Geo-Information Technology in Disaster Management: A Case Study in Akkaraipattu Municipal Council Area

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Abstract: The natural hazards occur in Sri Lanka make severe impact on the country's economy and the social and environmental conditions. The research focuses mainly on Disaster Management in the light of Geo-information technology in Akkaraipattu municipal council area and to identify the draw backs of traditional disaster management and the potentials of Geographic Information System in disaster management and to prepare the disaster risk map for the area. The past available events of hazards of the area were incorporated with Geo-spatial Information System. All risk map layers; tsunami, disease, flood and cyclone were integrated. A comprehensive analysis of the basic data related to multi-hazards in GIS environment, resulted the disaster locations, affected community (male, female, children, families and total populations) were carried out in Council area which is the basis for relief aids and rehabilitation activities of disaster management process. In combining all disasters to produce multi-hazard zone for Akkaraipattu Municipal Council Area shows that 4.9 % of houses and 5.4 % of population are falling under very high risk zone, while 43.9 % of houses and 42.1 % of population are falling under low risk zone. The results of the present study facilitate to set up GIS Database in the area and the system will provide sophisticated data base and that can be used for relief activities.

Keywords: Multi-Hazard, Geo-Information Technology, Disaster Risk, Emergency Response, Communication

Introduction

Sri Lanka, The pearl drop of Indian Ocean is one of the countries located in the disaster prone belt of the Asian Region. Figure 1.1 shows that the Asia is world's most disaster affected region in the world. In Asia every year 46,000 people killed, 180 million people affected and USD 35 billion of damage caused by disasters (World Disaster Report 1997). Most natural disasters experienced by the eastern coastal region of Sri Lanka are water-related either through excess water or a lack of it; cyclone, flooding, storm surges, tsunami, drought and diseases.

Further the natural and human disasters affected physical, social and economic development of our country during ethnic conflict destructed the infrastructure of North and Eastern region. Akkaraipattu Municipal Council area has been facing these disasters since many years.

We are presently living with the fast growing trends in computer technology, information systems and virtual world to obtain data about the physical and cultural worlds, and to use these data to do research or to solve practical problems. The current digital and analog electronic devices facilitate the inventory of resources and the rapid execution of arithmetic or logical operations. The Geo-information Technology; Geographic Information System (GIS), Remote Sensing and Global Positioning System (GPS) are undergoing much improvement and they are facilitate to create, manipulate, store and use spatial data much faster and at rapid rate as compared to conventional methods.

Hazard Occurrences in Akkaraipattu

The tsunami in 2004.12.26 sweeps over sixGiramaNiladhariDivisions highly damaged infrastructures of Akkaraipattu Divisional Secretariat area. TheGovernment and Non-Government Organizations take part in reconstruction and rehabilitation activities after math.

Table 01: Disaster history in Akkaraipattu

Hazard	Period	Potential Impact	Year
Floods	November - January	Life, Livelihood, Crops,Infrastructures, Animal	2008
Tsunami	December	Life, Animal, Crops, property,Livelihood, Infrastructures	2004
Cyclone	November	Life, Livelihood, Crops, Infrastructures, Animal	1978
Strong wind	June-July	Life, Crops, Animal	2007
Plague		Life	1998

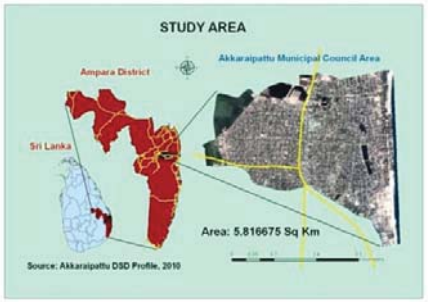
(Source: Akkaraipattu Municipal Council, Disaster Management Branch - 31/03/2014)

Infectious Diseases: Infectious diseases are disorders caused by organisms - such as bacteria, viruses, fungi or parasites. Many organisms live in and on our bodies. They're normally harmless or even helpful, but some organisms under certain conditions may cause disease (Wikipedia).Dengue, Malaria and Asthma are the common diseases found in Akkaraipattu area. Dengue affects during north-east monsoon period (from October to January) every year due to favorite weather condition for the Dengue mosquitoes.Malaria was very severe in 1980 to 1990. After the Malaria control activities the effects are gradually reducing to significant level in Akkaraipattu.

Tsunami: The Tsunami disaster adversely affected the economic framework and psychosocial environment of the people in 6 Girama Niladhary (GN) Divisions in Akkaraipattu. The Tsunami waves traversed 500m inland and thus many households, public service centers, transportation, electricity, communication and road network were severely damaged. Hence, most of the community infrastructure suffered extensive damages, effectively paralyzing the social and economic life of the entire community.

Cyclone: Akkaraipattu area was very badly devastated by a cyclone in 1978 November when all transport, communication, electricity services were completely disconnected more than a week. Though there were no death a huge cost were lost due to the destroyed buildings, crops, infrastructure, etc.

Research Area



Akkaraipattu is a coastal village in the Ampara District of Eastern province of Sri Lanka. Geographical coordinates are 7° 13' 0" North and 81° 51' 0" East. It has high population density with 42,375 people accommodated in 28 GN Divisions (5.8 km^2) (Resource Profile – Akkaraipattu DS Division, 2010).

There were no any studies or research conducted using Geo-information technology on Disaster Management in Akkaraipattu area so far. In order to improve the efficiency in data collection and accelerate the rehabilitation and reconstruction process it is highly recognized to implement and incorporate Geographic Information System in Disaster Management in Akkaraipattu area.

Research Questions

1. Whether the traditional disaster management processes provides accurate information and remedy to the stakeholders?
2. What are the draw backs of traditional disaster management processes?
3. Why we need a Modern Technology for the disaster management?

Research Objectives

1. To use Geographic Information Technology for disaster management process in Akkaraipattu Municipal Council area.
2. To identify the drawbacks of traditional disaster management process and the potentials of Geo-information Technology in disaster management.
3. To prepare a hazard map for Akkaraipattu area using Geo-information Technology.

Methods and Procedures

In the collection of necessary information and data for the study, the research depends on both qualitative and quantitative data from both the primary and secondary sources. For this study, the following data collection techniques are used;

Primary Data Collection

The primary data have been collected through questionnaires, by personal observations and interviews with stakeholders. The primary data used in the study have been collected from a social survey of households using a questionnaire. The data have been gathered from 100 sample households widely scattered in the Akkaraipattu MC area on related variables.The following primary data collection tools and instruments have been used for this study; Questionnaire,Direct Interview, Participatory rural appraisal (PRA), Field visits and observation, Focus group discussion from Divisional Secretary, Municipal Commissioner, Agrarian Society, Fishery Societies, Community Based Organization (CBOs), Rural Development Societies, GramaNiladharies, Samurdi Officers and local public.

Secondary Data Collection

The secondary data have been collected, from the published and unpublished sources. The following sources of secondary data collection have been used in this study; Published /unpublished earlier studies, Government Documents / Reports, Department Reports, Private (NGO's) Sources, Remote Sensing Analysis, Printed Maps and Collection from the web and Library Search.

Quantitative and Qualitative Data

Quantitative methodology usually deals with a variety of variables and statistics. The past available events of flood, cyclone, tsunami, drought and diseases of Akkaraipattu MC area were incorporated with Geo-spatial Information System, data regarding physiographic divisions, land cover classification, elevation, drainage network, Girama Niladary administrative divisions, population density and environmental parameters are to be modeled to create hazard maps for flood, cyclone, tsunami, drought and diseases. Preparation of Disaster Vulnerability map (Very High, High, Moderate and Low classes) of Akkaraipattu MC Area is designed based on the following criteria obtained from past evidences, questionnaire survey and from field investigations;

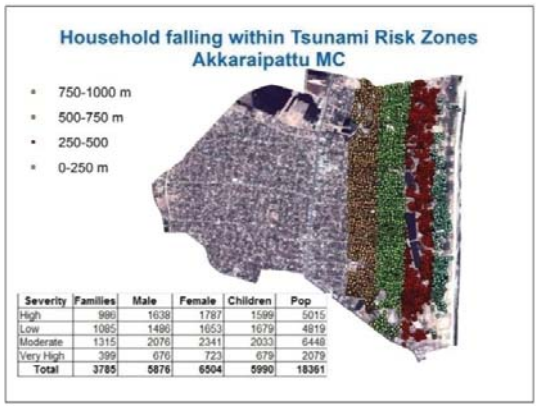
Table 02: Disaster Risk Criteria for multi-hazards

DisasterVulnerability Map	**Disaster Risk Criteria**			
	Very High	**High**	**Moderate**	**Low**
Flood (from MSL)	<6ft	<5ft	<4ft	<3 ft
Diseases (from sensitive area)	0-50 m	50-100 m	100-200 m	200-300 m
Tsunami (from coastal area)	0-250 m	250-500 m	500-750 m	750-1000 m
Cyclone (from coastal area)	0-250 m	Other area		

Results

A comprehensive analysis of basic layers were undertaken in order to create disaster risk maps such as health detrimental area, tsunami risk area, flood risk area and cyclone risk area. These maps were further analyzed with population data in order to obtain the affected people (families, total population, male, female and children) falling under each risk zones. The emergency relief activities, rehabilitation and reconstruction activities are undertaken based on the above information.

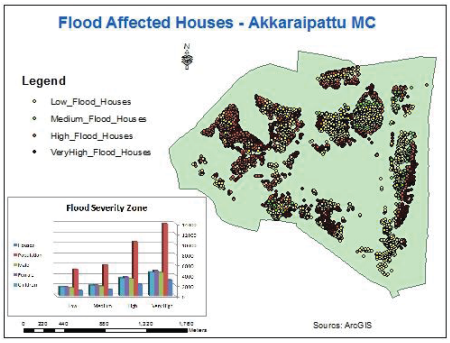
Tsunami Evacuation Zone Map



Severity	Families	Male	Female	Children	Pop
High	986	1638	1787	1599	5015
Low	1085	1486	1653	1679	4819
Moderate	1315	2076	2341	2033	6448
Very High	399	676	723	679	2079
Total	**3785**	**5876**	**6504**	**5990**	**18361**

It is an urgent reality to order immediate, mandatory evacuations of the coastal people. A tsunami evacuation zone maps are quickly prepared for decision support for the major event. As part of a larger team of emergency responders, I have to redraw the evacuation zone maps for the Akkaraipattu Municipal Council Area. Then the area has been classified into the following evacuation zone namely very high (0-250 m from sea coast), high (250-500 m from sea coast), moderate (500-750 m from sea coast) risk and low (750-1000 m from sea coast) risk. These tsunami evacuation zones will be used to prioritize evacuation efforts and allocate guard and rescue personnel and emergency resources and supplies.

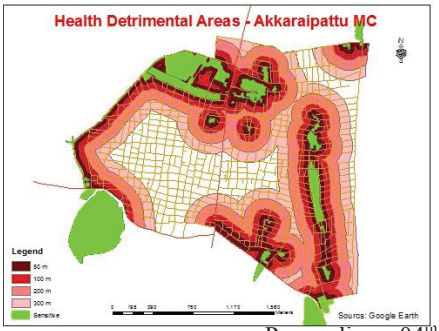
Flood Risk Map

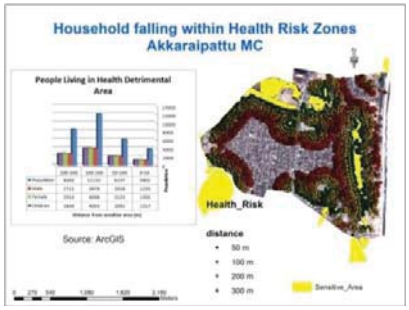


Inundation area of Akkaraipattu Municipal Council Area is identified based on the past experiences since 1978 flood (Divisional Profile-Akkaraipattu 2012). The study area is categorized in to 4 flood inundation areas namely very high flood (6 ft. below MSL), high flood (5 ft. below MSL), moderate flood (4 ft. below MSL) and low flood (3 ft. below MSL).

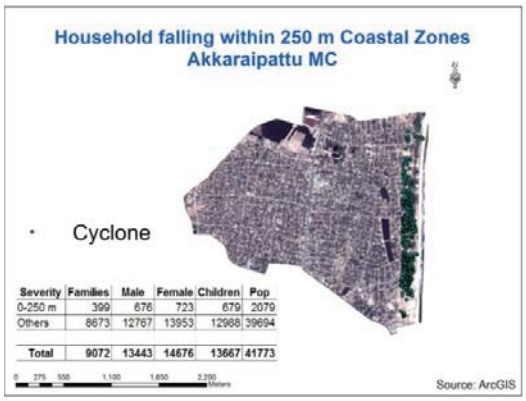
Health Risk Map

The Akkaraipattu Municipal Council Area is highly intensified with settlements after civil war in North and East. Few small patches of inland water bodies are remaining during the urbanization process. Further few industrial zones are concentrated especially in North-West part of the Municipal Council Area. Both Water and Industrial areas are categorized as environmental sensitive area.





Cyclone Risk Map



Due to the presence of Bay of Bengal in the East coast of Akkaraipattu Municipal Council Area causes depressions and cyclones. There were a lot of consequences due to the depression after 1978 cyclone. Anyhow Akkaraipattu is located beyond the depression path so this area is safe to some extent. Even though under emergency situation we have to evacuate the public living within 250 meter from coastal area to the safer places. Therefore we have categorized the total study area in to two risk zones namely high risk zone (250 meter from coast) and low risk zone (rest of the area)

Table 03:Households falling under multi-hazard risk zones

Risk	Male	Female	Children	Population	Families
Very High	717	793	737	2246	441
High	2367	2637	2548	7545	1526
Medium	4702	4975	4720	14396	3124
Low	5882	6274	5439	17591	3982
Total	**13668**	**14679**	**13444**	**41778**	**9072**

From the comprehensive analysis of the basic data related to multi-hazards in GIS environment, I have found that the very useful information about the disaster locations, affected community (male, female, children, families and total populations) within Akkaraipattu Municipal Council area which is the basis for relief aids and rehabilitation activities of disaster management process (summarized in Table 04).

Table 04: People living under different severity areas of Multi-hazard zones

Severity	Male	Female	Children	Population	Families
Flood					
Very High	4529	4868	4605	14000	3043
High	3344	3668	3477	10489	2247
Medium	1883	2102	2038	6022	1274
Low	1630	1777	1749	5155	1080
Total	**11386**	**12415**	**11869**	**35666**	**7644**
Cyclone					
0-250 m	676	723	679	2079	399
Others	12767	13953	12988	39694	8673
Total	**13443**	**14676**	**13667**	**41773**	**9072**
Health					
Very High	1233	1355	1317	3902	842
High	2028	2123	2092	6237	1296
Medium	3979	4098	4055	12132	2569
Low	2711	2913	2839	8463	1873
Total	**9951**	**10489**	**10303**	**30734**	**6580**
Tsunami					
High	986	1638	1787	1599	5015
Low	1085	1486	1653	1679	4819
Moderate	1315	2076	2341	2033	6448
Very High	399	676	723	679	2079
Total	**3785**	**5876**	**6504**	**5990**	**18361**

Conclusion

Disaster risk information is spatial in nature and Geographic Information Systems (GIS) plays an important role in disaster risk assessment and management. For this reason, there is a significant need to create awareness among the disaster management professionals and to the public regarding the importance of GIS usage.Equally important is creation of awareness on the use of Open Source software solutions, both for development and management use and for GIS work to improve accessibility for people and organizations with lesser means of funding GIS implementation and use.

The research shows that the potential of Geographic Information System (GIS) for creating spatial data layers for multi-hazards through multi-dimensional view for Akkaraipattu Municipal Council Area.

GIS has given a wonderful environment to undertake the big task within a short period very accurately on pixel basis.

Findings

In combining all disasters to produce multi-hazard zone for Akkaraipattu Municipal Council Area shows that 4.9 % of houses and 5.4 % of population are falling under very high risk zone, 16.8 % of houses and 18.1 % of population are falling under high risk zone, 34.4 % of houses and 34.5 % of population are falling under moderate risk zone and 43.9 % of houses and 42.1 % of population are falling under low risk zone.

Key Problems identified regarding Disaster Management in Akkaraipattu MC Area

- Poor awareness on disasters and disaster management
- Poor adaption for modern technology
- Absence of early warning system
- There is a relatively poor level of commitment to community, management and fundraising activities.
- Unwanted political interferences
- Lack of integration of all stakeholders
- Increasing population density and land demand increases the vulnerability to disasters

Key Potentials regarding Disaster Management in Akkaraipattu MC Area

- The quality and variety of skills among the stakeholders
- The resource potentials for disaster management
- The good working relationship of responsible authorities with other services
- A strong leadership team
- Improved Social and Community activities

Recommendation

The Chinese philosopher, (Laozi 500 BC) wrote “the issue far away is easy to avoid, the brittle is easy to break and the small is easy to disperse. Take action before it appears; create order before there is disorder”. Unfortunately, many of our problems and challenges are now very close upon us. We should now however, act to contain those that are just now appearing and which we can glean from our GIS platforms. Laozi continues: “The great tree comes from a tiny sprout, the high building from a heap of earth; the longest journey starts with a single step”. So, we should not be overwhelmed by the task and not hesitate to take a first step.

We have to emphasize to take advantage of our good working relationship with other services to work and train with them more. In order to utilize the key potentials and to minimize the key problems, we must formulate a frame work to implement disaster management process for Akkaraipattu Municipal Council Area. To achieve the above task the following parameters are set in an order.

- Data collection and creating a GIS Database for Akkaraipattu Municipal Council Area
- Set up early warning system for multi-hazards
- Set up a Special Task Force representing all stakeholders from Municipal Council, Divisional Secretariat, Police, Religious Leaders, Girama Niladharies and Samurdhi Officers.
- The action plan could be implemented according to the National Disaster Management Policy

According to the policy, the grass hood level activities have to be carried out from Girama Niladhary Divisions (GND). Because the public administration begins from GND which is a vital part of the disaster management process such as; data collection, database management, emergency response, damage assessment, relief aids, rehabilitation, etc.

A fully fledged GIS environment has to be facilitated at Divisional Secretariat to set up GIS Database. Girama Niladharies of every GND regularly update the database about the household statistics and the necessary changes occurred in their respective divisions. If a disaster occurs the system will prepare all necessary map layers and provide the detail regarding the affected people in no time that will be used for relief activities.

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