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Proceedings of ninth International Conference on Hydro-Science and Engineering (ICHE 2010), IIT Madras, Chennai, India.
2 - 5 August 2010

FLOOD ZONE MAPPING – A STUDY ON COOUM RIVER

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Abstract: *The urban population of India has rapidly increased in recent years. Urbanization is a challenging factor for Metropolitan sustainability. Urbanization near by the river can affect the physical process of river growth, modify stream structure and further influence the functions of river system. The urban disasters became an important social problem and causes serious floods. Therefore accurate delineation of flood extents and flood depths within the flood plain is necessary for the flood management. Preparation of flood hazard maps for the flood prone areas will assist in flood mitigation and land management that can reduce the flood damages to a greater extent. The Cooum river in Chennai is a highly polluted urban stream that under goes flooding due to high urbanization near by the river. The purpose of this study is to prepare a flood hazard map using data available for a typical channel reach. The peak discharge of the river was calculated by Rational method for different return period. Terrain modeling of the land surface TIN was generated using SRTM DEM of the study area. Preprocessing was done in HECGeoRAS and the result was exported to the HEC-RAS. The water surface profile of the Cooum river was generated in HEC-RAS. In the PostProcessing process the terrain model TIN and the water surface TIN was overlaid to provide improved flood plain visualization (2D&3D). Thus the flood zone mapping of the Cooum river has been done for different return periods. The results obtained are verified with the PWD flood reports and also with the answers which are obtained from questionnaire survey. Several mitigation measures and recommendations are suggested according to the out come of these results that helps the people to a greater extent.*

Keywords: *Urbanization, Flooding, HEC- RAS, HEC-GeoRAS, TIN, DEM.*

INTRODUCTION

Flooding is a serious natural disaster which cause damages to the people, livestock, surrounding infrastructure and affects the people socio-economic activity to a greater extent. With a increasing population, uncontrolled urbanization near by the areas of the river will be subjected to flood events seriously. Therefore accurate delineation of flood extents and depths in the flood plain is necessary for flood management. Determining the amount of flood extent and its height with respect to the ground surface elevation and finding the flood characteristics for different return periods is known as flood zoning (Zadeh et.al.2005). Flood zoning is considered to be important because it determines the type of development activity in the flood plain and the environmental effects due to flooding. One of the ways to study and understand the flood behaviour is by flood extent or flood risk map (Hassan et.al.2006). Mapping of flood prone areas for a extreme flood events in natural rivers can be made by some engineering practice. Chennai is one of the major cities in India that face flooding often heavy inundation takes place at many places in Chennai and Cooum river is one such hot-spot. Therefore mapping of flood hazard zones helps the people near by the river helps the people near by the river in Flood Management (Prevention & Mitigation). The main scope of the study is to assess and predict the extent of flood water in Cooum by the integration of ArcView GIS and HEC-RAS model using HEC-

GeoRAS extention. Further analysis of HEC-GeoRAS will produce the flood plain maps with the predicted flood depth and flood extent for different return periods.

STUDYAREA

Cooum sub-basin (682 km2 situated between latitude 12°54'30" and 13° 9' and longitude 79° 36'30" and 80° 19') is part of the Chennai basin. The River Cooum originates at Kesevaram anicut near the village of Cooum, about 65 km away from Chennai and finally joins the Bay of Bengal near the Napier Bridge in Tamil nadu. With rapid urbanisation and accompanied pollution, Cooum and other rivers in the city became vulnerable to floods experiences and heavy rain during the northeast monsoon. Hindrances to the flow of water during flood in the form of bridges with restricted width and urbanisation near the river banks etc cause hazards due to floods. Major flood events were occurred in Chennai city during 1943, 1976, 1985, 1996, 2002, 2005, 2008. A part of the Cooum river from Maduravoyal bridge to Chetpet delineated as the study area from watershed map of Cooum basin. In this study, the flooding pattern (depth and extent) of the Cooum river for different return periods has been analyzed.

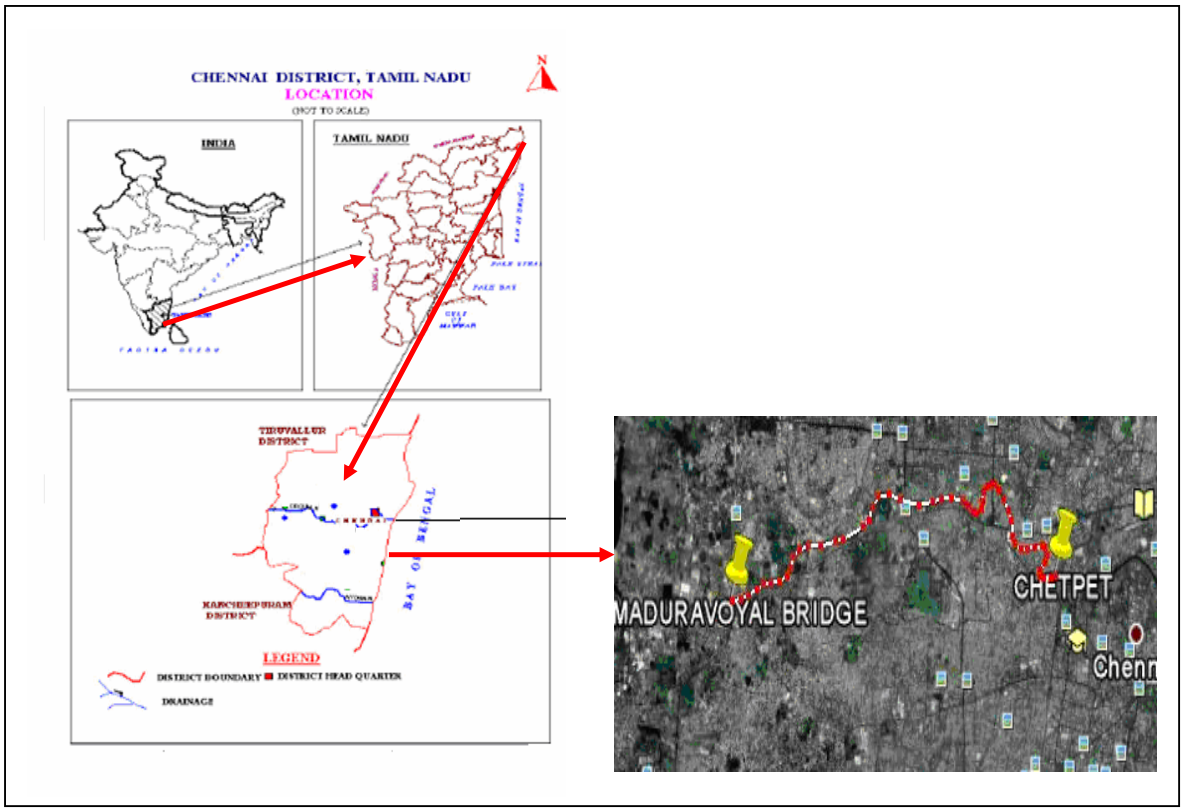

Fig.1 Google image of the study area (Maduravoyal bridge and chetpet)

OBJECTIVES

The objectives of the study are to,

- Study the flooding pattern of Coum River.

- Identify the flood hazard zones for different return periods in Cooum river.
- Suggest the flood mitigation measures for the flood impacts.

DATA USED FOR THE STUDY

- GPS surveyed data collected along the two river banks by 4600 LS Differential GPS.
- The DEM (Digital ElevationModel) of the flood plain taken from the SRTM (Shuttle Radar Topography Mission)
  (Source: SRTM website).
- The Google Earth Image acquired on April 21 2009 as the base map of the flood extent.
- Intensity Duration Frequency (IDF) curve of the Chennai city.
  (Source: Sahadevan 1980).

PREPARATION PHASE

A Terrain model is created using the DEM from SRTM (Shuttle Radar Topography Mission) in the Arc GIS software for the study area . The topographic data of the TIN consists of elevation of the flood plain. HECGeoRAS extracts terrain information stored in TIN generates a HECRAS import file. HEC-GeoRAS preprocessing is carried out by the creation of series of RAS layers like stream centre line, main channel banks, flow path centre line, and crosssectional cut lines. Crosssection are taken at 58 positions at the river. After creating each RAS theme, GIS data were exported and stored as GIS RAS Import file to run in HEC-RAS.

EXECUTION PHASE

The objective of the phase is to generate a flood map for different return periods.n the HEC-RAS, after importing the geometric data extracted from GIS, Manning roughness coefficient for channels are given as input to complete geometry data. GPS elevation data taken from the field survey had been manually adjusted to correct erroneous representations caused by TIN resolution. Due to the lack of peak discharge data measured using guage stations, rational method is adopted in this study. Flow data and associated boundary condition chosen is the normal depth with a upstream slope 0.001and downstream slope 0.0005. In the next step, water surface profile calculation for the flood of 5, 10, 50,100 and 200 year return periods are performed with a mixed flow regime. Once the water surface profiles ig generated, the results are exported to GIS format in HECRAS. At the last step, HEC-RAS results were imported into the HECGeoRAS and a floodplain map for each profile is developed.

VERIFICATION AND FLOOD MAPPING PHASE

Delineation of flood extents and depths within the flood plain in Cooum river is conducted for different return periods based on the integration of hydraulic simulation results and GIS analysis using the HEC-GeoRAS extension of Arcview. HEC-GeoRAS postprocessing is carried out for the flood plain delineation for different return periods which results in an inundation depth grid and flood plain polygon. In this study the validation of the results are done using the PWD reports (improvement to macro drainage system in Chennai Metropolitan Area under renewal

mission scheme). The flood hazard areas identified using the HEC-GeoRAS is same as in the reports. The most vulnerable areas under flooding are Amjinjikarai, Anna Nagar, Naduvankarai and Arumbakkam. GPS (Global Positioning System) readings are taken and verification as well as some corrections in geometric data are made with these readings in HECRAS . The result generated from the model are compared with the data obtained from such that questionnaire survey. Table1 shows the comparison between the model output and questionnaire survey.

Table1 The comparison between the model output and questionnaire survey

FLOOD MAPPING	MODEL OUTPUT	QUESTIONNAIRE SURVEY
EXTENT	75m-130m	120m-180m
ELEVATION	9.96m-12.37m	7.2m-12m

RESULTS AND DISCUSSION

Flood zone mapping shows the extent and depth of flood for different return periods. There is a change in extent of flooding for different return periods. This is due to the increase in discharge for various return periods in the river. The width of flood zone varies from 1km to 0.5km for different return periods. The results of this study can be used to distinguish high hazard from low-hazard areas in the floodplain in order to minimize future flood losses. Figure2 shows the XYZ Perspective plots for the Cooum river from Maduravoyal to Chetpet. Figure2 shows XYZ Perspective plots for the Cooum river from Maduravoyal to Chetpet. Figure3 shows Flood zone mapping for 200 years return period.

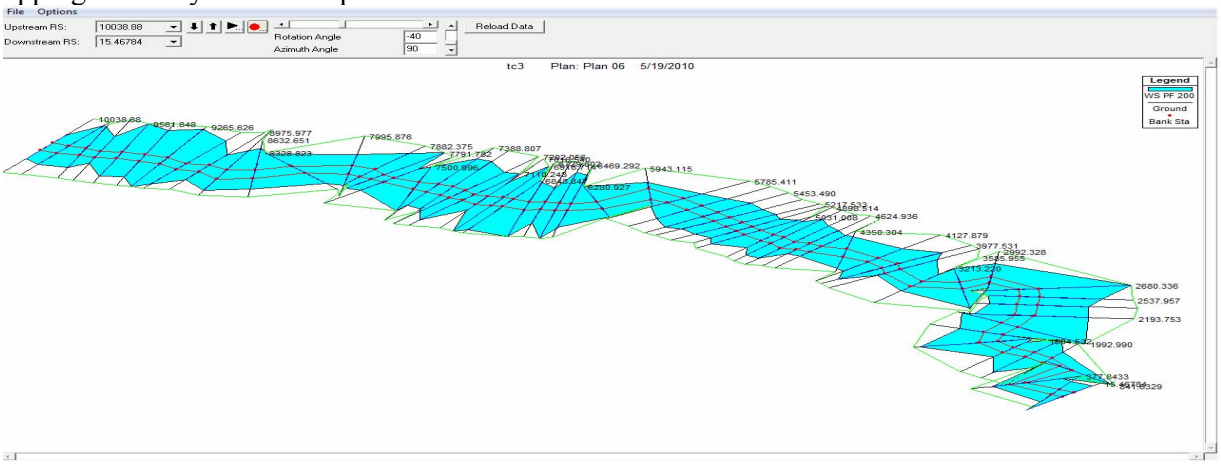

Fig 2 XYZ Perspective plots for the Cooum river from Maduravoyal to Chetpet.

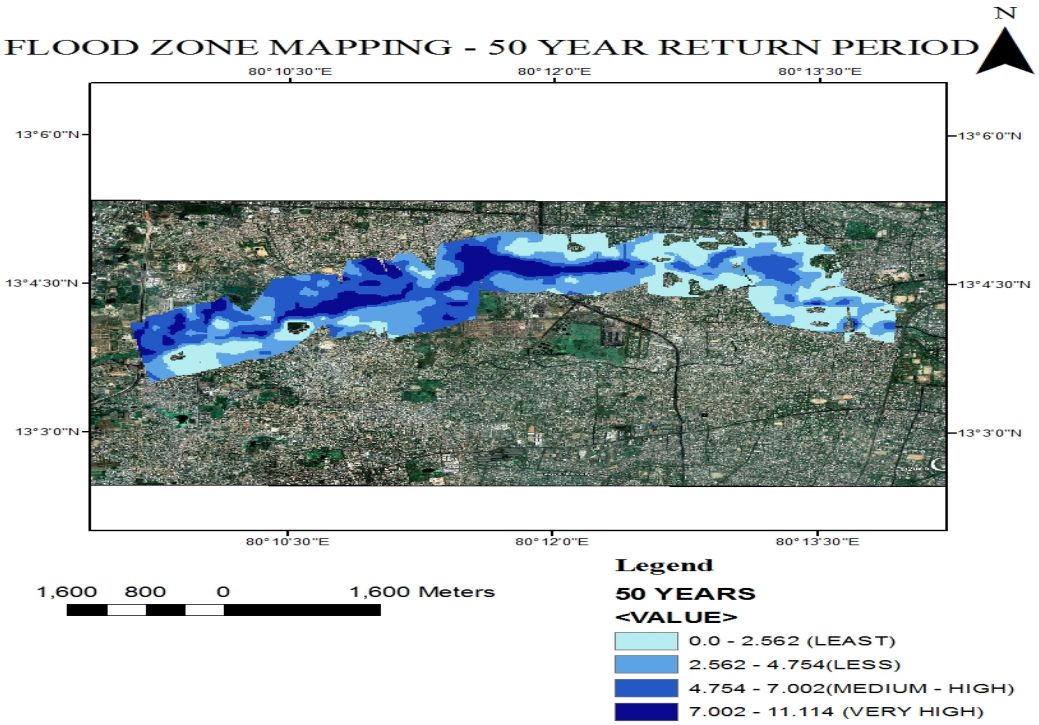

Fig 3 Flood zone mapping for 50 years return period

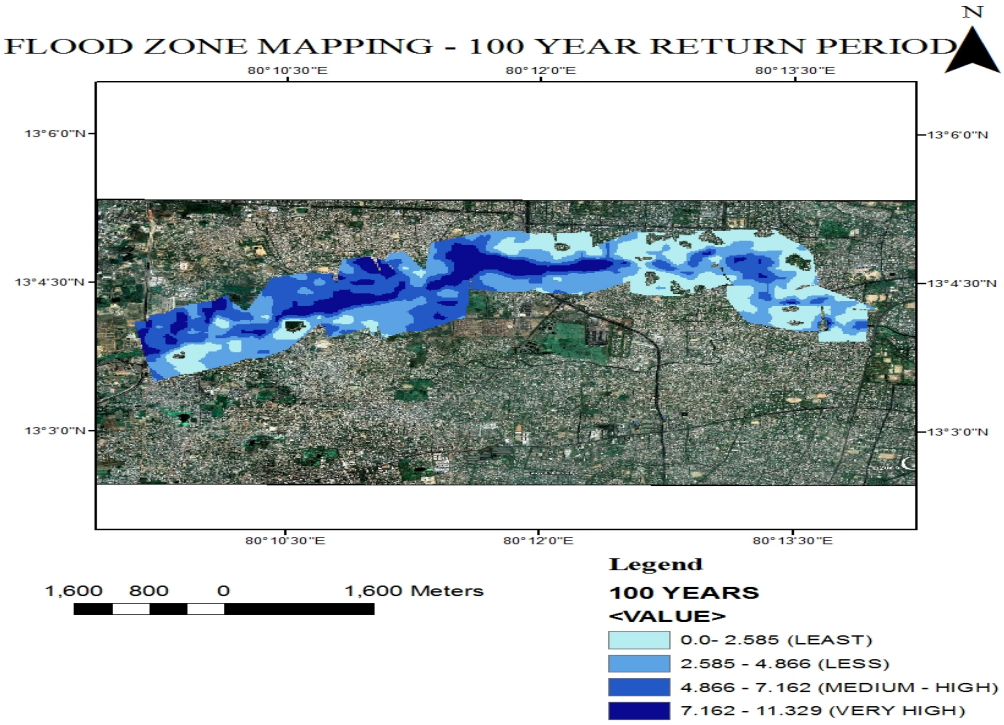

Fig. 4 Flood zone mapping for 100 years return period

Table2 shows the Summary of the flood area and the maximum flood depth . Figure 4 shows Flood zone mapping for 50 years return period. Figure 5 shows Flood zone mapping for 100 years return period. From these maps the pattern of flooding for different return periods are identified. The coverage of flood plain zones for different return periods shown clearly in the map. The changes with various colour in the map distinguishes the difference between different flood depths with various range values. Their values of flood depth can be seen clearly from the legend and it varies from least, less, medium-high and very high. Table 2 shows Areas near Cooum river with Various degree of flood hazard as identified from the figure5. The elevation of flood waters are very high from Amjijikarai to Anna Nagar and in the region Chinna Nolambur and Arumbakkam as identified from the map. Thus these regions are more vulnerable during the time of flooding. Moreover the flood water extend to a maximum upto 0.3 km on both side of the river banks near Amjikarai , Naduvankarai, Choolaimadu and Anna Nagar. Thus the flood hazard zones for different return periods of the Cooum river for flooding is identified using HEC-GeoRAS.

Table 2 Areas near Cooum river with Various degree of flood hazard

Type of hazard zone	Area (m^2)	Percentage (%)	Locations
Least	0.577	8.48	Ayyavoocolony, Shenoynagar, Arumugamnagar,Pallikupam Kanchumapuram
Less	1.284	18.88	CMDAnagar, Viswasanagar, Everestnagar,
High and medium	2.529	37.202	Cholaimedu, NSKNagar, Golden GeorgeNagar,Villa Houses, PP Gardens
Very High	2.408	35.422	Annanagar,Amijikarai,Arumbakkam, Naduvankarai, Chinna Nolambur
Total	6.798	100	

SUMMARY OF THE FLOOD AREA AND THE MAXIMUM FLOOD DEPTH

Table 3 Summary of the flood area and the maximum flood depth

Return period	Flood area (Km^2)	Area Difference	Max Flood Depth (m)	Depth Difference
5	6.7981	-	16.38076	-
10	7.0259	0.2278	16.85393	0.4731
50	7.6863	0.6604	17.64424	0.7903
100	8.6908	1.0045	17.92892	0.2846
200	9.9214	1.2306	18.17244	0.2435

Summary of the flood area and the maximum flood depth shows the flood area changes upto 1.3 km^2 for 200 year return period and maximum flood depth varies upto 0.2435m.Thus flood area varies slightly for 5 years and 10 years return period.

CONCLUSION

Flood zone mapping forms the foundation for flood risk and disaster management by providing essential information about the nature and characteristics of flooding to the community people. These maps are useful for operational risk management and for flood mitigation. In

flood-prone areas estimation of both the depth of the water and extent of flood areas are essential and it is made in the present study. These flood inundation maps produced here can be used for identifying the region that will be affected by the flood for different return periods. It is to plan for emergency need eg food, shelter and medical supplies during the flood events. It is used to identify minimum height of flood protection works such as dikes to protect the river from flooding and also to assess flood damages in the areas in around the river. Finally the results have widespread applications for city planners, environmental planners, flood control ministration by the government and land use policy in flood prone areas and totally help will help in flood hazard mitigation.

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