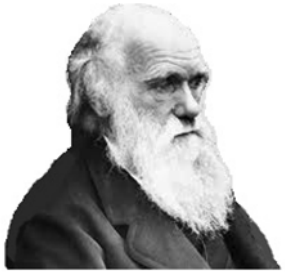
Available online at www.worldnewsnaturalsciences.com



World News of Natural Sciences

WNOFNS 15 (2017) 20-36 EISSN 2543-5426

The management actions for the effects of natural disasters: a study based on Maruthamunai area

M. I. F. Nasliha[1], **M. H. M. Rinos**[1] and **S. Mathanraj**[2,*]

[1]South Eastern University of Sri Lanka, Oluvil, Sri Lanka

[2]Eastern University of Sri Lanka, Vantharumoolai, Chenkalady, Sri Lanka

E-mail address: smathan02@gmail.com

ABSTRACT

Natural disasters are extreme events that result in death or injury to humans, and damage or loss of valuable infrastructure and environment. Such horrible catastrophes affect the village of Maruthamunai in Ampara District. It is situated in the tropical zone. Maruthamunai routinely experiences floods, drought, tsunami, and contiguous diseases. The study was undertaken to identify the effects, causes and the disaster management activities. We also prepared a disaster risk map for the Maruthamunai area to identify the affected zone. Several methods are used to analyze this study. These include qualitative and quantitative data that were analyzed using SPSS and Arc GIS application to produce the maps. The study clarified the effects of natural disasters and prepared disaster risk maps to identify safe places. Our work will help to minimize the effects of disaster and will also support better environmental practices to mitigate the problems.

***Keywords*:** Disaster risk, Damage, Flood, Drought

1. INTRODUCTION

Disasters are as old as human history but the dramatic increase and the damage caused by them in the recent past have become a cause of national and international concern. Today, most of the countries are facing the various types of natural disaster in an everyday life in the world. We can't mention any country without occurrence of a natural disaster. Every country has different familiarity of various natural disasters. It is the major problem in the current world. A natural disaster occurs when the impact of hazard is born by "elements at risk" that may be vulnerable to the hazard. The elements are people, infrastructure, and economic activities. A

disaster can be defined as "A serious disruption in the functioning of the community or a society causing wide spread material, economic, social or environmental losses which exceed the ability of the affected society to cope using its own resources" (Singh R.B., 2006, "Natural Hazards and Disaster Management", Prem Rawat for Raat Publications, Satyam Apts. Sector 3, Jawahar Nagar, Jaipur, India).

A natural disaster is a major adverse event resulting from natural process of earth that causes great damage or loss of life. It could be related to weather, geology, biology or even factors outside the earth (Singh, 2006). Natural disasters are extreme events within the earth's system that result in death or injury to humans, and damage or loss of valuable goods, such as buildings, communication systems, agricultural land, forest, natural environment, etc.

In the world, Asia is the worlds' most disaster affected region. In Asia, every year 46,000 people are killed, 180 million people affected 35$ billion of damage caused by disasters (based on world disasters report 1997). Total amount of disaster damage in Asia from 1991 to 2001 equaled 400641.8 million dollars and 51% of the total global loss associated with natural disasters. In 2014 more than 2000 people were dead in African countries by EBOLA virus, and in 2015 massive earth quakes happened due to the conversion of the plate tectonics in Nepal, therefore about 7000 people were deadh (Ramana Murthy K. 2004, "Disaster Management", Dominant Publishers and Distributors, New Delhi 110053). In addition to this, Sri Lanka is being included, which is effecting by various types of natural disasters because of Sri Lanka is an island that is located in the disaster prone belt of the Asian region. Sri Lanka's past disaster history shows the long history of natural disasters which most frequent occur in Sri Lanka are landslide, flood, drought, cyclone, sea erosion, tsunami, lightning, and epidemics like malaria and dengue (Ilangovan, P. S. 2009, Perception of Flood Risk: A Case Study from the Flood Affected Areas of Madhurai. Natual Hazards and Disater essay on Impact and Managment, International Conference Volume. Anantapura: Department of Geography, Sri Hrisna Devaraya University, India).

When we observe the past experience in the research area's history of previous disasters of Maruthamunai area, this is differing from Ampara district. Ampara district is mostly affected by flood, that is 87.5%, landslide 4.91%, elephant damage is 0.91%, cyclone is 2.72%, sea erosion is 1.09%, drinking water 0.8%, accidents 0.82%, and casual 1%. The study area mostly occurrence of the natural disaster experienced by the climate change either through more access of water or lack of water are flooding, drought, tsunami, and diseases. We have a long history but still we haven't enough documents to give full information about natural disasters, therefore this research will solve the drawback. So, it is important and I hope it will be as a precedent. Then it will assist into a future research.

2. STUDY AREA

Ampara District is situated in the part of the Eastern province in Sri Lanka. Maruthamunai is located in out of 2.3 km far from North of Kalmunai DS Division in Ampara District. Its boundaries are North by Periyaneelavanai, the south Pandiruppu, the West by paddy fields, and the East Indian Ocean.

Maruthamunai is in the coastal zone area. Its elevation is 3 meters above the sea level. Maruthamunai area extent is 4 squere kilometers. It has 9 Grama Niladhari Divisions and it is including Periyaneelavanai, Pandiruppu Muslim Division, Maruthamunai, and Akbar village.

The majority of population are Muslims communities living in this area. Total population is approximately 17,954. The mean annual temperature of the study area is about 28 °C. The rainfall varies and it is distributed throughout the year and has a heavy intensity in the months of October to March, with less rains in April to September by south west monsoon.

The North East Monsoon is the main rainy season. Maruthamunai is located as a coastal area and large proportion of land is allocated for paddy. Peoples' main livelihood is the agriculture, fishery and weaving, and now the education, economics and weaving are the main occupations.

3. OBJECTIVES

- To identify the effects of natural disasters in Maruthamunai Area.
- To prepare the hazard risk maps for the Maruthamunai Area.
- To find out the disaster management activities for the Maruthamunai Area.

4. MATERIALS AND METHODS

In the study, both quantitative and qualitative methods were being used in order to get all the necessary data from various sources. Various tools have been used in this study to collect and interpret data. The data are collected both by Primary Data Collection and Secondary Data Collection.

4. 1. Primary Data Collection

Primary Data collections have been gathered through Interviews with MOH Officer, Disaster Management officer Kalmunai, metrological officer Pottuvil and Fisheries Officer Kalmunai. Questionnaire survey was performed with 100 households' as follows: Disaster Management officer 2, Fisheries Officer 3, Grama Niladhari 5, Fishermen 20, Farmers 20, Businessmen 10, and Public 40. Direct observation was done in the study area.

4. 2. Secondary Data Collection

This secondary data has been collected from the published and unpublished sources such as magazines, articles, files, Remote sensing analysis map, Printed maps, chart, books, government and nongovernmental reports and documents, Department reports, and Library research and webs.

The basic map of research area gathered from Divisional Secretariat, Kalmunai. The village vital information statistics on human and physical features, such as population, educational, occupational structure and disaster statistics were gathered from Divisional Secretariat, Kalmunai, and MOH office. Meteorological data were collected from Meteorological Department, Pottuvil and Fiheries data collected from fisheries office, Kalmunai.

4. 3. Basic Layer Preparation

Printed paper map and Google image were used to produce basic layer map preparation (**Figure 1**). These printed paper map and Google image were scanned and input into Arc GIS 10.4 to produce the following disaster affected area map to show the affected area (**Figure 2**).

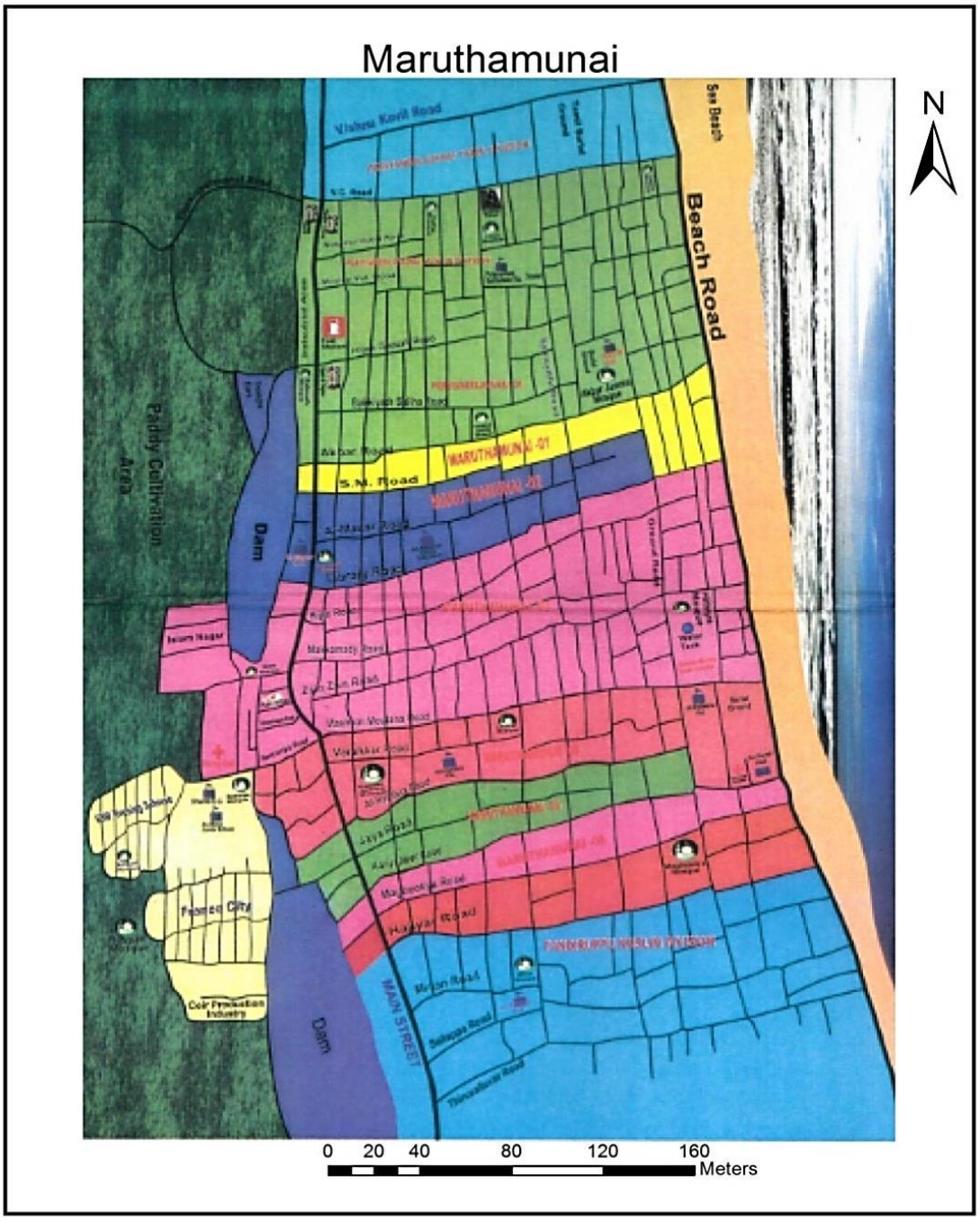


Figure 1. Basic layers- Maruthamunai
(Source: - Maanpuru Maruthamunai, 2016)

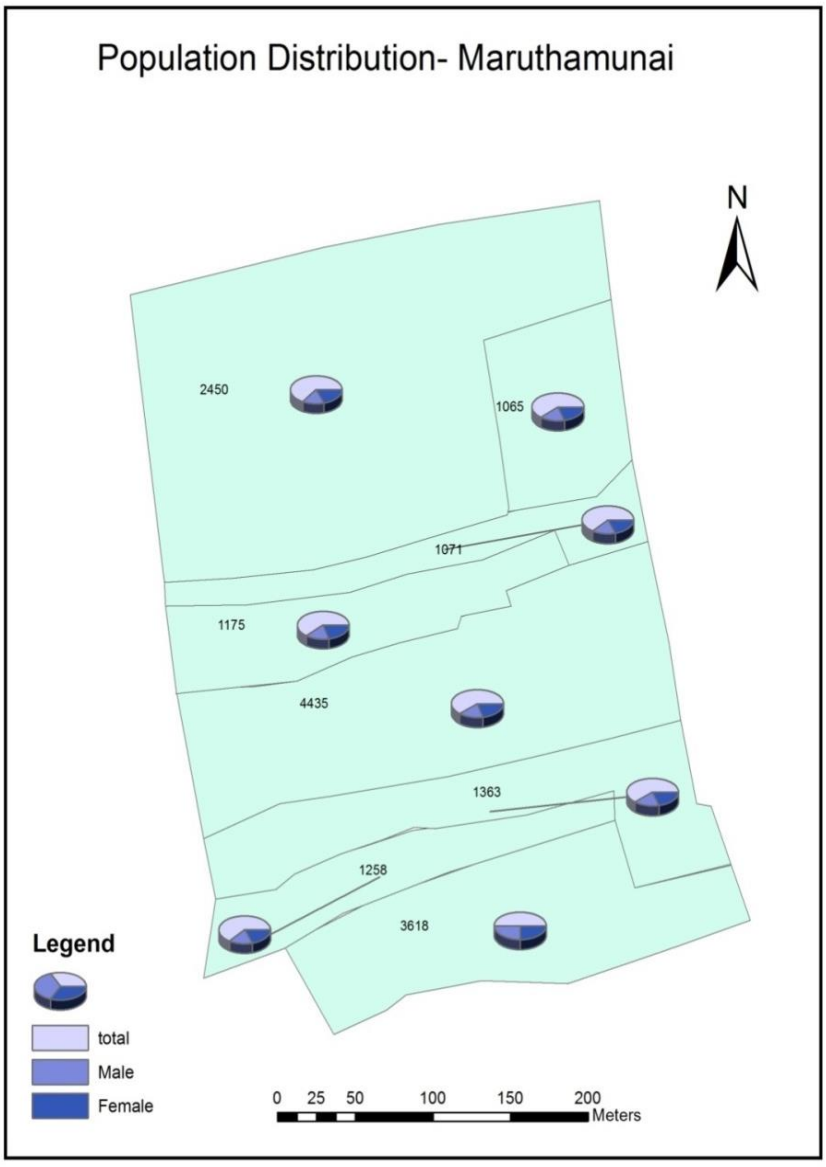


Figure 2. Population Distribution
(Source: - Retrieved in Arc GIS 10.4, 2017)

5. RESULTS AND DISCUSSIONS

5. 1. Preparation of Hazard Maps

A combination analysis of basic layer were undertaken in order to create hazard maps (**Figure 3**), such as flood affected area, and tsunami effected area. These maps were added and analyzed with population data (Fig. 2) in order to obtain the affected people falling under each affected area. Following Fig. 3, and **Fig. 4**, help to create the household falling within tsunami area map in Arc GIS to identify the affected population and damaged houses under in each Grama Niladhari Divisions in Tsunami affected area.

Figure 3. Tsunami Affected Area and Houses
(Source: - Retrieved in Arc GIS 10.4, 2017)

Figure 4. Photos Clarify of Tsunami Effects in Maruthamunai, 2005

5. 2. Flood Hazard Map

Research area mostly effected by floods is given in **Figures 5**, **6**, and **7**. Every year it has been facing flood but severe floods occurred in two years during 2011 and 2014 and their effects were devastations. According to that, following tables were used to produce the flood hazard maps and flood affected families falling under each GN Division for 2011 and 2014.

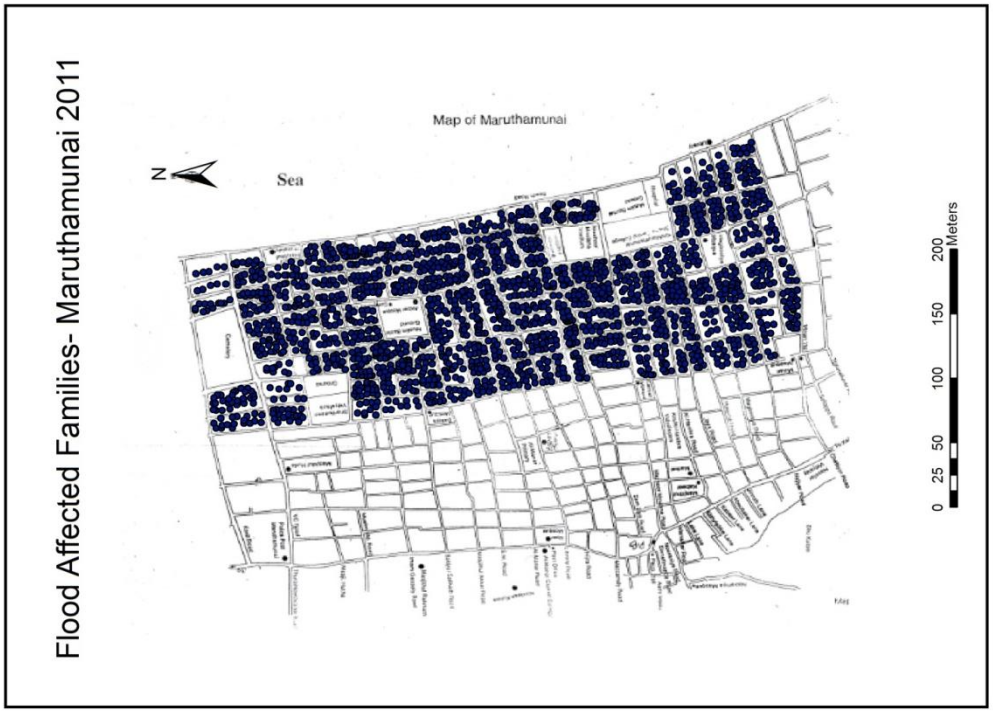
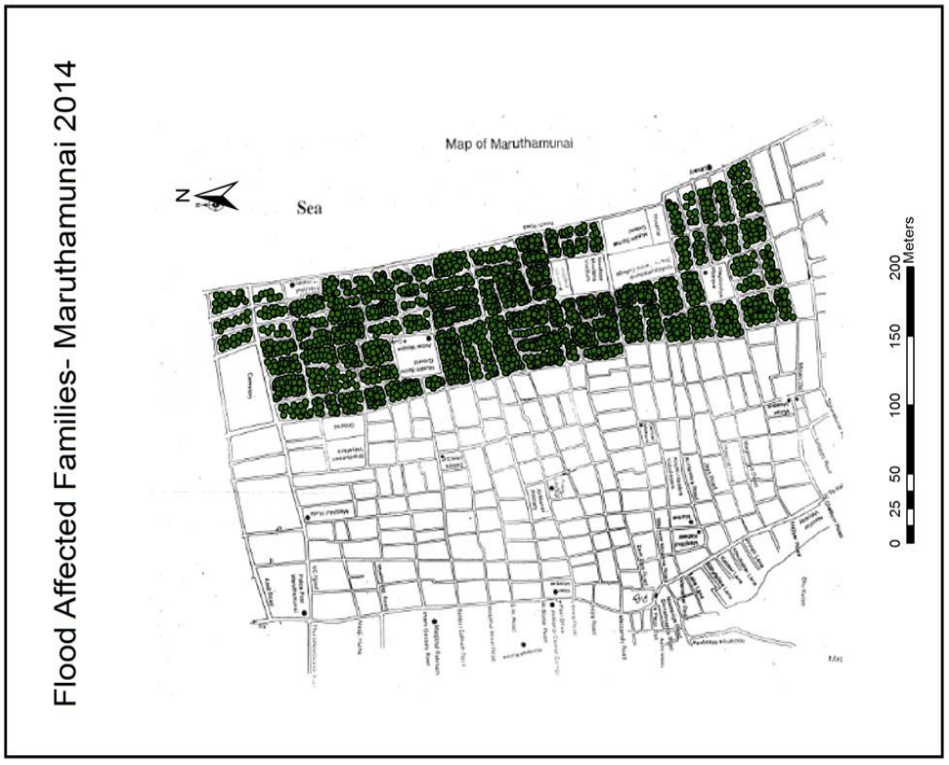


Figure 5. Flood Affected Area and Families
(Source: - Retrieved in Arc GIS 10.4, 2017)



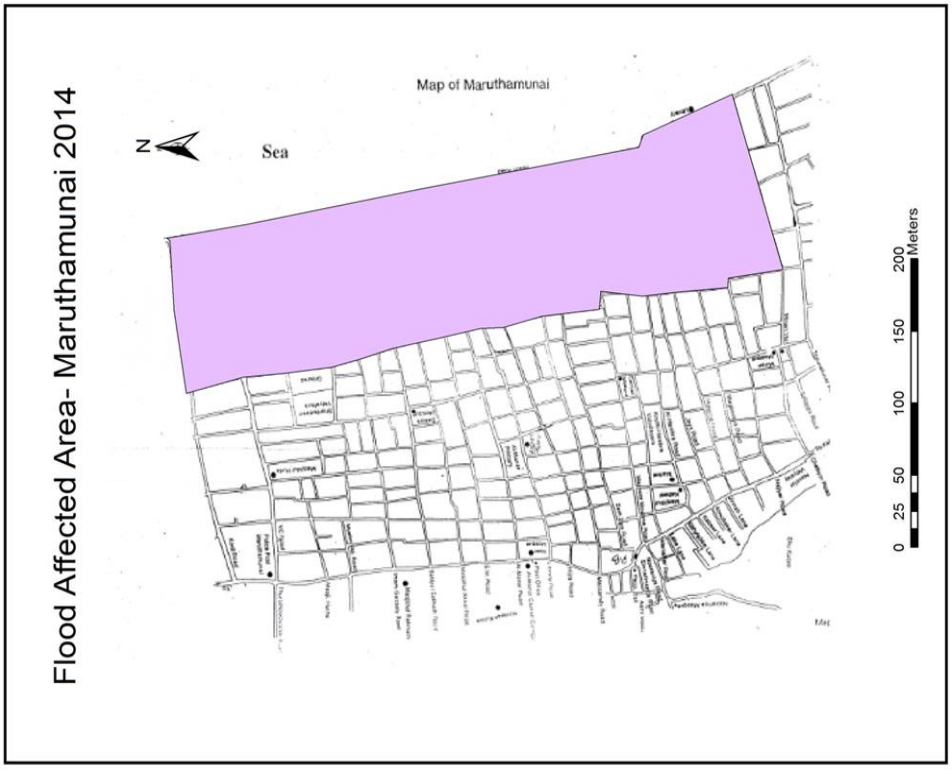


Figure 6. Flood Affected Area and Families
(Source: - Retrieved in Arc GIS 10.4, 2017)

Figure 7. Photos of Flood Effects, 2014

5. 3. Safer Places

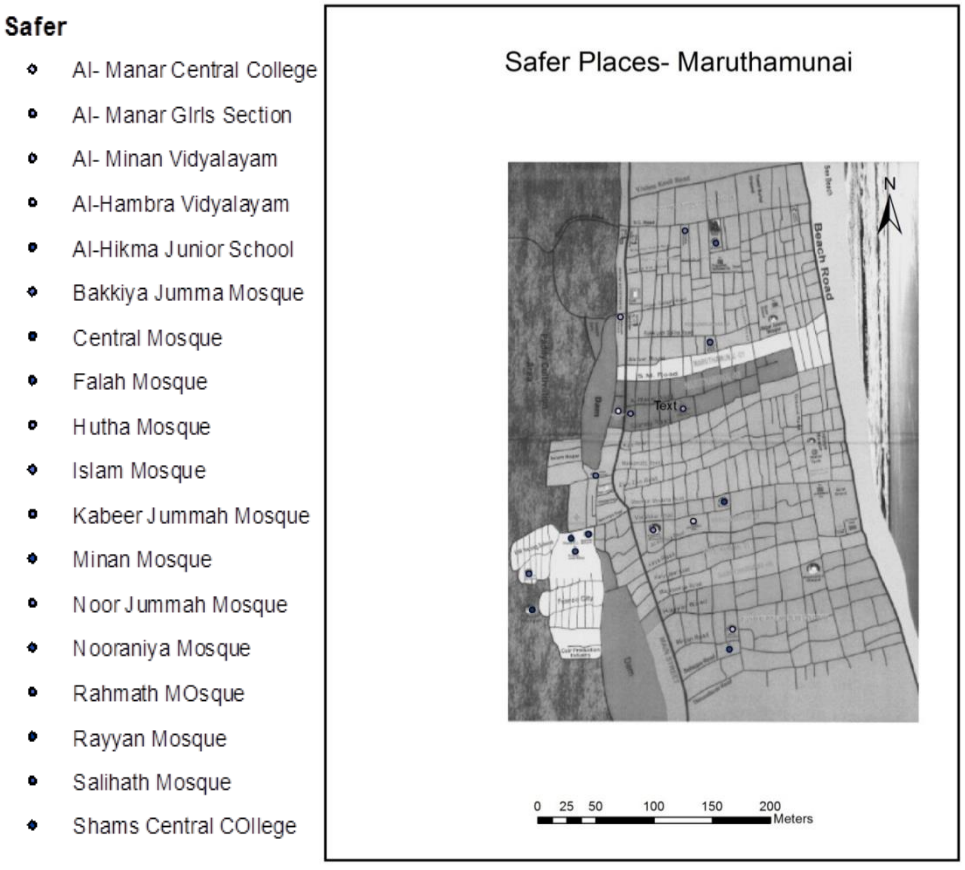


Figure 8. Safer places (Source: - Retrieved in Arc GIS 10.4, 2017)

In Maruthamunai, 18 locations have been identified as a safer place for hospitability to affected people during all disasters. Those places are shown in **Figure 8**. For this Figure, Maruthamunai area has enough accommodation facilities for victims, and totally 17,900 people could be accommodate in all safer places.

6. CONCLUSIONS

In the world, all effects are formed due to the natural disasters and manmade disasters. Natural catastrophe has been molded continuously more enormous than a manmade disaster. The study area also is not exception from it, because it's distinct various natural disasters happen continuously.

The effects of tsunami dated 2004.12.26 did not wipe out from hearts of the effected people and non-effected people in this study area yet. The effects of tsunami were massive in Sri Lanka. Especially, Maruthamunai area of Ampara District effected severely compared with other places within Ampara District. This was recorded as highly effected area with its entirely lost socio-economic, education, and environmental infrastructure during this period.

In 2004, the total population was 17,939 in the study area. In this total amount of population, 9,631 people were affected by the tsunami. This is more than 53.8% of the total population. Then 1,643 people were died during this disaster and this is almost 9.5% of the total. During this time, around 3,164 houses were totally and partially damaged, that is 57.52%. In this record, many houses were destroyed in Maruthamunai-3, shown above. Most houses in 0-200 m were fully and partially damaged in this area in all GN division.

Flood disaster is the familiar one and one of the most common natural disasters in research area. Flood is mostly occurring seasonally in the research area. Every year, the area facing floods, but 2011 and 2014, were seriously affected by the severe floods due to the high rainfall. Here, the loss and damages were high in during the year 2011. During this time the total affected people were estimated around 3,002 and it is more than 66% of the total population.

Geographic Information System (GIS) is a computer based system that helps the user to assess, document, and improve data quality, and also analyze and interpret multi-variety spatial scientific databases. Based on the results analyses, with the base printed maps we are to accompany with geographic information system to be created, and the hazards maps for flood and tsunami. GIS has given a wonderful environment to undertake the big task within a short period accurately to achieve our objectives. It is very useful to reduce the disaster affected area in maps and prepare the suitable safer palaces for victims.

According to the research questionnaire, the people who did not have any knowledge about the disaster before tsunami disaster, but now, after the tsunami, about 75% of people mostly know of disaster. Only 25% of people partially know about the disaster. What we can observe, most of the people have knowledge about disaster after the tsunami. According to flood management activities, they are not implemented in the study area by the 65% of public comments yet.

According to the questionnaires, when the disaster occurs in an area, mostly non-government organizations (60%) and religious institutions (40%) are helping the public. Furthermore, government and public institutions must take more responsibilities and public participation in the disaster management activities, that is now below 10%. Natural disasters not only collapse the society and its economy but also they affect the development of the

country and research area. We can build up the stable developments in our country when we shrink the disasters by proper management activities. Though we can't suddenly stop-over the disaster, but we can diminish the effects of the disasters. If we implement the proper management activities we can reduce the disaster effects and we can build up the stable development in research area.

7. RECOMMENDATIONS

According to the research, there was not any proper management activities implemented in the research area. Therefore, when we implement the following disaster management activities in the study area we can minimize the disaster effects and can enhance the area into the sustainable development. This can support the country's development, based on these management activities given below:

Selected Management Activities to Minimize the Tsunami Effects

- **Establish Coastal Barriers**

They are the best mitigation activities in coastal areas. The barriers can be as a seawall or elevated Dikes. They can reduce the Volume and velocity of water is achieved by increasing the top of the coastal barrier to 30 ft., plus building a 28-ft seawall along the waterfront. Additionally, reinforced buildings are constructed behind the seawall, thereby decreasing the through-flow of water. Therefore the barriers are reducing the flooding and the effects of inundation area and allow the water depth is only marginally less. Total velocities are decreased with the highest velocities adjacent to breakwaters and the inland side of the seawall. This plan would decrease water depth mostly in the inundation area.

- **Improve Tsunami Education**

Development comprehensive educational programs for the diverse users of the coastal environment is of importance. Individual and community education programs are thus the most important aspects of a tsunami mitigation program. Improving early detection of tsunami and facilitating mitigation of effects of tsunami, educating communities to ensure an appropriate response when a tsunami strikes are of high importance. Tsunami information should frequently and regularly be provided at different levels, from primary school to general public in awareness campaigns, also belonging to educational programs involving different modules and grades. It encourages collaborative efforts of existing education programs and strategies to meet local needs. Therefore, public can serve their lives and property.

- **Mock Drill**

Mock drill is an integral part of the mitigation plan. It is a preparedness drill to keep the community alert. When organizing a mock drill in the village, people can understand how to act during the disaster and practice the exercise to improve the cohesiveness of the community during an emergency.

➢ **Prepare the Evacuation Maps**

It is very useful to mitigate the tsunami effects in the research area. Tsunami evacuation map is a drawing or presentation that outlines danger zones and designates limits beyond which people must be evacuated to avoid harm from the tsunami waves. Tsunami evacuation maps depict three different types of features: Evacuation Zones, Evacuation Routes, and Safe Areas. Evacuation zones should be defined through the tsunami worst case scenario for each area. Tsunami evacuation map products may be based on printed maps, digital map files, or interactive web-based maps. When we draw these maps, there are guides to people who can move to safer places very quickly and easily.

Individuals/families/work groups should have a detailed knowledge of the evacuation plan that should be followed during a tsunami warning and practicing evacuation plans makes the appropriate response more of a reaction, requiring less thinking during an actual emergency situation.

➢ **Proper Planning**

In order to develop a strategy of coastal planning, it is important to primarily evaluate the geographic and geomorphological characteristics of a coastal area. Tsunami wave penetration (run-in) is strongly conditioned not only by the height of the wave but also by the geomorphological features against which it collides. The detailed knowledge of the geomorphological characteristics of a given coastline allows for better planning in terms of creation of infrastructures, evacuation routes, and mitigation strategies. This simple characterization immediately allows the establishment of zones with higher risk of tsunami inundation (i.e. beaches, estuaries, and coastal lagoons) because of their flat and low-lying configuration thus offering less resistance to wave invasion (in contrast with cliff areas). Physical environment is important to legislate, in order to avoid or constrain possible damages in case of a tsunami event.

➢ **Public Awareness**

Public awareness is very important to avoid the tsunami effects. It can be raised through the use of media, advertising campaigns, and simulation exercises by disaster management team. This should be directed not only to specific groups (i.e. schools) but also to the general public. As a recommendation, one can disseminate on the tsunami and tsunami preparedness. It should be promoted by the government bodies, local authorities, or by emergency services with the following actions:

- Disaster education at the school level
- Implement community-level public awareness programs
- Enhance information management systems
- Improve coordination mechanisms within the disaster management system.

Common awareness campaign, by taking advantage of art and media, can also be used to highlight the tsunami risk. For example, screening of short-films, theatrical plays, music, and innovative approach using internet (even social networks) are more readily accepted by younger

generations that more easily will assimilate the information delivered.

Creation of permanent (or mobile) centers for tsunami awareness and preparedness are dedicated to disseminate information to the general public and can be used in articulation with science and civil protection authorities (**Figure 9**).

Figure 9. Tsunami hazard zone signals (Source: - itic-unesco.org)

➢ **Plant Mangroves and Other Coastal Forests**

Mangrove forests and other coastal forest tree species are playing a major role to protect the housing against tsunami. The reduction of waves and current velocity is on passing through mangroves, and other vegetation. Although they provide important information relevant to the mitigating effect of coastal forests on tsunami, their results cannot be directly applied, as tsunamis are transient waves with much longer wavelengths, and as such their impact is much greater when they strike coastal areas. Therefore the action should be taken to plant mangroves and other coastal forest in the research area, because the coastal forests can prevent the effects from tsunami (see the Figures above). IKONOS images before and after the West Java tsunami show how vegetation is reduced by tsunami effects in Pangandaran beach.

➢ **Build Elevated Shelter**

Near the coastal area the shelters should built as an elevated shelters or architectural and engineering inputs put together to improve building design to avoid the risk of tsunami (see the above Figures).

➢ **Proper Maintaining of Tsunami Warning Tower**

The research area had a tsunami warning systems. It is the first tsunami warning system in Sri Lanka. It provides timely and effective tsunami information and warnings to the population to minimize the hazards of tsunamis, especially to human life and wellbeing in

research area. To achieve this objective, the TWS continuously monitors the seismic activity and arranges the mock drills. Then it provides the Coordination Group for the Tsunami Warning System to spread over the area and issue to the dissemination agencies. The dissemination agencies then implement predetermined plans to evacuate people from endangered areas. Therefore it can protect the people from tsunami by proper maintains (**Figure 10**).

Figure 10. Tsunami Warning Tower of Maruthamunai, 2017

Selected Management Activities to Minimize the Flood Effects

- Establish the proper drainage systems in the low land area to prevent the flooding
- Prevent the garbage disposal into drainage
- Fill the low lands
- Reconstruct the roads or the roads to recovery
- Drainages are periodically cleaned by proper authority or cleaned before flood period
- Flood forecasting
- Prepare the seasonality calendar of flood disaster
- Arrange the awareness programs and early warnings to public by propaganda of flood warning signs, news, and broadcast
- Take the legal action against to those who are destroying the drainages
- Elevate the low land buildings and houses to be against the flood impacts
- Take the proper action to the low land drained water into drainages to reduce the flooding
- Implement the flood management systems
- Create the new dams or ponds to store flood water in apart from the village
- Protect the individual properties:

Property owners may fit our home to stop water entering the house. Personal flood plans may involve blocking doors and air vents, waterproofing important areas, and sandbagging the edges of the building.

- **Protection of communities**

When more homes, shops, and infrastructure are threatened by the effects of flooding, then the benefit of a greater protection is worth the additional cost. Temporary flood defenses can be constructed relatively quickly in certain locations and provide protection from rising flood waters. Floods are often controlled and channeled. Water rising above a drainages full capacity may cause flooding to spread to other waterways and areas of the community, which causes damage. Defenses (both long-term and short-term) can be constructed to minimize damage, which involve raising the edge of the water with levees, embankments or walls.

- **Flood risk management**

The most effective way of reducing the risk to people and property is through the production of flood risk maps. Produced maps which show areas prone to flooding based on flood data show the areas at risk. Low lying areas are in need of flood defense. The most sustainable way of reducing risk is to prevent further development in flood prone areas and old waterways. It is important for at-risk communities to develop a comprehensive floodplain management plan. Communities participate must agree to regulate development in flood prone areas.

- **Diversion canals**

Floods can be controlled by redirecting excess of water to purpose-built canals or floodways, which in turn divert the water to temporary holding ponds or other bodies of water where there is a lower risk or impact to flooding.

- **Self-closing flood barrier**

The self-closing flood barrier (SCFB) is a flood defense system designed to protect people and property from inland waterway floods caused by a heavy rainfall. The SCFB can be built to protect residential properties and the whole communities, as well as industrial or other strategic areas. The barrier system is constantly ready to deploy in a flood situation, it can be installed in any length and use the rising flood water to deploy. It can be designed to west part of the Maruthamunai area.

References

[1] Michael K. Lindell and Carla S. Prater. Assessing Community Impacts of Natural Disasters. *Natural Hazards Review* November 2003, Volume 4, Issue 4

[2] Bill Faulkner, Towards a framework for tourism disaster management. *Tourism Management* Volume 22, Issue 2, April 2001, Pages 135-147 https://doi.org/10.1016/S0261-5177(00)00048-0

[3] Debarati Guha-Sapir and Michel F. Lechat. Information systems and needs assessment in natural disasters: An approach for better disaster relief management. *Disasters* Volume 10, Issue 3, September 1986, Pages 232–237

[4] Shahul Hasbullah and Benedikt Korf. Muslim geographies and the politics of purification in Sri Lanka after the 2004 tsunami. *Singapore Journal of Tropical Geography* Volume 30, Issue 2, July 2009, Pages 248–264

[5] Benedikt Korf, Shahul Habullah, Pia Hollenbach and Bart Klem. The gift of disaster: the commodification of good intentions in post-tsunami Sri Lanka. *Disasters* Volume 34, Issue s1 January 2010, Pages S60–S77

[6] Siri Hettige, Richard Haigh, (2016). An integrated social response to disasters: the case of the Indian Ocean tsunami in Sri Lanka, *Disaster Prevention and Management: An International Journal*, Vol. 25 Issue: 5, pp.595-610, https://doi.org/10.1108/DPM-11-2015-0263

[7] Shreen Saroor. Impact of tsunami in the East – Muslim women's perspective. *South Asian Popular Culture* Volume 8, 2010, Issue 1, 57-71, http://dx.doi.org/10.1080/14746681003633259

[8] Jonathan Goodhand, Bart Klem, Benedikt Korf. Religion, Conflict and Boundary Politics in Sri Lanka. *The European Journal of Development Research* December 2009, Volume 21, Issue 5, pp 679–69

[9] T. Descilo, A. Vedamurtachar, P.L. Gerbarg, D. Nagaraja, B.N. Gangadhar, B. Damodaran, B. Adelson, L.H. Braslow, S. Marcus, and R.P. Brown. Effects of a yoga breath intervention alone and in combination with an exposure therapy for post-traumatic stress disorder and depression in survivors of the 2004 South-East Asia tsunami. *Acta Psychiatrica Scandinavica*, Volume 121, Issue 4, April 2010, Pages 289–300

[10] Benedikt Korf. Antinomies of generosity: Moral geographies and post-tsunami aid in Southeast Asia. *Geoforum*, Volume 38, Issue 2, March 2007, Pages 366-378

[11] C. Giri, Z. Zhu, L.L. Tieszen, A. Singh, S. Gillette, and J.A. Kelmelis. Mangrove forest distributions and dynamics (1975–2005) of the tsunami-affected region of Asia. *Journal of Biogeography*, Volume 35, Issue 3, March 2008, Pages 519–528

(Received 02 October 2017; accepted 16 October 2017)