

# STUDY OF VULNERABILITIES AND CAPACITIES FOR NATURAL COASTAL HAZARDS IN NEGOMBO, SRI LANKA

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**Abstract-** Vulnerabilities and capacities for natural coastal hazards (Tsunami, Cyclone, Flooding, Sea level rise and Salt water intrusion) of selected GN divisions of Negombo, Sri Lanka were studied, estimated and gradient maps were prepared using the software Arc GIS.

Descriptive qualitative research methods were mainly used to develop a data base under three categories: personal profile, capacity and vulnerability which was quantified to produce five personal profile indicators, PPI), nine capacity indicators (Nano Capacity Indicators (NCI) and ten vulnerability indicators (Deca Vulnerability Indicators (DVI) respectively.

Capacity and vulnerability ranking of selected GNs was carried out. Accordingly, Thalahaena has the highest capacity strength and the second lowest vulnerability strength. Also, Kapungoda has the highest vulnerability strength with the lowest capacity strength.

Unemployment rate of 18% and education level below ordinary level of 14%, were the two key factors to be addressed seriously in terms of enhancing capacities and decreasing vulnerabilities of Negombo DS. Providing information for policy developers is also important as lack of proper drainage system in Negombo DS was 96%, especially in proper land use planning and development. Statistical analysis revealed a moderate positive relationship between Infrastructure and Educational level, Technology vs Age Range, Cope up

vs Age Range and Cope up vs Educational Level. A positive weak relationship between wealth vs Educational Level, Technology vs Educational Level and Information vs Status. And also a very weak negative relationship between Awareness vs Gender and a very weak positive relationship between Information vs Educational level and Institutional vs Educational level were identified.

**Keywords-** Capacity, Vulnerability, Coastal hazards, Gender, Negombo, Disaster

## I. INTRODUCTION

Disaster increasing, deaths down but number affected sky rocketing, even before recovering another disaster hitting the same population, recurrent disaster occurring with no ceasing, before getting up knocked down again, very difficult to recover and build a resilience despite the huge amount of financial spending, people always dependent on outer sources for living, putting a great burden to the society by very same people who had lived fully independent high neck people, economically, socially, and even psychologically no good and significant amount of revenue of the country is needed to compensate or to rebuild or to basically to look after them (Table 1, <https://www.emdat.be/database>, <https://www.unocha.org/events>, <https://www.preventionweb.net/english/professional/statistics/>).

Therefore it is very important to study what is making them susceptible to be affected by disasters, what are the capacities they have in order to recover, what are the vulnerabilities they possess keeping them susceptible all the time and what are the capacities they lack.

Clearly, people are the most important; even a single death due to a disaster is not an option. Also homeless/affected with no capacity to recover should not be an alternative option too. Prevention/ mitigation must be the very first option. To make decisions about above proper scientific transparent assessment has to be done, for a start clear assessment of what is at risk has to be performed.

Coastal community account for between 15% to 20% of the global community. This make it highly susceptible to the damaging effects of a hazard. (UNISDR, 2009, Hanson

2011). Any effective disaster's response as a community is imperative and vital in understanding and in awareness of capacities of a community to cope up with or to withstand a disaster. This is to minimize both tangible and intangible damages, to safeguard coastal cities, to conserve eco systems and to protect the environment where people live. Being a coastal with a population of 142,136 (About 48% of whole District) Negombo is under high risk to all types of coastal hazards. It is vital to understand and estimate the different components in order to safeguard the people and prevent any loss of lives thereby minimizing tangible and intangible damages due to coastal disasters.

Disaster risk is the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity (UNISDR 2017).

**Table 1. Disaster Profile of Sri Lanka: 2001-2015**

Year	Occur rence	Total deaths	Injured	Homeless	Total affected	Total damage
2000	4	12	-	-	775113	3000
2001	2		-	160	1000160	
2002	1	2	-	-	500000	
2003	1	235	-	-	695000	29000
2004	3	35493	23176	480000	1234306	1316500
2005	1	6	-	-	145000	
2006	1	25	2	-	333002	3000
2007	3	33	-	-	406000	50
2008	4	57	-	-	826905	
2009	4	349	-	60000	415007	
2010	2	35	10	-	770265	105000
2011	5	254	92	106023	1355308	500000
2012	3	53	21	69000	2316021	58200
2013	3	117	15	3861	81300	
2014	7	336	29	330	3005826	25000
2015	2	10	9	-	27309	-

Capacity is the combination of all the strengths, attributes and resources available within an organization, community or society to manage and reduce disaster risks and strengthen resilience. Capacity may include infrastructure, institutions, human knowledge and skills, and collective attributes such as social relationships, leadership and management. (UNISDR 2017).

According to UNISDR 2017, vulnerability is defined as the conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

In this study vulnerability and capacity of 10 GN divisions of Negombo DS division has been measured by undertaking descriptive statistical methods.

## II. METHODOLOGY AND EXPERIMENTAL DESIGN

### *ii. a. : Data Collection:*

This study was carried out using a questionnaire and other data gathering methods among randomly selected sample population in different GN divisions in the study area. Questionnaire was designed to collect social economic parameters in a systematic way by presenting in each respondent by assigning values to a series of yes/no answers, a set of questions based on a Licket scale and a group of questions assessed according to a pre designed key.

Secondary data were collected from the Resource Centre: Negombo, AGA Office (Negombo, Wennappuwa and Kochchkade), Community Organisations, Religious Leaders and Senior citizens/ Retired Government Offices.

Primary data were collected mainly by field survey methods: focus group discussions, structured interviews, semi structured interviews and participatory activities.

### *ii. b : Preparation of Data Base:*

Data were entered in Microsoft Office excel spread sheets and in SPSS 13.01 Data view and Variable views, arranged into three scales systematically: individual base, GN division base and DS division base.

Data base was prepared using soft wares Microsoft Word 2007, Microsoft Office Excel 2007, Arc GIS 10.1, ArcMAP 10.1 and SPSS 13.01 for window, 13.01 eventually data base was arranged to build up personal profile indicators (PPI), Nano Capacity Indicators (NCI) and Deca Vulnerability Indicators (DVI).

### *ii. c. : Indicators*

- PPI includes six indicators: Gender, Age Range, Status, Educational level and Number of members in the family and Residence ownership
- NCI includes nine capacity indicators: Wealth, Technology, Information, Infrastructure, Institutional, Skills acquired, Ability to cope up, Awareness and Preparedness.
- Ten vulnerability indicators under DVI were Gender, Age range, Status, Income level, Residence, Safe Drinking water. Proper sanitary, Drainage system, Past experience and Distance to the ocean.

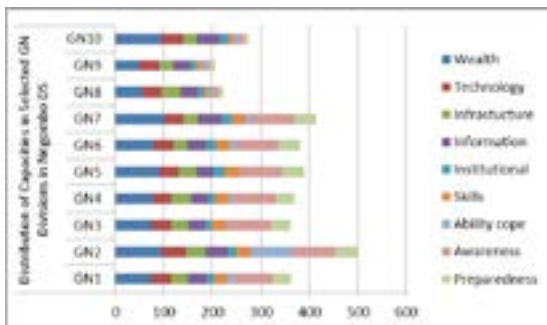
### *iii. Results:*

Three major categories studied in this research were: personal profile, capacities and vulnerabilities for natural coastal hazards in Negombo area (Table 2). A sample size of one hundred respondents in ten GN divisions was questioned using a questionnaire with 37 questions. Responses were quantified and strength of each 19 indicators were analysed, assessed and calculated.

**Table 2. Major Categories of Data Collected for Natural Coastal Hazards: Risk Components with their Relevant Indicators**

Population Profile Indicators	Capacity Indicators	Vulnerability Indicators
Gender	Wealth	Gender
Age range	Technology	Age range,
Status	Information,	Status Infrastructure
Educational Level	Institutional Skills acquired,	Income level, Residence
Number of Members in Family	Awareness Preparedness.	Safe Drinking water.
Income level	Ability to cope up	Proper sanitary, Drainage system, Past experience
Residence ownership		Distance to the ocean

**iii. a.: Results for Nano Capacity Indicators:**



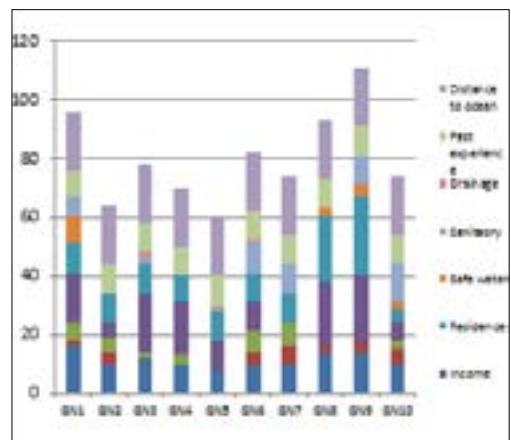
**Figure 1. Strength Distribution of NCI in Selected GN: Negombo DS**

From the graph above GN2: Thaladena has the highest NCI whereas GN9: Kapungoda has the lowest all NCI values. . Ascending order of NCI is as following; GN2: Thaladena, is the highest; GN7 is the second highest following closely. GN6>GN5>GN4 =GN1>GN3>GN10>GN8>GN9: Kapungoda.

Under wealth GN7 has the highest capacity in terms of wealth, whereas GN8 and GN9 showed very low values of wealth. Under

Technology GN2 highest, GN10 next, GN1, GN3, GN4=GN5=GN6=GN7=GN8=GN9. Under infrastructure GN7 highest, GN2 close and second, GN9 lowest. GN2 the highest with highest preparedness, equal highest of awareness, cope up extremely high 8 times higher than others, Skills equal highest, institutional in the middle which may due to the presence of foreigners.

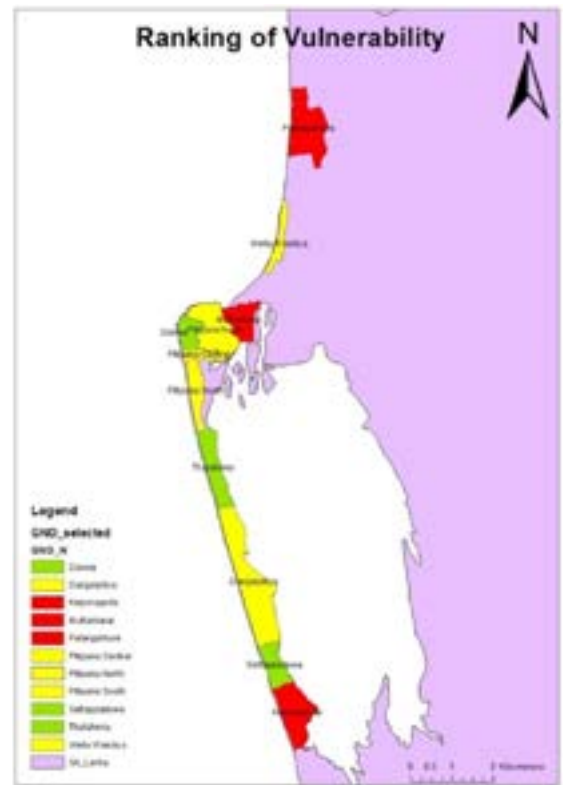
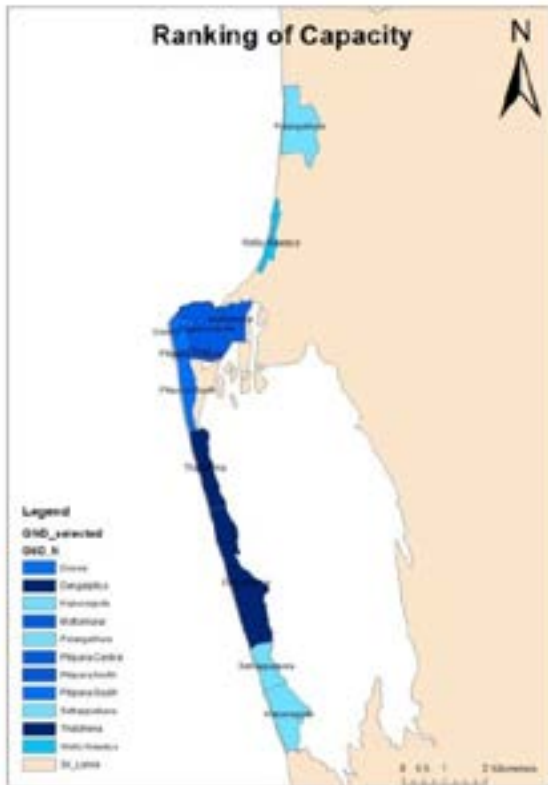
**iii.b.: Results for Deca Vulnerability Indicators:**



**Figure 2. Strength Distribution of DVI in Selected GN: Negombo DS**

iii.c: Preparation of Capacity Ranking Maps Using ArchGIS Software

iii. d.:Preparation of Vulnerability Ranking Maps Using ArchGIS Software



Map 1: Ranking of NCI: Capacity of Selected GN:Negombo DS

<33=LOW	<66=MEDIUM	>66=HIGH	>80=VERY HIGH
<33=Low	<66=MEDIUM	>66=HIGH	>80=VERY HIGH

<33=low	<66=medium	>66=high
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Map 2. Ranking of DVI: Vulnerability of Selected GN :Negombo DS

**Table 3. Statistical Analysis: Computing Pearson’s Correlation Coefficient**

Pearson’s Correlation coefficient of PPI Vs NCI and DVI				
	Gender	Age Range	Educational Level	Status
Wealth	-0.15	-0.13	0.39	-0.16
Technology	0.10	0.40	0.33	0.05
Infrastructure	0.00	-0.01	0.51	-0.15
Information	-0.07	0.20	0.21	0.34
Institutional	-0.12	-0.19	0.23	-0.07
Skills Aquired	0.19	0.07	0.05	0.07
Cope up	-0.04	0.40	0.45	-0.12
Awareness	-0.24	0.00	0.14	0.10
Preparedness	-0.18	0.02	0.05	-0.11
TOTAL	-0.10	0.15	0.53	-0.19

The Pearson’s correlation coefficient was computed and calculations revealed that there was a moderate relationship between following two variables with a respected values. Between Infrastructure and Educational level with a correlation coefficient of 0.51, between Technology vs Age Range with a correlation coefficient of 0.40, between Cope up vs Age Range with a correlation coefficient of 0.40 and between Cope up VS Educational Level with a correlation coefficient of 0.45.

There was a weak relationship between Wealth VS Educational Level with a correlation coefficient of 0.39, Technology VS Educational Level with a correlation coefficient of 0.33 and Information VS Status with a correlation coefficient of 0.34. Also a very weak negative relationship between Awareness vs Gender with a correlation coefficient of -0.24 and a very weak positive relationship between Information vs Educational level 0.21 and Institutional vs Educational level 0.23 were identified.

### III. DISCUSSION

From the results obtained there is a variation of strength of capacities and vulnerabilities in ten selected GN divisions.

By looking at the relationship between, it seems there is a negative correlation between capacity and vulnerability values obtained for each GN division. However, no strong correlation was obtained. There is a gap in the research done in the field, as not much research has been done to identify vulnerabilities and capacities in the study area.

The population profile indicators studied were gender, working status, age range, educational level and residence. Percentage of male population in the sample population studied was higher in GN divisions, GN5 and GN7, lower in GN1, GN8 and GN9 whereas other GN divisions showed equal gender distribution in the sample population. A higher ratio of female was observed in the total sample population of Negombo DS similar to what UNHABITAT 2011 reports. The percentage of working force or the population from 20-65 years was 4/5 the of (80%) total similar to annual report of Negombo Municipality 2012. The aggregated value of population with age range above 65 and below 20 years came to 20% or one fifth of the total sample population of Negombo DS much higher than the values reported in UNHABITAT 2011. In GN5, GN8 and GN9 all the respondents were employed whereas there was a higher population of students; almost 2/3 of the sample population in GN7 (60%) which has not been reported earlier this may be due to the fact that few

enthusiastic school children were involved themselves in the survey. There is an unemployment rate of 1/5 th or 20% in the sample population of GS Negombo much higher to the value reported in Similar to annual report of Negombo Municipality 2012. Working force was only 2/3 of the respondents of the whole DS division of Negombo.

The 1/7 the of the population has education level below ordinary level. Only 1/10 the of the population holds a degree or a diploma, in accordance with the value reported in Sri Lanka Statistical Survey 2012. More than 4/5 the of the sample population have more than 4 members in the family living under one roof. Half of the sample population has 5 members in their family. This may be an important factor in strategies to cope up as more support could be expected from a larger extended family. One in every 20 people has no house/place of their own to stay, therefore living in illegal dwellings.

The indicators assessed under NCI were: Wealth, Technology, Information, Infrastructure, Institutional, Skills acquired, and Ability to cope up, Awareness and Preparedness.

Under wealth GN7 has the highest capacity in terms of wealth, whereas GN8 and GN9 showed very low values of wealth. Under the indicator Technology GN2 has the highest value followed by GN10, GN1, GN3, GN4=GN5=GN6=GN7=GN8=GN9. Index the indicator infrastructure GN7 highest, GN2 close and second, GN9 lowest. GN2 shows highest preparedness, equal highest of awareness, cope up extremely high 8 times higher than others, Skills equal highest, institutional in the middle. Residing of some foreigners may be the reason for those values of GN 2 for information is second only by 1 point, Infrastructure is second to GN 7 by 3 points, Technology is highest, wealth is second highest with only 5 point less. GN2 has the highest NCI total whereas GN9 has the lowest. Ascending order: GN2 is the highest; GN7 is the second highest following closely. GN6 > GN5 > GN4 = GN1 > GN3 > GN 10 > GN8 > GN9. Thalahoma and Dungalpitiya GN Divisions showed higher ranking capacities. Thalahoma GN division exhibited highest ranking distribution of capacity with technology Thalahoma and Dungalpitiya GN Divisions recorded highest capacity distribution regarding infrastructure. Lowest capacity distribution for information showed by Kapungoda while highest was shown by Thalahoma and Dungalpitiya GN Divisions. Muttakkare has the lowest institutional capacity among all the ten GN divisions

studied Highest capacity distribution for skills exhibited by Thalahoma, Dungalpitiya and Pitipana South whereas lowest exhibited by Palangathurei and Wella veediya. Kapungoda and Wella Veediya GN divisions showed lowest Awareness from selected GN divisions in the study. Dungalpitiya and Palangathureyi were among the GN divisions with lowest capacity in Preparedness.

#### IV. CONCLUSIONS

Among the ten selected GNs, (Munnakkare ,Thalahoma , Pitipana , Pitipana south, Duwa, Basiyawaththa, Dungalpitiya, Palagathurei, Kapungoda, and Lellama) in Negombo, Thalahoma has the highest capacity and second lowest vulnerability. Concerning Vulnerabilities, Kapungoda has the highest values and it happen to have lowest capacity value too. GNs 1,8and,9;Munnakkare, Palangathurei.and Kapungoda have high vulnerability ranking. And Doowa and Thalahoma have the LOW ranking whereas other GNs have MEDIUM ranking.

**Table 2. Final Vulnerability and Capacity Ranking for Selected GN Divisions**

GN	Capacity Ranking	Vulnerability Ranking	Name of the GN Division
GN1	H	H	Muttakkare
GN2	H	L	Thalahoma
GN3	H	M	Pitipana
GN4	H	M	Pitipana south
GN5	H	L	Doowa
GN6	H	M	Basiyawaththa/ Pitipana central
GN7	H	M	Dungalpitiya
GN8	M	H	Palanga thurei
GN9	M	H	Kapungoda
GN10	M	M	Lellama/ Wella veediya



# PROCEEDINGS

Among 10 selected GNs Lellama, Palangathurei and Kapungoda are the places with MEDIUM capacity. All other seven GN divisions showed comparatively higher values to each other.

The following recommendations are the results of analysis of data of the present study:

1. There is an unemployment rate of 18% in the DS Negombo and is a key issue to address. This need to achieve by increasing the education, institutional skills and the computer literacy which is only 22% for the whole Negombo DS.
2. Drainage facilities are the worst of all the infrastructure facilities, only 4% and need to be addressed by better and proper land use planning. Here implementation of proper land planning policies could be recommended.
3. By providing education, skills and capital needed to start new or alternative livelihood option also recommended

In turn which means the special objective ii of providing recommendations has been also accomplished.

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