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Research paper

Flood Modelling of Adyar Basin

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Abstract

This paper is about the flood modelling of Adyar basin which was done by integrating ArcGIS and HEC-RAS modelling software. The SRTM DEM of 30m resolution were used as base data in ArcGIS. The river banks, center line of the river and its boundary were processed in the HECGEO-RAS then this geometry data is exported for the further working process in the HEC-RAS. The data is imported in it then it is processed with the peak discharge values for the steady flow analysis. The data from HEC-RAS is again post processed in the ArcGIS for the creation of the inundation map for the Adyar River. The Flood model setup is created for the Adyar River. The current study will help to evaluate the extent of flood plain in the study area it also helps the administration to figure out height of the flood if it happens again in that particular area.

Keywords: *Flood, Modelling, HEC-RAS, Mapping, SRTM DEM, Adyar River*

1. Introduction

Floods are caused due to the extreme rainfall. It develops within a short period of time. Flood attract immediate attention because of its sudden and destructive effects of lives and property. This study is about the flood modelling of the Adyar Basin to develop the efficient strategies to minimize the impact of the flood and to mitigate the people before they got affected by the flood. The flood modelling is done by using HEC-RAS tool. The SRTM DEM of 30m x 30m resolution is used for the spatial analysis in ArcGIS software. The flood inundation map was made by processing the flow data and the geometric data.

1.1. Study Area

Chennai is the capital city of Tamilnadu, located in the North Eastern corner of Tamilnadu. The Chennai Metropolitan Area (CMA) comprises the city of Chennai, 16municipality, 20 town panchayats, and 214 village panchayats. Chennai is trisected by two rivers namely Adyar River and Cooum River. The Adyar basin was chosen for the study area. Adyar is a Short river of 42km. In this project it was taken from Meenambakkam to the Bay of Bengal of totally17km. The passes through Nandambakkam, Saidapet, Guindy, Adyar, R.A.Puram.

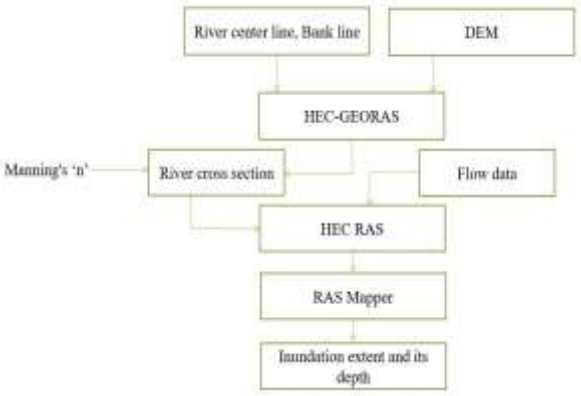
1.2. Software Used:

- Google Earth
- Arc GIS[10.2.2]
- HEC-GeoRAS
- HEC-RAS

1.3. Data Collected

a) Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM)
b) Inundated water level depth at the field.
c) Flood Experiences in Adyar River for the past thirty years
d) River flow data and the Geometric data of the river

2. Methodology



2.1. Progress

In this project the study area boundary is marked in the Google Earth and then the center line and the river banks were drawn in the boundary then it is exported as .kml format for the further working in the Arc GIS.In the ArcGIS the exported .kml files were converted to layer using the kml to layer conversion tool. Then the SRTM DEM of 3m x 30m resolution is imported to this.

Then the DEM is converted to TIN using the Raster to TIN tool in the ArcGIS. These processes were saved.

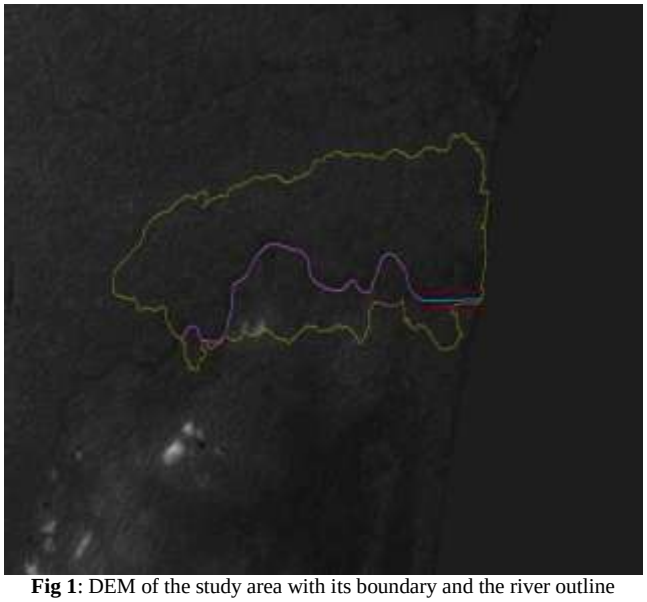


Fig 1: DEM of the study area with its boundary and the river outline

In the fig 1 shows the SRTM DEM with 30m x 30m resolution with the boundary of study area and the river center line and river bank.

The preprocessing in HEC-GeoRAS has started. In RAS Geometry the stream center line, Bank line, Flow paths and xs cutline were created. Then the river center line, banks were copied to the created layers except the xs cutline. The ID is given for center line and left, right bank with channel were provided in flow path. The river is sectioned to many cross section using construct xs cutline with the width of 100m and length of 1000m. The layer is set to the TIN. Later the Stream Centre line attributes and xs centerline attributes were checked. After all these process the data is exported using the Export Ras Data.

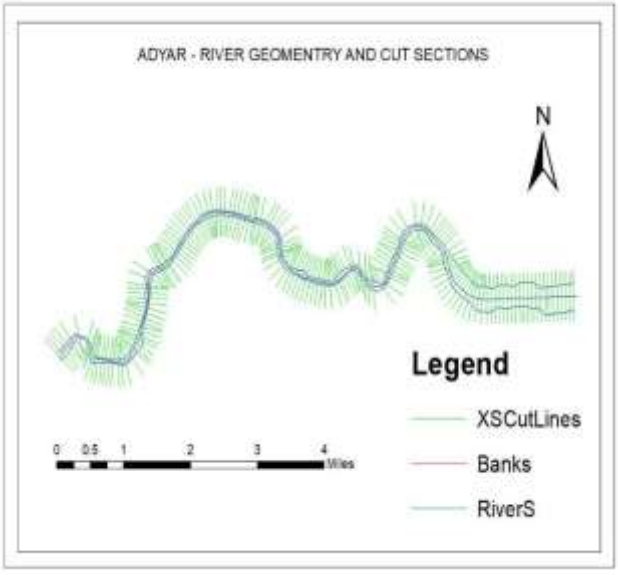


Fig 2: Cut Section of the Adyar River

The fig 2 shows the cut section of the Adyar River with the 100m width and 1000m length in the ArcGIS.

The post processing in the HEC-RAS is started by importing the preprocessed data from HEC-GeoRAS to the geometry data in HEC-RAS. The Manning's n value of 0.02 is provided for the river because it is a natural drain. Then the steady flow data is processed for the 2500 m^3/s runoff with the known water surface of 1.2m. Then the steady flow analysis is run for the further processing. Then it is exported GIS Data in. SDI format.

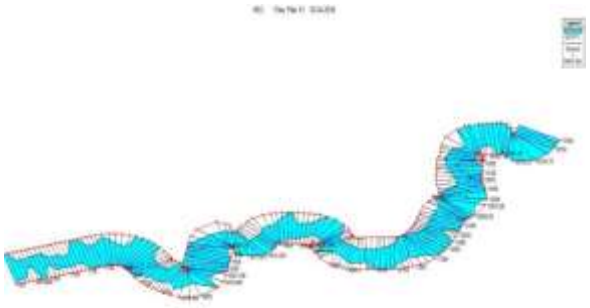


Fig 3: River boundary with the xs cut section in HEC-RAS after processing the data

In the final processing the SDI file is converted. The process is started again is HEC-GeoRAS. In RAS Mapping layer is settled up for the further process and then the RAS DATA is imported. Then in the Inundation mapping the water surfaces is generated for a profile. Again, in the Inundation mapping flood plain delineation using Taster is created.

Finally, the inundation map is generated for Adyar Basin with the runoff of 2500m^3/s. Then all the points in the Raster is extracted to the table to know the elevation at that point is extracted to the table. Finally the marked up location with the depth of inundation which is taken in the field were imported to the ArcGIS. Then the both valued from the inundated map and field values were compared for the accuracy of the generated report. And to finalize if again the flood with this or more runoff came these areas will be affected and up to this depth water will be inundated at that areas.

Table1:

S.NO	THEME	DISCRIPTION
1.	Stream centreline	The stream centre line was digitized from upstream to downstream using the base map. It was used to calculate river station in at each cross section. The stream attributes like river topology, length / stations and elevations were created. Shape length, hydro, ID, river, reach, from node, to node and the arc length were populated automatically in the attribute table.
2.	Bank lines	Bank lines were located at the edge of the main channel, bank lines were used with the cross sectional cut lines to determine bank stations at each cross section. Shape length, hydro ID, river, reach, from node, to node and The arc length was populated automatically in the attribute table.
3.	Flow path	Flow path lines were used to calculate the downstream reach lengths in the left overbank, main channel and right overbank between cross sections. Shape length, OID and line type were populated automatically in the attribute table.
4.	Cross sectional Cutline	Cross sectional cut lines were digitized from left to right over bank. They were created perpendicular to the flow. The river/reach name, bank stations and downstream reach lengths are populated automatically in the attribute table. TIN was given as input to convert 2D cross section

		layer to 3D. The attribute table for 3D cross section cut lines was populated accordingly.
5.	Land use area	Land use (LU) areas were used to estimate Manning's n values for each cross section. The land use data was a polygon layer and the reference n values are entered for different land uses. Finally, LU Manning table was created where n values are extracted along each cross section
6.	Storage area	Storage areas were used to model the flood plain detention storage. In this study, two storage areas namely Chemberambakkam and Nemam are digitized. TIN was given as input so that the maximum and minimum elevations were populated automatically
7.	Storage area connections	Storage area connections were used to pass flow between Storage areas. They were oriented from left to right. The Storage connection data were extracted from the terrain model.

4. Results and Discussion

The outputs obtained from HEC-GeoRAS and the parameter estimation of HEC-RAS are produced in this chapter. The results of model run, calibration validation and consequent discussions are also detailed.

The variations in the runoff coefficients and peak discharges are higher across urban watersheds compared to the nonurban watersheds. The rate of increase of flood discharge would vary across watersheds and it depends on the distribution of the imperviousness surface and application of flood mitigation practices.

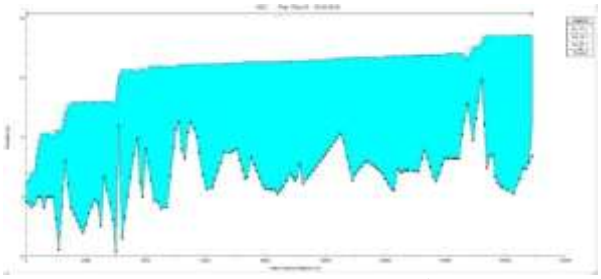


Fig 4: Total cross section and water level of Adyar River

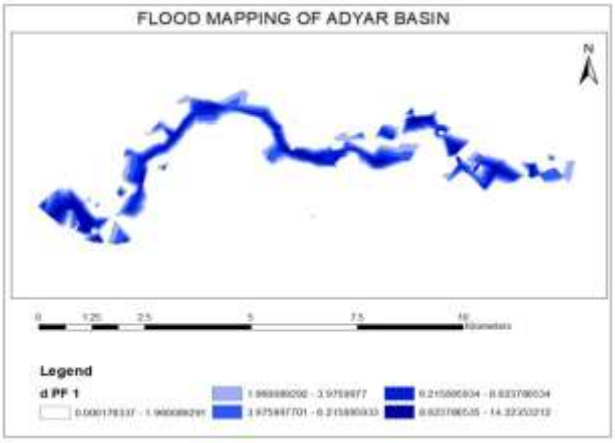


Fig 5: the inundation map of the Adyar River

In the fig 5 shows the total cross section and the water flow elevation in the Adyar River in the x axis is main channel distance in meter and in y axis direction is elevation of the water level in meter.

The fig 5. Is the flood inundation map of the Adyar River which is processed in the ArcGIS, HEC-RAS which gives the elevation of water level in the Adyar basin.

Table 2: Difference between the field depth and the model given depth

FIELD DEPTH	MODEL GIVEN VALUE	DIFFERENCE
2.7	2.577865	0.122135
2.6	2.783562	-0.18356
2.5	1.897623	0.602377
2.5	2.567186	-0.06719
2.5	2.099312	0.400688
2.5	2.358985	0.141015
2.44	1.505159	0.934841
2.28	2.385443	-0.10544
2.25	2.019248	0.230752
2.2	2.837856	-0.63786
1.5	0.066829	1.933171
0.9	0.981903	-0.0819
0.75	1.053753	-0.30375

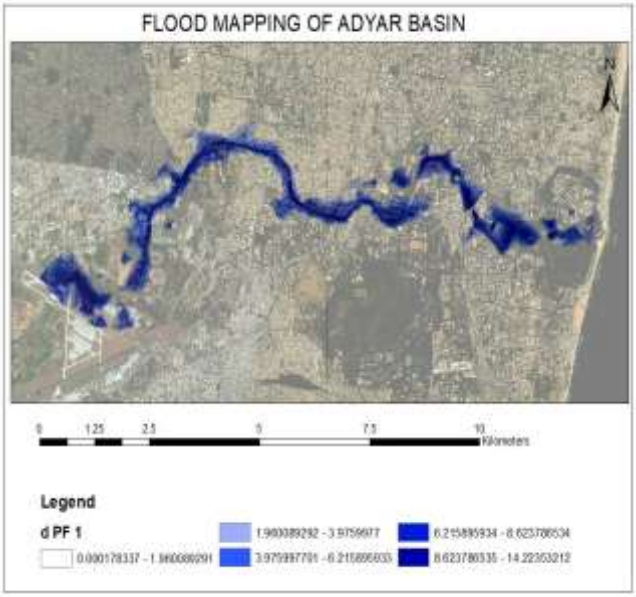


Fig 6: Flood map of Adyar basin

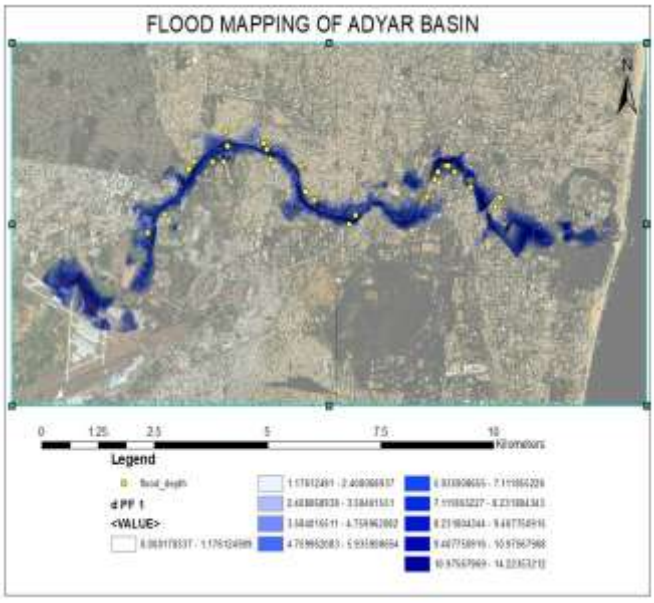


Fig 7: Flood map with the pointed locations

Table 2 it shows the difference in elevation between the field depth value and model given value. The accuracy of the model obtained is ±0.5m. It states that depth obtained in HEC-RAS model with help of SRTM DEM giving accuracy of ±0.5m and more reliable to the field depth.

5. Summary

Literatures are reviewed for simulation using HEC-RAS in event-based conditions. This study is an event-based simulation of runoff, in which the model is made for the Adyar River by using the SRTM DEM of 30m x 30m resolution and by processing with the flow data obtained. Geometric data is processed in HEC-GeoRAS and exported to HEC-RAS. In HEC-RAS the flow data is processed with manning's n value and run for the steady flow analysis to export the HEC-RAS. Finally the flood inundation map is created in ArcGIS with the ras mapping in HEC-GeoRAS. Then field taken depth and model given depth were compared for difference in depth for the accuracy of model given depth result.

6. Mitigation

If flood happens again in Adyar River it helps to determine how much flood will inundate in that particular area. Also helps the administrative people to take necessary measures in that area and to vacate the people from flood affecting place to safe zone.

7. Conclusion

- If flood happens again in Adyar River it helps to determine how much flood will inundate in that particular area.
- On the basis of this flood modelling, Officials / Authorities can make decisions by knowing of flood extend and depth by using flood inundation map.
- Also helps the administrative people to take necessary measures in that area and to vacate the people from flood affecting place to safe zone.

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