated guidelines by considering these reinforcing international agreements.

## 2. Background

It has been more than a decade since the 2004 Indian Ocean Tsunami, which led to the widest reforms in disaster management in Sri Lanka, with a movement from a reactive response and relief framing, to a mitigation and preparedness framing encapsulated in the concept of Disaster Risk Reduction (DRR). Broadening the focus to DRR from response and recovery is necessary to cope with the dual challenges of climate change and changing population dynamics. As mentioned before, climate change has been identified as the reason for the increased frequency and severity of natural disasters[3], which is evident when looking at the recent disaster events in Sri Lanka.

During the recent past Sri Lanka has experienced successive cycles of droughts, floods and landslides with the government facing a trend of increasing relief payments [4]. A recent report released by the Ministry of Finance with the assistance of the World Bank analyzed the cost of disasters on the Government's budget from 1998 to 2012. On average, the housing, roads, and relief sector-specific losses per year from natural disasters were estimated at LKR 50 billion (US\$0.38 billion). The highest cost component was for flooding at LKR 32 billion, followed by cyclones at LKR 11 billion. This is equivalent to 0.5% of Sri Lanka's gross domestic product (GDP) or 3% of total government expenditure. To put these figures into context, the preliminary findings of the Post Disaster Needs Assessment (PDNA) conducted by the government, with the support of the United Nations and World Bank, show total damages and losses of more than USD 570 million (approximately LKR 82.6 billion) [5]. When looking at the relief and expenditure spent by the Sri Lankan government it is seen that there is a considerable increase, and in 2011 the amount is almost twice as the previous year [6]. Hence, application of the advances in technology and modeling are necessary to simulate future climatic conditions, coupled with a greater understanding of population dynamics to make it possible for the nation to prepare for future risks.

During the past two years, Sri Lanka was exposed to three main disasters. The first disaster, collapse of the garbage dump in Meethotamulla during the 14<sup>th</sup> April 2017 caused 32 deaths including 4 children affecting 36 families in the nearby community [7]. The second disaster, Flooding in the Kelani river basin and the landslide in Aranayake occurred due to Cyclone Roanu which occurred on May 2016 where 340,150 were affected causing 84 deaths [8]. Most recently, Cyclone Mora hit Sri Lanka on May 2017 caused severe floods affecting 15 districts, killed at least 208 people and left a further 78 people missing. As of 3 June, 698,289 people were affected, while 11,056 houses were partially damaged and another 2,093 houses were completely destroyed [9]. When looking at the floods in 2016 and 2017, there were areas which were affected from both floods which clearly shows that there are several inefficiencies in the Disaster Management (DM) framework in all the phases of DM. During a parliament debate on the 2017 floods it was highlighted that the Disaster Management Centre (DMC) has been focusing more on distributing relief, without properly planning to reduce the disaster risks which was the main task to be done [9]. This is the main reason for a

proper evaluation of the efficiency and effectiveness of the DM frameworks in Sri Lanka to suggest proper plans and give recommendations for DRR and DM.

### 3. Existing disaster management frameworks in Sri Lanka

The institutions related to Disaster Management (DM) and Disaster Risk Reduction (DRR) have undergone several changes since 1995 (table 1).

Table 1. Plans and legislations for DM and DRR

Policy/ Planning documents/ Legislations	Date of Publication	Description
National Disaster Management Policy (SLNDMP)	2010 (revised 2014)	This policy is organized under five cross cutting principles, namely: Multi-dimensional, collective responsibility, equity, diversity and inclusion, transparency and accountability, and best fit of best practice. Policy is to be reviewed every five years or after a major disaster event, and should be updated to meet emerging needs [10]
National Disaster Management Plan (NDMP)	2013 – 2017	Incorporates all aspect such as: institutionally mandated and institutional development, hazard, vulnerability and risk assessment, multi-hazard early warning systems, disaster preparedness and response planning, disaster mitigation, and integration into development planning [11]
Comprehensive Disaster Management Plan (CDMP)	2014 – 2018	Main objective is to set up legal and institutional systems, prepare vulnerable communities for disasters, and enhance efforts to minimize disaster risks [6]
National Emergency Operations Plan (NEOP)	Draft available and dated 2016.	Provides the guidelines for emergency preparedness in Sri Lanka. The NEOP is under MDM review prior to submission to Cabinet for approval [12]
Disaster Management Act No. 13 (DMA)	13 May 2005	The DMA is based on a National Disaster Management Bill submitted to Parliament in 2003. This Act governs the functions of the National Council for Disaster Management (NCDM) and the DMC. Also, DMA authorizes the President to declare a ‘State of Disaster’ in the event of an existing or an impending disaster which cannot be counteracted with resources normally available to the administration. The Act mandates the formulation of key framework documents including the SLNDMP, NDMP and NEOP by the Council [13]
Ministry of Finance and Planning – Budget Circulars No. 152 (I) (II) and (III)	No.152 (I) – 4 July 2013 No.152 (II) – 26 December 2014 No.152 (III) – 29 December 2014	These circulars govern the distribution of relief (emergency relief and rehabilitation) by NDSRC (through MDM) and relevant line ministries.

A dedicated body to manage disasters was first recognized through the establishment of a National Disaster Management Centre (NDMC) under the Ministry of Health, Highways and Social Services. The need for a proper institutional framework was identified after the 2004 Indian Ocean Tsunami. The NDMC was brought under the Ministry of Disaster Relief Services by gazette notification no.1422/22 dated 8 December, 2005 to plan and implement relief, rehabilitation and reconstruction activities. It was renamed as the National Disaster Relief Services Centre (NDRSC) by a Gazette Notification dated 9 January, 2007 [14]. Both these institutes are currently under the Ministry of Disaster Management (MDM). Main functions and tasks carried out by the NDMC and NDRMC is highlighted in table 2.

Table 2. Main functions and task carried out by the NDMC and the NDRMC

NDMC	NDRMC
Formulation of National Disaster Management Plan (NDMP) and National Emergency Operations Plan (NEOP)	Formulate and implement programs to rescue people from both natural and man-made disasters
Coordination of post disaster activities including relief and disaster mitigation	Coordinate and direct relevant parties to ensure the implementation of reconstruction and rehabilitation activities
Hazard mapping and risk assessment while managing early warning and dissemination	Conduct awareness programs for public officers and people on how to face disaster situations and relief mechanisms

#### 4. Efficiency and effectiveness of the existing DM frameworks

In accordance with the Asia Regional Plan [15], which guides the implementation of the Sendai Framework, national policies should seek to align to the Sendai principles; placing special emphasis on coherence and integration with international agreements for development and climate action [16]. Since the main governing policy for the DM and DRR in Sri Lanka is the National Disaster Management Policy (SLNDMP), it is necessary to investigate whether the application of the policy is made effectively and efficiently. In addition, alignment with comprehensive global frameworks like the Sendai Principles was checked in parallel to identify its alignment with the global standards as well. The SLNDMP was evaluated against seven criteria, which were identified after carefully analyzing the requirements of the Sendai Framework. Applications of the SLNDMP was evaluated with respect to three disaster incidents occurred recently; collapse of the garbage dump in Meethotamulla on 14 April 2017, Colombo floods and the Aranayake landslide during May 2016. These most recent floods due to Cyclone Mora was not selected because the post disaster processes are still underway. In addition, some of the 37 points indicated in the SLNDMP [10] were also considered in this study.

##### 4.1. Whole of government response

The SLNDMP recognizes that disaster management is a shared responsibility, as enshrined in the principle of Collective Responsibility (point 12). However, Sendai Principle 1 acknowledges that primary responsibility for disaster risk reduction lies with the State. This is in addition to the state responsibility for creating a system and a process for the inclusive participation of all stakeholders.

Before the Meethotamulla disaster Western region Mega polis planning project suggested a waste to energy process during the risk identification process [17]. Also before the Colombo floods, several studies were done for the flood inundation mapping along the Kelani river basin and vulnerable areas were identified [18]. During the rescue and relief processes, armed forces and voluntary organizations like Red Cross and Sarvodaya provided aid. Also in the rehabilitation processes, it is seen that the involvement of the central government is high, as they have provided funds from the National Insurance Trust Fund (NITF) [19]. However, during the DRR processes even though the professionals had identified several risk mitigation measures, the central government had not taken further actions. Even though DM is a shared responsibility, it is visible that the primary responsibility lies with the state for proper execution of the plans.

##### 4.2. Coherence and integration

At present, SLNDMP does not refer to the Government's Sustainable Development agenda and the important role DRR plays in helping to achieve Sustainable Development and growth. Creating linkages to the National Adaptation Plan (NAP) for Climate Change Impacts in Sri Lanka (2016 – 2025) in the SLNDMP is necessary in order to strengthen coherence with Sustainable Development and climate change agendas.

The UNISDR has placed a strong focus on coherence and integration because of the strong synergies that exist among these agreements. Climate Change Adaptation (CCA) can be considered as DRR over the medium to longer

term. Sustainable development also internalizes the multi-dimensional interactions of various sectors and their impacts to society, environment and the economy, as does disaster management.

As the SLNDMP was approved in 2014, it only refers to the Hyogo Framework currently. Given the tone of the Sendai Framework to lead the international community towards DRR and ‘Build Back Better’ to set the nation on a more disaster resilient and therefore sustainable path, the Preamble to the Policy should include a strong statement reflecting this intent. Moreover, the Preamble should recognize the common goals of Sustainable Development Goals (SDG) and CCA to DRR, with direct reference to the relevant policies and plans for each of these agenda at the time of revising the SLNDMP.

According to the Sustainable Development Goal (SDG) 12, by 2030 halving per capita global food waste at the retail and consumer levels is necessary. When considering the Meethotamulla disaster it is visible that if the generation of food waste was reduced the risk of collapse would have been easily minimized. Also NAP clearly highlights to improve the existing systems of disaster risk management to minimize the vulnerabilities and increase the preparedness. After the lessons learnt from Colombo floods 2016, identifying and mapping areas vulnerable to droughts and flood hazards to prepare disaster risk management plans has become a priority action. According to the literature, there were several flood inundation maps in the Kelani river basin but the risk reduction measures were taken too slowly to prevent damage during an extreme flooding event. If the Government’s sustainable development agenda and SLNDMP were integrated before these disasters the impact and the damage could have been minimized by improving disaster resilience via sustainable measures.

#### *4.3. Resource allocation*

The Sendai Framework notes that the DRR should be administered in a manner that protects people and their health, cultural and environmental assets, property, and livelihoods. The SLNDMP refers to meeting the needs of people, economy, infrastructure, livelihoods through legislation (legal Basis, point 9). When responding to disasters, adequate relief services are provided, (point 20) and provision or reconstruction of infrastructure and housing that incorporates DRR to reduce risks (points 24 and 25), obtaining financial assistance on concessionary terms and risk transfer (point 26), and integration of DRR and DRM education to schools and universities (points 30 and 32). However, the SLNDMP fails to address the protection of environmental assets under the Policy Statements adequately. Aside from a reference to the environment in its objective statement, which is reiterated under the section Legal Basis (point 9.a), reference to managing the prevention of environmental degradation and post-disaster environmental restoration should be included as a policy statement.

Looking at the three disasters mentioned previously, it is visible that resource allocation for DRR measures was not adequate. During the Aranayake landslide the threats were identified before the event but no preventive measures were taken[20]. Since the Kegalle district is a landslide prone area proper environmental measures must be taken in order to prevent landslides. Issuing warnings during a heavy rainfall is necessary for proper evacuation but the damages to infrastructure remain.

Before the collapse of the garbage dump in Meethotamulla, unauthorized dwellers in the area were transferred to the nearby housing scheme, Sudu Nelumpura, and government offered Rs. 1.5 million as an incentive for others to find alternative housing [20].

During the rescue, relief and rehabilitation phases of the disasters, the allocated resources by the government were not enough to satisfy the needs of victims. Allocating resources quickly depends on the efficiency of the respective agencies. Several organizations and the community in Sri Lanka helped in this processes in order to provide better facilities for the affected people. Considering the future risk reduction measures after the Colombo floods in 2010 Metro Colombo Urban Development Project (MCUDP) was initiated in order to convert the city into a flood free zone[21]. During the 2016 floods, still Colombo city flooded where the project was partially completed. Though all the funds are provided by the World Bank, other relevant resources like professionals and labor force should be constant in order to complete projects on time and reach targets.



#### 4.4. Multi-stakeholder approaches

Inclusive decision-making, multi-sectoral and multi-institutional coordination are addressed in the SLNDMP by four principles, namely: Multi-dimensional (point 11); Collective responsibility (point 12); Equity, diversity and inclusion (point 13); and Transparency and accountability (point 14). The clauses under the policy statement ‘Integrated approach to reduce disaster risks’; clauses supporting a multi-stakeholder approach include education training and professional development (Point 30 – 31); and participation of NGOs, civil society and private sector in implementing the DMP. In addition to government agencies (point 34), other organizations support a multi-stakeholder approach to DRR and DRM. As such, the current SLNDMP adequately addresses the need for a multi-stakeholder approach to DRR

During all the disasters mentioned above, a multi – stakeholder approach was visible where both government officials as well as NGOs provided their full support in the post-disaster management processes. Even though no special consideration was given to the general public to share the responsibility, people provided aid by providing relief items and assisting in rescue operations. In addition, the DMC has assigned several line agencies for hazard analysis which shows a collective responsibility (table 3).

Table 3. Plans and legislations for DM and DRR

Hazard	Responsible line agency
Meteorological hazards	Meteorological Department (WMO Focal Point)
Landslide hazards	National Building and Research Organization (NBRO)
Earthquake hazards	Geological Survey and Mines Bureau (GSMB)
Coastal and Sea level related hazards	Department of Coast Conservation / National Aquatic Resources Research and Development Agency (NARA)
Tsunami	Meteorological Department (IOTWS Focal Point)
River Flood hazards	Department of Irrigation
Storm/Urban Drainage hazard	Sri Lanka Land Reclamation and Development Corporation (SLLRSC)
Health related hazards	Ministry of Health (MoH)

#### 4.5. Localized approaches to DRM

The principle of ‘Best fit of best practice’ (point 15) refers to the need to draw on indigenous knowledge and traditional methods, and for approaches to be socially acceptable. The SLNDMP recognizes the need to engage local authorities in making direct references to the participation of Local Government agencies under the policy statement, ‘Integrated systems to reduce disaster risk reduction’ regarding supporting legal mandates, adequate capacity and ICT, land use planning and building codes (points 22 and 25).

When looking at floods and landslides, small water tanks must be built and these smaller tanks must be connected to reservoirs. This will stop upstream water being dispersed quickly to downstream which will eventually stop the floods [21]. During ancient times, the irrigation network in Sri Lanka was designed to save water and prevent floods. Currently, most of the irrigation networks are not working properly and it is necessary to repair them in order to maintain a proper water management system. If these traditional methods are incorporated with modern technology then it would help to reduce disaster risks. The DMC must always identify the unique features and technologies Sri Lankan ancestors used which can be implemented in the future as DRR measures. Since they are traditional methods they would be socially acceptable as well.

#### 4.6. Data driven approach

The SLNDMP notes that a multi-dimensional approach to disaster management is necessary and that the sharing of disaster risk information, provision of information to those impacted, alongside accountability and transparency in the decision-making process, and handling of resources are all necessary (point 14). The SLNDMP notes that scientific

research tools and methods should be available to develop risk profiles and maps (point 23). Promotion of research and development in DRR is also supported in the policy (point 32). However, the SLNDMP fails to include monitoring and evaluation, which is a necessary tool to collect the data necessary to support an informed, scientific, and multi-hazard approach. Line agencies (table 3) such as the NBRO and the Meteorological Department carry out research and gather data to provide relevant disaster related information for the DMC to give early warnings to the public.

There are merits and demerits of the data driven approach of SLNDMP. The official website of the DMC provides considerable amount of information about the previous disasters, which helps the researchers to gather information easily. During the Meethotamulla disaster, the risk of the landfill exploding was identified by referring to the previous event which occurred in the Bloemendhal dumpsite [22]. With this information, the community began to react via protests to remove the garbage from Meethotamulla. However, the DMC was unable to evacuate the vulnerable community in time. Furthermore, proper flood and landslides modeling must be done by the line agencies of the DMC as DRR measures. For example, the rain gauge system in Sri Lanka were not technologically updated and do not have the capability to provide data when necessary.

#### 4.7. Safeguard investment through preparedness and 'Build Back Better'

The safeguarding of investments through preparedness is covered under the policy statements named preparedness and response (point 16) and integrated systems to reduce disaster risk (Point 22). The 2010 version of the SLNDMP made a direct reference to 'Build Back Better', while the current SLNDMP does not. However, the current SLNDMP operationalizes the concept in a more detailed manner (policy statement – Integrated systems to reduce disaster risk). As the term 'Build Back Better' is internationally synonymous with DRR and resilient reconstruction, and with direct reference to it under the Sendai Principle 11 and Sendai Priority Action 4, the next iteration of the SLNDMP should seek to incorporate the term into the text.

The SLNDMP fails to refer to the need to conduct Post Disaster Assessments. Post Disaster Assessments are an important tool through which the DRR actions and the performance of institutions involved in the response operations, can be assessed. The relevant findings are invaluable with respect to addressing the principle of 'Build Back Better'; providing the most up-to-date findings that may influence new investment; and continuously improving disaster management services to the community. The findings would also inform mitigation activities and help to close the loop between Reconstruction and Mitigation in the disaster management cycle.

After the Garbage dump collapse in Meethotamulla, post disaster assessments were done only to identify mitigation measures and future risks. Proper post disaster assessments are needed after every disaster, which will critically evaluate the DRM and DM strategies and identify the inefficiencies in processes.

## 5. Recommendations for the improvement of the frameworks

Reflecting on the Sendai Framework Priorities of Action, there are three important technical actions that Sri Lanka should undertake as mentioned below.

- Upgrade National Hazard Profile: The Sendai Framework adds biological and man-made hazards to Hyogo Framework for Action (HFA) and increases the scope of action in recovery, rehabilitation and reconstruction. The focus on different types of hazards demands understanding the key characteristics of hazards, which includes their magnitude, active time, and frequency. Such an effort may require upgrading the National Hazard Profile developed by the DMC, with UNDP assistance.
- Develop vulnerability Profile: Sri Lanka initiated the drafting of hazard maps. However, authorities should endeavor to prioritize the development of a vulnerability profile, without which Sri Lanka is unable to have a clear understanding of exposure to risk. This data is also necessary to develop Risk Maps. The progress of DRR activities will be stifled without the presence of this baseline information.
- Develop guidelines for the design and construction of infrastructure: Infrastructure loss and damage accounts for a significant proportion of financial resources following a disaster, as well as posing a safety risk for inhabitants. To 'Build Back Better' requires developing guidelines for design and construction of infrastructure in hazard prone

areas. On this front, a proposal to develop building codes for Sri Lanka is being led by the National Building and Research Organisation (NBRO). It is important that the MDM and DMC provide strong support for this activity.

## 6. Conclusions

According to the evaluation criteria, it can be concluded that only minor alignments with the global standards are present, and that the existing framework has not been able to manage previous disaster incidents properly. There are considerable inefficiencies in the “whole of government” response, coherence and integration as well as in the resource allocation. It can also be concluded that multi-stakeholder approach of SLNDMP complies with the global standards. Localized approaches and data driven approaches must be improved via research and development. Even though the post-disaster assessment is necessary for preparedness and to “Build Back Better”, the SLNDMP has failed to do proper post-disaster assessments. In addition, it can be concluded that, the DRR measures taken by the DMC were not adequate or not present at all, however, during the response stage rescue and relief operations were handled up to a satisfactory level. During the post-disaster management processes, rehabilitation and reconstruction works were carried out slowly due to the delay in resource allocation. Hence, by preparing necessary hazard and vulnerability profiles and introducing proper guidelines for the SLNDMP to align with the global standards, effective and efficient DRR and DM measures can be implemented.

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**Appendix 2 – Scopus Indexed Journal Paper**

**“Important aspects in building community resilience of  
coastal districts in Sri Lanka”**

**International Conference on Disaster Management**

**2018**

**Indonesia**



Andalas University

**INTERNATIONAL CONFERENCE ON DISASTER MANAGEMENT 2018**

**(ICDM 2018)**  
**, Padang, May 2-4, 2018**

Jointly organizing by  
**Andalas University**

**Indonesian Disaster Expert Association (IABI)**



April 13, 2018

**Subject: Acceptance of Full Paper and Invitation to International Conference on Disaster Management (ICDM 2018), 2nd - 4th May 2018, Indonesia**

Paper ID Number : **ICDM - 009**

Dear Gimhan Pramodith Jayasiri, Chandana Siriwardena, Samantha Hettiarachchi, Ranjith Dissanayake, Chaminda Bandara

Greetings from Dr. Febrin Anas Ismail, Organizing Chair of ICDM 2018.

First of all, we would like to thank for your interest and valuable research contribution to International Conference on Disaster Management (ICDM 2018), during 2nd - 4th May, 2018 jointly-organizing by Andalas University, Indonesian Disaster Expert Association (IABI) and National Agency for Disaster Management (BNPB), Indonesia.

We are pleased to inform you that after careful review and assessment, the members of the ICDM 2018 Technical Committee have accepted your full paper “**Important aspects in building community resilience of coastal districts in Sri Lanka**” for “Oral” presentation at the Conference.

The paper is selected for publication in *International Journal on Advanced Science, Engineering and Information Technology (IJASEIT)* – Scopus Indexed, Q4 (paper will be further reviewed by IJASEIT’s editor).

It is our great pleasure to send formal invitation to you to participate and present your paper in this conference.

Please find attached review reports of your paper and submit your revised paper via our online submission system before April 20, 2018. Please also prepare for **10 minutes presentation** including Q&A.

Should you require more information, please do not hesitate to contact us. We look forward to hearing from you soon. Please always refer your paper ID number for future correspondence.

Sincerely yours,

Dr. Febrin Anas Ismail,  
Organising Chair of ICDM – 5th PIT IABI  
Andalas University - Indonesia  
E-mail: [icdmiabi@eng.unand.ac.id](mailto:icdmiabi@eng.unand.ac.id)



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## Important Aspects in Building Community Resilience of Coastal Districts in Sri Lanka

G.P Jayasiri<sup>#</sup>, C.S.A Siriwardena<sup>#</sup>, S.S.L Hettiarachchi<sup>#</sup>, P.B.R Dissanayake<sup>\*</sup>, C.S Bandara<sup>\*</sup>

<sup>#</sup> Department of Civil Engineering, University of Moratuwa, Moratuwa, 10400, Sri Lanka

E-mail: [gimhanjayasiri@gmail.com](mailto:gimhanjayasiri@gmail.com), [chaasi@uom.lk](mailto:chaasi@uom.lk), [sampens1955@hotmail.com](mailto:sampens1955@hotmail.com)

<sup>\*</sup> Department of Civil Engineering, University of Peradeniya, Peradeniya, 20400, Sri Lanka

E-mail: [ranjith@fulbrightmail.org](mailto:ranjith@fulbrightmail.org), [chamindasbandara@yahoo.com](mailto:chamindasbandara@yahoo.com)

**Abstract**— This research is carried out to identify the important aspects in building community resilience of coastal districts to provide suitable recommendations in order to strengthen them. After carrying out a thorough literature review and interviewing key personnel related to the Disaster Management and Disaster Risk Reduction, existing status of the coastal hazards, multi-hazard assessments, early warning mechanisms, national policies, guidelines and efforts and regional cooperation were identified. During the literature survey, it was observed that Sri Lanka has developed a Hazard profile for the country and an Early Warning Dissemination System exists as well. Furthermore, the country is in the process of aligning the existing policies with the post 2015 global standards. When looking at the regional efforts, Sri Lanka is a member of Indian Ocean Tsunami Warning and Mitigation System (IOTWMS) and Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES). Even though Sri Lanka lacks proper and efficient resilience mechanisms focused on the coastal communities, national efforts are underway to build up the coastal resilience. Training and public awareness campaigns, efficient funds, properly maintained hierarchy and concern to the coastal ecosystems are some of the enablers associated in building coastal resilience. Developing a multi-hazard map, improving the interagency cooperation and focusing more on the development of a people-centered Multi-Hazard Early Warning Systems (MHEWS) are some of the recommendations given.

**Keywords**— Coastal resilience; Early Warning Systems; Hazard assessments

### I. INTRODUCTION

The effect of climate change has led to considerable losses due to climate-induced disasters in the world making most of the regions vulnerable to multiple hazards [1]. Recently, Asia compared with the other countries in the world has suffered from several disasters, which have made a significant impact on both the livelihood and the economy of the affected states. Sri Lanka being a tropical island has a coastal belt around the country comprising primarily congested communities, infrastructure, and fauna and flora, which are exposed to various hazards caused due to natural occurrences and human-induced phenomena. Cities in the coastal belt are rising the ladder of economic development and are under severe pressure resulting from various scenarios of development,

population growth, human-induced vulnerability, frequently increasing coastal hazards of larger magnitudes and impacts of global climate change. These unrivaled changes are placing coastal communities at increasing risk from various hazards such as severe storms, storm surges and tsunamis leading to coastal erosion, flooding and environmental degradation.

Indian Ocean Tsunami of 2004 is the major coastal disaster, which devastated the infrastructure and livelihood in most of the coastal belt of the island. Then the Disaster Management Centre (DMC) and together with other agencies implemented several programmes to improve the community awareness and resilience with the increased capacity in tsunami-prone districts [2]. Furthermore, 2016 floods and landslides affected Colombo, Puttalam and Gampaha districts severely,

while the number of affected families raised up to 800,000 in total [3]. 2017 floods and landslides, which occurred a year later, affected Kalutara, Galle, Matara, and Hambantota districts in the southern coastal belt of the island[4]. These events show that risk perception of the communities should be changed to encourage protective action against multiple hazards [5]. The lack of awareness about hazards, vulnerability, and deficiencies in capacity and response has led to this study to address the intellectual and normative challenges in placing multi-hazard assessments, early warning and preparedness in the broader trajectories of societal behavior in communities at risk.

## II. THE MATERIAL AND METHOD

To assess the condition of the community resilience of the coastal districts in the island, initially, an in-depth literature survey was executed to find out the plans, policies, assessments, and programmes prepared by several government bodies, research institutions, and nongovernmental organizations. Then the study was strengthened by interviewing eleven key professionals and experts who are actively involved in Disaster Management (DM) activities including academic staff of several Higher Education Institutes (HEIs). They were presented with a detailed questionnaire followed up by a discussion to gather information and knowledge. Altogether eleven expert data were collected, which provided sufficient information to come to a proper conclusion and provide necessary recommendations. The thematic content analysis was used to analyze the data under the key themes identified in assessing resilience in the study namely; coastal hazards, multi-hazard assessments, early warning systems, national policies and guidelines and regional cooperation. Then several conclusions were made and provided adequate recommendations to improve the community resilience in coastal districts in Sri Lanka.

## III. RESULTS AND DISCUSSION

The results and information gathered from this study are discussed under the themes mentioned in the methodology above.

### A. Coastal hazards

Coastal districts of Sri Lanka are vulnerable to several hazards including floods, sea level rise, coastal erosion, storm surges, tropical cyclones, oil

spills, droughts, landslides and Tsunamis [6]. Variability of the return periods associated with respective hazards is the main characteristic to be considered in the coastal multi-hazard approach. When considering Sri Lanka, erosion and storm surge set off by the North East & South West monsoons have an annual return period, storm surges unleashed by cyclones are multi-centennial, and a significant tsunami can be even multi-centennial to millennial [7]. Floods are the most frequent disaster in Sri Lanka (37%) followed by strong winds, landslides, and cyclones [8]. Furthermore, when looking at the disasters in a percentage of a number of deaths point of view Indian ocean Tsunami has the highest number of deaths with 39,143, which is a significantly higher value compared to all other disasters combined [6]. Furthermore, it has led to the decrease of a number of people who are involved in fishery-related industries and coir industry in the coastal belt of Sri Lanka [9]. Colombo floods, which occurred in May 2016 affected 54,248 families [3], and the floods in 2017 caused significant damages to the city of Galle where 40184 families have reportedly been affected [4]. Furthermore, coastal erosion has been identified as a major hazard along the densely populated southwest coastline of the country [10]. Moreover, Salinity intrusion in Colombo and Gampaha districts is becoming a primary concern at present [11]. The number of affected people due to various disasters from 1965 to 2017 shown in Fig 1 provides sufficient evidence that a significant impact was made to the coastal districts as well as to the country as a whole.

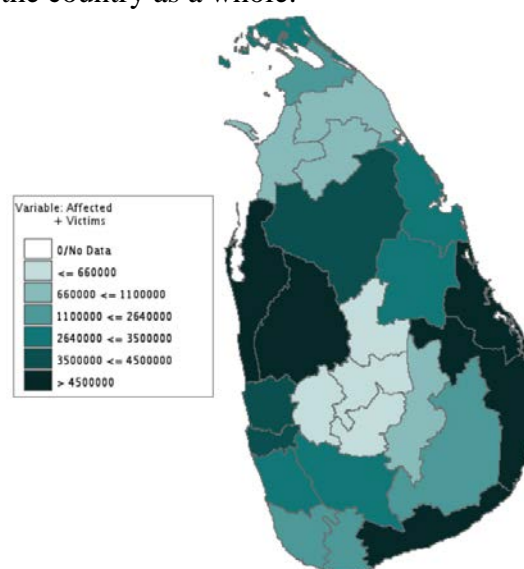


Fig. 1 Affected people from disasters (1965 - 2017)  
Source: <http://www.desinventar.net/DesInventar/profiletab.jsp>

Also, M V Meliksha Incident was one of the leading oil spill events occurred near the Bundala coast which released fuel and fertilizer damaging the marine environment [12]. Furthermore, due to the sea level rise, National Hazard Profile shows that the Puttalam district will have additional 1113 ha inundated in 2037 [6].

The distribution frequency of the events, number of people affected, and loss of life due to disasters throughout the islands show that coastal districts are the most affected [13].

Information gathered throughout the interviews show that economic loss, displacement of the coastal communities, the effect on the water quality, and loss of habitats in estuaries are some of the critical impacts of the coastal disasters. Also, drought and saltwater intrusion, loss of beachfront properties, damage to the population, and rapid loss of land have also made a significant impact on the coastal belt of Sri Lanka. Additionally, the importance of handling Sri Lankan coastal hazards at both national and local levels was identified during the literature survey and interviews which is summarized in Table 1.

TABLE I  
IMPORTANCE OF HANDLING COASTAL HAZARDS

National Level	Local Level
To issue accurate early warnings for the people to evacuate in time.	To evacuate and go for shelter during a disaster to reduce the loss of lives
By introducing proper policies, and legislation can protect the coastal communities from several hazards	Community leaders can educate and guide people on policies and guidelines to be followed to make them resilient
The tourist attraction can be increased to improve the economy of the country	Opportunities which will arise from tourism will ensure the development of the economy of the local villages
Can introduce advanced technology which will also assist the research and development work in the coastal hazards sector	Fishers, in local communities, can get early warnings in time for them to not to go fishing during storm surges or heavy rains
To make coastal communities aware of the hazards which they are vulnerable	Risk awareness and knowledge will help local communities to increase the preparedness and capacity

### B. Multi-hazard assessments

At present, there are no any specific multi-hazard assessments being done for the coastal hazards in Sri Lanka. A multi-hazard map for the whole

country by combining the individual hazard indexes for droughts, floods, cyclones, and landslides, with weighing hazards in different ways was developed in 2006, which is outdated now due to the climate change, potency and frequency of the disasters [14]. In the National Policy on Disaster Management under the section “Multi-dimensional approach,” it has been highlighted that multi-hazards should be given consideration [15]. At present individual natural hazard mapping and assessments are finalized, and hazard profiles for coastal erosion, floods, drought, sea level rise, storm surge, tropical cyclones, and Tsunami were produced [6]. Furthermore, the deterministic analysis undertaken for Tsunami hazard focusing on the south-west coast of Sri Lanka [16], GIS-based flood risk analysis was done for a 50 year rainfall to develop an information systems for flood forecasting in the Kalu river [17] and the flood hazard mapping done for the lower reach Kelani river basin [18] are some of the hazard assessments done considering individual impacts of the hazards. The hazard prediction calendar in Sri Lanka prepared by Disaster Management Centre and other line agencies identifies the monthly variation of several hazards which provides a guideline for stakeholders to prepare for impending risks [19].

During the interviews, it was noted that Disaster Management Centre (DMC) and relevant technical agencies at National level carry out the hazard assessments. Sri Lanka as a country can carry out the hazard assessment work but what lacks is the advanced modeling software. Hence, most authorities work with the international agencies to carry out the assessments. Making hazard maps for selected districts available online assist the authorities and other interested parties to update and use them [20].

### C. Early warning mechanisms

When handling a coastal disaster, Early Warnings (EW) play a crucial role to reduce the impact on the vulnerable communities. Department of Meteorology (DoM), Irrigation Department (ID) and National Building Research Organization (NBRO) are the leading technical institutions which are mandated to provide early warning messages to DMC. When severe weather conditions like heavy rainfall are expected, officers of National Meteorological Centre (NMC) and directors share the information, and a warning signed by the



forecaster is issued to relevant agencies and media. The warnings are disseminated to DMC and pertinent other stakeholders [8]. DoM also gives marine forecast and city forecast on their web page so that users can quickly get the weather forecast online [21]. The ID informs the DMC the observed water level and rainfall by using FAX. The frequency of data transmission is once a day during normal times or every 3 hours during flood situation [8]. Also, flood warnings are issued based on the observed water level at 34 gauging stations [8]. NBRO manages over 100 rain gauges throughout the country. Based on rainfall data collected in these rain gauges, NBRO issues landslide warnings to DMC and public through the NBRO homepage [8]. Sometimes the vulnerable community can become the primary source of information to the responsible agency regarding an impending disaster.

Dissemination of the said early warnings from National level up to the grass root level is divided into four layers as shown in Table 2 [19].

TABLE III  
EARLY WARNING DISSEMINATION LEVELS

Level	Description
National	EW messages from International and Regional Technical Agencies are received by the Emergency Operation Center (EOC) of the DMC. A national level EW message is sent to the emergency response committees where they have to pass the messages to the relevant organizations. Intra Governmental Network (IGN), Satellite and Radio Communication are some of the dissemination methods used
District	EW is conveyed via District Disaster Management Centre Units (DDMCU) to the District Secretariat, stakeholder agencies, and political authorities
Divisional	DDMCUs pass the EW messages to the Divisional Secretariats who will send the message to Search and Rescue teams, police and relevant local authorities
Grama Niladhari (GN)	Last mile communication tools such as sirens (Hand and Electric), temple and church bells, riders/ push bicycle and motorcycles/messengers and Early Warning Committees (Door to door) are used to send the EW messages to the vulnerable communities

Role of media is also significant as they cover the entire island easily through television and FM radios with more than 50 channels. During disaster

situations, mass media notify the public with timely and factual information including guidance for the actions to be taken [19]. Furthermore, Technical Advisory Committees (TACs) which are appointed by National Council of Disaster Management (NCDM) must establish a proper chain of early warning of the disaster.

Disaster and Emergency Warning Network (DEWN) is the first GSM-based EW system which generally uses accessible mobile communications technologies like short messages service (SMS) for early warning and cell broadcast (CB) to provide an efficient and reliable mass alert system. DEWN links relevant stakeholders including the general public to the EOC at DMC [22]. Even though the quick transfer of EW message is present in this method, the effectiveness is reduced due to the vague and unfocused information sent to the public. In addition, the community based early warning system project initiated by Sri Lanka Red cross identifies the importance to prepare the coastal communities to receive early warnings in time [23].

The existing early warning mechanism shows an increased response capacity where entire Eastern coastal community was evacuated within 55 minutes (March 2006) and 90% of the coastal communities were evacuated in 1.5 hours (April 2012) after issuing the Tsunami early warning [24]. Even though the Tsunami early warning mechanisms are strengthened the Post Disaster Needs Assessment of floods and landslides which occurred in May 2016, apparently identifies poor early warning and lack of flood modeling resulted in the almost total loss of household assets of the affected households [3]. Furthermore, Dodanduwa and Hikkaduwa fishery harbors not receiving the official red warning in time during the devastating weather hit on 29<sup>th</sup> November 2017 provides sufficient evidence of severe gaps in EW system [21].

During the interviews, it was noted that the locally available techniques and methods could be used effectively to manage village level early warning systems. In addition, providing training to community leaders in early warning mechanisms is also highlighted [25].

#### D. National Policies, Guidelines, and efforts

Before 2015, Sri Lankan government has taken necessary actions to amend the relevant Disaster Management (DM) plans and programmes to

Hyogo Framework for Action [26]. At present, the country is in the phase of aligning the national policies and programmes with post-2015 global frameworks such as the Sendai Framework for Disaster Risk Reduction, Paris Climate Change Agreement, and Sustainable Development Goals. Also, according to the Asia Regional Plan [27], which provides a detailed guideline to implement Sendai Framework, alignment of national policies with Sendai principles is necessary; focusing on adherence with the international agreements for the development and climate action. To do proper amendments, professionals are in the process of evaluating existing DM frameworks in Sri Lanka [28].

According to the Sendai Framework data readiness review, Sri Lanka is planning to have Multi-hazard monitoring and forecasting systems at the beginning of the year 2020 which refers to the Global target G of the Sendai Framework [29].

Even though Sri Lanka signed the Paris Climate Change Agreement on 22 April 2016, the impacts of climate change to hazards were considered in the Comprehensive Disaster Management Programme which was prepared in early 2014 [2]. National Council for Disaster Management (NCDM), National Disaster Management Coordination Committee (NDMCC), Ministry of Disaster Management (MDM), Disaster Management Centre (DMC) and National Disaster Relief Services Centre (NDRSC) are the primary stakeholders, which are involved in the implementation process of global standards in Sri Lanka. Table 3 shows the existing policies and guidelines available in the country for Disaster Management (DM).

TABLE III  
POLICIES AND GUIDELINES AVAILABLE FOR DM IN SRI LANKA

Name	Description
Disaster Management Act No. 13 (DMA)	Provide for the initiation of the NCDM and DMC to appoint TACs and to prepare disaster management plans [30]
National Policy on Disaster Management (NPDM)	Make Sri Lanka as resilient and safe as possible from disaster risks [15]
Comprehensive Disaster Management Programme (CDMP)	Ensure the Disaster Risk Reduction of the country which minimizes impacts on livelihood and the economy by providing a detailed investment plan with eight strategic components [2]
National Disaster Management Plan (NDMP)	Reduce disaster impact on communities, critical infrastructure, facilities, shelter, public properties, economic and development activities in Sri Lanka [31]

National Emergency Operations Plan	Provides Standard Operating Procedures and mechanisms allocated to all line agencies and emergency operation mechanisms during a disaster [19]
National Climate Change Adaptation Strategy for Sri Lanka	Lays out a prioritized framework to systematically guide Sri Lankans towards a disaster resilient future by identifying action and investment for the 2011- 2016 period [32]
Coast Conservation Act	Provide the legal guidance to formulate and execute strategies and plans for coast conservation within the coastal zone [33]
Coastal Zone Management Plan (CZMP)	Provides for Capacity building for management, control coastal erosion, facilitate integrated management of coastal resources, operating permit system and setback standards, monitor coastal water quality [34]
The Sri Lanka National Oil Spill Contingency Plan	Gives the scope, geographical coverage, and responsibilities related to the emergency response which may result due to an oil spill event which can harm the coastal belt of Sri Lanka[35]
Hazard Resilient Housing Construction Manual	The purpose is to promote the use of engineering design and correct construction practices to build hazard resilient houses. It is aimed at the national level [36]
National Guidelines for School Disaster Safety	Gives a detailed School Disaster Safety Plan which includes identification of hazards and resources, hazard assessments and awareness and training [37]
Implementation Framework for the Resettlement Programme in Kalutara, Galle, Ratnapura, and Matara	Guides the resettlement programme for the information of the responsible officers, who are involved in the resettlement process to ensure successful implementation [38]

In addition to the above District Disaster Response plans and divisional disaster response plans are also available. All the documents are available online for the public to access whenever they need to gather information.

Furthermore, Disaster resilient city development strategies for Sri Lankan cities have been introduced by UN-Habitat program to strengthen the community resilience of the cities and townships in disaster-prone regions of Sri Lanka. Mannar [39] and Batticaloa [40] are such two coastal towns, which will be made resilient under those strategies. Improving the physical environment of the city by developing sustainable urban drainage systems and adapting to the built environment as well as integrating social and

economic development by enhancing community networks are necessary for city resilience [39].

Furthermore, Community Resilience Framework developed by DMC identifies governance and risk knowledge as the two main essential aspects of a resilience community [41]. In addition, a guide to assess the community resilience to coastal hazards which was developed by the US – IOTWS identifies several benchmarks for the resilient components mentioned in the guidelines for Sri Lanka [42].

When looking at the integration of these policies, guidelines, and frameworks to improve EW and coastal community resilience, interviewees mentioned that it is at a minimum, but provisions do exist. Considering the present status, Sri Lanka is mostly involved in post-disaster activities while the authorities must be proactive and focus more on Disaster Risk Reduction. Furthermore, DoM believes that for specific weather forecasting local area modeling is required. High-performance computer systems are needed to do said local area modeling to run high-resolution models. At least one model is needed for each province for better performance. Sri Lanka is included in the Regional Models and forecasting, but downscaling is required to give a localized prediction. Furthermore, weather dynamics in the tropical areas are not understood very well thus forecasting has become difficult to greater accuracies.

DoM believes that the application developed by DoM is said to be more accurate for weather forecasting in Sri Lanka compared to the “Accuweather” which is used worldwide. However, DoM needs to make it more attractive and user-friendly. DoM also have developed a High Heat Index (HHI) with the Ministry of Health that can be used efficiently in months April and May.

National Insurance Trust Fund (NITF) covers lives and properties up to LKR 2.5 million each in respect of damages (per event) caused to their property and contents due to cyclones, storms, flood, landslide, hurricane, earthquake, Tsunami and any other similar natural perils, excluding drought [40]. CCD believes that even though NITF is present, a focused insurance method for coastal hazards does not exist. Furthermore, National Planning Department (NPD), has not given priority to the coastal zone when making plans for public hazards. The professionals involved in Disaster Management sector believes that the release of dams and

resulting sudden additions of water to the coastal area due to climate-induced floods; ocean acidification due to climate change and temperature relationship with EW must be considered when designing the Early Warning systems for Sri Lanka.

#### *E. Regional Cooperation*

There are several regional stakeholder partnerships to support effective EW systems and increase the disaster resilience of coastal districts in Sri Lanka. The island is one of the member states of Indian Ocean Tsunami Warning and Mitigation System (IOTWMS) where DoM acts as the National Tsunami Warning Centre for the country [43]. Furthermore, Sri Lanka is one of the twelve member states of The Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) which aims to establish a regional early warning system within a multi-hazard framework to initiate and convey early warning information, and build capacity to prepare and respond to trans-boundary hazards [44]. In addition, the country is also a partner of Regional Specialized Meteorological Centre (RSMC) for cyclones over North Indian Ocean, which will issue tropical weather outlooks and tropical cyclone advisories in the WMO/ESCAP panel region [45]. The Coastal Community Resilience (CCR) is a focused initiative funded by Asian Disaster Preparedness Center (ADPC) that promotes tsunami and other hazard readiness via the dynamic cooperation of state and provincial emergency management agencies, coastal managers, training institutions, and local communities. Sri Lanka being a part of it will increase public awareness, create required standards and promote sustainable livelihood in the country [46]. Furthermore, Sri Lanka is a member of the Asia Pacific Alliance for Disaster Management (APADM), which is an agreement among the stakeholders in order to implement effective and efficient relief and recovery activities [47].

Sri Lankan experts also contributed in preparing the Tsunami Risk Assessment and Mitigation for the Indian Ocean to inform and assist relevant stakeholders at both local to national levels in assessment of the tsunami risk [48]. Coast Conservation Department (CCD) has taken part in several workshops where most of them were focused on Coastal and Marine Risk Mitigation Plans. During some these workshops, it was identified the fact that low-lying areas of Sri Lanka

which are just above the sea level are likely to be hard hit by a sea level rise [49]. Also, CCD is also working with the Indian Ocean Ring Association (IORA), which has Disaster Management as one of the priority areas. Its member States are considering the cooperation in three main areas namely; early warning, disaster risk reduction and the establishment of regional response capabilities.

Some of the primary objectives of the regional cooperation of CCD is erosion maintenance, management of river outlets, Implementation of Coastal Zone Management Plan (CZMP) and obtaining assistance in the preparation of CZMP and guidelines. Sri Lanka should engage in regional dialogue and have mechanisms to incorporate geographical knowledge into the national efforts. Regional stakeholder partnerships can be efficiently used in capacity building and disaster response as well. Oil spills are one specific example that requires regional alliances and corporation. During the interviews, it was further noted that for slow-onset disasters like water or air pollution, efficient information sharing and related capacities are needed.

#### IV. CONCLUSIONS AND RECOMMENDATIONS

The said results and discussion led to several conclusions regarding the community resilience of the coastal districts of the country. Productivity and efficiency of the existing EW systems are questionable considering the recent disasters while the identification of the impacts of coastal hazards at all levels is vital in upgrading them. The early warning mechanisms must be people-centered so that the relevant stakeholders will be adequately benefitted.

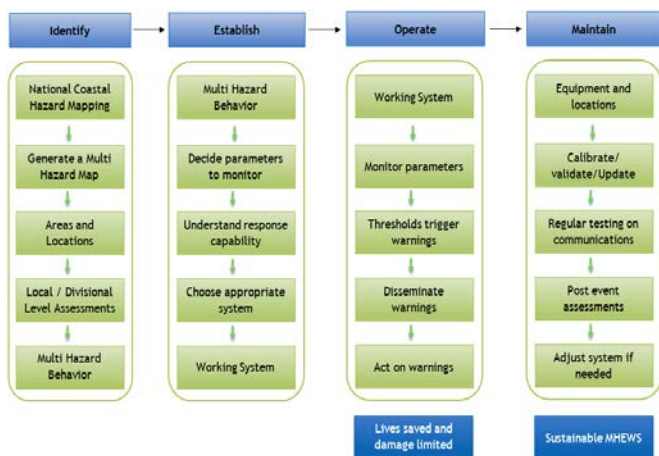


Fig. 2 Schematic representation of MHEWS

The suggested schematic representation of the people-centered Multi-Hazard Early Warning System (MHEWS) following the methodology stated in the Caribbean Handbook on Risk Management is given Fig 2 above [50].

In addition, the necessity of a multi-hazard assessment focusing on the coastal zone is identified which will lead to the upgrading of the existing hazard profiles, developing a vulnerability profile and a risk profile.

Furthermore, it can be concluded that current National policies and frameworks related to coastal hazards are yet to be aligned to the post-2015 global standards. When aligning the tendency to re-invent strategies and plans must be omitted, and the continuity is the key, which will eventually lead to a stable implementation. It was also noted that both soft and hard resilience mechanisms for coastal hazards must be upgraded to increase the capacity and preparedness of the coastal communities.

Training and public awareness campaigns, adequately maintained hierarchy, concern to the coastal ecosystems, diversifying possible hazard responses plays a pivotal role in capacity building of coastal communities. Furthermore, multi-stakeholder and multi-agency cooperation, coordination for the exchange of data and integrating local knowledge for Disaster Risk Reduction measures are some of the enablers identified from the discussion to improve community resilience of the coastal districts in Sri Lanka.

#### DISCLAIMER

The European Commission support for the production of this publication does not constitute an endorsement of the contents, which reflects the views only of the authors, and the Commission cannot be held responsible for any use, which may be made of the information contained therein.

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**Appendix 3 – Scopus Indexed Conference Paper**

**“Need of Strong University-Industry Partnerships: A Case  
Study in Sri Lanka”**

**International Conference on Disaster Management**

**2018**

**Indonesia**



Andalas University

INTERNATIONAL CONFERENCE ON DISASTER MANAGEMENT 2018

(ICDM 2018)

, Padang, May 2-4, 2018

Jointly organizing by

Andalas University

Indonesian Disaster Expert Association (IABI)



April 14, 2018

Subject: **Acceptance of Full Paper and Invitation to International Conference on Disaster Management (ICDM 2018), 2nd - 4th May 2018, Indonesia**

Paper ID Number : **ICDM - 074**

Dear Chameera Randil, Gimhan Jayasiri, Chamal Perera, Chandana Siriwardana, Champika Liyanage, SSL Hettiarachchi, Dilanthi Amaratunga, Richard Haigh

Greetings from Dr. Febrin Anas Ismail, Organizing Chair of ICDM 2018.

First of all, we would like to thank for your interest and valuable research contribution to International Conference on Disaster Management (ICDM 2018), during 2nd - 4th May, 2018 jointly-organizing by Andalas University, Indonesian Disaster Expert Association (IABI) and National Agency for Disaster Management (BNPB), Indonesia.

We are pleased to inform you that after careful review and assessment, the members of the ICDM 2018 Technical Committee have accepted your full paper **“Need of Strong University-Industry Collaborations: A Case Study in Sri Lanka”** for “Oral” presentation at the Conference.

The paper is selected for publication in **MATEC Conference Proceeding – Scopus Indexed.**

It is our great pleasure to send formal invitation to you to participate and present your paper in this conference.

Please find attached review reports of your paper and submit your revised paper via our online submission system before April 20, 2018. Please also prepare for **10 minutes presentation** including Q&A.

Should you require more information, please do not hesitate to contact us. We look forward to hearing from you soon. Please always refer your paper ID number for future correspondence.

Sincerely yours,

Dr. Febrin Anas Ismail,  
Organising Chair of ICDM – 5th PIT IABI  
Andalas University - Indonesia  
E-mail: [icdmiabi@eng.unand.ac.id](mailto:icdmiabi@eng.unand.ac.id)



Andalas University

**INTERNATIONAL CONFERENCE ON DISASTER MANAGEMENT 2018  
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*Jointly organizing by*

**Andalas University**

**Indonesian Disaster Expert Association (IABI)**



## Need of Strong University-Industry Partnerships: A Case Study in Sri Lanka

Chameera Randil<sup>#</sup>, Gimhan Jayasiri<sup>#</sup>, Chamal Perera<sup>#</sup>, Chandana Siriwardana<sup>#</sup>, Champika Liyanage<sup>\*</sup>,  
S. S. L. Hettiarachchi<sup>#</sup>, Dilanthi Amaratunga<sup>~</sup> and Richard Haigh<sup>~</sup>

<sup>#</sup> *Department of Civil Engineering, University of Moratuwa, Moratuwa, 10400, Sri Lanka*

*E-mail: chameerarandil@gmail.com, gimhanjayasiri@gmail.com, chamalanjana5@gmail.com, chaasi@uom.lk, sampens1955@hotmail.com*

<sup>\*</sup> *School of Engineering, University of Central Lancashire, Lancashire, PR1 2HE, United Kingdom*

*E-mail: clliyanage@uclan.ac.uk*

<sup>~</sup> *Global Disaster Resilience Centre, University of Huddersfield, Huddersfield, HD1 3DH, United Kingdom*

*E-mail: d.amaratunga@hud.ac.uk, r.haigh@hud.ac.uk*

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**Abstract**— University-Industry Partnerships (UIPs) in the field of DRR have produced several innovative tools, services and advancements of industrial applications globally. However, from Sri Lankan perspective, the level of UIPs appear to be significantly lower compared to the global context. In Sri Lanka, a country that has suffered a lot from natural disasters such as landslides and floods especially over the past few years, DRR activities are undertaken by the governmental and private sector organizations and volunteers, mostly as separate entities. This could lead to inefficiencies, overlapping of efforts, and also to reinvention of wheel. The Universities as Higher Education Institutions have a key role to play in bringing the aforementioned stakeholders together not only to strengthen the work they do by effective partnerships but also to come up with innovative solutions through research and development. The purpose of this paper is to explore how effective UIPs can be created in Sri Lanka to achieve the above by exploring; 1) current status of UIPs in Sri Lanka; 2) barriers in creating UIPs; 3) needs and opportunities for creating UIPs; 4) identifying best practices in creating strong and sustainable UIPs. The purpose will be fulfilled with the use a literature review and by gathering stakeholder opinions. The research findings revealed that there is a need to develop a policy that addresses the aspects of knowledge diffusion, production, engagement, increasing the exposure of the academia for the industry and capacity building in universities. This is in order to tackle key barriers in creating UIPs. There is also a need for a strong and effective leadership initiatives from universities to ensure sustainability of UIPs in Sri Lanka.

**Keywords**— University Industry Partnerships; Disaster Management; Best practices; Barriers and Challenges; Leadership

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### I. INTRODUCTION

Sri Lanka being a tropical island in the Indian Ocean was identified as one of the ten most affected countries from climate risks during 2016 [1]. Historical records also show that government and external expenditure on Disaster Risk Reduction (DRR) in Sri Lanka has an increasing trend [2]. Colombo floods and the Aranayake landslide which occurred in May 2016 [3], and floods which affected Galle and Matara districts in 2017 [4]

clearly show that the country is gradually becoming disaster prone due to climate change issues. Also the dramatic increase in number of affected people through these disasters [5], [6] is a fact that cannot be ignored. In order to reduce the disaster risk and to increase the community resilience, Research and Development (R&D) activities should be undertaken. To carry out R&D activities, technology and innovation links between universities and industry are of critical importance. The close partnership between universities and



industry related to DRR is essential to reduce the community vulnerability as well. Here, a partnership can be defined as a contractual relationship between the university and the industries, having specified and joint rights and responsibilities. Each party bear equal share of the reward as well as the risk. The main purpose of the University-Industry Partnerships (UIPs) will be to bring the best of both universities and industries by mixing the theory with practice. In addition, university-industry collaborations can be seen as a subcategory of partnerships, when several stakeholders pool their common interests, possessions and skills to serve to the community's benefit.

This eventually aims to fulfil the national targets with respect to Sendai framework, which can be enlisted as a) halving the annual average disaster mortality, b) halving the number of affected people, c) 50% reduction of direct disaster economic loss in relation to gross domestic product (GDP), d) 75% reduction of disruption of education for children during a disaster by discouraging use of school building as safe centres by 2030, e) having over 80% of district offices and local authorities adopted disaster risk reduction strategies and plans by 2025, f) enhancing international cooperation by 50% compared to 2005-2015 period and g) having total population at risk covered by multi-hazard early warning systems by 2030.

The said UIPs include three intensity levels, i.e. low, medium and high. Low intensity herein refers to the transfer of intellectual property, medium intensity implies mobility of participants and the high intensity includes research partnerships and shared infrastructure [7]. The industry comprises of government and semi government institutions including technical agencies, private sector profit based companies and non-governmental non-profit organizations. Furthermore, most of the countries in the European Union identify UIPs as a dimension of Entrepreneurial activities which drive the economic growth and development [8].

There are many UIPs in the global context which have led to many successful results. Those partnerships have not only addressed the issues in industries, but also have helped in the R&D activities in universities. One example could be taken as the partnership between Centre for Disaster Management and Public Safety of University of Melbourne and Volunteer Fire

Brigades Victoria (VFBV) for the project Surge Capacity Analysis and Visualisation Tool for the Fire Incident Report System (FIRS), which has developed spatially enabled decision support tool to visualise volunteer fire fighting capacity across Victoria [9]. Another example would be the partnership between University of Southampton, UK, EPSRC and BAE systems for the project ALADDIN (Autonomous Learning Agents for Decentralised Data and Information Networks) which aims to develop methods for modelling, designing and building decentralised systems that can bring together information from a variety of sources in order to take informed actions [10]. This is especially supposed to operate in dynamic environments such as in a disaster. Therefore, it is apparent that the UIPs lead to valuable outcomes that would not have been possible to achieve individually.

The purpose of this paper is to explore the ways and means of creating effective UIPs in the context of Sri Lanka by exploring research questions on; 1) current status of UIPs; 2) barriers in creating UIPs; 3) needs and opportunities for creating UIPs; 4) identifying best practices in creating strong and sustainable UIPs. The main sections of the paper will be based on the above. Beforehand, the method adopted to identify the relevant findings are discussed as well.

## II. METHODOLOGY

In order to assess the current state of the UIPs in Sri Lanka a literature survey was carried out initially based on existing University Industry Partnership literature and related regulations and policies. The purpose of the literature survey was to identify the current context of UIPs in Sri Lanka. This literature survey include studies carried out as part of a major EU funded ERASMUS+ project [11] considering three selected universities in Sri Lanka, namely University of Moratuwa, University of Colombo & University of Ruhuna to assess the current condition of research facilities, staff and programmes related to DRR sector. The three universities were partners in the aforementioned EU funded project, thus, only they were taken into consideration in gathering information.

Next, expert stakeholder roundtable discussions were held during a Symposium on 'Creating University-Industry Partnerships' held on the 12<sup>th</sup> of March 2018 with the Ministry of Primary

Industries. The symposium brought together more than 60 academics, policy makers, industry professionals and financial institutions involved in UIPs. The event consisted of several inaugural speeches from distinguished invitees, thematic presentations of related to university – industry links and a final roundtable discussion to fulfil all four research questions mentioned in the introduction section.

The final discussion was carried out with fourteen officials from the Disaster Management Centre, where the role of universities in DRR sector was discussed. The findings of the data collection process led to identify the existing gaps, barriers and challenges which helped to provide recommendations to build effective and sustainable UICs in Sri Lanka.

### III. RESULTS AND DISCUSSION

Following sub-sections will present a synthesis of all findings emerged from the literature review, interviews, questionnaire and roundtable discussions as per the themes of the research questions.

#### A. Current Level of UIPs in Disaster Risk Reduction

The historical records show that Sri Lankan universities have had a low level of R&D activities as primary duty of the faculties was identified as teaching [12].

When looking at different types of UIPs, consultation projects appear to be one of the most common type of UIP in Sri Lanka. For an example, the Disaster Management Centre (DMC) in Sri Lanka, the main technical body involved in DRR activities, has involved in consultative projects such as preparation of coastal hazard profiles and tsunami inundation maps and development of drought hazard profiles with some Government Universities, e.g. University of Peradeniya [13].

Then looking at the other governmental authorities affiliated to Ministry of Disaster Management, National Building Research Organization (NBRO) has done significant amount of consultation for the projects with national importance with University of Moratuwa [14]. Another significant project which has been taken place from 2014 is the Climate Resilience Improvement Project (CRIP) by Irrigation Department in partnership with Mahaweli Authority, DMC and many other non-governmental

organizations and governmental organizations including University of Moratuwa [15].

The private sector organizations have made their contribution in effective UIPs. Development of the application DEWN (Disaster Early Warning Network - Sri Lanka's first mass alert early warning system) can be seen as a success story of a strong UIP established between Dialog Axiata, Dialog-University of Moratuwa (UoM) Mobile Communications Research Laboratory and Micro image [16]. Same laboratory developed automated rainfall monitoring systems [17] in partnership with Meteorological Department and a system to detect and locate elephant breaches in elephant guard fences which is called eleAlert [18] has been developed in partnership with Sri Lanka Wildlife Conservation Society.

With the above cases considered, it is visible that there are some UIPs which have produced successful outcomes, but it was agreed by the stakeholders that there are many barriers and challenges in creating UIPs according to their experiences.

#### B. Barriers and Challenges in creating effective UIPs

As discussed by the participants during the symposium, there are many barriers and challenges that have to be overcome within the process of creating effective UIPs. The first and the most important point raised by the practitioners and the academia is the gap between the outcome and the impact. The unavailability of the disaster related research problems for the academia, which should be prepared by the DMC was highlighted. Furthermore, it was raised that the readiness to accept more risk in investing in R&D works should be borne by the DMC, rather than moving for consultative work.

Another aspect considered was the absorptive capacity of the industry to apply the outcomes of the research for their own applications [19]. For instance, many advanced researches have been carried out in universities (E.g.: Development of damage functions for flood risk assessment in the city of Colombo (Sri Lanka)[20]), referring to global literature and practices, but it could be seen that the local authorities have made a very little or no use of the produced knowledge from them. There are articles published by the authors in partnership with the relevant agencies, which evolves the knowledge on advanced subject matter,

but the knowledge in those publications are not put in to practice up to date (E.g.: How to Make your House Safe from Natural Disasters [21]). Therefore, participants stated that the absorptive capacity of the industry should be enhanced.

In addition, lack of networking and networking models in use [22] was seen as a major barrier in creating UIPs. As aforementioned, there is no existing mechanism to link the universities to industries, other than the personal contacts held by both parties. On the other hand, the both parties should realize that a relationship between university and the industry should not be engineered other than the financial aspects. Higher the informality of the relationship, higher will be the benefits and understanding among each other [23]. Therefore, expanding the boundaries in the relationship with industry should be considered in enhancing UIPs.

Sri Lanka could be taken as a country with a lowest rate of employment of Ph.D. graduates in the industry. This could be due to academic orientation of the Ph.Ds. rather than focusing to the problems in the industry [24]. Due to the fact that most resource persons have foreign degrees for PhDs and MScs, the applicability of the knowledge could be limited within the local context. It was discussed that, in DRR sector, a little or no graduates with BScs are made from local universities. A very little number of M.Sc. and Ph.D. graduates are produced from all local universities, even from them, the number of M.Sc. graduates supersede the number of PhDs [25]. The available courses in DRR were enlisted as M.Sc. in Disaster Analysis, Management and Mitigation by University of Colombo, M.Sc. in Disaster Management by University of Peradeniya, two post graduate diploma courses from the same institutions and the Diploma in Disaster Management by University of Kelaniya. In addition, there is a course module offered in Disaster Management under the M.Sc. in Project Management by University of Moratuwa.

Furthermore, at times, the academics do not realize the importance of industry related research [26][27]. These negative attitudes should be changed in order to create strong UIPs.

Another fact raised was the mistrust between the industries and academics. Industry might have second thoughts about the technology capacities of the universities and expertise on supervisors. This might have caused because of past experiences of

UIPs and attempts on forming UIPs. Participants agreed that expected outcomes from an effective UIPs are adequate timely delivery, focus of the end goals, production of tangible outcomes, good quality and acceptable quantity of the produced outcomes and holding the liability of results [26]. Lack of the above-mentioned deeds combined with discontinuities in the university system (E.g.: Worker union actions: strikes) have caused the failure of forming and continuing UIPs effectively. As an example, failure of business incubators of University of Ruhuna was brought into notice by the symposium participants. Because of this, some authorities even have problems with convincing their employers and employees about the significance of the UIPs as well [22]. Therefore, it was agreed that the academia should have to put a lot of effort in gaining trust and forming healthy relationships by being exemplary.

Another aspect which was considered is the research culture. The industry was oriented to establish short term relationships with the universities which are having a consultative basis, over the past years. But the universities tend to establish longer relationships, as a UIP could mean a sponsorship for a candidate in M.Sc. or Ph. D.[28]. In this case, it would be good to have a duration of commitment which is compatible for both parties.

Availability of data was considered as another aspect. Some authorities hold data which are available for only on request and for a price. Sometimes reaching these data even for a company working in the same range would be much difficult (E.g.: Government organizations). The perspective of the people gathered was that there should be a mechanism to exchange this information. At the same time, another related problem was the exchange of knowledge. Problems have been arisen in past years for not acknowledging the data providers with research publications and not sharing the results of publications with the concerned stakeholders. Even these problems have led to damage of the UIPs in great terms.

The symposium participants also stressed the barriers related to financing. When Sri Lankan country profile is considered, the percentage allocation from the GDP for the research and innovation sector has been on decline (0.3% in 1966, 0.18% in 1996, 0.17% in 2006 and 0.1% in 2013) [29]. This is very low when compared with some of the regional countries; Malaysia 1.3%

(2015), Singapore 2.2% (2014), India 0.63% (2015) and developed countries such as Japan 3.28% (2015), USA 2.79% (2015) [30].

When considered about the industries which are willing to fund for DRR sector, a handful of organizations can be seen. The funding may have benefited some private organizations and universities, but in general, such UIPs are still not significant in contrast to the government funding. It would be a good trend if more of private investors are attracted by universities with respect to DRR related studies. Furthermore, funding will be available depending on the industries recognition and understanding upon the value of UIPs and research work, therefore the attitude upon academia should be enhanced as well.

At the same time, the symposium participants stressed that the universities should be able to come up with feasible rates in UIPs [26]. Sometimes the researchers are asking for unreasonable rates and at most of the time due to rules and regulations, a high amount of fund is allocated for the university itself on behalf of the facilities and resources, which doesn't seem to benefit the researcher directly. The transparency of some of these regulations are in question, which is seen as a barrier in the path of creating UIPs [23], [28]. One example is that for any consultation done through the university, 46% of the total value of the work should be deposited to the university on behalf of 'University Overhead' by regulation, which is very less transparent for both the academia and the industry.

When considered about intellectual property related conflicts, it was the common agreement that the governmental funding agencies such as NSF will allow the public disclosure of knowledge, as in some instances, the private funding agencies could be reluctant of public disclosure of the findings of research and consultancy. It would be a better practice for the companies to adopt to academic disclosure practices in exchange of valuable knowledge [31]. More complications could arrive in the case of patenting and licensing; therefore, the rules and regulations and memorandums of understandings should be able to address the plausible complications.

Finally, another minor detail came in to the concern of the participants was the engagement of the officers in the R&D divisions of the industry, to other non-R&D work such as management related and quality control and quality assurance work.

This will make those officials become less focussed and committed in R&D work, and that will make them to depend more on the researchers from the university side [23]. The common understanding was that the industry representative should be sound on the subject matter he or she is dealing with the university, but under the said circumstances, that officer could lag behind.

Therefore, with all the barriers and challenges, the participants suggested that the discussion should be focussed on needs of requirements to be considered in creating and maintaining successful UIPs.

### *C. Needs and Requirements*

The discussions in the meetings yielded that the most important requirement would be the need of research topics, research problems and ideas. This was seen as a requirement which should be addressed by the industry, as the industry knows the problems they are encountering better. If the requirement is made from the industry side, the academia will be able to align their research to answer the problems, hence produce results which could be used by the industry.

Another important fact that risen was that the industry needs to be confident of the capabilities of the universities. It was raised that academia could be slow in producing results as the resource persons are busy with teaching, administrative work and other consultative work and with the hierarchical processes. Nevertheless, according to a study done in Australia, it should be noted that the universities could be holding the best and up to date knowledge on the subject, and multi-disciplinary approaches will be much enhanced with working with universities [24]. Therefore, the confidence of the industries towards universities has to be enhanced.

Another point considered in the discussion was the availability of subject expertise and a mechanism to identify the subject expert. With the points discussed under current level of UIPs in DRR, it can be observed that the industries are keen to approach the universities and universities are also keen in assisting problems and working together.

Looking at an industry perspective, there is a limited number of links with universities which are not widespread. Most of the organizations tend to contact the same expert from the university since they have gained trust or has a good work history

with them. But sometimes this expert may get busy with other projects and there can be several other experts who are yet to emerge. Hence if there is a good mediator who knows very well about the expertise of the universities, he can coordinate properly with the industry to get everyone involved in the projects without any confusions. Furthermore, Science and Technology Management Information System (STMIS) is a computerized information system which creates a working network among academic institutes, R&D centres and industry which is developed by the National Science Foundation (NSF) of Sri Lanka [32]. (NSF is responsible for the promotion of R&D by funding and monitoring projects in natural resources, energy and science and technology in Sri Lanka.) STMIS enables the professionals from industry to get registered in the database which will give them access to identify the required expert for their projects.

When analysing the Sri Lanka Disaster Management Act, it advises the Disaster Management Centre (DMC) to promote research and development programmes partnering with higher education institutes [33]. Furthermore, National Disaster Management Policy supports the multi stakeholder approach by identifying the need of education training and professional development which are two main concerns of an UIP [34]. When looking at the global standards, Sendai framework highlights the requirement for close partnership of academia and public and private organizations to integrate disaster risk to their management practises [35].

One final requirement would be the transparency in the policies and agreements. Many literature have shown that many questions rise with regards to the ownership of the intellectual property (IP) and with the transfer of knowledge [31], [36] and complications rise along with the rules and regulations [28]. The discussions strongly highlighted the delays and miscommunications took place due to the inefficient policies and regulations, which could be summarized as the discrepancies due to bureaucratic issues.

Furthermore, it was emphasized that the auditors should be more aware and educated with the auditing processes within the universities, as the funding cycles are present within the universities. It was considered that the policies and regulations

should be more transparent to the industry as well as to the academia.

With the discussed facts on needs and requirements, next it was considered the enablers and opportunities to be considered in creating effective UIPs, which were identified during the symposium and focus group meetings.

#### *D. Enablers and Opportunities in creating effective UIPs*

Enablers and Opportunities can be defined as the key factors that allow the universities to get along with the industry, to work together for advanced and better results. There are several enablers identified at the symposium which could be discussed as follows.

With regard to the DRR practices, the current enablers were seen as the undergraduate research projects which carry a component of DRR. And, in post graduate studies, diploma programmes, M. Sc. Programs and Ph. D. programmes offered by the local universities can include a component or can be based on DRR. Other than that, attending to workshops from DMC or any other stakeholder government or non-government organization were identified as enablers which are in practise, in the discussions.

Sri Lanka Disaster Risk Management Plan (2018-2030) which will be the roadmap for DRR in Sri Lanka (which is still in a draft stage) has identified the need of disaster related research and technological innovations from universities, lack of integration of research findings in to DRR [37] which was seen as a good opportunity for both industry and universities to collaborate in practice. Most of the work carried out by the DMC was consultative, rather than research oriented at the time. Furthermore, it has identified that the investments for the research activities should be made available.

Another enabler recognised was the social and geographical proximity of the universities and the relevant organizations [23]. DMC raised the point that the geographical proximity could be used in much effective ways in the DRR process in Sri Lanka, as if the universities are given the responsibilities of the DRR related studies for a specific region, based on their geographical locations. For instance, under this concept, landslide risk assessment in upcountry areas can be assigned to University of Peradeniya which is located in the upcountry, while the risk assessment

of coastal floods in down country can be carried by University of Ruhuna which is situated in the coastal belt. In this way, the proximity of academia and industries could be utilized.

Another strong suggestion was to have the Technology Transfer Offices (TTOs) which are currently unavailable in the local universities. These TTOs are located inside the university and they are supposed to act between the industry and the university in case of a consultancy or in case of a research development. These TTOs will have the duties of undergoing through the policies and regulatory procedures for the industries to reach the universities and to find financial supports for the university researches. From the TTOs, the burden on universities to find financing will be lessened, therefore, the researchers can focus more on the subject matter. On the other hand, the industry will feel more encouraged to reach the universities for subject matter expertise, as the rigorous procedures are handled by a third party for the industry [36]. Even the TTOs can play a role in the cases related to IP and patenting [38].

In addition to the improvements related to the rules and regulations, it was agreed in discussions that a proper code of ethics should be introduced for the UIPs. This will create more work friendly background for working, and the space for discussions will be large, as the understanding among each party will be higher than what is in practice now. Especially when it comes to the human interrelations, ‘boundary spanners’ can enhance the level of interaction between each party. These boundary spanners pose the qualities of having open mindsets, active listening and active participation in conversations, strong ability to extract information, strong communication skills and emotional maturity, empathy and integrity while interacting with stakeholder companies [39]. People with these qualities can act as mediators between the university and the industry.

Since there were concerns about data and result sharing, having a common platform to share the results among all the other stakeholder agencies was seen as a good enabler. In relation to this, open data policies can be implemented. Some acts such as right to information act of Sri Lanka emphasize the access to information [40], more specific policies should be implemented on open data sharing, at least for governmental institutes. One such initiative is the ‘Desinventar’ online database

which consists of all the details available about disaster situations happened from 1974 up to date[41]. More initiatives like Desinventar will enable the UIPs in great contexts.

Another point agreed in discussion which was raised by the academia was improving the R&D culture in universities. This could be done through having research allowances, salary hikes based on h-index for research publications and citations. (Universities in Sri Lanka are having low world rankings, mainly because of the lack of publications [42].). The stipend paid for a researcher with PhD qualification is about USD 560 (LKR 90,000) in Sri Lanka, therefore increasing this amount could be seen as an enabler, as money can be a good motivator.

Finally, the discussions made it clear that the availability of funding will work through its way to strong and successive UIPs, and it will make the researchers feel more secure about their study and it will keep them more focussed and in line with the subject matter. Identification of this requirement and stating the measures to address them in the roadmap for the years 2018-2030 for DRR is a considerable improvement. It will be better if the other stakeholder authorities do the same in the near future, such that the creation of UIP platforms could be broadened.

With all of the above enablers being discussed, the discussions continued in recommending the best practices and sample cases for the betterment of UIPs.

#### *E. Best practices and Recommendations*

There were many best practices and recommendations were stated in discussions, one of the most outstanding practices was having an external body which can undertake projects from the industry which is affiliated to the university. A living example was given as UNI Consultancy services (UNIC) which is operated within the premises of University of Moratuwa. UNIC is a limited liability company which is registered under the company act of act no. 07 of 2007, which makes it enable for the company to bid for the projects in the industry which is a privilege that the university does not have. And the objective of UNIC is to facilitate the industry with the expertise that can be gained from the academic staff in the university through the R&D culture [43].

UNIC limits its membership only to the academic staff in the university, and it is handled by a board of management consisting of university academic members, but the vice chancellor of the university is not permitted to be a member in UNIC, to avoid any ambiguities in the operations of UNIC and university. UNIC is audited by an auditing firm, and as it uses the name of the university, 15% of any payment made to an academic member in UNIC is paid to the university. Through UNIC, it has been easier for the industry to approach the university and consult for its services, without going through the rigorous and time-consuming procedures within the university. And as a consulting firm, UNIC was able to produce quick and accurate results with project within the given timeframe. If establishments similar to the UNIC can be formed and the disaster related research could be consulted through that establishment, a big amount of time and money could be saved rather than going along with typical university procedures.

Given that, another recommendation is the provision of a good framework or a policy that addresses the aspects of knowledge diffusion, knowledge production, knowledge relationship and knowledge engagement [44]. These frameworks will enable for both universities and industries to work in understanding about each other. Furthermore, these frameworks can include meetings among industry and university which discuss about the industry need and the research problems, state of art references made by the university, concept solutions brought forward by the university which is open for discussion for the industry, separate evaluations by the industry and the university where the both parties can interact and have interventions about the solutions and finally a validation which is issued by the university [23]. Then the both parties can put a combined effort in publishing the findings and in applying the findings into practice.

A different setup of recommendation was the provision of state of the art knowledge incubators. With correct handling and optimization, incubators are capable of producing good results [23]. The Rubber Products and Process Development Incubator in University of Moratuwa in partnership with Samsons International PLC was explained as a success story. However, it should be noted that the incubators which are not managed and focussed properly have damaged the UIPs in great quantities.

A demonstration in the discussions was the case with business incubators in University of Ruhuna.

Increasing the awareness and the exposure of the academia for the industry was recommended too. This includes sending the undergraduates to the establishments related to DRR to have the in-plant training programmes, accommodating the M.Sc. and Ph.D. candidates in those establishments to work together and the academics to spend their sabbatical leaves in those establishments (local or overseas) [22]. This way, the relationships with the industry can be strengthen and these are the best methods of identifying the industry requirements for research gaps. Within the process with the high-quality work of the university representatives, trust and the confidence of the industry towards the university will be built automatically. And the networking aspects of building UIPs will be addressed as well.

On the other hand, it was agreed that it is very important to build the capacity within the organizations to apply the theoretical knowledge in practice, therefore the industry is encouraged to recruit the people with necessary qualification and the expertise, in order to build the capacity within the organization.

The results of the discussions can be summarized as shown in table 1.

TABLE I  
IDENTIFIED PROBLEMS AND SUGGESTED SOLUTIONS IN THE DISCUSSIONS

	<b>Identified problems</b>	<b>Suggested solutions</b>
1	The unavailability of the disaster-related research problems for the academia	The industry should produce and maintain a set of challenges they encounter, which needs a research component in finding a solution, having TTOs.
2	The inadequate absorptive capacity of the industry	Provide employment opportunities to qualified academics (MSc, PhD holders in respective expertise) in the industry with competitive salary schemes.
3	Lack of networking	Employment of a mediator between the industry and universities, having a database of resource persons, having TTOs.
4	Mistrust between the industries and academics.	Carrying out small-scale pilot projects with industry-academic partners, before moving into full-scale projects. The industry needs to be confident of the capabilities of the universities, Universities adopting many beneficial and efficient methodologies in partnering.

5	Non-availability of a well-established research culture	Government and DMC should initiate research centers in selected universities. Enhance the employment of students doing higher studies in industry-related research.
6	Non-availability of data	Maintaining free accessible databases (at least for government agencies) and make the fee structure available in the websites, digitizing the data and make the process smooth. Introduce policies to improve the flexibility of accessing data.
7	Challenges of getting the funding	Making funding sources and deadlines available to the academia, making the funding mechanism smooth. Adhering to various models of partnerships, universities presenting more feasible economics in partnerships.
8	High charges in UIPs	Academics getting along to work with industry, revision of policies that incurs expensive and less-transparent overheads
9	Conflicts with IP rights and ownership	Making the policies and agreements transparent, both industries and universities working on an understanding of each other's ambitions.
10	Engagement of the officers in the R&D divisions of the industry	Having dedicated officers for industrial divisions of R&D, with boundary-expanding qualities.

#### IV. CONCLUSIONS

This study is composed based on results from a symposium which had over forty participants from fifteen different institutes including academic institutes and from a meeting held with DMC of Sri Lanka to uncover the possibilities of UIPs, where there were fourteen participants. The study could be extended to gather the opinions from other establishments who are interested in studies in DRR such as NBRO, Irrigation Department, Mahaweli Authority, Meteorological Department, Geological Mines and Survey Bureau, Survey Department etc. which could be identified as the future work.

In conclusion, the discussions stated that the UIPs in DRR segment in Sri Lanka are not a common and popular phenomenon for most universities and for most industries, on contrary of the urging need of both universities and industry getting together. Therefore, it was a common agreement that the UIPs should be enhanced in order to make use of the theoretical knowledge which might not be driven from the industrial needs,

to a certain extent, and for the betterment of the industries.

In order to implement an effective university industry landscape, well defined policies and regulations are needed [6]. It should be noted that the necessary actions are being taken to modify the policies that are being hurdles to the current UIPs by the administration of the universities. Nevertheless, it should be noted that the new paths and frameworks of UIPs should be discovered and put in to practise rather than getting used to undergo the typical procedures to engage in with universities.

In general, the discussion led in gathering the ideas of different stakeholders in the sequence of needs and requirements in creating UIPs, barriers to create them, enablers and opportunities to create UIPs and finally the recommendations and cases of best practices in creating them. As a principle, it was agreed by all of the participants that the leadership of creating UIPs should be taken very seriously. There are many responsible parties that can take the responsibility of leadership, and they could do the reaching out task either for the university or for the industry. Other than that, both the industry and the universities were quite confident that they pose the ability to carry along UIPs, for mutual benefits.

#### ACKNOWLEDGMENT

The authors gratefully acknowledge the EU Erasmus+ funded projects ASCENT (Advancing Skill Creation to ENhance Transformation) and CABARET (Capacity Building in Asia for Resilience EducaTion) for providing funds and expertise in carrying out this research.

#### DISCLAIMER

The European Commission support for the production of this publication does not constitute an endorsement of the contents, which reflects the views only of the authors, and the Commission cannot be held for any use, which may be made of the information contained therein.

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**Appendix 4 – Conference Paper**

**“Role of Higher Education Institutes in Coastal  
Community Resilience & Risk Management”**

**Abstract got accepted for  
International Conference on Building Resilience  
2018  
Portugal**

---

**ICBR 2018 notification for paper 15**

1 message

ICBR 2018 &lt;icbr2018@easychair.org&gt;

Wed, May 16, 2018 at 2:10 AM

To: Gimhan Jayasiri &lt;gimhanjayasiri@gmail.com&gt;

Dear Gimhan Jayasiri

Congratulations! Your abstract "**Role of Higher Education Institutes in Coastal Community Resilience & Risk Management**" has been accepted for ICBR'2018.

Submission ID: 15

If the reviewers have required changes to the abstract, please consider them during the preparation of the full paper. If the indicated changes specifically require corrections to the abstract, you may apply them when preparing the abstract to include on the full paper. For the moment, there is no need to re-upload a new PDF file with the corrected abstract.

In short, we'll be uploading to the website <http://2018.buildresilience.org> a template for the preparation of the full paper and Instructions for Authors.

Looking forward to your participation in this event!

Kind regards,

ICBR'2018 Organising Committee

## ----- REVIEW 1 -----

PAPER: 15

TITLE: Role of Higher Education Institutes in Coastal Community Resilience &amp; Risk Management

AUTHORS: Gimhan Jayasiri, Chandana Siriwardena, Samantha Hettiarachchi, Ranjith Dissanayake and Chaminda Bandara

Criteria 1: Technical merit: 4 (good)

Criteria 2: Readability: 5 (excellent)

Criteria 3: Relevance: 3 (fair)

Criteria 4: Originality: 4 (good)

Reviewer final decision: 5 (Accept (score 14-16))

## ----- Comments to Authors -----

"Abstract is written well and also very much suited to the conference theme. However, not sure how relevant the title of the paper (and contents to some extent) to this given track 2C on 'Public and private initiatives in risk management'. Hope this issue will be addressed by the authors in the full paper. In the methodology, more details with regard to the types of experts participated in the interviews need to be given. Hope this can be addressed in the full paper as well.

"

----- REVIEW 2 -----

PAPER: 15

TITLE: Role of Higher Education Institutes in Coastal Community Resilience & Risk Management

AUTHORS: Gimhan Jayaisiri, Chandana Siriwardena, Samantha Hettiarachchi, Ranjith Dissanayake and Chaminda Bandara

Criteria 1: Technical merit: 4 (good)

Criteria 2: Readability: 4 (good)

Criteria 3: Relevance: 5 (excellent)

Criteria 4: Originality: 5 (excellent)

Reviewer final decision: 5 (Accept (score 14-16))

----- Comments to Authors -----

The abstract reads well with clear background and methodology. It will be good to include what the findings are (e.g. categories of the barriers and contributions, etc). well done.



Gimhan Jayasiri &lt;gimhanjayasiri@gmail.com&gt;

---

**ICBR 2018 notification for paper 15**

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**ICBR 2018** <icbr2018@easychair.org>  
To: Gimhan Jayasiri <gimhanjayasiri@gmail.com>

Sun, Sep 23, 2018 at 5:46 AM

Dear Gimhan Jayasiri

Please find below the review of your paper with the ID 15. Consider only Review 1 because Review 2 refers to the abstract.

Please, consider the corrections and comments and re-submit the revised version by September 30, with a tolerance of 5 days due to the delay on the delivery of the review.

Thank you,

Kind regards,

The 8th ICBR Organizing Committee

## ----- REVIEW 1 -----

PAPER: 15

TITLE: Role of Higher Education Institutes in Coastal Community Resilience &amp; Risk Management

AUTHORS: Gimhan Jayasiri, Chandana Siriwardena, Samantha Hettiarachchi, Ranjith Dissanayake and Chaminda Bandara

Reviewer's final decision: 3 (Accept upon minor revisions)

## ----- Comments to authors -----

The paper is written well. However, it needs a thorough proof read prior to its final submission as there are some minor syntax errors (e.g. round table - it should be one word, preparing Disaster Risk Reduction and Preparedness plans - prepare appears twice in the same sentence, which is not good). There are some other comments for the paper as follows:

I am aware about the EU project you are talking about in the methodology, but in my view, its focus is not one 'coastal community resilience', it's focus is on disaster resilience in general. Therefore, there is problem with the validity and reliability of the paper findings particularly to CCR.

Your main focus of the paper is role of the HE, but at times your discussions away to University Industry Partnerships (UIPs), why?

In the methodology section you mention mainly three methods, interviews, focus groups and a workshop on UIPs. But you have hardly discussed any findings about the latter in the findings section of the paper. Rightly so, as it has very little relevance to your discussions (looking at the title of the workshop). Hence, I think it's better to leave it out from the methodology.

Not sure how the final diagram shown is developed and how the relationships shown are evolved. A detailed discussion on this would be very helpful to understand the diagram better.

You mention two EU projects in the Acknowledgement section, but only one is mentioned in the methodology.

## ----- REVIEW 2 -----

PAPER: 15

TITLE: Role of Higher Education Institutes in Coastal Community Resilience &amp; Risk Management

AUTHORS: Gimhan Jayasiri, Chandana Siriwardena, Samantha Hettiarachchi, Ranjith Dissanayake and Chaminda Bandara

Reviewer's final decision: 3 (Accept upon minor revisions)

## ----- Comments to authors -----

The abstract reads well with clear background and methodology. It will be good to include what the findings are (e.g.



# Role of higher education institutes in coastal community resilience & risk management

## Abstract

Sri Lanka being an island is vulnerable to various coastal hazards. Out of them, 2004 Indian Ocean Tsunami affected both the critical infrastructure and communities in the coastal belt of the country. 2016 and 2017 floods, which affected Colombo, Gampaha and Matara districts can be considered as the most recent disasters, which made a considerable damage to the coastal community. To face these hazards, resilience of the coastal communities are important. As the driving knowledge foundation of the country, Higher Education Institutes (HEIs) play an important role in building Coastal Community Resilience (CCR). Their expertise and research findings can provide sustainable inputs in capacity building and increasing resilience of the communities. This study investigates the contributions made and the barriers faced by the HEIs while capturing the current status of University Industry Partnerships (UIPs) within the process of building the CCR of Sri Lanka. The research procedure involved a roundtable discussion and a set of in depth interviews with key professionals who are involved in the Disaster Risk Reduction sector. Information gathered was analysed thematically. Improvements and recommendations are also provided to strengthen the capacity of HEIs to overcome the barriers and to contribute effectively and efficiently for risk management activities in the country.

Keywords: Coastal Resilience; Hazards; Higher Education Institutes; University Industry Partnerships

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## 1. Introduction

Climate induced disasters have contributed to widespread damage to infrastructure and to the loss of lives and livelihoods globally. For the years 2017 & 2018 extreme weather event has been ranked first in top global risks in terms of likelihood while the occurrence of natural disasters was identified within the top five ranks of likelihood and impact of the risks (WEF, 2018). Sri Lanka being a tropical island with 14 coastal districts was identified as one of the top ten most affected countries from climate risks during 2016 (Eckstein et al., 2017). The said coastal districts comprises of congested communities, critical infrastructure and a wide range of bio diversity. The cities and towns in the coastal belt are going through a period of economic development which increases the population growth, human induced vulnerability and the risk to various coastal hazards such as severe storms, storm surges and tsunamis leading to coastal erosion, flooding and environmental degradation.

Indian Ocean Tsunami of 2004 is the major coastal disaster, which made a significant impact to both the livelihood and infrastructure of the coastal districts in the island (MDM, 2014). Furthermore, 2016 floods and landslides affected Western province severely, affecting more than 800,000 families (DMC, 2016). 2017 floods and landslides, which occurred a year later, affected the Southern province severely (MoNPEA, 2017). These events show that the coastal belt of the island has a rising trend to get affected from natural hazards frequently.

At present Sri Lanka is in the stage of aligning local frameworks with recent global standards (Siriwardana et al., 2018). As the driving knowledge foundation of the country Higher Education Institutes (HEIs) play a pivotal role in contributing to the said alignments while building coastal community resilience. At present Sri Lanka has fifteen government universities (MoHE, 2018) and several other recognized private institutes who offer degree programmes. The HEIs can contribute in building community resilience via education programmes, sustainable innovations, expertise and advocacy. Furthermore, University Industry Partnerships (UIPs) provide a solid foundation to carryout research activities which enable HEIs to contribute more effectively and efficiently to build capacity and preparedness in coastal communities.

Outdated course curricula, duplicate innovations, lack of expertise and capacity to think outside the box and inadequate resources in the HEIs are some of the factors which led to prepare this paper to investigate the contributions made and the barriers faced by the HEIs while capturing the current status of UIPs related to Disaster Risk Reduction (DRR) in a broader trajectory.

## 2. Methodology

In order to assess the role of HEIs in CCR, initially an in depth literature review was carried out to find the existing contribution made by the HEIs via plans, programmes, policies, UIPs and other mechanisms. This literature survey include studies carried out as part of a major EU funded ERASMUS+ project (Hayat, 2015) considering three partner universities in Sri Lanka, namely University of Moratuwa, University of Colombo & University of Ruhuna to assess the current condition of research facilities, staff and programmes related to DRR.

Then the study was strengthened by a set of interviews and round table discussions which led to capture the expert stakeholder opinions. Eleven key professionals and experts who are actively involved in Disaster Management (DM) activities including academic staff of several Higher Education Institutes (HEIs) were interviewed initially by providing them with a detailed questionnaire followed up by a discussion to gather their knowledge & opinions. Representatives from the leading technical institutions in DRR sector including Disaster Management Centre (DMC), Department of Meteorology (DoM) and National Building Research Organization (NBRO) expressed their ideas focussing on HEIs. Following up the said interviews, expert stakeholder roundtable discussions were held during a Symposium on 'Creating University-Industry Partnerships' held on the 12th of March 2018 with the Ministry of Primary Industries. The symposium brought together more than 60 academics, policy makers, industry professionals and financial institutions involved in UIPs. The event consisted of several inaugural speeches from distinguish invitees, thematic presentations of related to university – industry links and a final roundtable discussion which provided sufficient information to assess the current status of UIPs in Sri Lanka.

The thematic content analysis was used to analyse the data under four themes namely; education and awareness programmes, expertise and advocacy, research and innovations and barriers and challenges. All four themes give a broad perspective of the UIPs as well. Then several conclusions were made and recommendations were provided to enhance the role of HEIs in building CCR.

## 3. Results and Discussion

The results and information gathered in this study are discussion under the aforementioned themes in the following sections.

### 3.1. *Education and awareness programmes*

Education and awareness is identified as an important activity in the pre disaster phase of the Disaster Management cycle in the National Emergency Operations Plan (DMC, 2015). Furthermore, DMC recognizes the importance of integration of DRR into university curricula (MDM, 2014) and most of the public HEIs have considered this fact as well (Prevention Web, 2015).

At present several public universities are offering modules and post graduate courses related to DRR. Masters of Disaster Management offered by University of Peradeniya (UoP, 2017) and Masters of Disaster Analysis Management and Mitigation offered by University of Colombo (UoC, 2018) have a direct focus on educating the students emphasizing risk identification and mitigation rather than the usual practice of relief-oriented approach. In addition, Disaster Management is included as a module in various courses in the fields of Business administration (OuSL, 2017), Bio systems technology (WUSL, 2017), Geography (UoR, 2017), Environmental engineering & management (UoM, 2017) and Medicine (UoC, 2013). This provides abundance of evidence that HEIs have understood the importance of educating students about DRR in several fields including the health sector.

Apart from providing education, HEIs put a great effort to increase the community awareness related to disasters via conferences and workshops. National Conference on Geospatial Sciences and Disaster Management is such a conference held in 2016 by UoC which identified the importance of geospatial science in DRR while commencing a Master's Degree programme in Disaster Analysis (UoC, 2016). Furthermore, training university students by including DRR in the subjects like urban planning, civil engineering and architecture help promoting awareness (DMC, 2005). In addition, several requests were made by the DMC for the university lecturers to conduct development programmes on methodologies and practices related to DRR (MDM, 2014b). Apart from the academics students from UoC and UoP have taken steps to inspire volunteerism which will eventually lead

to an effective network of volunteers who can provide their support and aid during a disaster situation (UN Volunteers Sri Lanka, 2017).

### 3.2. *Expertise and advocacy*

Promoting cooperation between academia and private sector has been identified to enhance the disaster response at global and national levels in the National Disaster Risk Management Plan for Sri Lanka (DMC, 2018). University of Peradeniya providing the assistance in preparing the national hazard profiles (DMC, 2012) shows that services of universities in collaboration with private organizations should be obtained when developing hazard and risk profiles (MDM, 2014).

Faculty of Architecture of University of Moratuwa (UoM) provided their expertise in preparing Disaster Risk Reduction and Preparedness Plans for Akkaripattu (UN - Habitat, 2014a), Balangoda (UN - Habitat, 2013) and Vavuniya (UN - Habitat, 2014b) towns. In addition, UoM provided assistance in preparing climate resilient action plans for coastal urban areas in Sri Lanka which provides four climate resilient adaptation strategies and supportive action plans (UoM et al., 2013). Most of the academics of engineering faculties in the HEIs have helped in preparing several manuals which give pictorial explanations on how to select a proper land and build hazard resilient houses (NBRO, 2015).

When looking at the globally recognized contributions two senior professors of UoM contributed immensely to produce Tsunami Risk Assessment and Mitigation for the Indian Ocean which provides a detailed guideline to assess the Tsunami hazard, vulnerability, preparedness and risk of the coastal communities (UNESCO, 2015). In addition, three Sri Lankan universities including UoM provided their expertise in preparing a guide to evaluate CCR which assist the decision makers from grass root level to the national level when the develop city and district plans (US-IOTWS, 2007).

Interviews and roundtable discussion revealed several significant facts related to expertise and advocacy by HEIs. As already happening in Sri Lanka, the experts could engage in policy advocacy. Organizing such expert consultancy by interdisciplinary groups of experts may support well in addressing complexities of coastal resilience. In addition, they should take part in the National Disaster Management Committee and the plans must be more people oriented. In addition, it was noted that professional advocacy needs to be based on global and local knowledge based on facts. Furthermore, UIPs provide a strong base for the HEIs to lend their expertise in many ways. At present existing linking mechanisms between HEIs and the industry are not sustainable, since most of them are due to personal contacts. Informal relationships will be more effective and beneficial to both parties (O'Reilly and Cunningham, 2017).

### 3.3. *Research and innovations*

After the Indian Ocean Tsunami struck Sri Lanka, a road map for Disaster Management was developed which has given a strong emphasis on integrating DRR in University education to encourage Master and Bachelor Degree students to select DRR themes for dissertations (DMC, 2005). Under the Disaster Management Act, Government of Sri Lanka has identified providing sufficient funding to carryout research and development activities related to Disaster Management (GoSL, 2005). In addition, focusing on the coastal belt of the country Coast Conservation Act authorises the Director in Administration to conduct research in collaboration with relevant stakeholders for coast conservation (GoSL, 1981). It is visible that the importance of research and development for DRR via HEIs has been identified since 2005.

Several advanced research has been commenced in the HEIs including the damage functions for flood risk assessment for the city of Colombo (Dias et al., 2018). In addition, Dialog – UoM Mobile Communications Research Laboratory of UoM which is a recognized UIP made several contributions to DRR related research. The Disaster Early Warning Network (DEWN) which the island's first mass alert network was built and executed by them (DMC, 2015b). Automated rainfall monitoring systems developed in collaboration with DoM (UoM, 2009) and the "eleAlert" system to detect and locate elephant breaches in elephant guard fences (Wijesinghe et al., 2011) are some of the other innovations by the said laboratory.

The experts who were interviewed noted that Cross-disciplinary and transdisciplinary research on DRR should be encouraged. In addition, the innovations must be low cost and community focused with the ease of implementation. Research dissemination should be web based even though it is not the current trend in Sri Lanka. Furthermore, during the data collection stages more focus should be given to the communities and village



level involvement rather than the officers in national levels as well as more partnerships with practitioners is the key for applied research. In addition, universities should have an interesting research culture supported by adequate funding and facilities.

### 3.4. *Barriers and challenges*

During the interviews and focus group discussions most of the experts stated that DMC and other technical agencies are responsible for the DRR education. An updating curricula is necessary to adopt to new technologies, changing climate and resulting new hazards. In addition, most of the academics believe that education curricula could integrate social learning processes that deals with coastal resilience to hazards. Integrating the topic to student projects in fields such as Civil Engineering, coastal and environmental engineering, sustainable development would enrich engineering education with other useful topics such as social designs, long-term perspective, resilience and vulnerability. Furthermore, several courses related to DRR are open for government employees as well but poor participation has been a problem due to lack of motivation. Most of the certificate programs cost around LKR 10,000 and 100 hours of education per annum. Sponsorships are required to enhance the participation. Private sector and Non-Governmental Organizations (NGOs) participate willingly. At the same time HEIs plays a huge role in converting Disaster Management to an attractive profession or a major component of other professions.

There are several barriers in establishing strong and sustainable UIPs as well. Most of the experts mentioned that there is a huge gap between the outcome of the researches and the impact to the society. The absorptive capacity of the industry is another challenge when capturing the essence of some of the advanced research carried out by the universities. Looking at the Sri Lankan context most resource persons have foreign post graduate degrees which can limit the applicability of knowledge within the local context. It was discussed that, in DRR sector, a handful of local graduates and post graduates are produced from the local universities which is not good for strong UIPs.

The mistrust and lack of confidence between the industries and academics was another fact raised in the discussions. The technological capacities of the universities might be questioned by the industry. Considering the past experiences of UIPs and attempts on forming UIPs. On time delivery, focussed end goals, tangible and quality outcomes, are some of the expectations from UIPs. In addition, discontinuities in the university system including worker union actions hinder the progress of research as well. Availability of data is also important when conducting effective research. A proper mechanism should be established when exchanging information between the industry and HEIs. The researchers must properly acknowledge the relevant parties and should share their findings for effective outputs.

The participants in the symposium stressed the funding barriers in DRR related research. Sri Lanka being a Middle income country has a declining percentage allocation from the GDP for the research and innovation sector in comparison for some of the regional countries (The World Bank, 2018). In addition, the researchers should always work for feasible rates and sometimes huge funds are allocated for the universities due to several rules and regulations which does not benefit the researchers directly. Conflicts in the intellectual rights can lead to a huge damage for the UIPs which should be administered carefully. Complications could arrive in the case of patenting and licensing; therefore, the rules and regulations and memorandums of understandings will help to address the relevant issues carefully.

## 4. **Conclusions and recommendations**

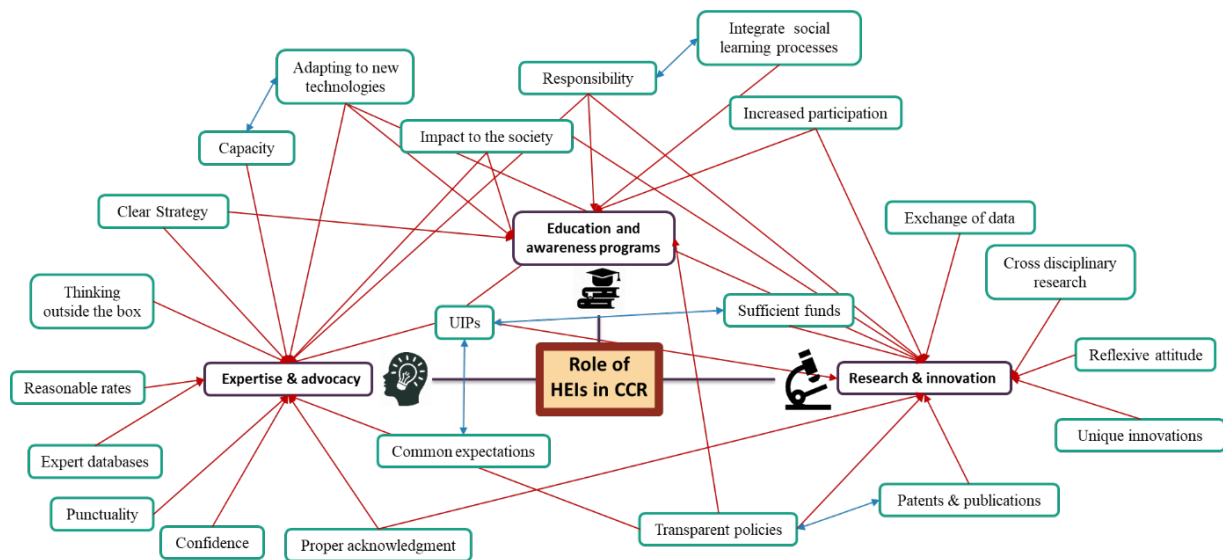
When looking at the information gathered via literature and expert stakeholder discussions it is visible that HEIs have contributed immensely to the DRR sector via education programmes, expertise and research activities extending up to the global level.

The mismatch of expectations by diverse stakeholders such as the academic experts, funding organizations, policy networks, affected communities and general public hinders successful coordination of projects, as well as the social impact. HEIs often face the challenge of their research findings are overlooked in the policy formulation process. In addition, duplicate innovations and lack of capacity to think beyond the main subject area or expertise, developing integrated solutions by partnering with other entities/agencies are key barriers HEIs face in their contribution to DRR. In country issues in obtaining patents for new technology developments and poor recognition are some of the other obstacles faced by the researchers in HEIs.

HEIs must be aware of the responsibilities to create social impact. They should have a clear strategy to address the identified barriers. Adopting long-term approaches and integrating with national budgets, continuous dialogue among agencies with better coordination are some of the key points highlighted by the experts to enhance the role of HEIs in DRR sector. Advising researchers to work with other stakeholders such as the policy makers, affected communities, encouraging DRR related research with long term societal impact, fostering reflexive research attitude in young researchers, encouraging and providing institutional environment that support transdisciplinary contextual research are some of the ways to overcome the barriers and challenges. In addition, HEIs must actively engage with DMC and conduct more research and motivate to include courses and modules within the National Education Systems in all levels.

Furthermore, formulating and conducting research that integrate aspects such as long-term sustainability and resilience of communities as key focuses, and integrate diverse stakeholders is necessary. In addition, HEIs can strive to design their research in a way that research efforts themselves could become key drivers of capacity building in societies. Particularly in Sri Lankan context, although challenging, all HEIs also can make extra effort to be more integrated to the national and regional policy process. UIPs for mutual benefits and synergy is a natural way of building capacity. Inter-HEI exchanges (local and abroad) is a must. HEI staff should undertake national level assignments as a part of the work and engage students in national problem solving.

When HEIs overcome the said barriers and challenges identified they can contribute more efficiently and effectively for the betterment of DRR sector. Figure 1 shows some of the enablers and their inter linkages identified in this study which will enhance the role of HEIs in CCR.



**Figure 1: Some of the enablers their linkages to enhance the role of HEIs in CCR.**

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## Disclaimer

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**Appendix 4 – Conference Paper**

**“IMPORTANT ASPECTS OF EVACUATION  
PLANING FOR THE COASTAL  
COMMUNITIES IN SRI LANKA ”**

**Abstract got accepted for**

**International Conference on Sustainable Built**

**Environment 2018**

**Kandy, Sri Lanka**



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## Session A

**ICSBE 2018: 99**

### **Topic: IMPORTANT ASPECTS OF EVACUATION PLANING FOR THE COASTAL COMMUNITIES IN SRI LANKA**

**Author(s):** Gimhan Jayasiri, Ranjith Dissanayake, Chandana Siriwardena, Chaminda Bandara, Sameera Hippola, Chamal Perera, Chameera Randil, Darshana Jayasooriya

Review Decision	<b>Accepted</b>
Presentation Mode	<b>Oral Presentation</b>
Reviewer Comments	<b>None</b>

Please note that the first author is responsible for notifying any co-authors of the status of the abstract and provide them conference information. Full paper submission is due on **15<sup>th</sup> September 2018**. Manuscripts of accepted abstract will be published in a conference proceeding with the ISBN number. Please revise your abstracts/papers as per the guidelines provided in the web site (<http://www.icsbe.org/icsbe/2018/about/cfp.php>) and completed papers should upload via **Easy Chair Account**.

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We thank you and look forward to seeing you in Kandy, Sri Lanka.

Yours faithfully,

Ms. Amali Palangasinghe

ICSBE 2018 Secretariat  
Department of Civil Engineering  
Structures Laboratory  
Faculty of Engineering  
University of Peradeniya

## IMPORTANT ASPECTS OF EVACUATION PLANING FOR THE COASTAL COMMUNITIES IN SRI LANKA

G.P Jayasiri<sup>1\*</sup>, O.P.C Randil<sup>1</sup>, G.M.C.A Perera<sup>1</sup>, C.S.A Siriwardana<sup>1</sup>, P.B.R Dissanayake<sup>2</sup>, C.S Bandara<sup>2</sup>

<sup>1</sup>University of Moratuwa, Moratuwa, Sri Lanka.

<sup>2</sup>University of Peradeniya, Peradeniya, Sri Lanka

\*gimhanjayasiri@gmail.com, TP: +94719376468

**Abstract:** Sri Lanka being a tropical island in the Indian Ocean has suffered from various disasters in the recent past. Flood events which occurred in the past three consecutive years showed that the country is getting affected from the climate change. During a disaster event evacuation of the vulnerable and affected communities is necessary to reduce the number of deaths. In the Sri Lankan perspective most of the recent disasters severely damaged the coastal belt of the country. This study was carried out to evaluate different aspects of evacuation planning with respect to coastal districts in Sri Lanka. Some of the aspects considered are early warning dissemination, evacuation routes, shelters, drills and training and the effects of having a family vehicle, disabled people, neighbours and domestic animals. During this study an online questionnaire survey was distributed after carrying out an in-depth literature survey to gather data. Lack of trust in authorities who disseminate early warnings and limited knowledge on the evacuation routes and shelters in the resident areas are some of the key issues which were identified during this study. Furthermore, it was identified that social media play a pivotal role in disseminating the early warnings. Increasing the number of awareness campaigns related to evacuation and using social media wisely are some of the recommendations made which will build the coastal community resilience via proactive measures.

**Keywords:** Evacuation Planning; Resilience; Early warning

### 1. Introduction

Extreme weather events and natural hazards have been identified as the top two global risks in terms of likelihood (WEF, 2018). When looking at Sri Lanka, it is visible that this statement is highly applicable considering the frequent disasters after the 2004 Indian Ocean Tsunami. During 2016, 2017 and 2018 the country witnessed extreme rains which triggered flooding in several urban areas. Number of affected people from 2018 floods were around 150,000 which shows a significant decrease compared to the events in 2016 and 2017 (DMC, 2018). 2017 flood event which damaged both the infrastructure and communities of the densely populated districts in Sri Lanka raised the number of affected families up to 630,000 (MoNPEA, 2017).

These three consecutive events show that Sri Lanka should undertake quick resilience measures in order to reduce the number of affected people. Evacuation planning is

such an aspect which should be given due recognition when building community resilience. Most of the vulnerable communities face several problems during evacuation process after an early warning is disseminated. The lack of awareness and trust in authorities, increasing number of deaths and deficiencies in capacity has led to carry out this research to find out the challenges and barriers in evacuation planning to provide recommendations to reduce the disaster risk of the coastal communities.

### 2. Methodology

To evaluate different aspects in evacuation planning for the coastal communities in Sri Lanka, initially an in-depth literature review was carried out to identify the existing status by referring to several plans and programmes prepared by several government and Non-Governmental Organizations (NGOs). Then an online questionnaire survey was distributed to gather the community perception on

evacuation planning in coastal communities. This questionnaire was developed following up the interactive discussions between groups of experts who are involved in the Disaster Management sector. Survey was distributed via social media and emails. Around 100 filled questionnaires were collected which led to assess the existing problems and challenges in evacuation planning. Most of the responses were from the younger generation (age group: 15-30 years) as they are using social media mostly. Figure 1 shows the sectors of the different respondents who participated in the survey.

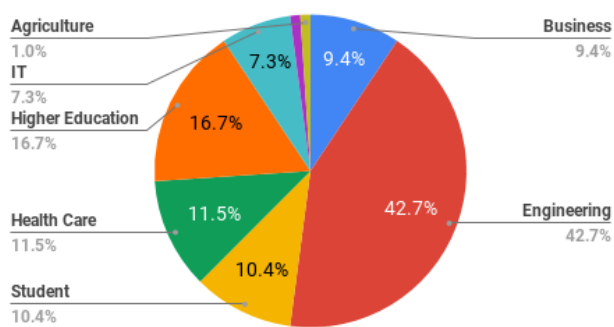


Figure 1: Sector composition of the respondents

Thematic content analysis method was used to analyse the data under the aspects of evacuation planning namely; early warning dissemination, evacuation routes, shelters, drills and training and the effects of having a family vehicle, disabled people, neighbours and domestic animals. After the analysis several conclusions were made and recommendations were provided to improve the evacuation planning for the communities in the coastal districts of Sri Lanka.

### 3. Results and Discussion

#### 3.1. General Information

Out of the 14 coastal districts, information from 9 districts were being able to collect. Most of the data is concentrated to Western province and Southern province as in hence the conclusions will be more focused to those two provinces. Most of the people who are responded were from the engineering & higher education sector. 34% were female respondents as well. More than 70% of the families consist of 4 to 5

members and at least one person has a mobile phone. Furthermore when looking at the education level of the families responded; more than 90% of them has at least one member who has diploma level or university level education. Facebook is the most commonly used social network by the respondents. According to Figure 2 when looking at the public transport facilities and road conditions in the respective areas respondents were satisfied with them.

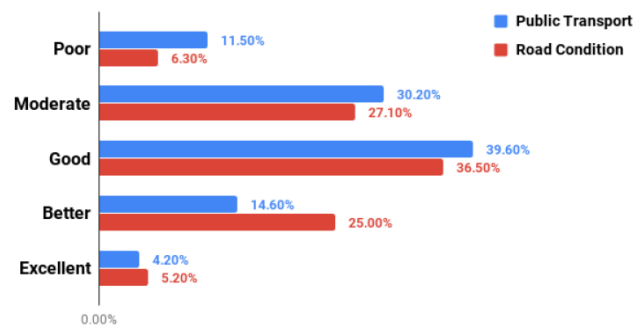


Figure 2: Road condition and quality of public transport according to respondents

Looking at the general opinions about the hazards more than 40% of the respondents think that storms, floods and lightning strikes will affect their area while 15% were confident that their area is hazard free. This might be due to lack of awareness of the terminology. When rating the trust placed on the authorities towards the notices issued by the authorities to evacuate for a disasters more than 70% rate it below 3, on a scale of 1 to 5 (1 being worse and 5 being excellent). This is a critical issue which needs to be addressed which shows that communities will not take the evacuation notices seriously.

#### 3.2. Early warning dissemination

Way of getting Early Warnings (EW) also play a pivotal role during evacuation. At present Sri Lanka has a Multi Hazard Early Warning Dissemination System and an Early Warning Coordination Network form national level up to the grass root level (DMC, 2015). In addition, National Emergency Operations Plan (NEOP) has identified the role of media and military for an effective EW dissemination (DMC, 2015). Analysis of the online survey shows that most of the respondents get early warnings



via Facebook, TV and Mobile phone SMS as shown in Figure 3. During a disaster sometimes access to internet might not be possible.

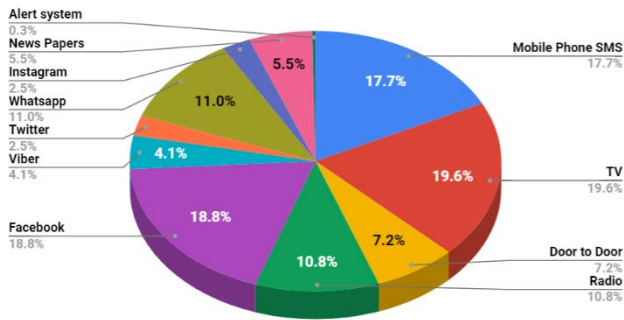


Figure 3: Way of getting EW messages

Furthermore, a statistical analysis was done to identify the correlations between the above responses. According to the Shapiro – Wilk normality analysis done to find a correlation between the respondent’s district and social media, all the selected variables have a significance less than 0.05 which depicts that the data significantly variate from normal distribution. From the analysis it was visible that there aren’t any correlation between the respondent’s districts and preferred way of getting EW messages. But it was visible that there are weak positive correlations between Facebook, WhatsApp, Twitter and other social media. This shows that a selected individual respondent has a slight similarity on their opinion of social media. Furthermore, WhatsApp and media channels have a weak negative correlation which shows a tendency for the respondents to prefer either one of them to get EWs. In addition, from the District & Social Network cross tabulation it was observed that more than 80% of the respondents either use Facebook or WhatsApp as a social media network.

Maintaining the trust on authorities who give evacuation instruction is a challenge (CEDMA), 2017). When analysing the comments made by the respondents there were some serious responses regarding the EW mechanisms. Some believe that announcements by local authorities are reliable as those are issued right prior to the disaster, but the predictions issued by Department of Meteorology (DoM) is

inaccurate. During a recent study it was noted that DoM needs advanced technology to do local area modelling which is needed to produce accurate results. (Jayasiri et al., 2018). Untimed EW and unnecessary exaggeration were also noted as critical issues. Some people felt that it is very important to respond to disaster warnings from the respective authorities even though the level of trust is low, because otherwise if something happened the loss will be severe. Furthermore, one respondent said that Sri Lanka has improved surveillance and other facilities regarding Disaster Management by introducing new communication methods. It was also noted that authorities may be having special attention to areas near the capital as well.

During the recent monsoon rains several early warnings were disseminated via social media which helped the authorities to inform the people about the upcoming disaster risk. Respondents also have mentioned that conveying early warnings via Mobile Phones and door to door methods are very effective while use of newspapers to distribute early warnings was not as an ineffective way. In addition, around 70% of the respondents are capable of passing the early warning messages they get to more than 10 people.

### 3.3. Evacuation routes, shelters, drills and training

According to NEOP Administrative heads of provincial, district, divisional and GN levels, DMC coordinators and fire service departments of local authorities are some of the responsible stakeholders for evacuation (DMC, 2015). In addition, Non-Governmental Organizations like Red Cross and Sarvodaya also come to aid during evacuation. Apart from the national level programmes awareness and knowledge on evacuation planning should be incorporated to the school level as well. More participation of children in local evacuation planning is necessary to increase their preparedness (Vásquez et al., 2018). At present the country has developed guidelines for the schools disaster safety which identifies the importance of

evacuation planning as well (DoE, 2008). In the post disaster recovery plans the importance of using schools as evacuation shelters was also identified (MoNPEA, 2017b).

During the analysis it was noted that 74% of the respondents have not undergone any evacuation drills. Most of them were from Colombo, Galle, Gampaha, Kalutara and Matara districts. 26% of the respondents who said that they have experience of drills noted that it was mostly Tsunami evacuation drills, fire drills at their work places and first aid drills. Furthermore, almost every sector responded have at least 10% of respondents with evacuation drill experience as in Figure 4.

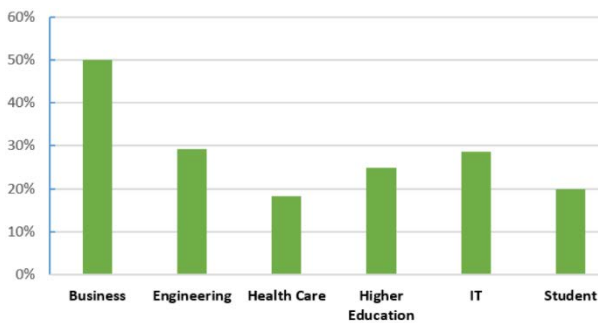


Figure 4: Respondents experience of evacuation drills

Knowing the safest and fastest ways to the evacuation shelters helps the residents to get out of their houses and reach a more convenient place in time. In addition, identification of the safest place in the relevant area which can provide shelter is important. During the survey, 37% of the people said that they know the evacuation routes while others were either not sure or thought there aren't any. Out of the 37% who said they know about the evacuation routes, 74% firmly said that there are no any evacuation signs along the routes. Due to the significant damage caused by the 2004 Indian Ocean Tsunami most of the evacuation signs in the country are for Tsunamis. But for the other disasters there are hardly any.

In addition, only 18% of the respondents know the evacuation shelters in the area. This is significantly a low value which the authorities should take immediate action by

conducting awareness programmes. Religious places, schools and hospitals can be taken as evacuation shelters since most of them are on a higher ground. According to the survey, respondents said that it will take around 5 - 10 minutes to reach the nearest shelter in their areas. All of the 18% who said they know the evacuation shelter; were confident that they know the shortest routes as well.

Furthermore, 60% of the respondents said that they don't have any personal experience of a disaster. Most of the remaining 40% has experience related to Tsunami, strong winds and floods. More than 70% of them rated their evacuation experience by giving a value greater than 3 within a scale of 1 - 5 where 1 been poor and 5 been excellent.

#### 3.4. Effect of having a family vehicle, disabled people, neighbours and domestic animals

Sometimes having a family vehicle helps a speedy evacuation for the residents except during a flood. 81% of the respondents said that they have a family vehicle and most of them were cars which has the capacity to carry around 5 five passengers. In comparison to the total number of family members of the respondents only 60% of them have the capability to carry their entire family at once during an evacuation by their vehicle.

During an evacuation protective care of disabled people is necessary supported by advance preparation (Owens et al., 2013). Only 7% of the respondents had disabled people and most of them need assistance in walking.

During an evacuation looking after the relatives and neighbours become sometimes priority rather than evacuating your own self. 80% of the respondents said that they will put an extra effort to take their neighbours with them if they are not capable. 6% of the respondents believed that they do not have enough space in their vehicles to carry them while 12% believe that they are capable to evacuate by themselves.

People who have pets and other domestic animals (people with farms) tend to care for them during an emergency. During this survey the importance of this issue was analysed and out of the respondents 47% had domestic animals and 78% mentioned that they will put an extra effort to carry their pets during an evacuation while the others believe that the animals can survive by themselves.

#### 4. Conclusions and recommendations

The analysis of the information led to several conclusions regarding the evacuation planning for coastal communities in Sri Lanka. Even though Sri Lanka has a properly established EW mechanism lack of trust in authorities who disseminate early warnings is an issue. Social media plays an important role when informing the general public about the evacuation notices. DMC and other relevant authorities should consider this fact and should use social media wisely for EW process. If the authorities can develop a mechanism that only the vulnerable people get an evacuation notices for their mobile phones as a SMS that would be a perfect scenario. Limited knowledge and awareness on the evacuation routes and shelters in the resident areas are some of the key issues which were identified during this study. Local authorities should undertake necessary actions to establish sign boards which will guide people for evacuation shelters quickly. In addition, they can conduct smaller scale awareness campaigns. Most of the people who live in towns have a family vehicle which helps them to evacuate quickly. For those who need transportation assistance local authorities with the help of NGOs can arrange those facilities during an evacuation process. Even though we should always care about our neighbours and other vulnerable people we have to make sure that we are safe first.

Proper evacuation notices, well established guidelines and clear sign boards to evacuation shelters will always help the affected communities to evacuate safely which will reduce the number of deaths during a disaster.

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