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Master Thesis

Real time evacuation in urban disaster management

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Keywords: urban disaster management, GIS, urban flood, building attributes, digital city.

Short summary:
The aim of research work is to evacuate people to safe areas during urban disaster so in theoretical part we start by introducing urban disaster technology tools which can help us during evacuation. In the practical perspective of this research work we tried to evaluate rainfall distribution for Tamil Nadu state in India. We start interpolating using ArcGIS spatial analysis and plotting the inserted layer over the map.

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Abstract

Urban areas are individually assailable not only because of the condensation of population, but also due to the interaction between people, buildings, and technological system . Disaster management is hence an important part of urban planning and ordering as disasters set a serious menace to sustainable development. There are basically three very important inconstancies in the way disaster management is performs. First one relates to the credence upon hazard zonation alone rather than applying risk as outlay for the selection and prioritization of mitigation strategies. Second one relates to the credence upon reaction rather than concordant attempt in both the predisaster and postdisaster phases. Last one relates to the deficiency of disaster information network which attune attempts between the many corporation involved.To adjust enough disaster mitigation strategies, integrative information of an acceptable precision level must be presented in suitable and timely manner to the decision makers. Geographic information systems (GIS) have significant potential for ameliorating urban disaster management since they present more proficiency and speed in the management,analysis,manipulation, input and output of data, and also because they simplify better decision making [1].

In this paper, we evaluate urban disaster management by interpolating using ArcGIS spatial analysis and plotting the inserted layer over the map. This will give us an approximate deduction of rainfall around the regions near the weather stations. In the practical perspective of this research work we tried to evaluate rainfall distribution for Tamil Nadu state in India.Rainfall is very important factor when analyzing flood situations. Flood harm prohibition includes structural flood control measures such as building of walls or river dykes and non - structural measures such as flood anticipating and warning, flood hazard and dignity management, public participation and institutional regulation, etc. [2] Urban flooding should be relieve by having a mix of both structural and non - structural tactics. With the extension of new information and technologies,and in particular convenience such as (GIS) and designing in the base of internet for communication, a span of possibilities is open up to detract the risk associated with disasters, proactive processes in response to emergencies and decrease delays in helping recovery from disaster event.

Keywords: urban disaster management, digital city, GIS, urban flood, building attributes.

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1. CHAPTER 1: INTRODUCTION

Natural disasters are the lash of a natural hazard over an assailable community resulting people's dead and huge economic losses upon the history of civilization.[3] Natural disaster dignity in urban areas are higher owing to diversity and collecting of elements at risk in urban areas. Contrary to the technology and science developments, man is not able of hampering or stopping their incidence yet. Flood, earthquake, landslide, Tsunami, wild fires and many other natural disasters have happened in the past. The main question that should be asked is that: Do we always have to bear from tragic result of a natural disaster, or scientific procedures can prevent losses and demolitions?

1.1 Aim of Theoretical Part

The aim of research work is to evacuate people to safe areas during urban disaster so in theoretical part we start by introducing urban disaster technology tools which can help us during evacuation. By understanding the technology which is necessary during urban disaster management it will be easier for us to plan evacuation. This work also include some use case studies about urban disasters which happened in the past and it can help us for further research. Conclusion contains overall summary of research work and future scope for this direction.

1.2 Aim of Practical Part

During urban disaster evacuation plan safety is the most important part that we should care about. In the practical perspective of this research work we tried to evaluate rainfall distribution for Tamil Nadu state in India. Rainfall is very important factor when analyzing flood situations. We start interpolating using ArcGIS spatial analysis and plotting the inserted layer over the map. This will give us an approximate deduction of rainfall around the regions near the weather stations.

GIS has a routing tool that can be used to plan routes and which we can use for our purpose to plan the routes for relief supply vehicles to the centers across the city. Using just the map and data available from each relief location we were able to plan out routes for centers across the state from a central point of distribution. This helps to provide such detailed maps to vehicles in order to expedite the relief process.

1.3 Urban Disaster Management

The urbanization of the world's populace is accelerating. Disasters can result from the way development occurs, and conversely can change the way development [4] takes place (World Bank, 2010). By 2008, more than 50 per cent of the global population already urban with more than one billion people living in the slums (UNFPA,2014). The disaster management needs to first distinguish disaster risk by risk appraisement and vulnerability mapping, second propitiate via urban planning by mainstreaming Disaster Risk Reduction (DRR) in to planning via risk sensitive land use planning and third create resilience and cornice capacity to fray disaster. With climate change and contrast showy notable menaces to the urban poor, urban populations are exclusively vulnerable to the risks, especially children.

The investiture in new city foundation offer massive chance to build tolerable (smart and effective) and recessive cities applying less energy and water especially in developing countries[5]. Key perspective of civic,economic,technological and indigenous systems functions differently in urban areas than in village or campsite. Urban systems have special aspects due to the compression, variety and mobility of cities, for example the ways that associations are determined, the ways that bazaars and economic expansion stand. We should increase the quality to answer to the blooming urbanization tendency to subsidence the needs of the world's most assailable children in urban ground.To gain this, we are adjusting our accede, coding models, dunnage and systems to content with urban version. One of the most critical problems handling disaster management narrates to planning authorities leaning on unfeasible information such as risk zonation rather than on unified information such as wealth loss and human calamity anticipation.

Any disaster can intercept necessary services, such as health care, water, electricity, transportation and communication.The interception can seriously affect the health, public and economic network of countries. Poorly design solace activities can have a serious negative strike not only on the disaster losses but also on donors and helping agencies. So it is important that physical therapeutics tend appointed programs rather than seeking individual attempts[6].

1.4 Geographic information system in urban disaster management

Bridging fractures in disaster management does not only initiate improvement in technical sights but also in practical sights of wisdom transfer in a way that provide the conclusive user, to realize and use it [7]. Unfortunately, in developing countries, infirm disaster handling is nearly uprooted in the absence of integrative information produce. For certifying palmy urban disaster management four different information should be present for ruling maker.

1. Character valence recourse to the scale in whichthe several pertinence teams can either gown the economic casualties themselves or via disaster assurance.
2. Danger evaluation and hazard evaluation of presumably scenarios summarize as yearly victims for every kind of natural accidents.
3. Dereliction factors of natural accidents.
4. Mitigation choices.

All these particles of data are important for disaster management. One of the best benefit of geographic information system (GIS) for disaster management is the speed of GIS, GIS machine simplify the quick efficiency ofthe several data products which are essential for ruling makers in emergency. Within reaction and improvement stage, GIS is a very valorous gizmo to for real time presentation of disaster events.

GIS is a helpful gizmo that mature information from plenty various founts to fulfill a twisted curb of dataset coalition in a quick and scientific way. As inherent disasters do not tribute executive edges, the lodgment of calamity data networks could guidance to a significant recovery in disaster management [8].

1.5 ArcGIS

One of the main parts in GIS technology is ArcGIS which built and sustain by Esri, the biggest joinery GIS software company. Esri GIS technology is expend in numerous disaster management infrastructures in different part ofthe world.Esri exposures a general span of GIS technology related to different disaster management functions [9].

We can use ArcGIS and ArcMap for desktop which has best aspects for disaster Management and mostly people receive specific pedagogy in this field. Esri exposures Different APIs for mobile operating systems like Android and Apple which can help to Make praxis GIS applications.

Lately esri worked a lot on ArcGIS online technology which can furnish availability to different kind of exclusivity introduced by desktop ArcMap.

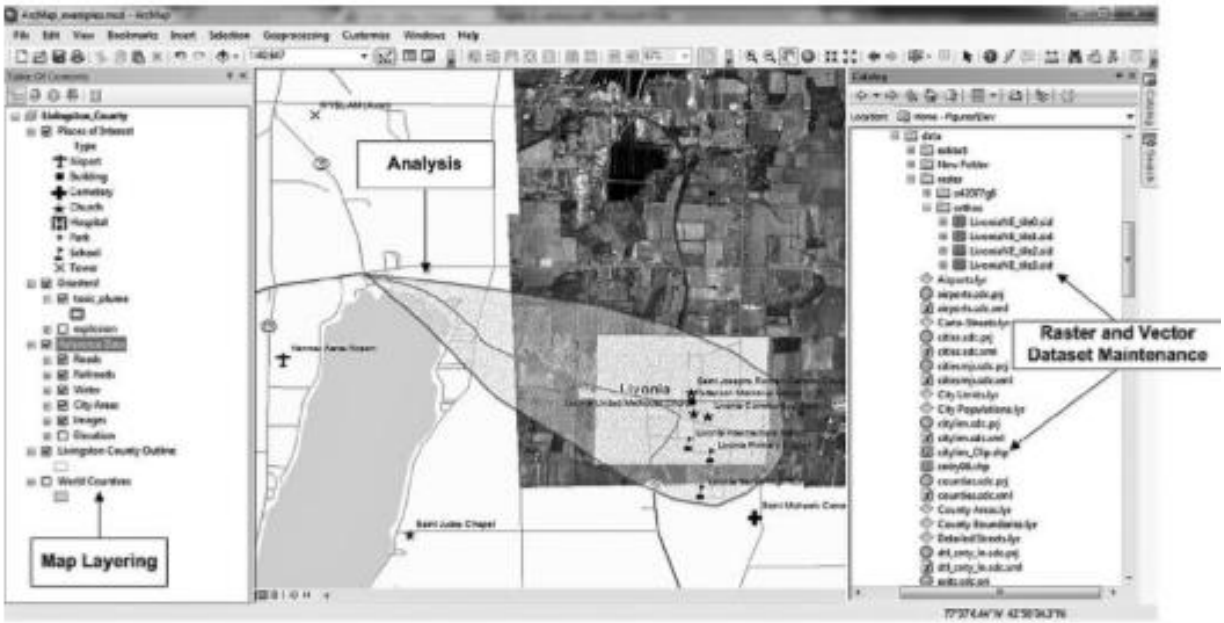

Figure 1 A disaster management example of map layering in ArcMap (source: Tomaszewski_Brian_Geographic_Information)

The inclusion of ArcGIS online is very scalable and it can be available in all kind of hardware platforms if there is an internet connection so we can say that ArcGIS online is a cloud base ambience. ArcGIS online can be used for multiplexing and exhibition of disaster management.

1.6 Google Map and Geospatial Technology

Google Map is probably the best legalized mapping technology, and geospatial technology contains Google Earth, APIs, and location partial functions. Google has also created their mapping technology further attainable to nontechnical specialists via technology like google map engine, this authorized to build substance on google base map sans having to work with programming languages such as JavaScript [10].

Because of agreeable character of google technology it increment the use of disaster management in general and also because of fondness that people have with google technology it is ease to use and mostly it cost free and there is no cost intricate in working with google earth and google map.

Figure 2 Google tension map (source: Tomaszewski_Brian_Geographic_Information)

1.7 Real Time GIS

Real time GIS is really significant for managing spatial information with decretive character of disaster. Very good example of lately appearing real time GIS technology is GeoEvent operator which is part of Esri and it can be suitable for disaster management answer. For connecting with different recorder like social media GeoEvent operator works with ArcGIS server and receive data in real time. For example as ambulance is find 1 mile away from hospital short massage can be sent to hospital employees to discreet them that and ambulance is near to the hospital and this flow work with GeoEvent protector. In this example a sober operated by thetime the ambulance has crossed the zone of concern which is known as Geo fence, it is exert to discuss to hospital [11].

Figure 3: Example of GeoEvent protector (source: Tomaszewski_Brian_Geographic_Information)

1.8 Problems of GIS in disaster management

With all the good parts that GIS can play in urban disaster management still there are some parts which need to improve in regard to urban disaster management. one of the main problems with the GIS technology is that the old version has different cultural view with new version and people use different version of GIS. As and example we can see the Katrina hurricane which happened in 2005 there was several kind of GIS datum subjects, during Katrina hurricane undertakers toil the factors of not owing plans for combining GIS with the replication the base maps were not up dated and there was a truly absence of GIS investing. After Katrina hurricane we can see a slowly increment in the knowledge of GIS for urban disaster management [12].

1.9 The case of Cartago

This season presents the state of the city of Cartago in Costa Rica. A summary will be genteel relevant to the record of the town in provision of the urban development. The assessment of the structure art and style, the understanding of the unstable events and the lash of the natural calamity. Relevant to the 2000 National Population Census, the state of Cartago has a populace of 432,923 as 125,000 exist in the city of Cartago. Relevant to Troyo (1998), about 3,000 tiny archeological spots of ceremonial, territorial, interment, crude substance exploitation intricacy are in the Costa Rican region. These spots uphold that human seizing of existing Costa Rican region history back to 10,000 B.C. [13]

Figure 4: Location of main cities in Costa Rica (Source: http://www.ticotimes.net)

Plenty writers are hang together that the society in today's Costa Rica was very petty at the time of the entrance of the Spanish people. In course of status, Troyo (1998) presume that the edge of the Mesoamerican culture was today's Honduras. The particles of articles used for the making of their constructions, also design of their hamlet, was of a very vital character. The locals were extracted down to a method of violence task that applied them as advisors for discovery, as bearer of consignment or as meal preparatory. In 1564 Vasquez de Coronado founder of Cartago, fetched a team of refugees wanting to ordain them on the territory and sufficient cattle to certify their prosperity. Hamlets were first connected operating available native ways.These native ways nevertheless had to be ream by the Spaniards to let the crossing of horses and rollers.

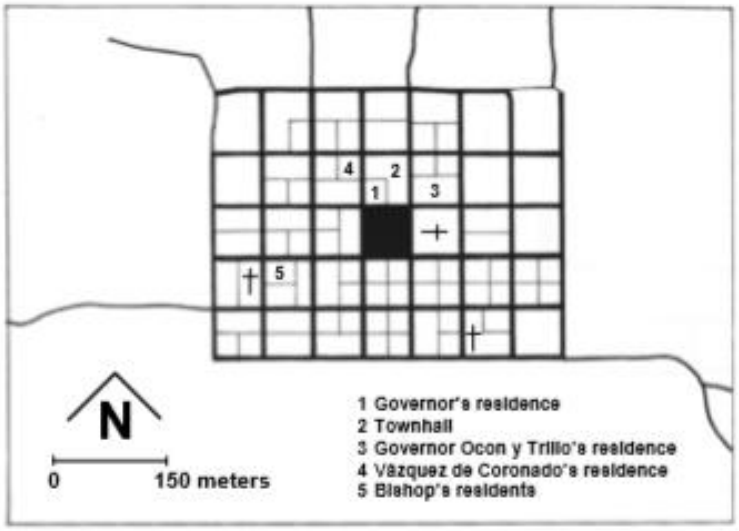

Figure 5: Cartago's Road Layout Design by De Anguiano, 1572 *(Source: Ponce 1993)*

The temblor of 1841 demolished Cartago and it caused that 31 people loss their life. And forth of 600 houses, 291 houses crumbled, and on the order hand the remainders were heavily blemished. Just four unique houses made of stone structure withstand the temblor properly. From a lump of seven kirks,five of them crumbled and two were heavily faulted. Continuation the temblor of 1841, leader Braulio Carrillo exquisite a dynasty of command with very factual objectives.

1. Rehabilitation of Cartago.
2. Alignment of available anatomy drills and plan.
3. Sketching the finance fount for the anatomy of collective buildings thus kirks, town hall, Prisons and army nerve center. [14]

The another major accident was the fatal and wrecking1910 temblor.The calamity velocity was very heavy, Fernandez and Cespedes (1910) cited that one in eight residents pass out. The same writers structured a much related heeds pertaining to the finance victims, they said that bricks of lump of homes in the city were created, collapsed easily, on the odder - hand few homes which made of wood skeleton remained standing.

Figure 6: Generic Bahareque Wall (Source: http://db.world-housing.net/building)

To temblor though the articles and manners exert diverse from domestic people who exert 500 years ago. From 1910 to 1950s, wood behoove to be a very beloved construction articles and also wood is very recessive in the occurrence of temblor.

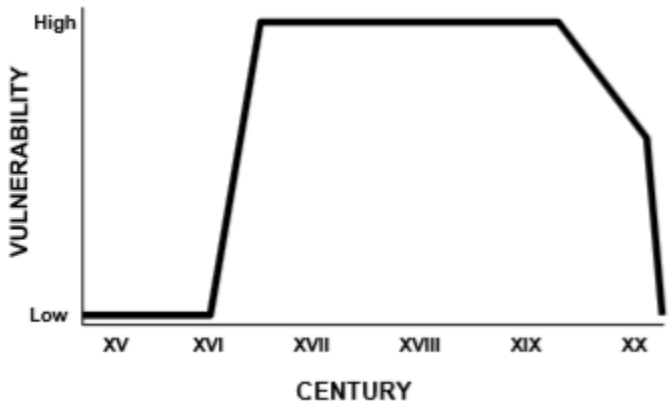

Figure 7: Estimation of Building Vulnerability in Cartago all over its History

(Source: https://link.springer.com/article)

1.10 The case of St Maarten

The isle of St Maarten is posit in the Norte of Netherland and on an average every 4 or 5 years it can experiment storms.As the most novel storms to cause significant harm are Irma storm (2017), Gonzalo storm (2014), Omar storm (2008), George storm (1998) and Luis and Marilyn storm (1995)and among them the most significant storm was Luis which left over 90% of all constructions and caused around 1 billion US dollars. And for the provision phase of its natural calamity the focus is on hampering dangers from expanding. One way of meliorating the provision for for normal disaster is to bargain in the (digital – city).Inthis nexus the solicitation that playsa fundamental role in the urban water machines is hydro informatics technologies. [15]

GIS schemes of zones at danger arevalorous information andconnection convenience in their own right. The can define flood fields , domain regions for conservation from drowning and recognize plans for disparate particles of land use.

Yang and Tsai (2000), properly introduced they behoove main alternative of relation data on possible natural calamity. Basement cable networks structure the set and showing of real time data more pragmatic.

Figure 8: Road Network flood hazard in GIS (Source: UNESCO-IHE 2007).

The suitable area of designing for the evaluation of disaster danger belongs conclusively on the character ofthe somatic condition and on the accessibility of information.Municipal survey, sewerage netting design and full geometry of netting can be readily reviewed with prevalent technology, but it is rather hard to proceed the impermanent dynamics of raining and streaming. Whence sill streams are limited to good given cylinders, a giant one – dimensional (1D) pattern can generally be instantiated, and applied to procreate secure outcomes for decision making.

The significant figure of designing is in integrating the inception of information to meliorate the understanding about the efficiency of a specific sewerage network , considering the related urban field. Specifying thus instantiated urban flood samples it is afterwards feasible to start optimizing the efficiency of the sewerage network in interval of reproducing the sewerage network it-self and presenting important correction to the urban survey that are solid with the suitable schematization criteria. Clearly there requisite to be fasten collaboration among the sewerage and schematization specialist in order to expand an impressive sewerage order.

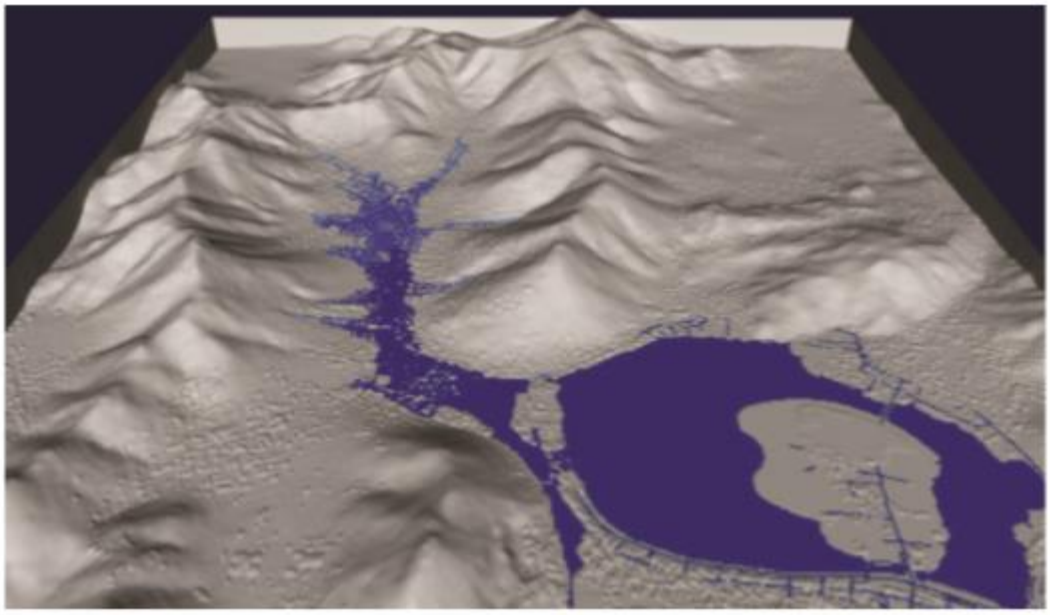

Figure 9: three-dimensional vision of the water level using a 1D-2D coupled model (Source: R.K. Price and Z. Vojinovic)

The placenta in this sample bring in channel flow begotten by a 1D pattern added on the sill valley recognized by a digitate terrain model (DTM) of the 2D land area. In the DTM , height external of all structures are setup by 5m and all causeways are pull down by 0.25m in order to display true physical status.

The primary concentration of "Digital City" notion is on fathering a surrounding in which end users accountable for several sights of the calamity handling plan are enabled to understand several flood related obstacles. The index of end users of the digital city intent must notbe narrowed to the tracers and disaster management delegations,a larger grandstand containing several stakeholders'teams and the citizen should also have range to such outlook. The two significant classes of scales are structural and non – structural. It is serious to memo that none of structural and non-structural accede is enough on its own, we require an allied accede that plan several extents. in specific, we should moot public, environmental and economic lashes in the passim estimation of technical scales.

We can use several accedes to selecting suitable structural and non - structural scales, These accedes vary relevant to the selected design incident. Generally, we select a design Incident relying on modulation of incident, the high eventual occurrence or the historical arrant case that has happened in a special part.

The common philosophy that has transpired from the study of urban flood calamity among the world is resumed by the Associated Program on Flood Management (2004): 1: Manipulate the urban water axle as a whole, grant consideration to the vulnerability of drinking water and drain remedy works to flooding and the outcomes for the publich health. 2: Complement urban schematization and water management,fetching vis-a-vis city planners and water engineers to art a more lasting, permanent, fixed and tolerable urban environment. 3: Accept a tone hash of structural and non-structural tactics for relieving urban flooding, taking in to account the unification of the region and resolution of the associated difficulties. 4: Certify a participatory accost by all skeholders to certify acquisition of disaster handling plans and to obtain and maintain autochthone and residential knowledge and wisdom. 5: Fracture the destitution axle trough ameliorated risk management that knows the vulnerability of the poor. [16]

1.11 The case study of Philippines disaster

The state of Philippines is located in the south east of Asia, and the disasters can trace any sector of the country. The Philippines is assume to be an extremely high danger state, as this country is the 7 most dangerous country in clause of hazards. The residential state executive system of the Philippines is divided in to three parts. 1: eparchies and highly unify cities, 2: portion cities, and, 3: barangays cities as the smallest executive units.

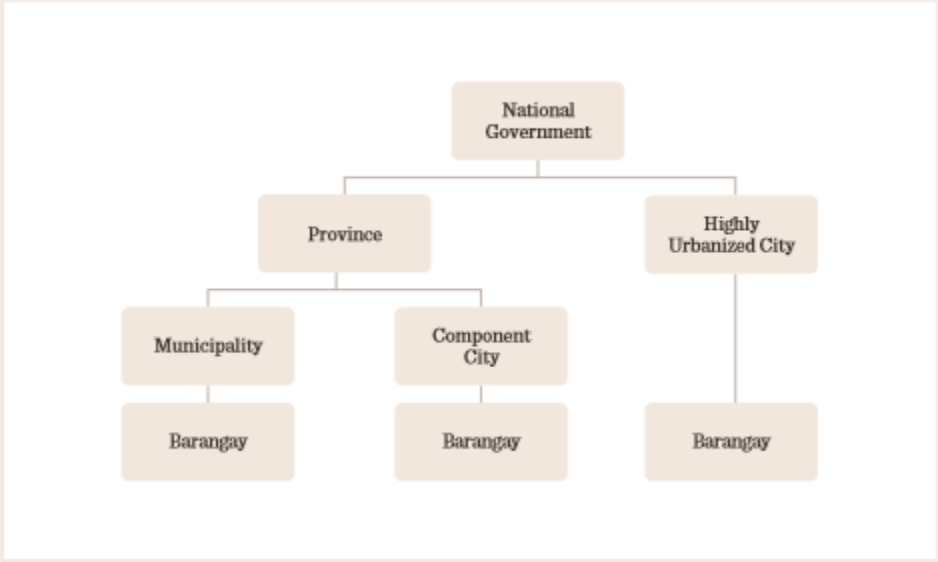

Figure 10 Philippines governance construction. (Source: Atienza, 200625)

Key diplomacy iterating to disaster management in the Philippines are the State Act 10121: Publich disaster danger reduction and management law (RA10121) and the State Act 10821: Children's emergency sedation and conservation act (RA 10821) public disaster replication plans are an accurate part of disaster management. State Act 10121 caters the legitimate foundation and the steering for the state government in its responsibility relevant to disaster. The state act 10821 is the latest regulation relevant to disaster risk reduction management (DRRM), wheels the preparation of emergency sedation and conservation for children before , during and after disaster and any other emergency conditions. According to RA 10121, in the times of emergencies the local disaster response risk reduction management (LDRRRRM) is accountable for replying and managing the harmful factors and in certifying the improvement. [17]

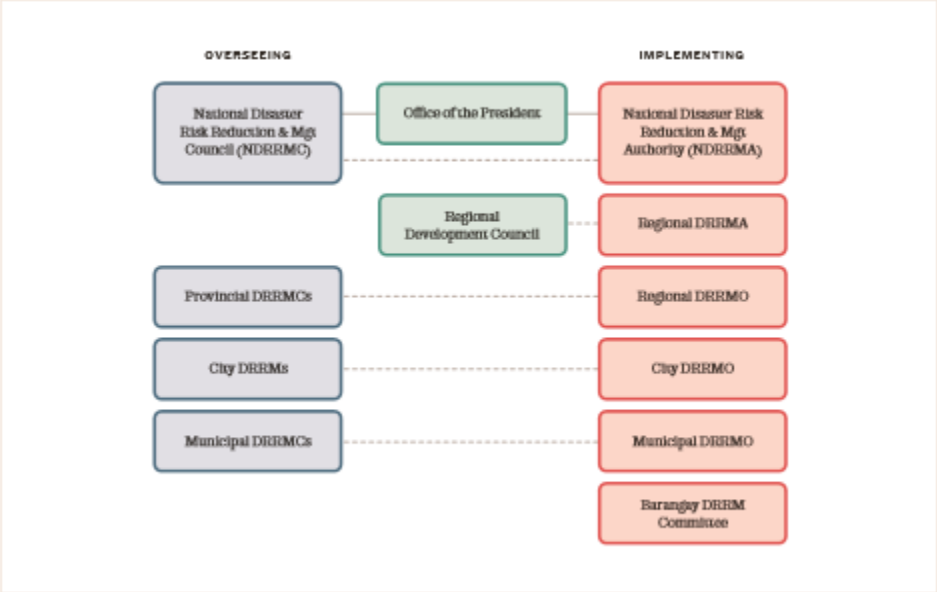

Figure 11: DRRMC contracture from the national to the local government units (Source: NDRRMC)

on 15 October 2013, an earthquake with the dignity of 7, 2 esteem harm the Visayas area, primarily striking the state of Bohol, causing death for 220 people and altering 671,000 families and more than 3.2 million singles. While replication was steady for the Bohol earthquakes sober levels were appointed for Typhoon Haiyan. The typhoon was the mortal incident of 2013,in the Pacific Asia,killing 6000 people and around 2,678 of the whole losses were recorded in the Tacloban city. The number of affected people raised to 14 million

amongst nine zones, containing 4 million people of lost staled dislocated from their homes. The replication was declared as system wide level 3 (L3) by the emergency sedation damper.

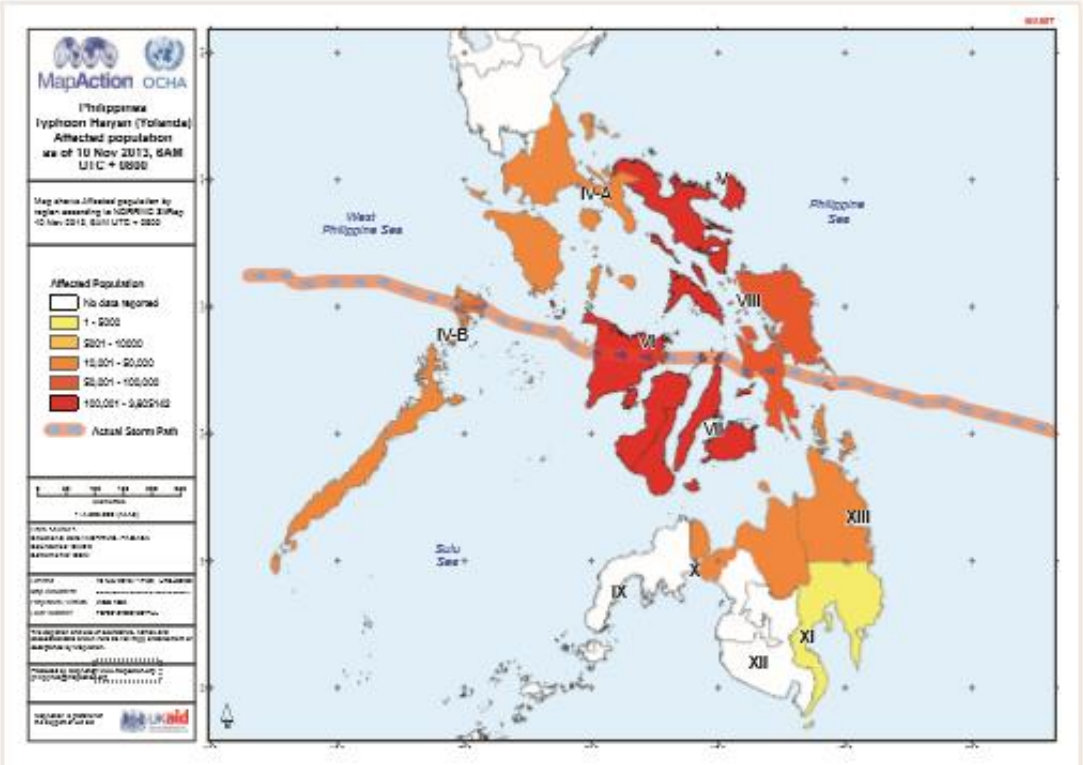

Figure 12: Affected society due to Typhoon Haiyan (Source: Map Action, OCHA, 201327)

in the Philippines different infrastructures purvey teaching on DRR and disaster respond. There has been a large number of skillful Filipino philanthropic help workers, lots of them working for non-government organizations (NGOs). It has been counseled that DRR teaching be supplied in good order foundation amongst the country the lumping intricacy of risk.

Several local delegations have tried to amplify the use of domain modulus and nucleus Philanthropic modulus and centralize these guidance to the Philippine terrain, but there is yet no general local evidence that clearly describes that how disaster undertakers if foreigners or natives will fulfill their functional inclusions, and local diplomacies are finite to the available orders of individual delegations while doing disaster respond. In the time of Haiyan typhoon robing became a significant security matter specifically in Tacloban city, where lots of big markets were hijacked as people running out of the food cause of this typhoon.

Public media has been applied largely in the Philippines as a connection gizmo by emergency responders. Companies use social media to warn people of what is going to take place in their place and also for answering the questions. [18]

In navigating the case study, it was feasible to talk about Filipino with large experiment in replying to emergencies. There is a nice expand system for emergency respond from local and public state. And the major problem for people in urban areas dominant pre-extending incongruence when an emergency happens.

1.12 Conclusion

Directing agents for flood disaster management needs a large bulk of water stacking quickly, or increasing speed which wisp vehicles and constructions. In this chapter it was included that in urban disaster management safety is the first step to start with and using such as GIS will really help as to do our evacuation plan faster and also using google Map and ArcGIS are so important for evaluating our data and also the final part of this chapter we discussed briefly about different case studies which basically gives more information about urban disaster and how to deal with urban disaster.

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2. CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

A literature review will be introduced relevant to the affiliation of numerals around disaster management, as well as the motion to disaster data networking. This chapter also conclude the process of hazards and the acceptable hazard which can be acceptable during disaster and finally the need for network in urban disaster and how to prevent risk during urban disaster.

2.2 Sphere for improvement

In order to get these goals the appendix purposes and objectives were expressed. 1. To ameliorate the valence of each country to alight the factors of disaster, with particular consideration appointed to helping developing countries in recognizing disaster harms potential, and in organizing primary warning systems and disaster insistent infrastructure. 2. To design suitable signals and tactics for using available theoretical and technical science, taking in to account lettered , economic and educative versatility will be important.[19] 3. To develop theoretical and engineering scramble target at addressing acute science to detract death and in order to decrease damage on estate and wealth of people is important. 4. To propagate novel and available technical data relevant to extent for recognizing disaster. 5. To expand sizes for recognizing and alighting natural disasters via syllabus of technical supports and technology transition and to appraise the effectiveness of these syllabus.

Unfortunately not all the regimes display a stability among their statements and the work that they perform and the titles for which they are making finance stock.This little conflicting treatment is in part to be attaint for “the acute gaze in the science” that the United Nation said as one of the important subject that need to be answered. [20]

2.3 The thinking process in hazard disposed urban areas

To some scope, the role of urban disaster plotters relevant to collection, processing and exhibiting information to let a system of questions to be respond so that decision makers can adjust prospering tactics. The first question to be answered is that **what is a risk?** Or we can say that what would be the envisage casualties of in human and their life, finances and their outcomes. [21]

Figure 13: Risk management applied to mechanize tunneling (Source: http://docplayer.net)

2.4 Deriving Risk

To illustrate that how risk is distinguish, according to United Nation explanation in 1991 a short is created about the arrangements attached:

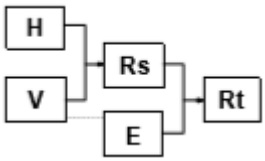

Figure 14: Conceptual Flowchart of Risk Assessment

Natural hazard (H) definition

Bring in the approximation of the contingency of incidence of a potentially harmful natural accident, the arrangement attached are land and atmospheric science and information.

Vulnerability (V) definition

Bring in the approximation of the scale of damage travailed by a certain root at danger or a Collection of likewise roots, terminate from the incidence of a natural accident of a given Value and explicit on a measure from 0 (no loss) to 1 (total loss), the arrangement attached Are human geography, structure and construction engineering, and many more can be add.

The elements at risk (E)

Contain the people, constructions, engineering works, public gears, etc ,at risk in a clear zone.

Specific risk (Rs) definition

Bring in the approximation of the anticipated point of damage owing to a specific natural accident and as a follower of both natural hazard and vulnerability (Rs = H.V) , the arrangement attached are human geography, structural engineering and many more cab be.

Risk theory (Rt) definition

Bring in the approximation of the anticipated harm of wealth and health of human and the cut of economic acting owing to a specific natural accident (Rt = E.Rs), the arrangement attached are urban planning, human and urban geography and also human economy and wealth can be.
The flowchart in figure11 demonstrate the methodology for risk fixation noted to wealth loss.

2.5 Acceptable Risk

Risk mayhap at acceptable surface, does not require government intermediation, or it mayhap at not acceptable surface, which basically require small or large intermediation from government. Cardona (1997) bring up acceptable risk to be the feasible damages that can be avowed by a society in return for a rating of interest. Petak and Atkisson (1982) vision it in interval of the size of the fracture between the eligible mammon of matter and realize reality. In their vision the size of the fracture defines whether some operation take place.Their vision highlights the gravity of tentative work in creating a sufficient model of the real world.

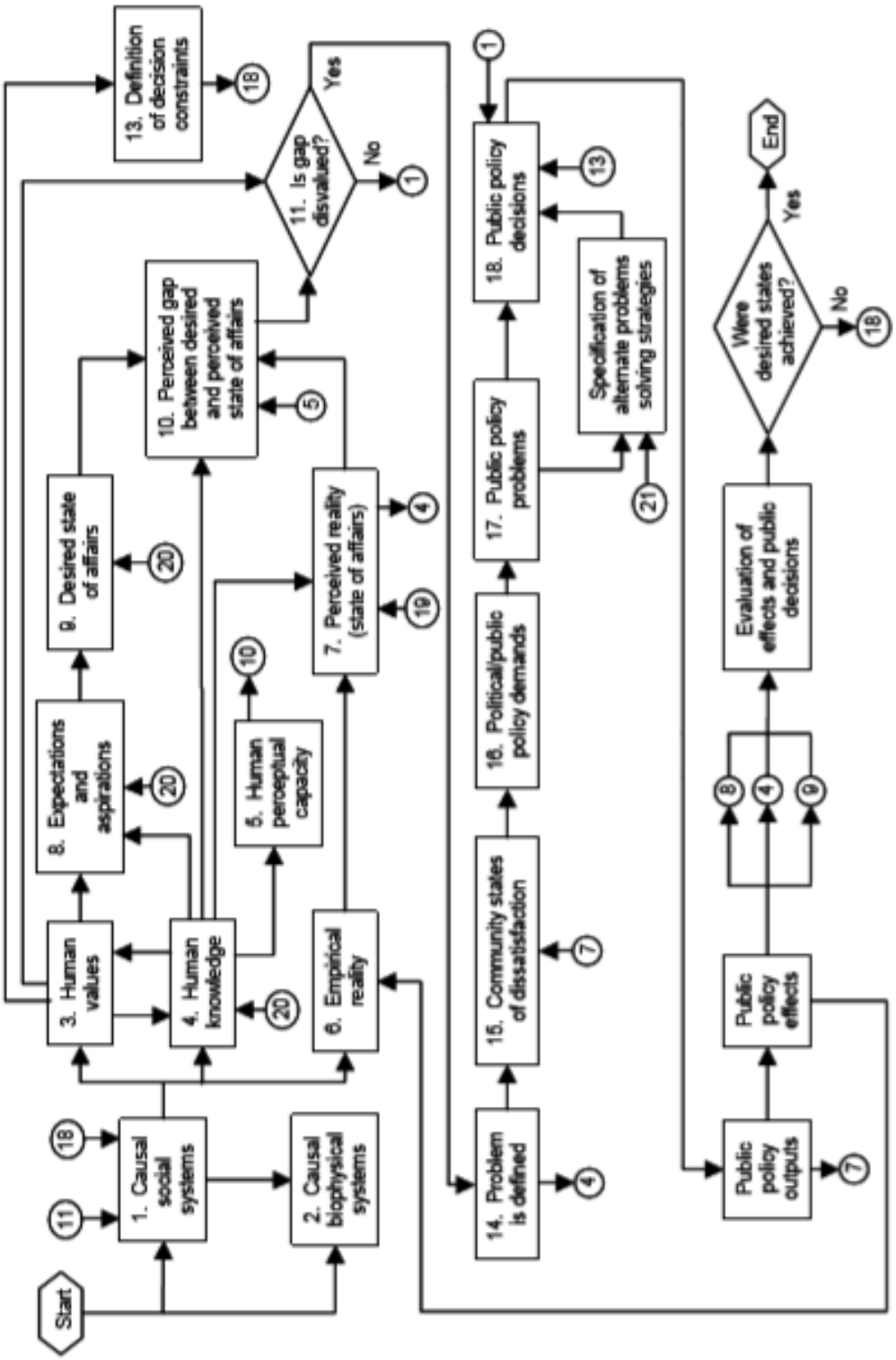

Figure 15: Decision-Making Process (Petak and Atkinsson 1982)

Some people have tried to appoint that what is an acceptable risk in a quantitative form. Sheehan and Hewitt (1969) propound acceptable risk that has result under appendix value. 100 people death or 100 people injured or 1 million US$ in damage.

2.6 Risk prevention and Reduction

Broadly speaking, risk can be decreased by sufficient disaster management. Selecting the correct performance tactics, but can be hard as there are more existent choices. A three dimensional matrix (Figure 13) characterize the span of feasible execution extents, including surface of government, management stage and implementation surface.

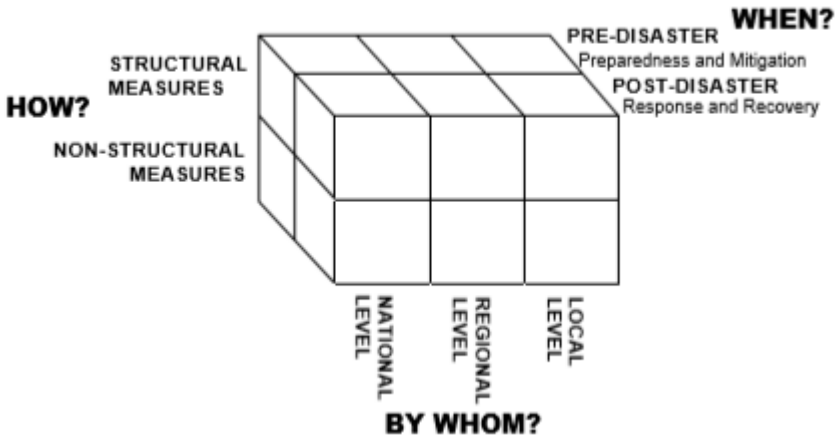

Figure 16: Range of Implementation Strategies (Source: Masser and Montoya 2000)

The mixture of these origins defines the span of feasible implementation tactics. In practice, some districts are more general then others, though all of them are available. For example:
1. A public emergence committee (national level) implementing an educational geostrategic relevant to the discharging of buildings to decrease the vulnerability of people for future.
2. A mayor (local level) building an article in order to decrease the damage for the future.
3. A ministry of community works (national level) restoring a pons destroyed by a flood.
One very significant perspective to be pass relevant to law fulfillment. Conforming from the non-aligned assurance factors of America (2000), damages from disaster Andrew could be reduced by 30 to 40% if available building codes been properly execute.

2.7 The Need for Networks in Urban Disaster Management

It is perceived that a general mistake in expanding countries is relevant to the believe that government regime should collect data and flow it with the purpose of using it for decision making at merely the government surface. It so significant to recognize all the possible users of risk area data with the national and local department to and to appoint the important figure they could play for economic sustainability of the information built by government delegations. The important part for completing this goal is to arrange all by:
1. Recognizing possible users and their inquiry needs, as disaster data users needs swap more.
2. Recognizing possible information catchers aswellas the specs ofthe inquiry the could cater.
3. Recognizing an existence that will harmonize relationship between these communities.

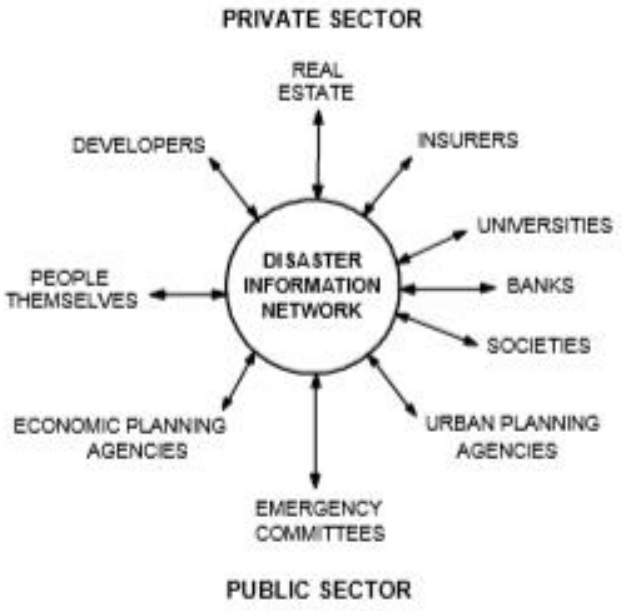

Figure 17: Members of a Disaster Information Network (Source: Federal Emergency Management Agency 1997)

Conforming from the committee on Geo-Science perimeters and policies of US National Research Council (1999), the entirely target of a disaster data network should be to decrease the velocity of disaster damages.

The lodgment of data networks should be numerous on planning agendas. And finally, as disaster management is just one of so many problems that decision makers will work onwith so scrambles should be prepared to boost knowledge of the advantage of disaster mitigation.

2.8 Conclusion

Urban disaster management is a twisted problem and it include multiple stakeholders and different possibilities to deal with. In this chapter it was included that urban disaster does not deal with anything so it needs more agendas and very high level of planning and in the last as disaster management is just a part that stakeholders deals with so there should be a muss to be prepare for raising notifications of the benefits of disaster mitigations.

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3. CHAPTER 3: IMPLEMENTATION

3.1 Introduction

Rainfall is very important factor when analyzing flood situations. We start interpolating using ArcGIS spatial analysis and plotting the inserted layer over the map. This will give us an approximate deduction of rainfall around the regions near the weather stations. GIS has a routing tool that can be used to plan routes and which we can use for our purpose to plan the routes for relief supply vehicles to the centers across the city. Using just the map and data available from each relief location we were able to plan out routes for centers across the state from a central point of distribution. This helps to provide such detailed maps to vehicles in order to expedite the relief process.

3.2 Chennai Flood Analysis using GIS

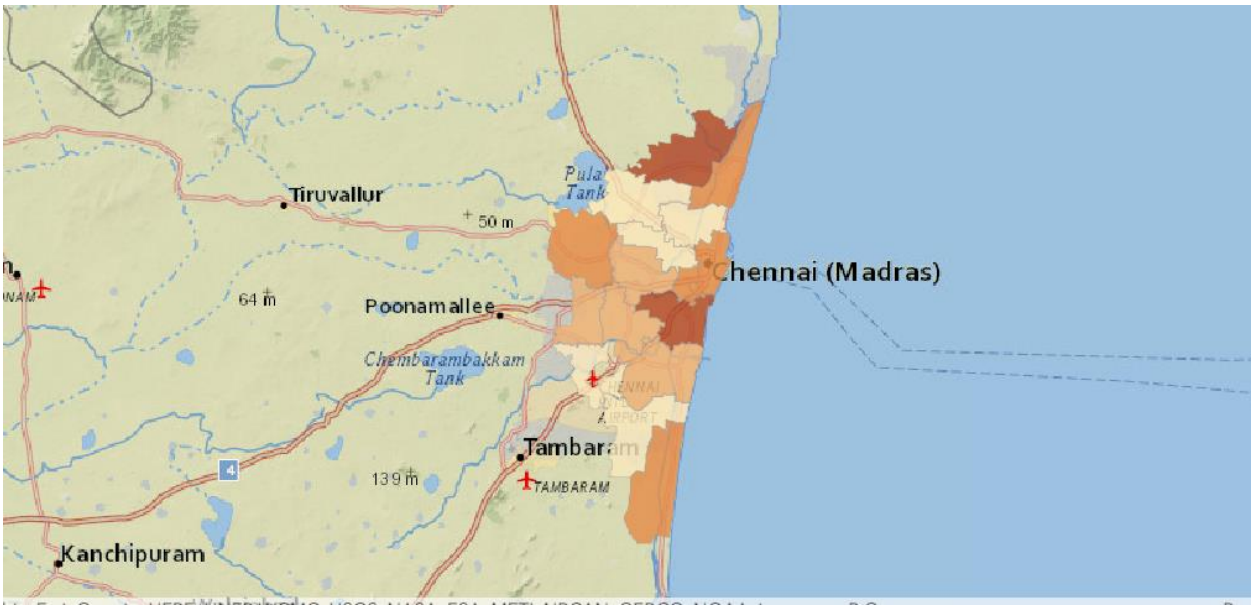
Chennai a coastal city in India belongs to the state of Tamil Nadu. It has a metropolitan population of about 8.24 million as per 2018 forecast. There are 3 rivers namely Cooum, Kosasthalayiar and Adyar that flow through the city and eventually drain into the Bay of Bengal. Even though there are 2 rivers, the city has been highly dependent on rains to refill their reservoirs.

It is completely depending on ground water resources to cater to its water needs. The average rainfall is 1,276mm. A city with so many problems for water was flooded to the roofs in 2015.

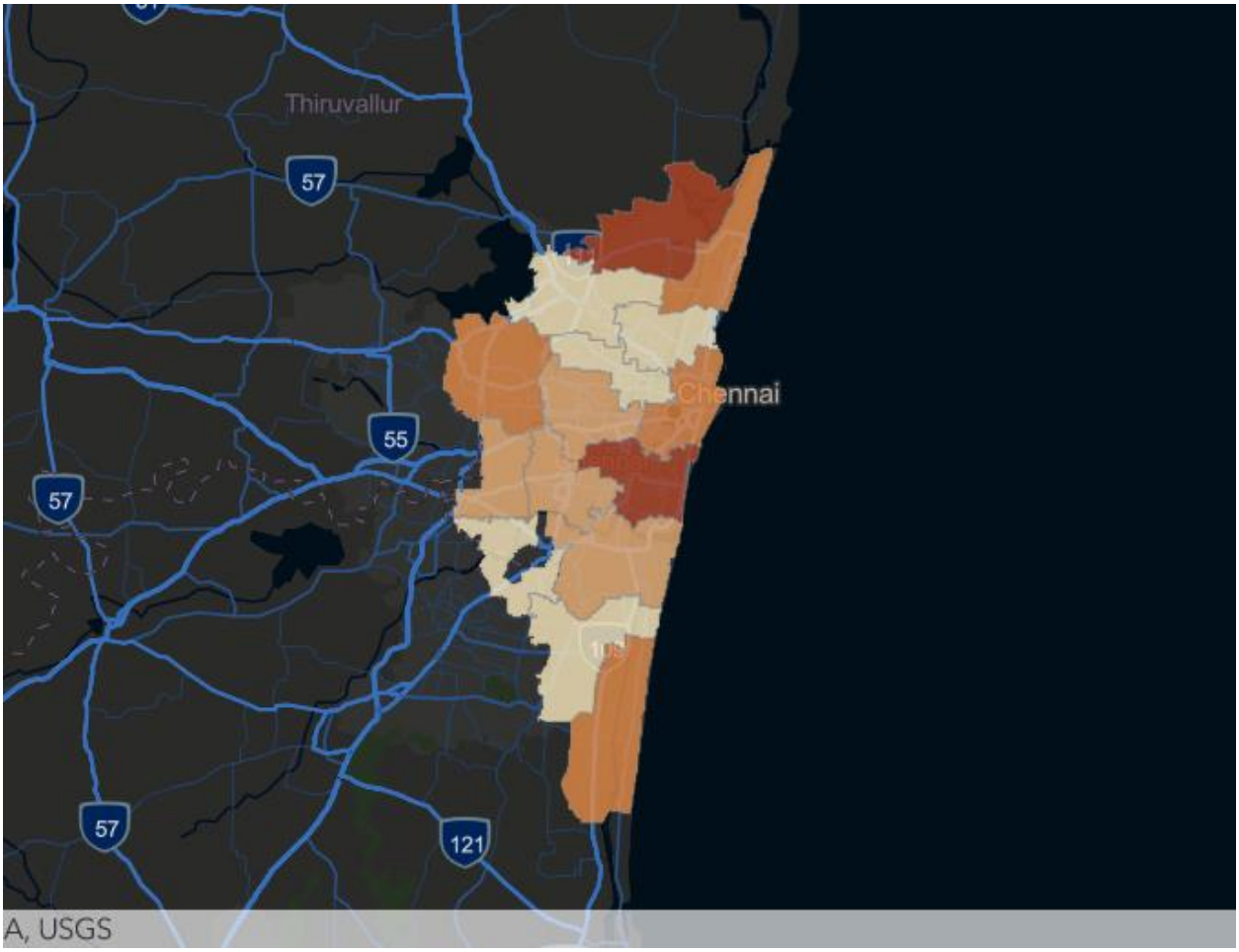
This was a result of a catastrophic rainfall in the months of November and December 2015.

Chennai Basemap rendered using ArcGIS API. The geographical nature of the city is quite visible here. It is bordered by the sea in the east and state of Andhra Pradesh in the north.

As per data from [1] in 2011 the city corporation grew by four fold and population gradually increased from 5.8 million in 2001 to 8.9 million in 2011. Open areas decreased and it turned into an urban planning nightmare.



Population density of Chennai visualized.Data as of April 2016.



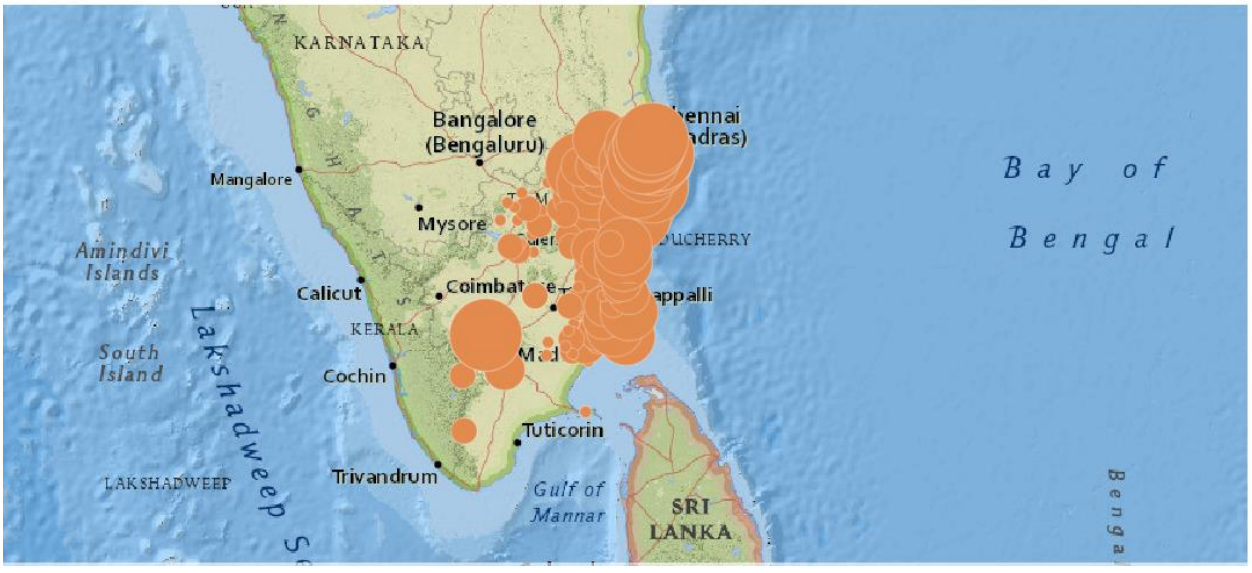
Visualization mapped with night street vector basemap distinguishes the population density.

There was no effort to link up hydrology to urban planning. Due to rapid urbanisation the natural flood sink was reduced to a mere 600 hectares.

Change in the area of the Pallikarni marsh between 2003 and 2005		
Segment	2003	2005
Garbage dump	50.25 ha	57.24 ha
Area impacted by garbage dumping/sewage	58.75 ha	132.25 ha
Northern segment	227 ha	150.56 ha
Southern segment	284 ha	279.65 ha
Source: Vencatesan, J, 2007, Protecting wetlands, Current Science		

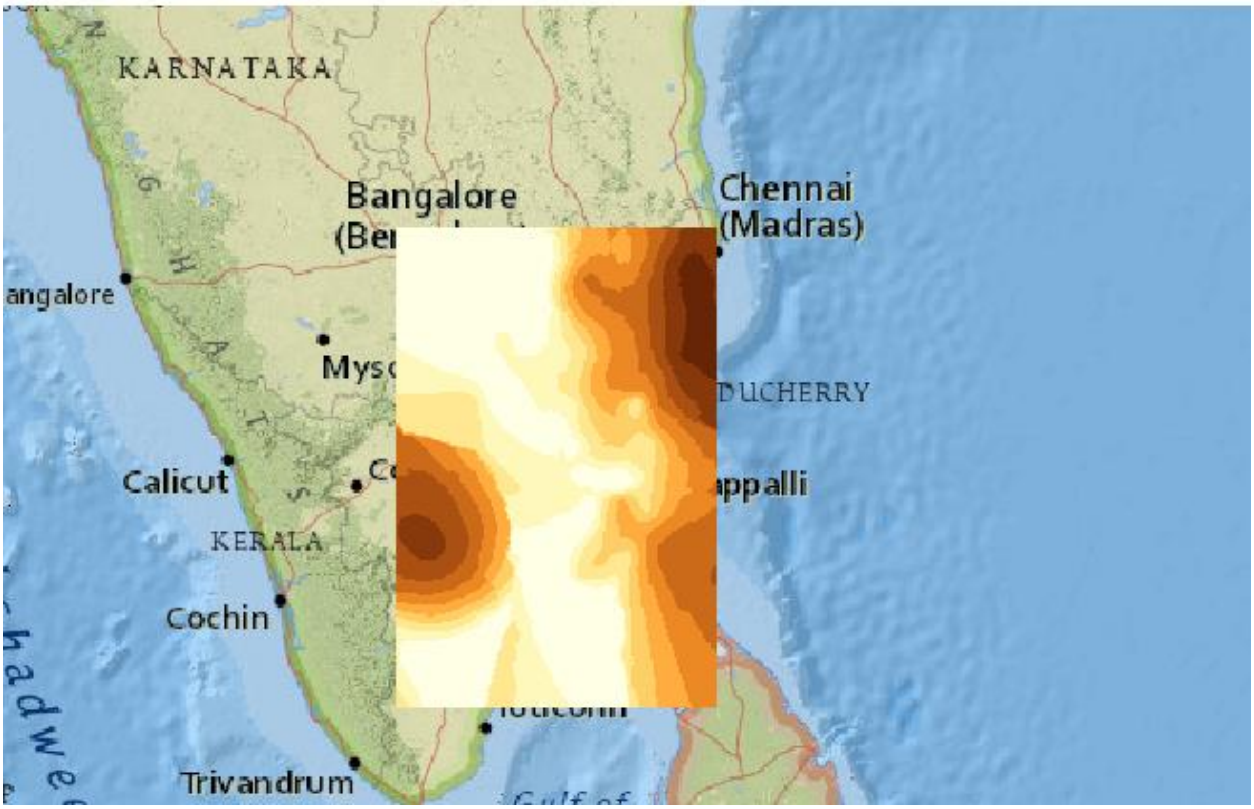
During October, November and December the southern India receives 60% of its annual rainfall, its the monsoon moving from north east India.

Data is gathered from Weather stations across the state. Rainfall is scaled according to the amount of rainfall noted at each station.



Rainfall distribution for Tamil Nadu state

Rainfall is very important factor when analyzing flood situations. Lets interpolate using ArcGIS spatial analysis and plotting the interpolated layer over the map. This will give us an approximate deduction of rainfall around the regions near the weather stations.



Interpolation of Rainfall

As it can be clearly seen that rainfall over Chennai very high and concentrated also in some central parts of Tamil Nadu.

3.3 Chennai Floods November 2015

The year of floods, Neyveli received 483mm of rainfall, some other parts of the city had a precipitation of 340mm for 24 hour period. The Manjalneer Kalvai, a flood drain overflowed and leading to floods on Gandhi Road and as a result closure of the roads.
The city bore witness to about 1000mm of rainfall in that month alone and it was the worst after 1918 which was about 1088 mm. As a result of heavy rainfall over the course of the next few weeks, schools and colleges were shut, hospitals closed and railways cancelled major services and the international airport closed.

As much as there was heavy rainfall in the month and storm like situation, the city was majorly unprepared to face floods, and the government termed it a man-made disaster rather than a natural event.

In order to understand what happened, we need to analyze the infrastructure and the geographical parameters involved. Using ArcGIS let's take a look at the major reservoirs in Chennai, plotted below. We can use the geocode function of ArcGIS to get the location of the reservoirs. The plot below.

```
lakes.draw(geocode("Ambattur, Tamil Nadu")[0],{"title":"Veeranam Lake","content": "Water reservoir" })
```

The major reservoirs are:

Chembarambakkam

Puzhal

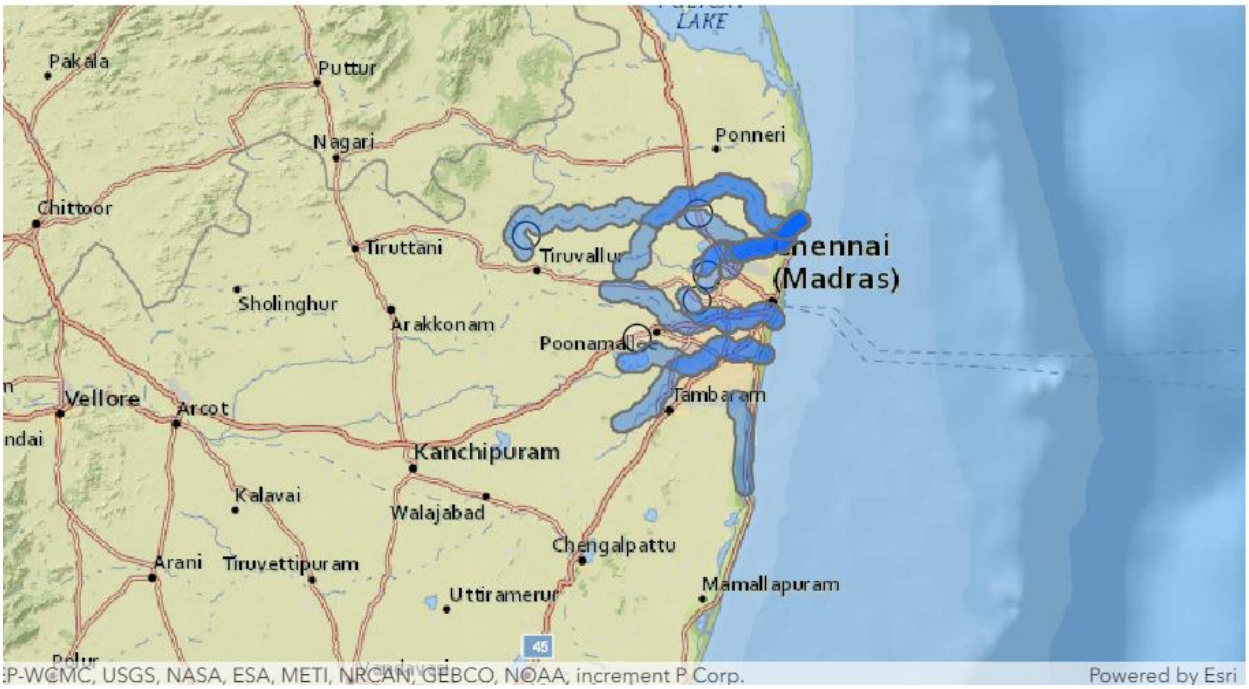
Kannampettai

Ambattur

Sholavaram

Five major reservoirs of Chennai

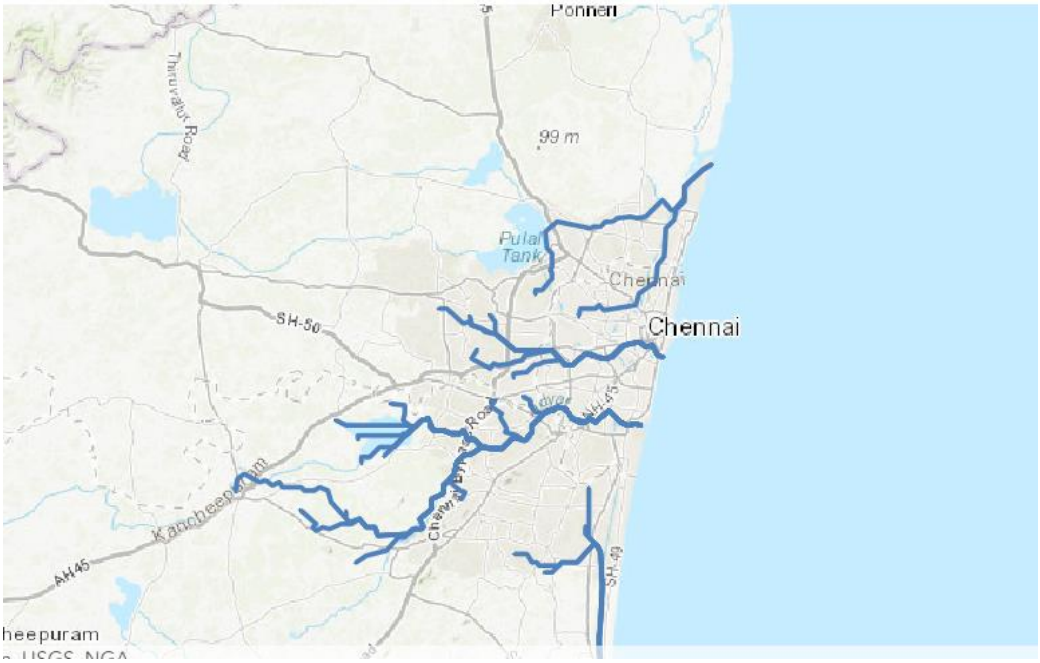
Now in order to identify areas that are likely to be flooded we will trace the path that the water would take when it overflows from the lakes. We can use the ArcGIS layer for Chennai Lakes. We can use the trace_downstream from the analysis tool in ArcGIS, and then buffer the trace paths by a distance in each direction and visualize.



Water flow path near the reservoirs.

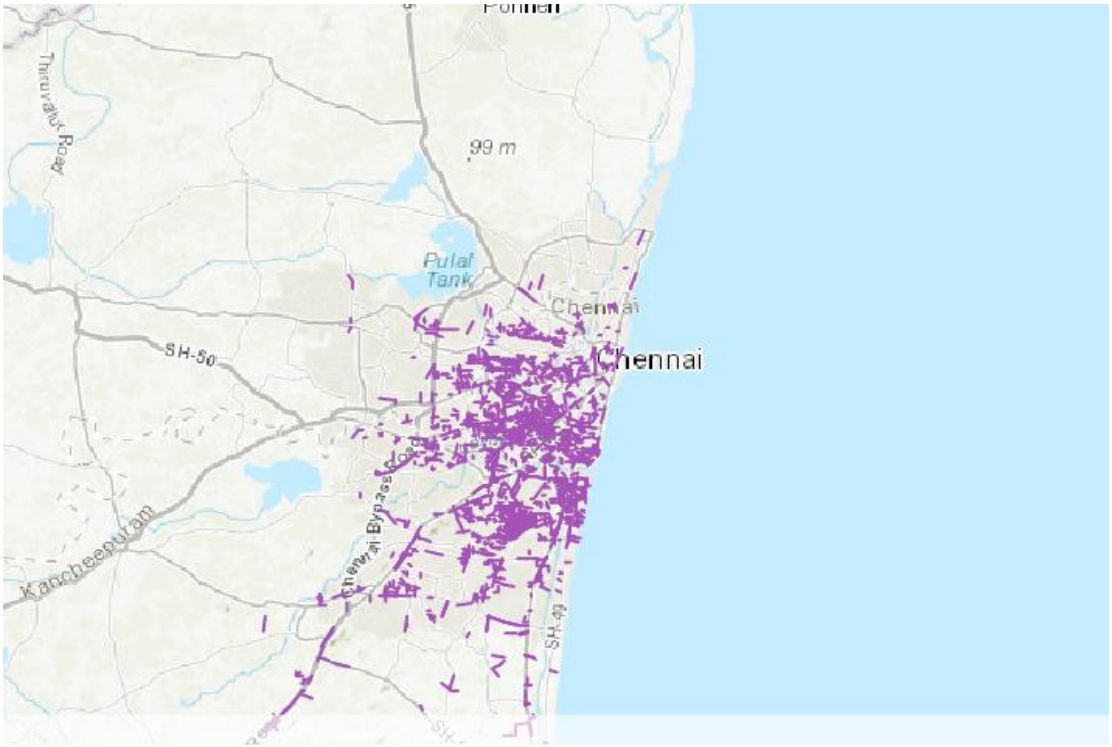
As we can see that areas in and around the streamlines marked in blue are susceptible to be flooded. This is an alarming discovery, because the entire city is in the vicinity of these flood prone paths.

Here's another look at the actual flood overflow path from ArcGIS dataset.



Overflow path

If we then plot the actual flooded streets in December 2015 we can compare and realize the devastating effects of the poor urban planning and rapid urbanization.



Flooded streets of Chennai

To our distress thats a disturbing image, as we saw earlier how the overflow path of the lakes affected the entire city, we see in reality that the level of destruction.

3.4 Analyzing the cause

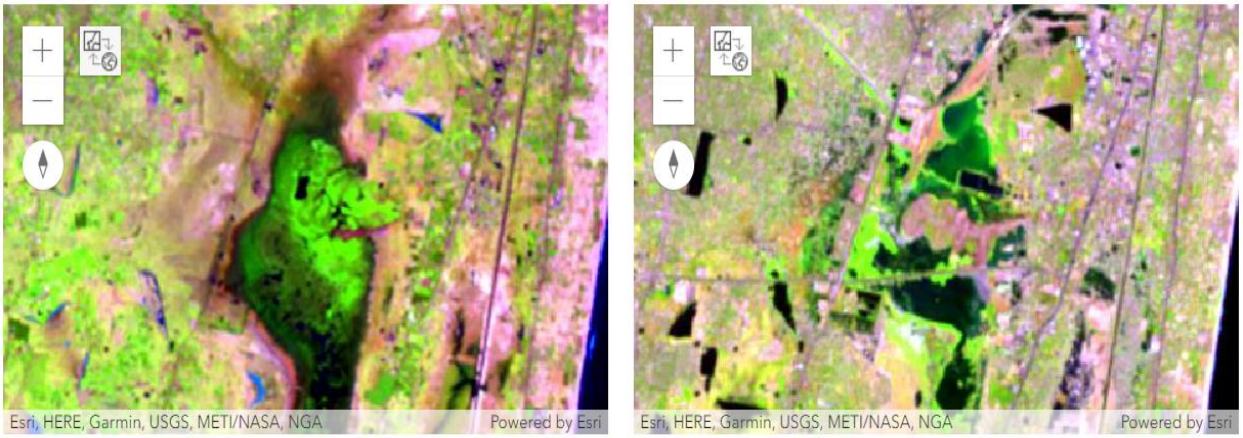
As discussed earlier the rapid civilization and the governments and peoples interest in concrete over forests had an adverse effect on the natural habitat and flood drains that Chennai was historically equipped to deal with floods and heavy rains.

The largest marshland in Chennai Pallikaranai, is situated adjacent to the Bay of Bengal and has an area of about 30 square miles. It's one of the last surviving one of southern India.

Toxic solid waste, sewage dump and construction of buildings have lead to the reduction of the marshland vastly in size. Let's take a look at the satellite images of the area and compare it with the most recent images.

The below image uses ArcGIS navigation through time. We create two mas and load the layer to visualize the difference.

On the left you can see the layer for year 1991 and 2007 on the right.



Marshlands comparison from 1990 to 2007

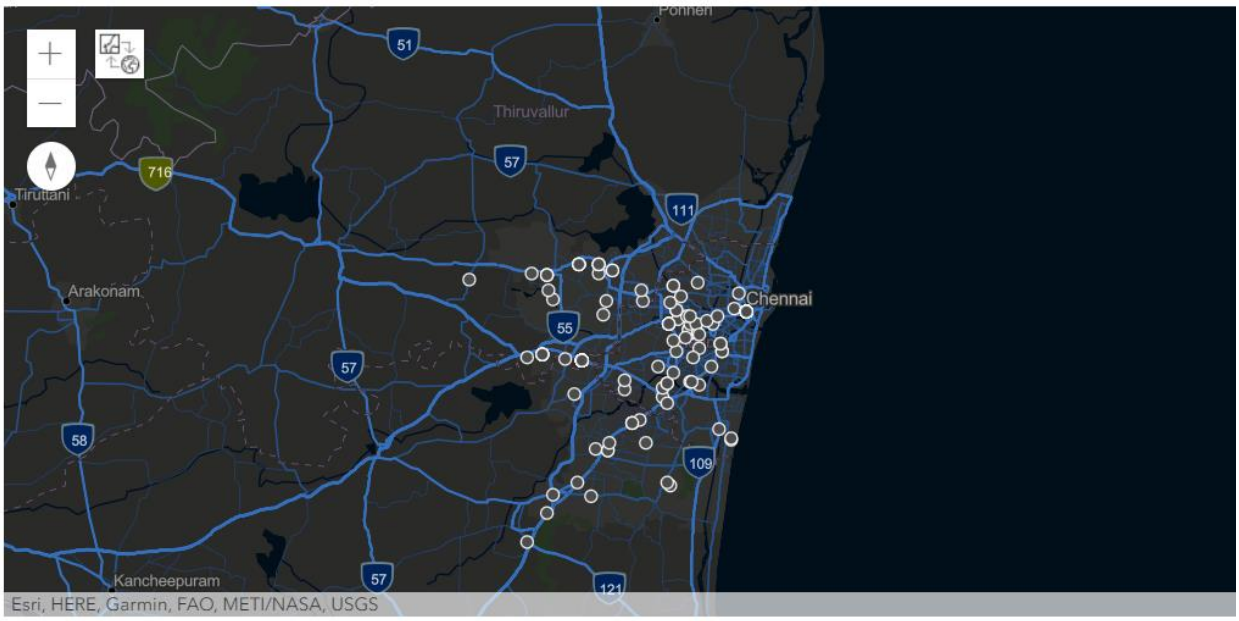
The devastation is quite evident from the satellite images. Marshland has been reduced to one third of its original size. Its green cover has been completely taken over by modern urbanization factors.

3.5 Relief Activities and Routing emergency supplies using ArcGIS

It's not a surprise that every city in the world needs to be prepared for a disaster even if there is no indication of any disasters in the history. In the wake of massive destruction in Chennai 2015 floods, the government set up relief centers in various places to aid the process of evacuation of relief. The location of the relief camps were published to the GIS as a layer to be visualized.

During the floods, the Tamil Nadu government set up 12 major cyclone shelters in Nagapattinam district and the National disaster response forces were dispatched to expedite the process.

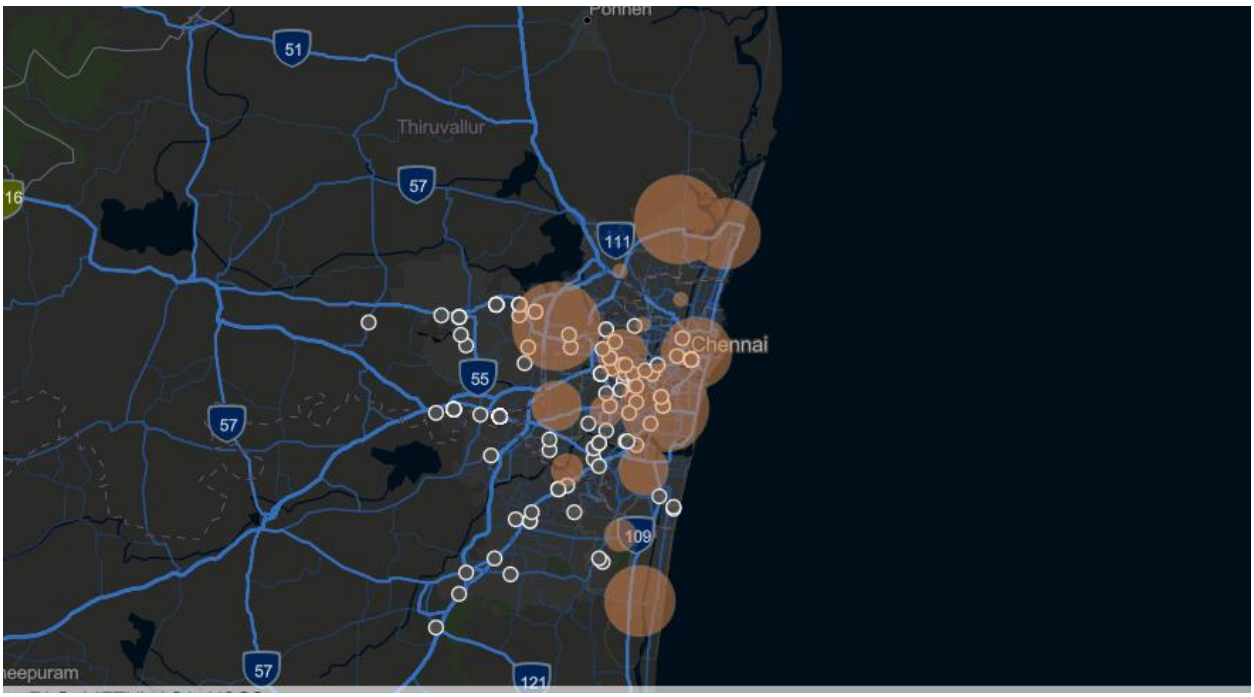
Let's take a look at the relief centers on the map. Most of the camps were run by volunteers.



Relief centers Chennai

The volunteers set up self-aid camps which decentralizing the distribution and helped larger group affected by the floods to receive aid as and when required [3]. The youth used social media as the main source of communication and lured the survivors into camps for treatment and evacuation. There were several donation coming towards each relief center, that included medical essentials, food and drinking water.

Lets plot the population of Chennai as another layer on the map to visualize how the relief centers were structured around large population clusters. As a result of this plot we can realize that the relief centers were set up in the right places in around the higher population density.



Population marked in Orange and Relief camps marked.

3.6 Scale of Relief camps

In order to understand the efforts into evacuation and relief lets take a deeper look into the data from relief camps by using pandas. Using pandas we can treat this layer as raw data and make some initial data exploration.

	Contact_No	Division____No	FID	No_of_Centres	No_of_families	No_of_persons	SHAPE	Sl_No_	Zone_____No	_Locations
121	Gnanavelu 9445190771	171	122	NaN	355	1420	{"x": 8936283.704100002, "y": 1469202.8202, "s...	122	NaN	Gandhimandapam & Rajaji Mandapam, Chennai
61	Selvakumar, 9445190401	101	62	NaN	20	80	{"x": 8930335.681000002, "y": 1468827.0702, "s...	62	NaN	Thiru.Vi.Ka Higher Secondary School, Chennai
53	Kannan 9445190399	99	54	NaN	75	300	{"x": 8919321.278900001, "y": 1452158.79879999...	54	NaN	Sathyasai Nagar Church, Chennai
112	Jayakumar 9445190758	158	113	NaN	22	74	{"x": 8936283.704100002, "y": 1469202.8202, "s...	113	NaN	GYM Building, Nathambakkam, Chennai
111	Jayakumar 9445190758	158	112	NaN	25	93	{"x": 8934689.9406, "y": 1456482.3795000017, "...	112	NaN	Kerla Samajyam, Nathambakkam, Chennai

A sample of the data gives us an idea into the data structure, each row represents a center and details about the number of people or families housed in these centers and their locations.

Summarizing the data we see that there were about 31478 persons in all of the camps and 8662 families in total from data collected from 136 centers.

```
1 relief_data['No_of_persons'].sum()
```

```
31478
```

```
1 relief_data['No_of_families'].sum()
```

```
8662
```

3.7 Emergency Routing Plan

The relief materials need to travel to each center and they needed to centrally distributed from one location which was scouted as the Jawaharlal Nehru stadium from where all the materials were sent to the affected people.
Lets plot this location on a new map. We will use the streets-vector basemap that will help facilitate our routing plan and emphasise the routes.

```
map11.basemap = 'streets-vector'
```

```
map11
```

Jawaharlal Nehru Stadium

As we can see the stadium is located at the dead center of the city which makes it easy for relief supplies to be distributed evenly across all directions.

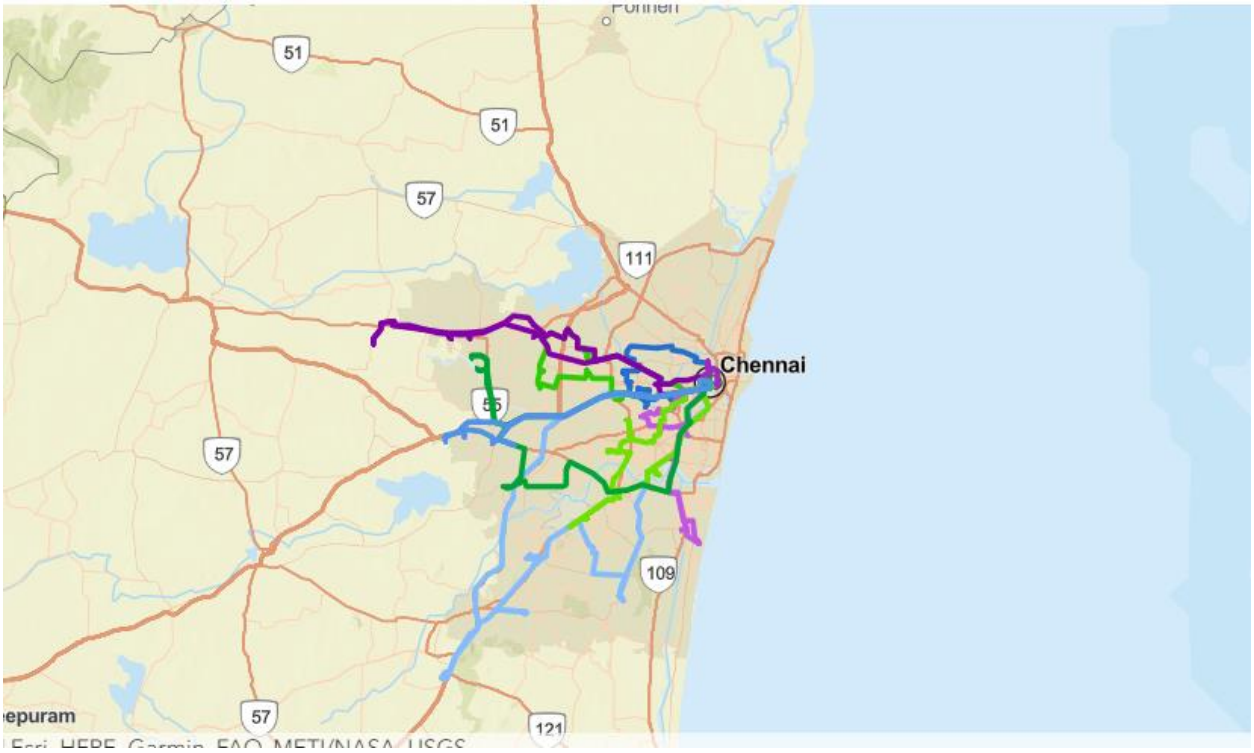
GIS has a routing tool that can be used to plan routes and which we can use for our purpose to plan the routes for relief supply vehicles to the centers across the city.

We can use the proximity analysis tool available in the gis API to plan out a route from the stadium to all the relief center camps that we earlier plotted.

Routing vehicles

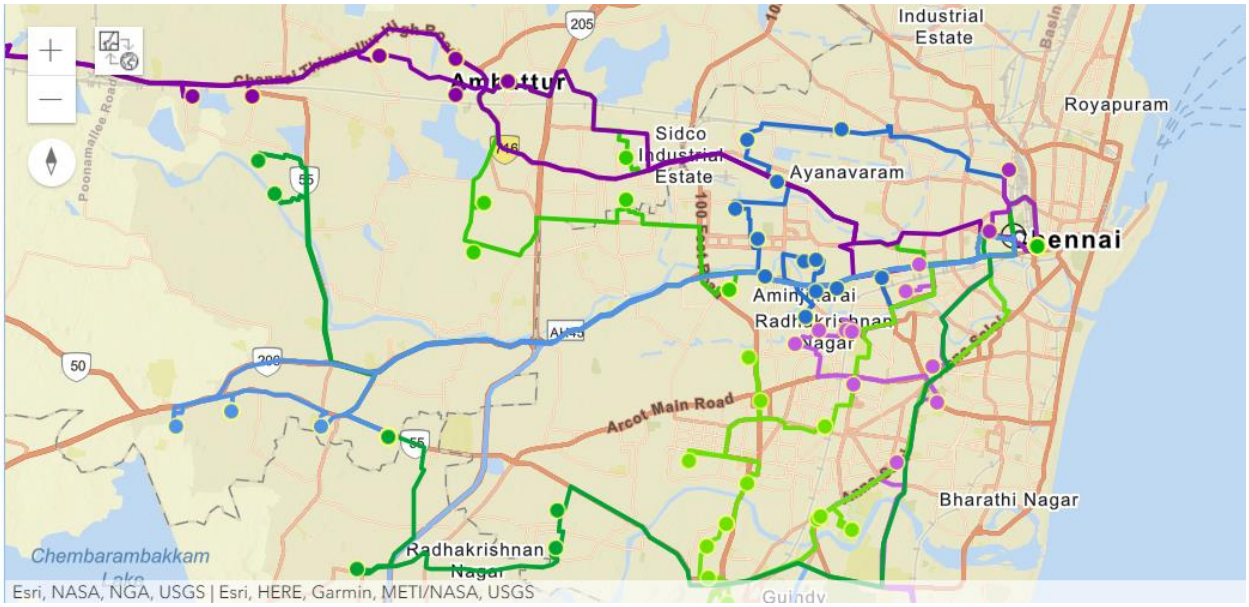
```
from arcgis.features import use_proximity
start_time = datetime.datetime(2015, 12, 13, 9, 0)
```

```
route = use_proximity.plan_routes(
camps,
15,
15,
start_time,
stadium,
stop_service_time=30)
```



Routes to the relief center from Nehru Stadium.

We can then assign the stops layer on to the same map for a better navigation route.



Route layer after assigning stops layer.

Using just the map and data available from each relief location we were able to plan out routes for centers across the state from a central point of distribution.This helps to provide such detailed maps to vehicles in order to expedite the relief process.

3.8 Conclusion

It is true that urban disaster specifically floods can be generated via streams emanating out of urban zone which afterwards crossing through it or via surplus rain trash on the urban Zone itself. For implementation of my thesis research I work on to find specific parts of city which were really under high risk zone after rainfall and tried to find a way which can be helpful for evacuating and Saving people life. And with the extension of new technology and to be more specific after extension of GIS a sphere of presumptions are opened up to control the damage from urban disaster and ameliorate activities which will be really helpful for the future.

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4. CHAPTER 4: FUTURE SCOPE AND CONCLUSION

4.1 Introduction

After having a brief discussion about urban disaster management and information about tools that can help us during evacuation plan in previous chapters in this chapter we provide some challenging research opportunities for future scope. Conclusion contain summary of overall research work.

4.2 Future scope

To have better plan for the future in the field of urban disaster there are several areas which required more research about. Sequentially the following are four scopes that furnish different research chances.

1. evaluating of population locomotion during the day which needs more researchers with the history in urban disaster management.

2. expansion of constructions to authorize poly hazard risk distinction to be navigated instead of exclusive hazard risk distinctions. And for this research we need professional People with the history of structural engineering.

3. another important aspect in the field of urban disaster management is computing harm of generation for the research. It requires different civil and architectural engineers to treatment research in to the approximation time need to resurrect hazards. For the next stage researchers required to check the computing harms via terminated generation.

4. coalition of transferable systems is another good scope with their usage in a perimeter of several gainers and data collection. Specific consideration needs to be done to swift ways of connecting the systems and coalition the data collected by different users.

Some of these topics not just needs poly punitive research teams but also needs other associations to be fixed.

4.3 Conclusion

Urban disaster management is a vast project it needs multiple stakeholders and different strategies to deal with. For the purpose of this research work we evaluate the evacuation plan by introducing ArcGIS and GIS technology with python language.In the end of the research work we prevent evacuation plan in the Chennai India. This chapter also include further research for future scope which can be really helpful for this subject.

When expounding hazard or peril plots it is important to be informed that these will not motion divinations. Because of lack of information available on disasters all of their loss will effects extrapolation for the future.

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