GEO-INFORMATION TECHNOLOGY IN DISASTER MANAGEMENT

A Case Study in Akkaraipattu Municipal Area

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The Chinese philosopher, (Laozi 500 BC) wrote

- **The issue far away is easy to avoid**
- **The brittle is easy to break**
- **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

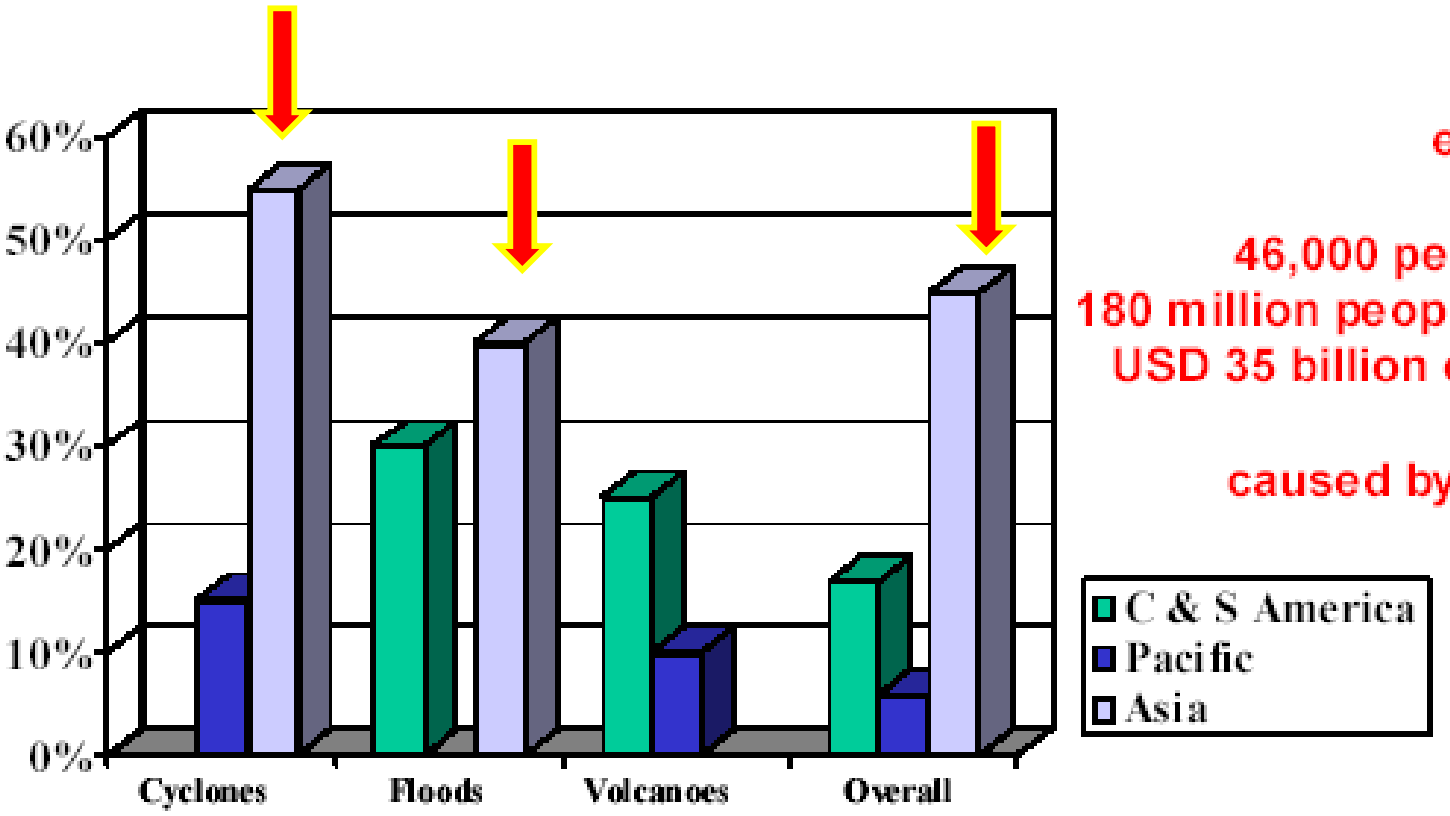
Introduction

- Among the disasters that occur in Sri Lanka are
  - **Floods**
  - **Droughts**
  - **Landslides**
  - **Cyclones**
  - **Tsunami**

are costing a strong impact on the country's socio–economic environment

Overview

ASIA IS WORLD'S MOST DISASTER AFFECTED REGION IN THE WORLD



In Asia

every year

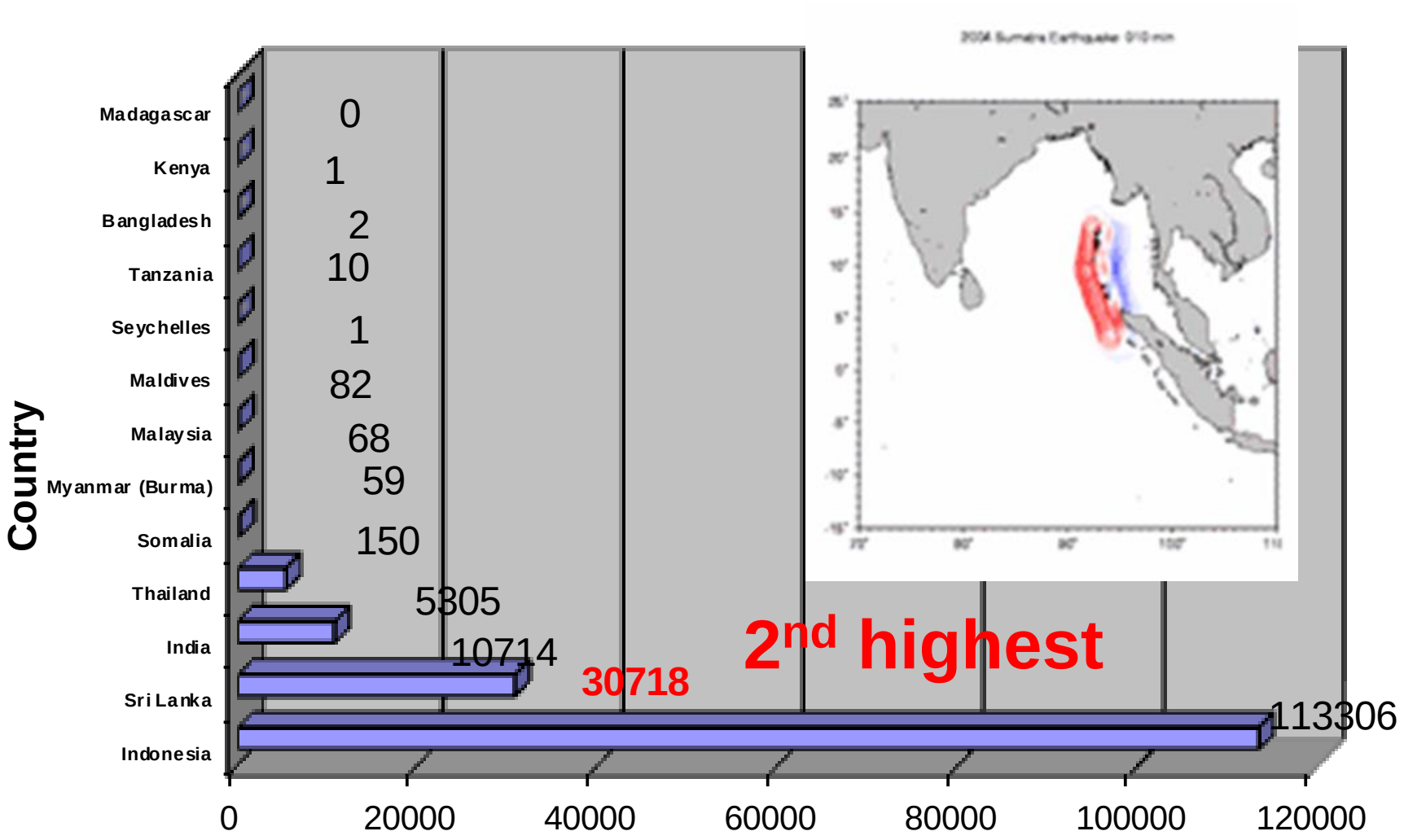
46,000 people killed
180 million people affected
USD 35 billion of damage

caused by disasters

Based on World Disasters Report 1997

adpc
Asian Disaster Preparedness Center

Deaths Confirmed in tsunami - World
2004 December 26



Disasters in Sri Lanka (2000-2007)

No	Disaster	Year	Area	Effects
1	Flood	2000	Galle, Matara	Dead-02 100,000
2	Flood	2000	Ampara, Batticaloa, Polonnaruwa	Dead-03 300,000
3	Cyclone	2000	Ampara, Anuradapura, Batticaloa, Mannar, Trincomalee, Polonnaruwa	Dead-05 375,000
4	Flood	2001	Matale	375,000
5	Flood	2002	Ampara, Anuradapura, Batticaloa, Mannar, Trincomalee, Polonnaruwa, puttalam, Kilinochchi	Dead-02 500,000
6	Flood	2003	Galle, Matara, Hambanthota, Nuwara Eliya, Kalutura	Dead-296 695,000
7	Flood	2004	Ampara, Anuradapura, Batticaloa, Mannar, Trincomalee, Polonnaruwa, Vavuniya, Jaffna, Matara	Dead-06 200,000
8	Tsunami	2004	Jaffna, Mullaitivu, Kilinochchi, Ampara, Galle, Matara, Hambantota, Batticaloa	Dead-35399 23176
9	Flood	2005	Colombo, Rathmalana, Gampaha, Trincomalee, Jaffna, Kilinochchi, Mullaitivu	Dead-06 145,000
10	Flood	2006	Colombo, Rathmalana, Gampaha, Puttalam, Matara, Badulla, Ratnapura	Dead-25 333,000
11	Flood	2007	Walappana, Meepai	Dead-18 68281

(Source: EM-DAT, the OFDA/CRED International Disaster Database - July 15, 2007)

Disaster history in Akkaraipattu

H	Pot	Reported Year
Floods	November - Ja	2008
Tsunami	December	2004
Cyclone		1978
Strong wi		2007
Plague		1998

(Sou 31/03/2014)

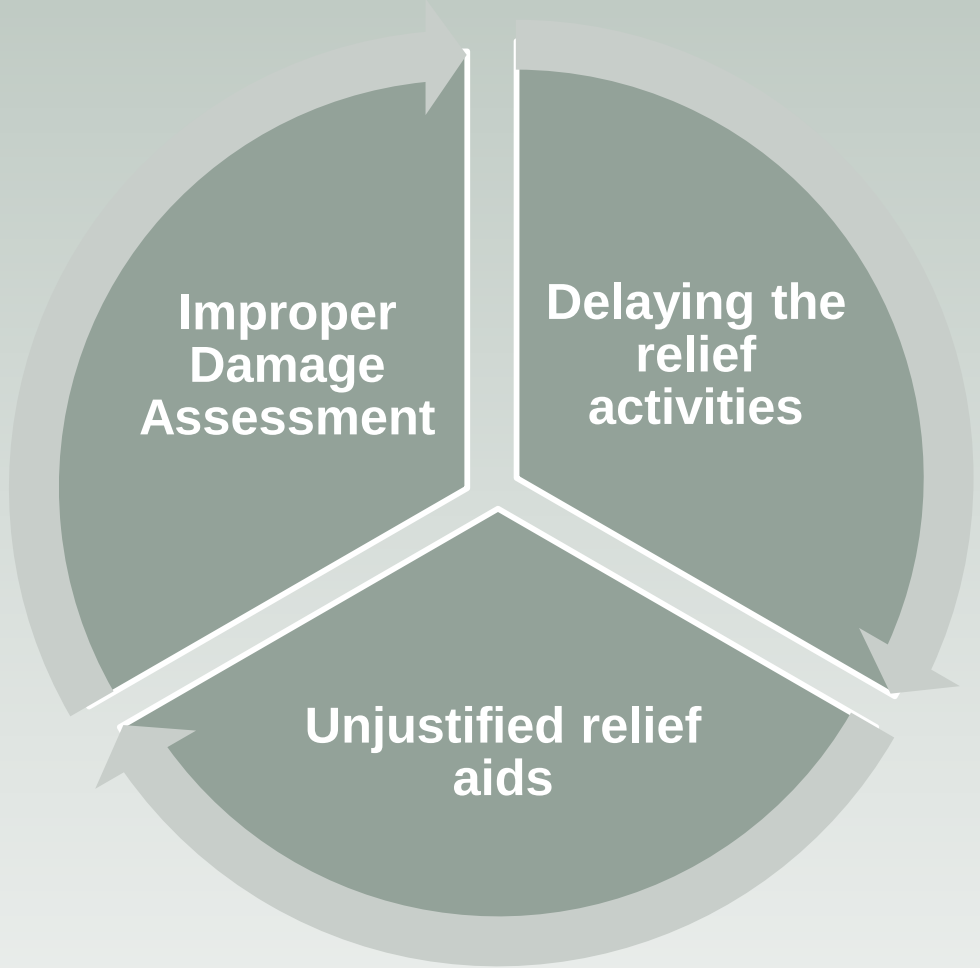
Collapse of Infrastructure & livelihood

Interruption of Communication

Victim found on 2nd day of the Tsunami

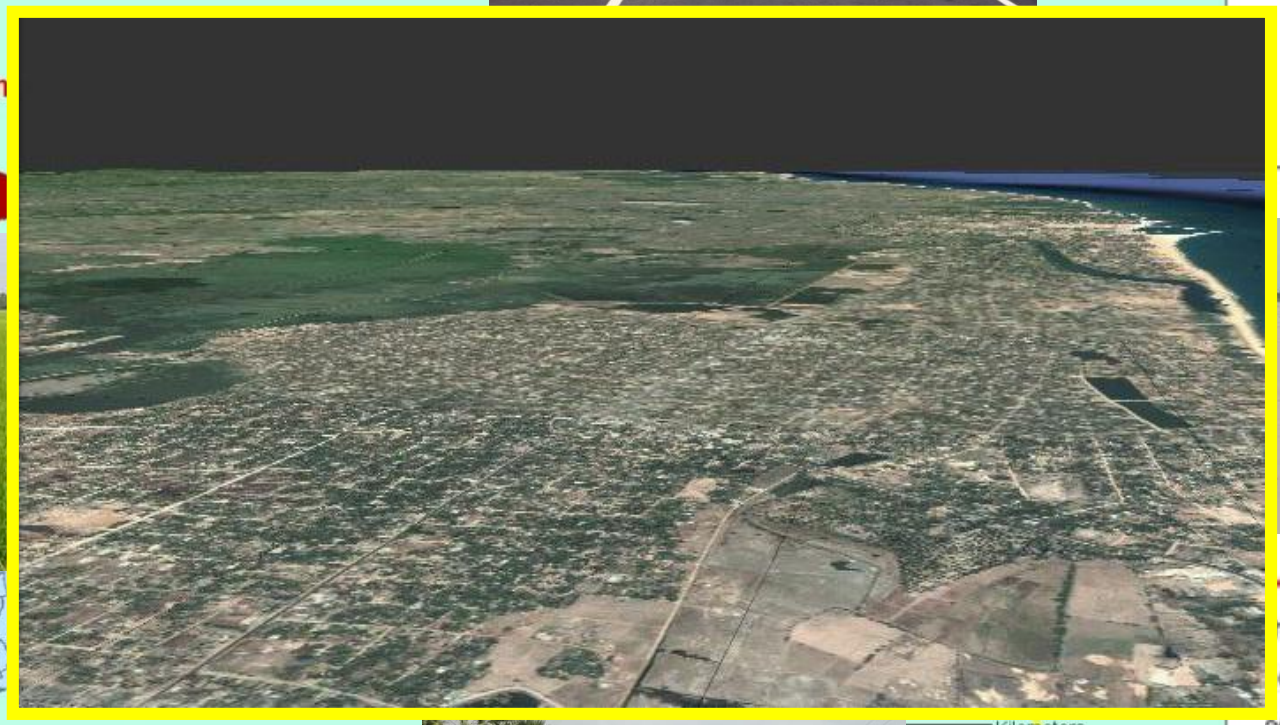
Disaster Management Process
(Traditional Model - ADPC)

Bottlenecks of Traditional DM Process



Therefore we need to find a solution to overcome these bottlenecks

Study area



Source: Akkaraipattu DSD Profile, 2010

Kilometers

Objectives

The research has been designed to achieve the following main and specific objectives

Main objectives

- To use GIS for disaster management process in Akkaraipattu MC.

Specific objectives

- To identify the potentials of Geo-information Technology in disaster management.

- To prepare a hazard map for Akkaraipattu area using GIS

Data Collection & Methodology

Stakeholders

NGOs | Municipal Council | DS

IUCN | JICA | Local NGOs | Field

Co-ordination Meeting

- ADPs
- Land Officers
- Fisheries Officers
- Forest Officers
- Coast Conservation Dept.
- MOH
- Livelihood Division/RADA
- Other Stakeholders

Field Data Gathering

- Questionnaire Survey
- GPS Data Collection
- Participatory Community Appraisal

Primary Data Collection

The data have been gathered from 100 sample households widely scattered in the Akkaraipattu MC area on related variables using Social Survey.

The following primary data collection tools and instruments have been used for this study;

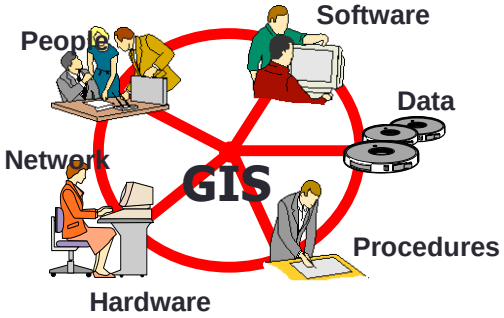
- **Questionnaire Survey (100 households)**
- **Direct Interview**
- **Participatory Rural Appraisal (PRA)**
- **Field visits and observation**
- **Focus group discussion**

Secondary Data Collection

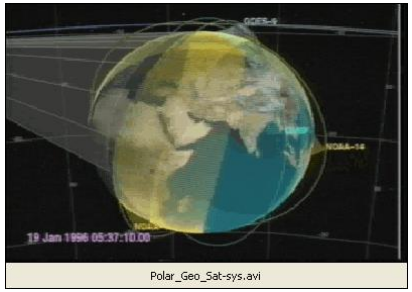
The secondary data have been collected, from the published (listed in the bibliography) and unpublished sources;

- Government Documents / Reports
- Department Reports, Private (NGO's) Sources
- Printed Maps and Collection from the web and Library Search
- Extent of land from Department of Survey
- Amount of population from census report of Sri Lanka
- Land use information from Land Use Policy Planning Division
- Livelihood information from Ampara District Livelihood Development Plan
- Mapping printed by UNHIC

Tools Used - Geo-Informatics



Mapping & complex Analysis
(ArcView 10.1)



GPS

New Evolution for data collection

Materials used

- **1. Remote Sensing Data**
  - Google Earth
  - IRS1C (LISS iii, 104/69, 22/2/98)
- **2. Topographic Sheet**
  - 1:50,000 & 1:10,000 (Survey Dept.)
- **3. Ancillary Data**
  - Meteorological Data
  - GN Division (GND) Maps
  - District Profile
  - Statistical Data
  - Elevation data obtained from Land Survey Department, Akkaraipattu Branch

FLOW DIAGRAM SHOWING OVERALL METHODOLOGY

DATA SOURCES

- **Satellite remote sensing data**
- **Analog data** (Topo map)
- **Ancillary data** (Rainfall)
- **Other data** (Field survey)

BASIC LAYERS

- **IMAGES**
- **AGRICULTURE** Soil, land use /land cover
- **TOPOGRAPHY** DEM, slope, aspect
- **HYDROLOGY** Watershed , Drainage network
- **METEOROLOGY** Rainfall
- **GEOLOGY** Hydrogeomorphology
- **SOCIO-ECONOMIC** Settlement area

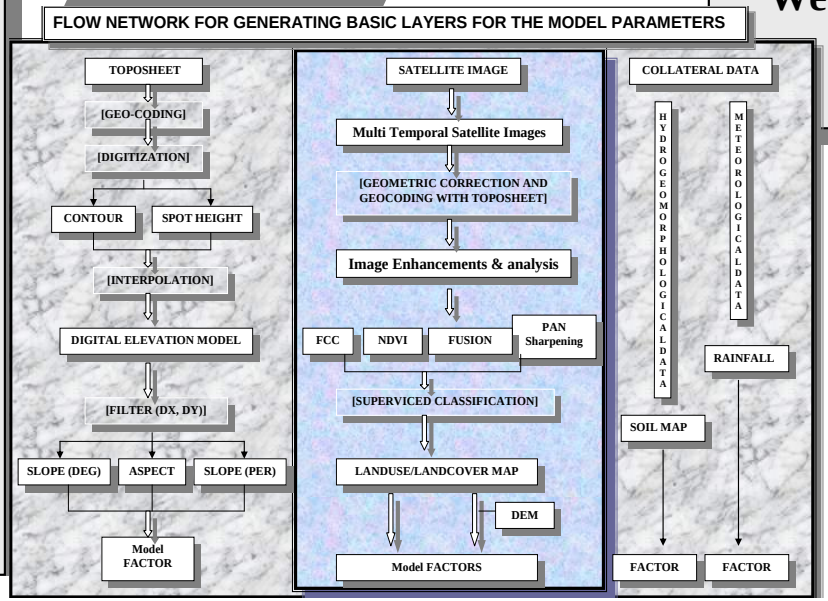
DERIVED LAYER

Required FACTORS

Multi Hazard Maps

Disaster Risk Map

For WebGIS



Analysis

- **Spatial data derived from satellite data and non-spatial data stored in the external database were integrated in the GIS and a systematic analysis is undertaken Using**

  - **ArcGIS 10.1**
  - **ArcGIS Model Builder**
  - **Geo-Spatial Statistics Tool**
  - **Erdas for image analysis**

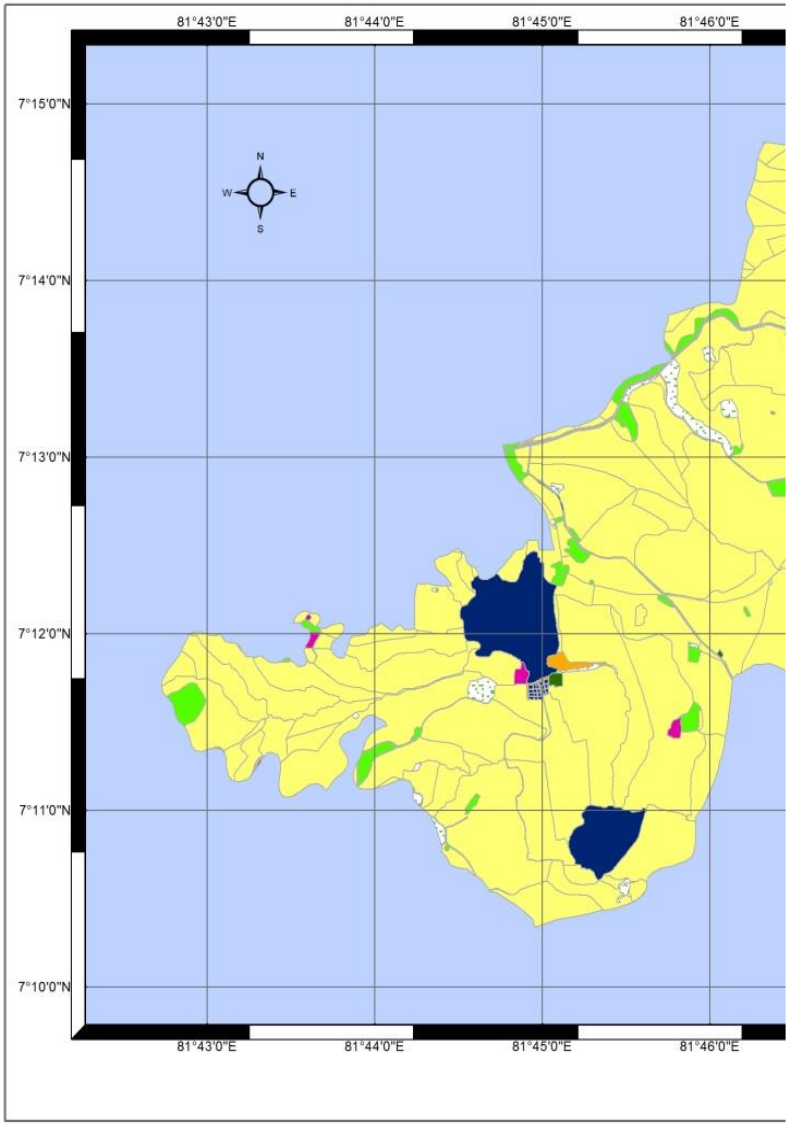
Analysis…..

- Preparation of Disaster Vulnerability maps are designed based on the following criteria obtained from
  - Past evidences
  - Questionnaire survey
  - Field investigations

Disaster Vulnerability Map	Disaster Risk Criteria			
	Very High	High	Moderate	Low
Flood (from MSL)	<6ft	<5 ft	<4 ft	<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		

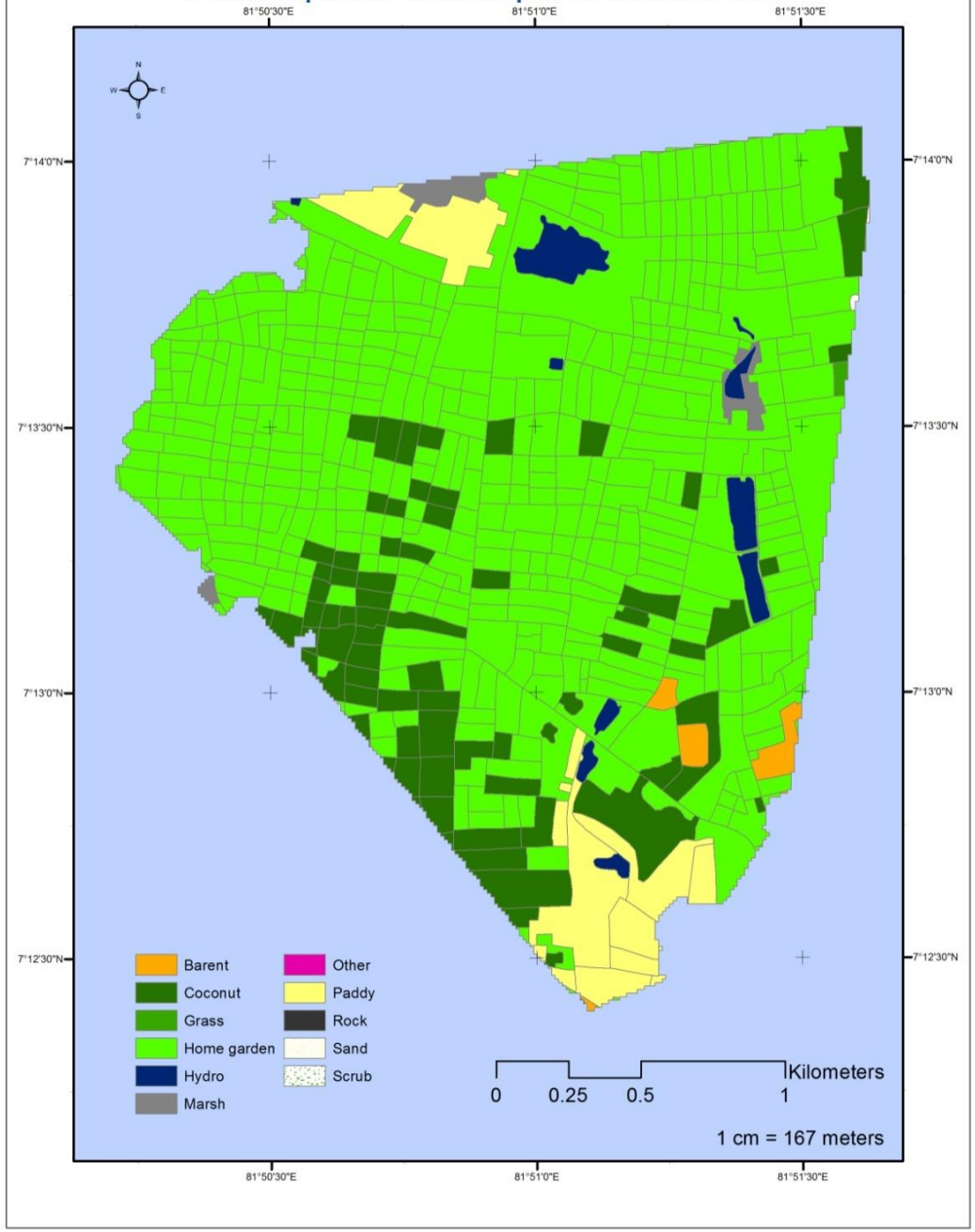
Results & Discussions

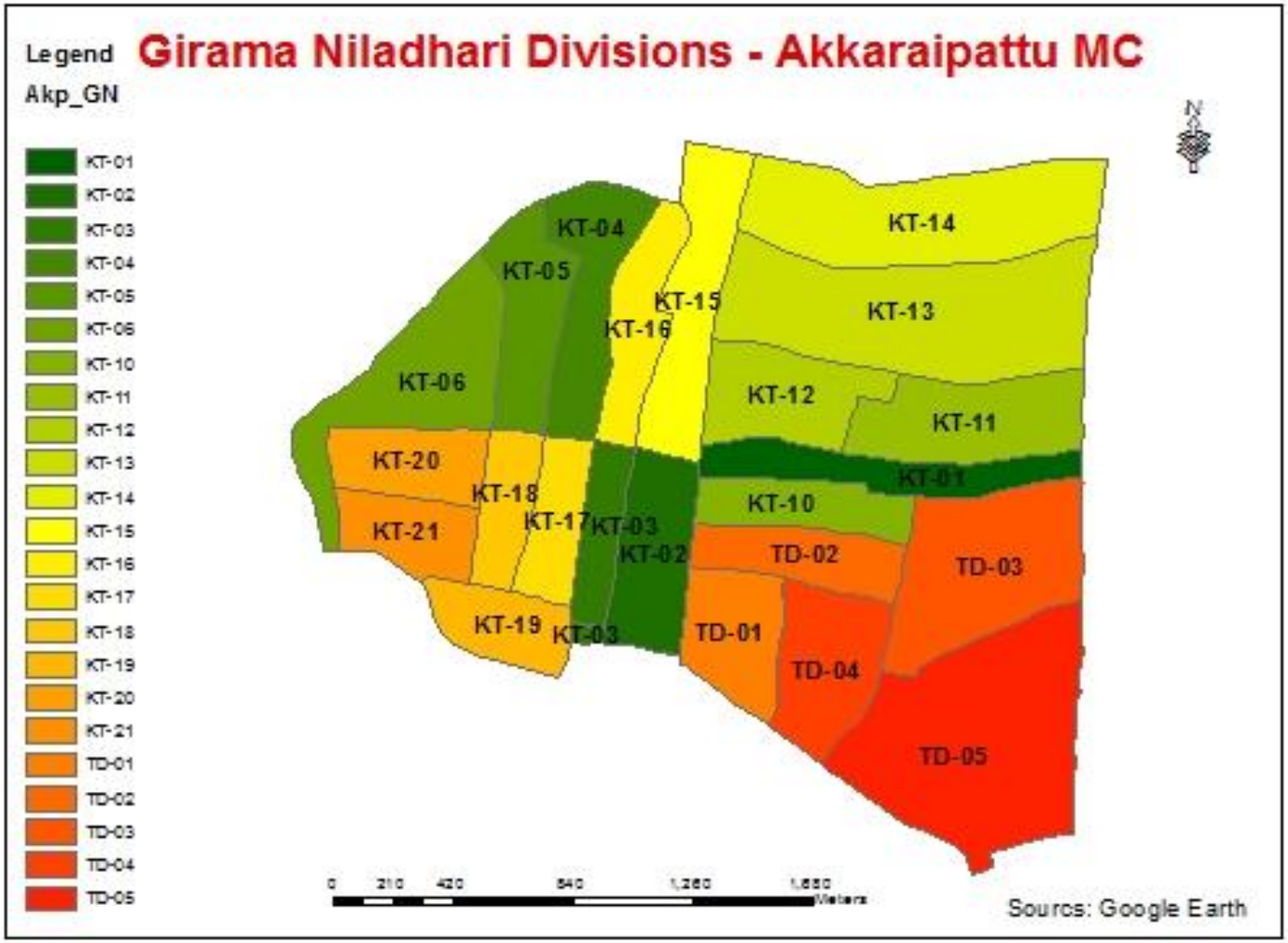
AKKARAIPA

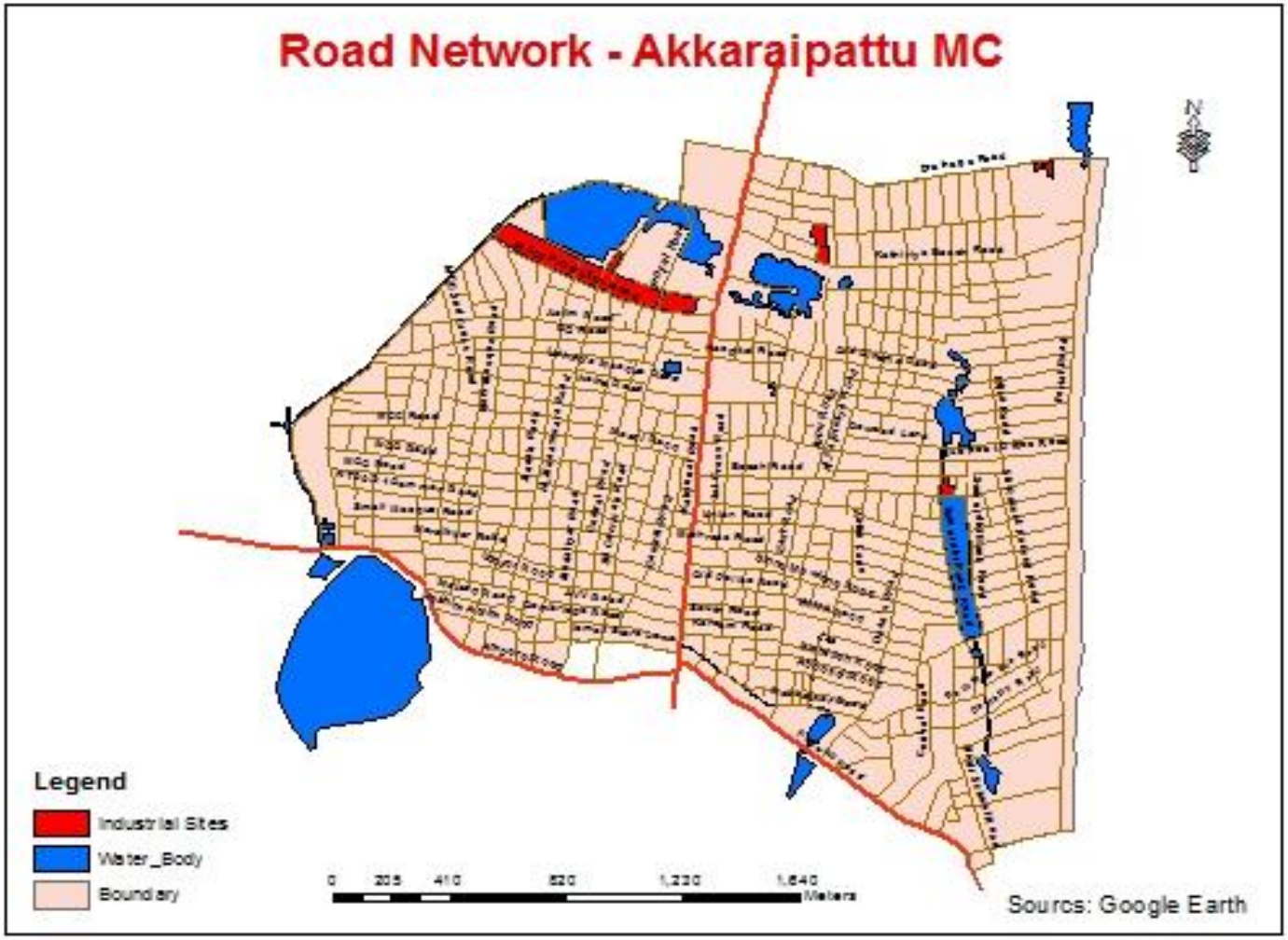


BRRNA
HYDRA
ROCKA
CCNTA
MRSHA
SANDA
GRSLA
OTHRA
SCRBA
HOMSA
PDDYA

Akkarapiattu Municipal Council Area

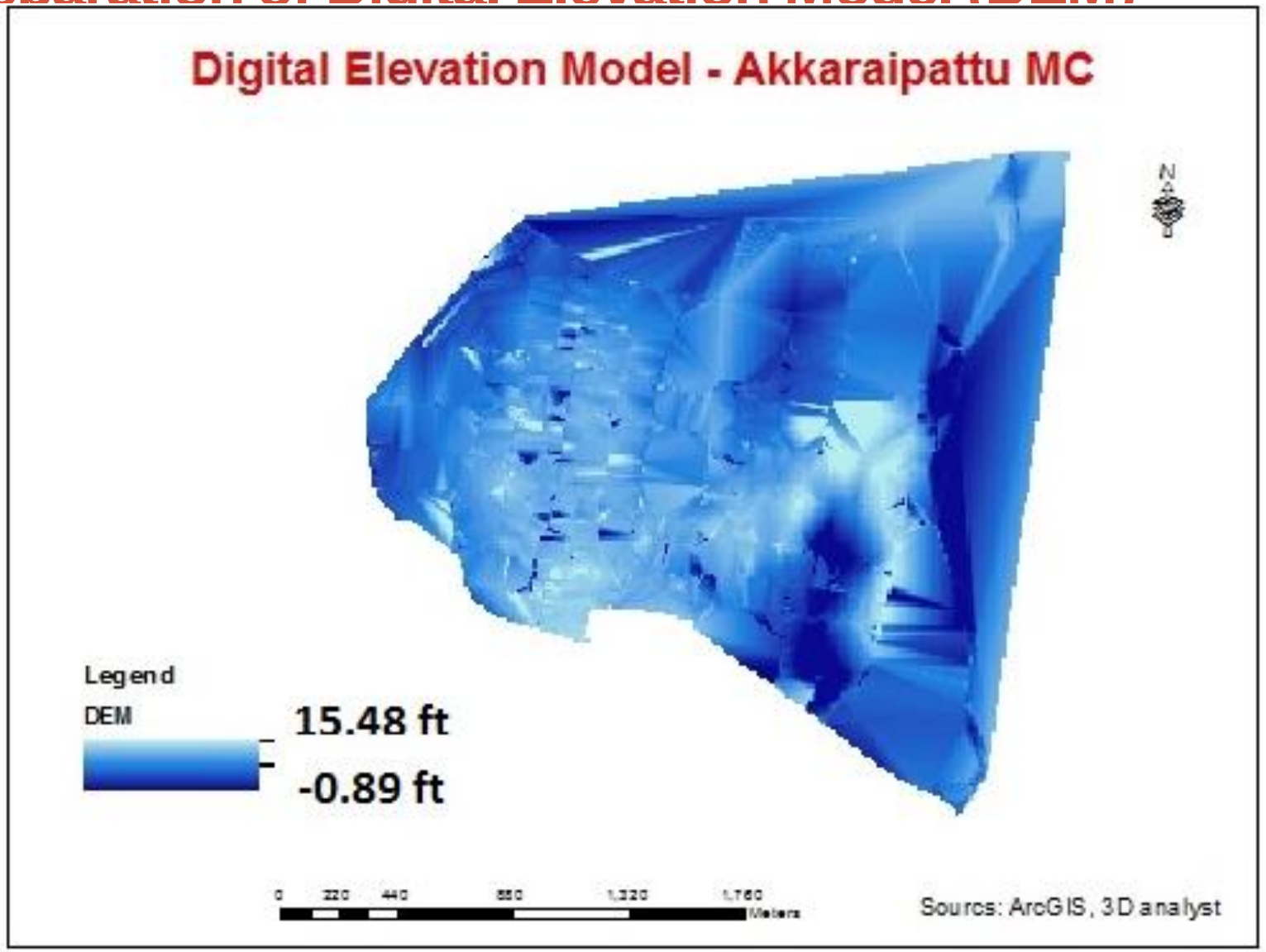



Legend
Akp_GN
KT-01
KT-02
KT-03
KT-04
KT-05
KT-06
KT-10
KT-11
KT-12
KT-13
KT-14
KT-15
KT-16
KT-17
KT-18
KT-19
KT-20
KT-21
TD-01
TD-02
TD-03
TD-04
TD-05
Girama Niladhari Divisions - Akkaraipattu MC
N
KT-04
KT-05
KT-14
KT-15
KT-13
KT-16
KT-06
KT-12
KT-11
KT-20
KT-01
KT-18
KT-10
KT-21
KT-17
KT-03
KT-02
TD-02
TD-03
KT-19
KT-03
TD-01
TD-04
TD-05
0 210 420 840 1,260 1,680
Meters
Sources: Google Earth


Road Network - Akkaraipattu MC
Legend
Industrial Sites
Water_Body
Boundary
0 205 410 820 1,230 1,640
Meters
Sources: Google Earth

Preparation of Digital Elevation Model (DEM)

- Ir p
  3D



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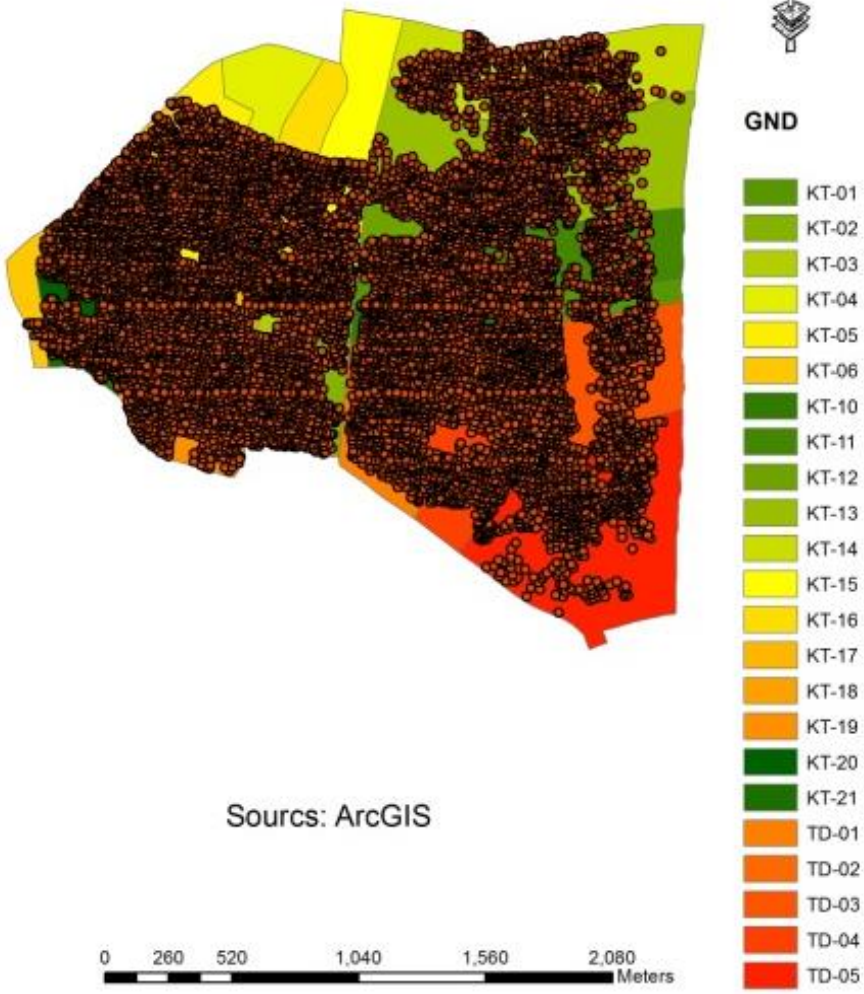
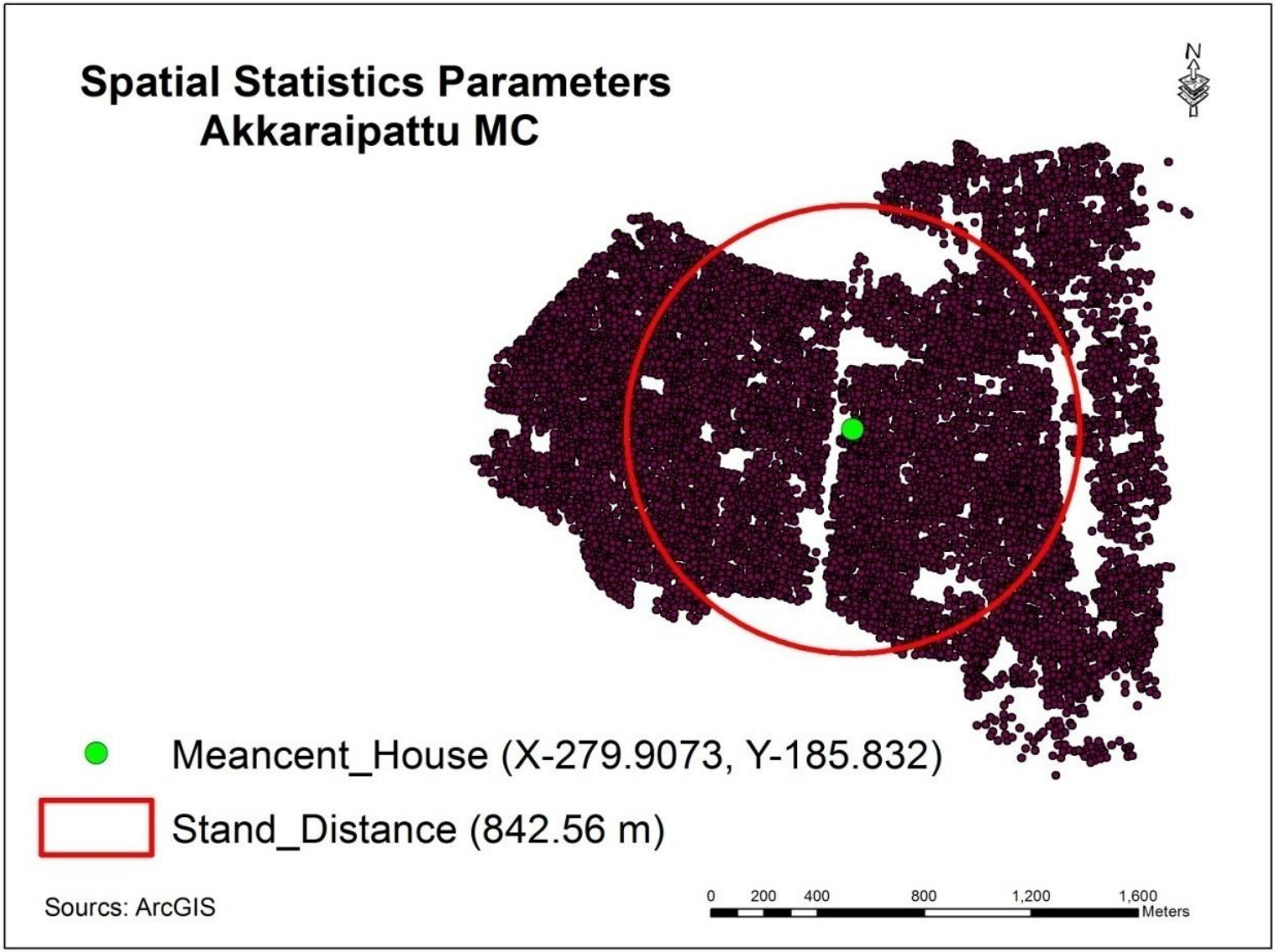
GND wise Household Akkaraipattu MC

GND	Families	Tot Pop	Male	Female	Children
KT-01	309	1088	337	382	382
KT-02	402	1482	589	491	402
KT-03	245	1247	296	475	476
KT-04	297	1444	572	406	466
KT-05	364	1019	332	389	298
KT-06	735	3145	1132	1081	932
KT-10	378	2069	540	779	750
KT-11	338	1526	625	494	407
KT-12	439	1777	890	327	560
KT-13	727	3503	1097	1508	903
KT-14	580	2476	703	825	948
KT-15	268	1618	553	548	517
KT-16	240	1428	477	475	476
KT-17	300	1199	134	564	501
KT-18	297	1121	223	449	449
KT-19	245	1007	211	398	398
KT-20	363	1896	691	729	476
KT-21	313	1631	585	390	656
TD-01	359	1272	277	455	540
TD-02	378	1992	741	757	494
TD-03	536	2923	804	1060	1059
TD-04	337	1234	404	493	337
TD-05	622	3676	1230	1206	1240
Total	**9072**	**41773**	**13443**	**14676**	**13667**




Spatial Statistics Parameters
Akkaraipattu MC
N
Meancent_House (X-279.9073, Y-185.832)
Stand_Distance (842.56 m)
Sourcs: ArcGIS
0 200 400 800 1,200 1,600
Meters

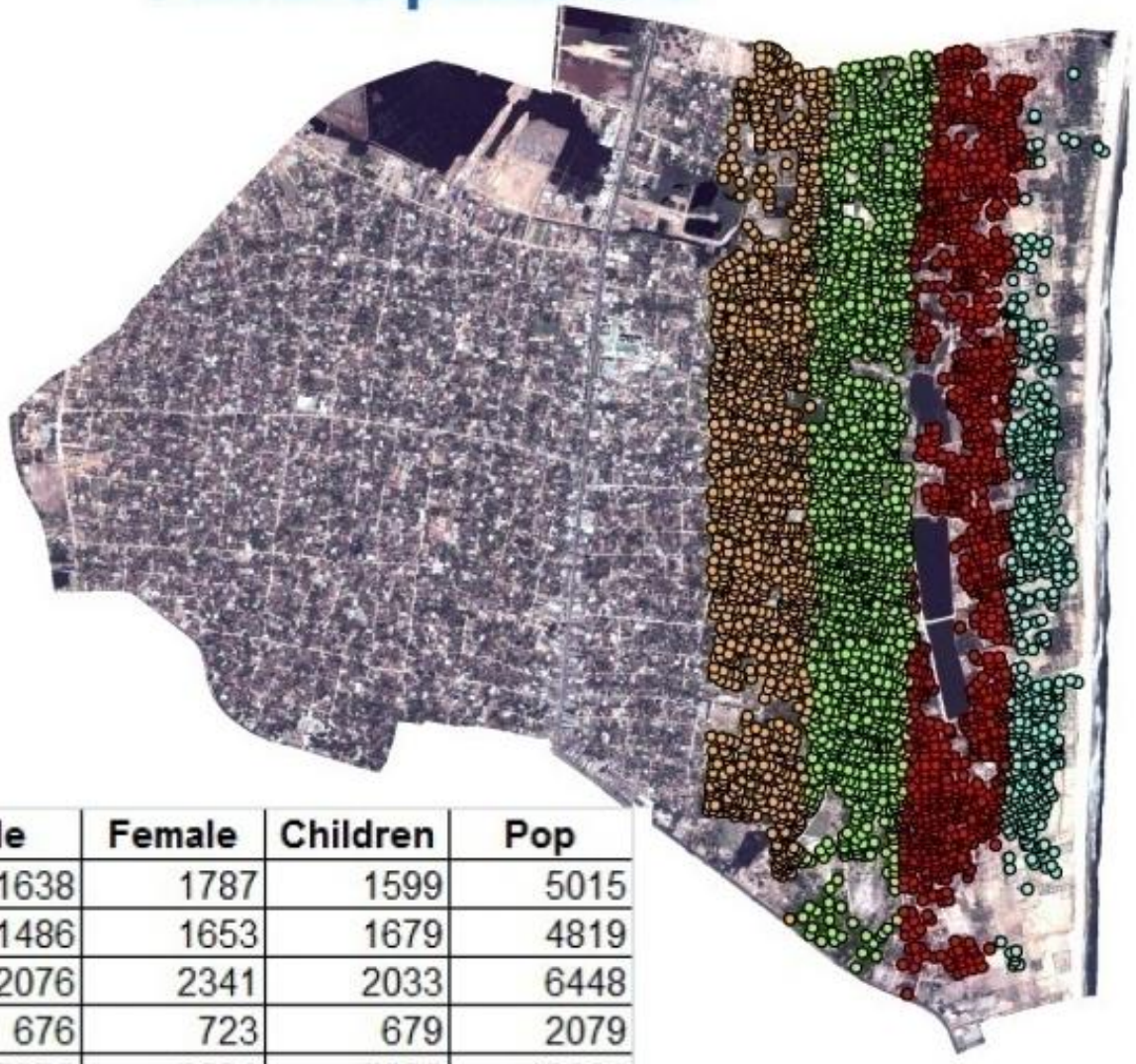
Preparation of Disaster Risk Maps

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**
- **Cyclone risk area**

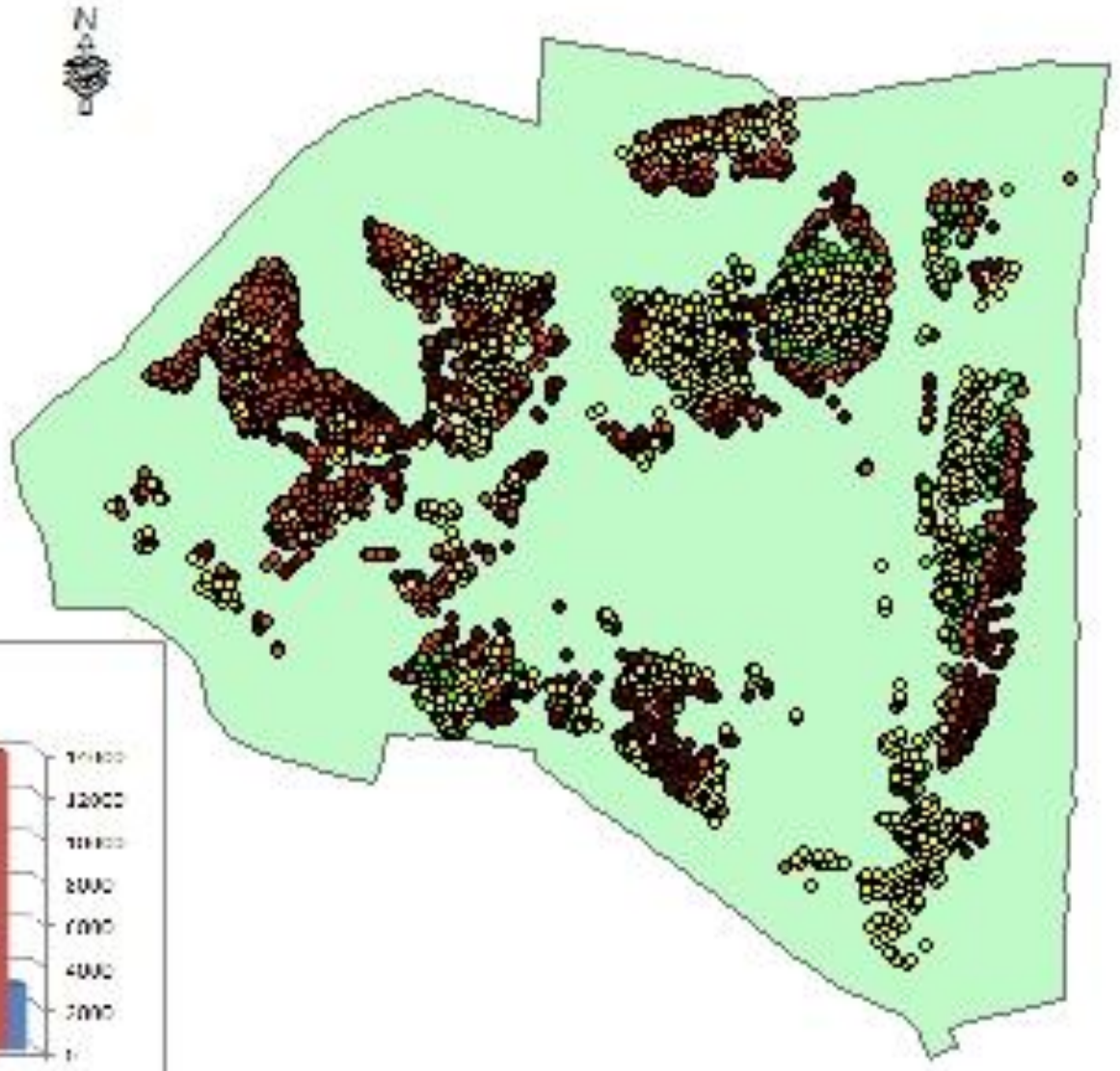
Household falling within Tsunami Risk Zones
Akkaraipattu MC

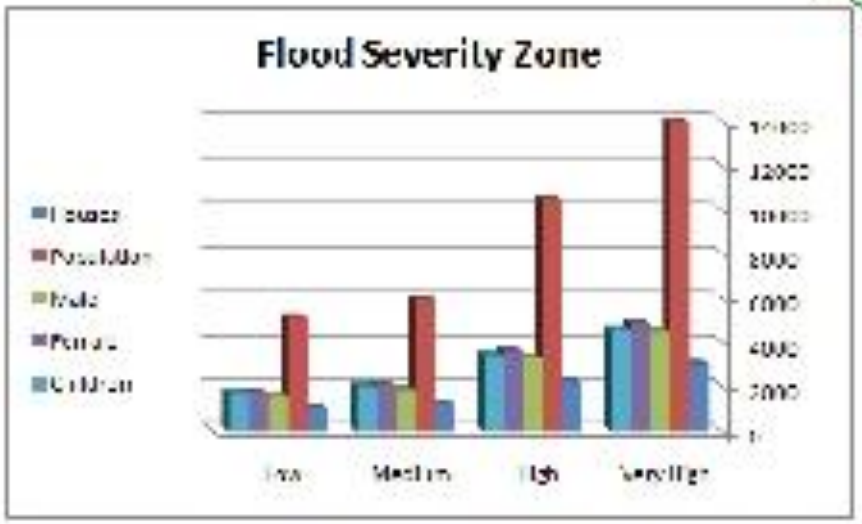
- 750-1000 m
- 500-750 m
- 250-500
- 0-250 m



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**

Flood Affected Houses - Akkaraipattu MC





0 220 440 880 1,320 1,760
Meters

Sources: ArcGIS

Household falling within Health Risk Zones Akkaraipattu MC

No	Name	Address	GND	G	Age	Date
1	AL. Nafeesa	48/1, Ampara Road	Aalim N	F	56	06.03.13
2	ALM. Nimsath	Old police Station Road	Akp 01	M	18	18.03.14
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
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14						
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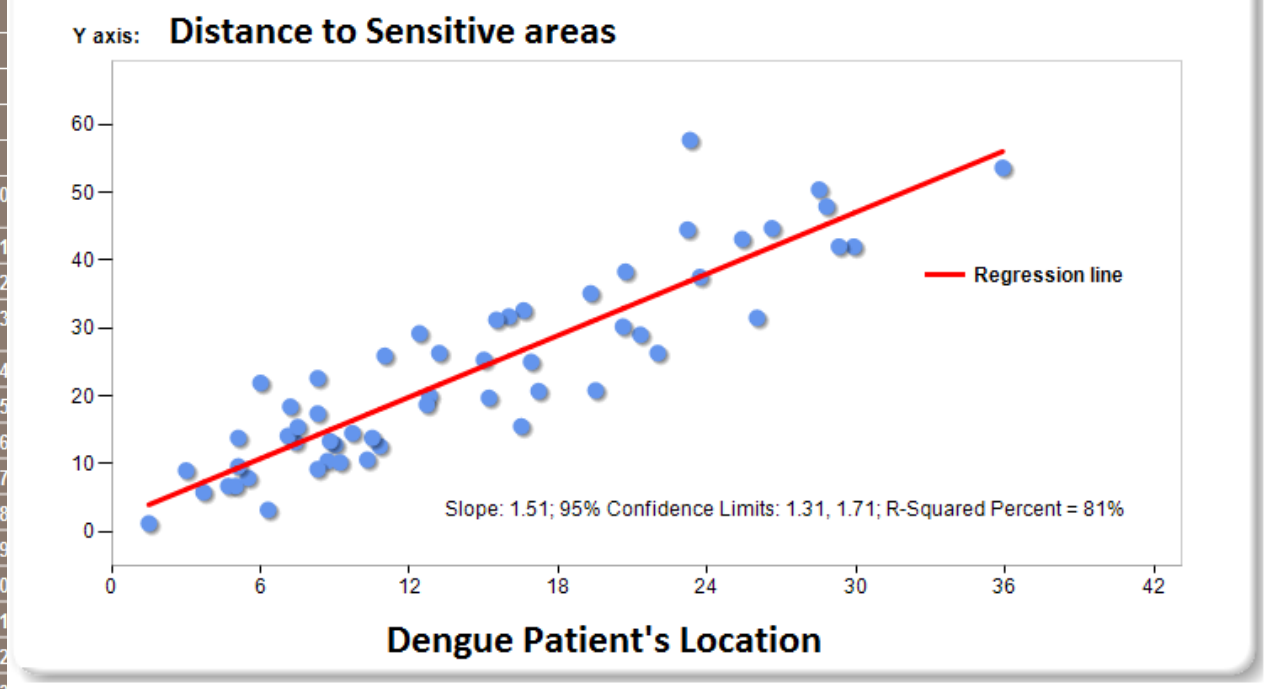
16						
17						
18						
19						
20						
21						
22						
23						
24	MIM. Najeek	02, Fiscal Junction	Akp 02	M	23	19.05.13
25	Natha Mariyam	15A, Fiscal Road	Akp 02	F	9	26.03.13
26	Hafaf	206, Town Mosque Road	Akp 02	M	6	28.02.13

People L

Population	8
Male	2
Female	2
Children	2

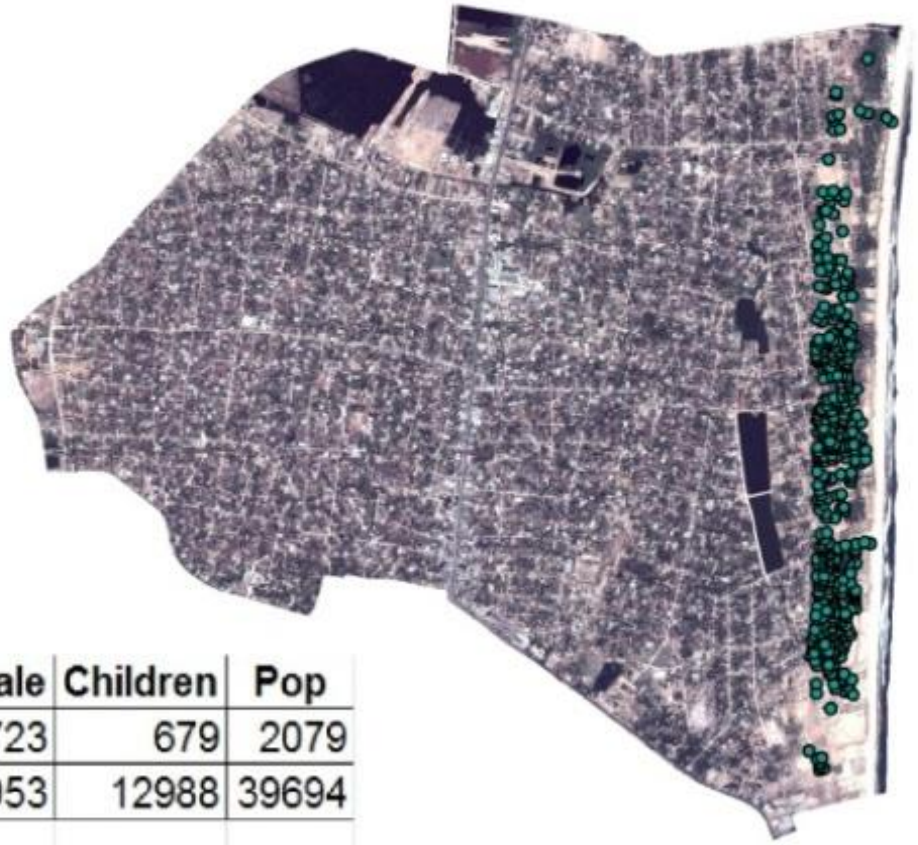


0 270 540 1,080 1,620 2,160
Meters

300 m

Sensitive_Area

Household falling within 250 m Coastal Zones
Akkaraipattu MC



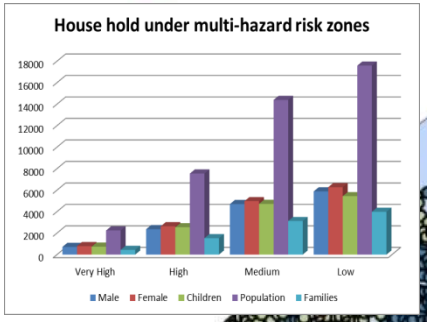
- Cyclone

Severity	Families	Male	Female	Children	Pop
0-250 m	399	676	723	679	2079
Others	8673	12767	13953	12988	39694
Total	**9072**	**13443**	**14676**	**13667**	**41773**

0 275 550 1,100 1,650 2,200
Meters

Source: ArcGIS

Houses under Multi-Hazard Zones
Akkaraipatuu Municipal Council Area



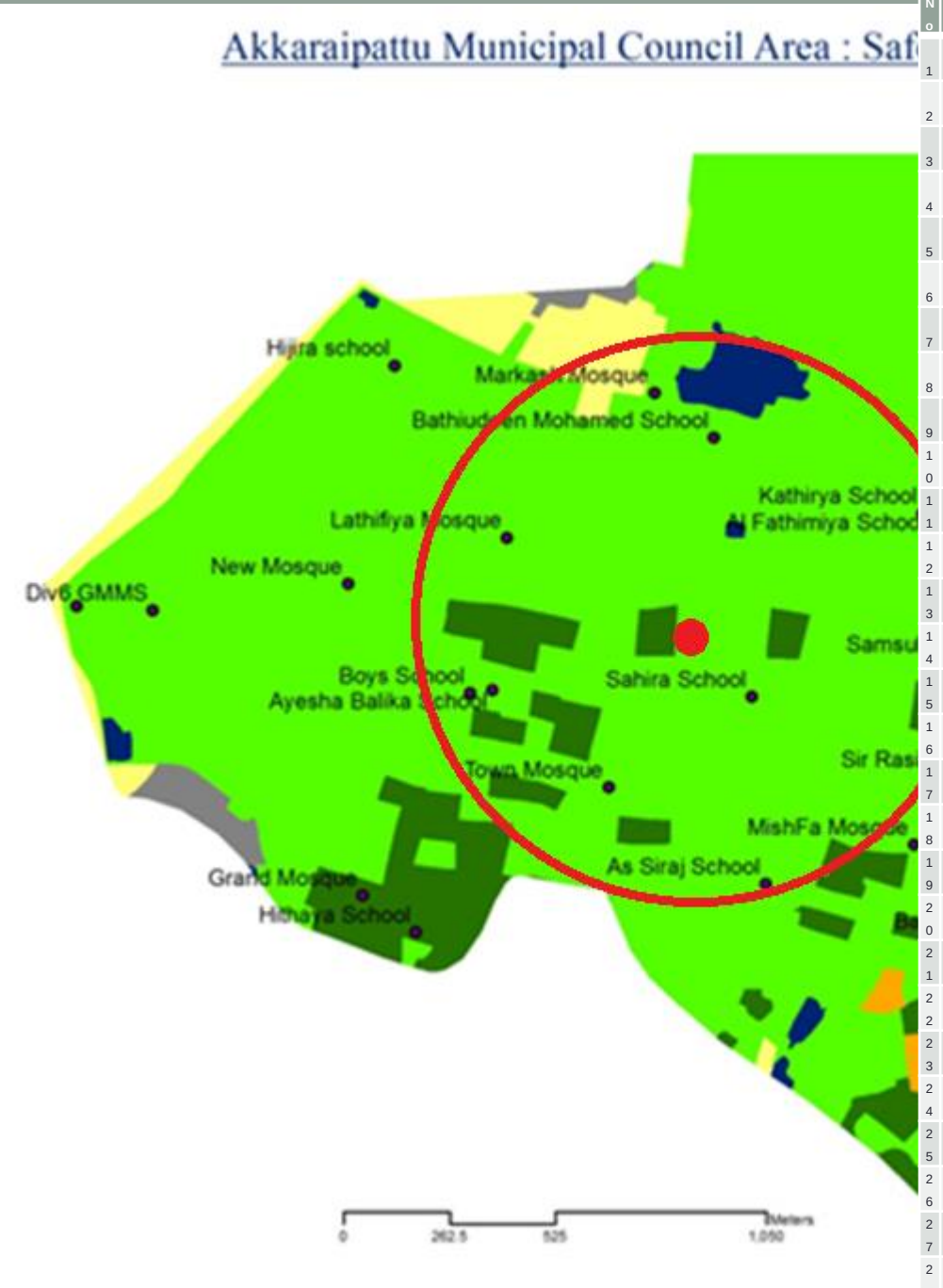
House_Risk

- Low
- Medium
- High
- Very_High

Risk	Male	Female	Children	Population
High	2367	2637	2548	7545
Low	5882	6274	5439	17591
Medium	4702	4975	4720	14396
Very_High	717	793	737	2246
Total	**13668**	**14679**	**13444**	**41778**

Sourcs: ArcGIS

0 220 440 880 1,320 1,760
Meters



No	Name of Safer Places	No. of Refugees could be Accommodated
1	Muslim Central College	1000
2	Al-Munawwara School	500
3	Boys Vidyalaya	400
4	Ayesha Balika Vidyalaya	2000
5	Budhist Vihara	100
6	Manba-Ul Khirath Madrasa	100
7	Al-Munawwara School	500
8	Boys Vidyalaya	400
9	As-Sahra Vidyalaya	200
10	Athaullah Arangam	2000
11	Al Fathimiya Vidyalaya	1000
12	As-Zahira Vidyalaya	200
13	Samsul Uloom Vidyalaya	300
14	Al-Badr School	300
15	As-Siraj Vidyalaya	5000
16	Ayesha Balika Vidyalaya	2000
17	Badiud-Deen Mahmooth Vidyalaya	300
18	Sir Razik Fareed Vidyalaya	100
19	Kathiriya School	200
20	Town Jumma Mosque	2000
21	Badr Jumma Mosque	500
22	Kathiriya Jumma Mosque	100
23	Marcus Mosque	100
24	Nooraniya Jummah Mosque	200
25	Grand Jummah Mosque	2000
26	Hithaya Mosque	300
27	New Jummah Mosque	2000
2	Lathifiya Mosque	50

Findings

Key Problems identified regarding Disaster Management in Akkaraipattu MC

- Poor awareness on disaster management
- Poor adaption for modern technology
- Absence of early warning system
- Lack of integration of all stakeholders
- Increasing population density
- land demand increases the vulnerability to disasters

Findings…….

Key Potentials regarding Disaster Management in Akkaraipattu MC

- 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

Conclusions

- **The research shows that the potential of Geographic Informatics for creating spatial data layers for multi-hazards.**

- **Multi-hazard Zone Map for Akkaraipattu MC 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**

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

Final Task

Out put

- 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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Thank You