Delineation of Flood Risk Zones in Hyderabad City: GHMC-West Zone

P.Neeharika Reddi, Mahesh Ravindranathan, M.Viswanadham

Abstract: Increase in urbanization leading to climate changes and human activities have resulted in flash flood scenarios with varying intensity rainfalls in the city. The uneven distribution of rain fall coupled with Mindless urbanization, encroaching upon and filling up of natural drainage channels and lakes to use the high-value urban land for buildings are the main causes of urban flooding. The built environment of urban areas transforms the natural pervious environment into impervious ground surfaces, inhibiting infiltration. Since water cannot infiltrate into the ground in these urban impervious surfaces, it runs across the surface when it rains and as the surfaces become larger and steeper the speed and quantity of runoff increases.

Key words: change detection flash floods, flood vulnerability, urbanization

I. Introduction

According to European Commission (2007), a flood can be defined as "a natural phenomenon that results in the temporary and quick submerging of land with water that does not occur under normal conditions".

"Flooding is a general temporary condition of partial or complete inundation of normally dry areas from overflow of inland or tidal waters or from unusual and rapid accumulation or runoff" - Jeb and Aggarwal, 2008.

Urban areas are susceptible to flooding in brief periods of time and sometimes precipitation over an urban area will trigger quicker and more severe flooding than in the suburbs or landscape. The impermeable surfaces in the metropolitan regions do not allow water to enter the soil and the water flows rapidly to the low lying places. Flash flooding happens so fast that individuals are caught off guard(it usually happens within 6 hours).If people meet elevated fast moving water while travelling their situation might be hazardous. If the individuals are in their homes or companies, the water can rise rapidly and trap them or cause property damage without them being allowed the opportunity to defend their property and their belongings. In this study an attempt has been made to identify pockets of land which may be prone to flash flooding situations considering the natural terrain and urbanization. The study has been done through remote sensing approach using landsat -imageries of 2005 and 2018 for the Landuse Landcover classifications. ArcGIS software was used to prepare thematic maps.

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II. STUDY AREA: HYDERABAD-WEST ZONE

Hyderabad city is located in central Telangana and is spread over an area of 260 sqkm. The city rises to an average height of 536 m above the sea level. The city is at 17.366° N latitude, 78.476° E longitude.

The greater Hyderabad municipal corporation is a civic body that oversees Hyderabad. The city is divided into five zones namely north zone, east zone, west zone, south zone, and central zone.

The West zone of GHMC has an area of 168 sq. km. The area sits on black soil. The slope slides towards the west and to the east from the central area.

LONGITUDE: Maximum: 78°37'12.722"E
Minimum: 78°14'19.509"E
LATITUDE: Maximum: 17°33'33.591"N
Minimum: 17°17'28.821"N.

Figure 1-location map of the study area

III. METHODOLOGY ADOPTED:

Stage 1: Data acquisition

- LANDSAT-5
- LANDSAT-8
- Open topography SRTM data
- OSM

Stage2: Data processing

- Layer stacking
- Composite band formation
- Projection
- Subsetting of the study area

Stage -3: Data Analysis

- Supervised classification
- Thematic maps

Stage -4: Generation of Output

- Reclassification of the required data
- Overlaying and creation of flood risk map
- Calculation of estimated area affected

Data Acquisition:

The change detection for Landuse Landcover is done for the study area using LANDSAT data. The satellite images used were, LANDSAT-5 for 2005 and LANDSAT-8 for 2018 obtained from USGS. The data required for the thematic map generation was obtained from open topography. The base map shape files were obtained from one of the open series maps.

Data Processing:

The software's primarily used for data processing are ArcGIS and ERDAS Imagine. Erdas imagine was used for composite band formation also known as layer stacking .Image subsetting is also done using the subset and chip tool .these functions performed would be further used for Landuse Landcover classification. The base for DEM was obtained from open topography.

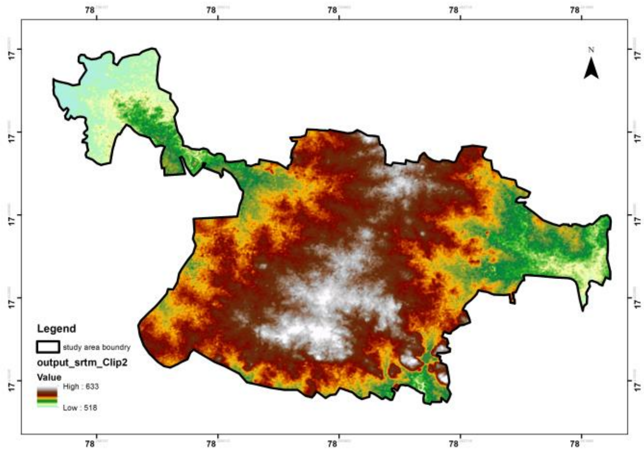

Figure 2-digital elevation model

Data analysis:

Landuse Landcover classification of four classes namely built-up, water body, open land and vegetation is performed using the supervised classification tool in the Erdas imagine platform.

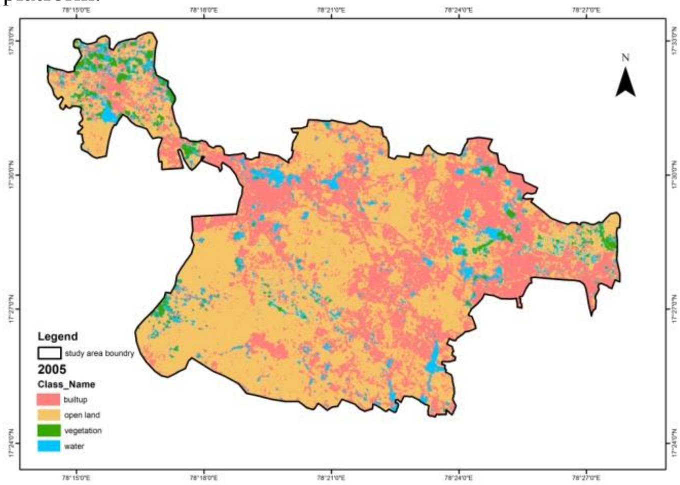

Figure 3-Landuse Landcover classification 2005

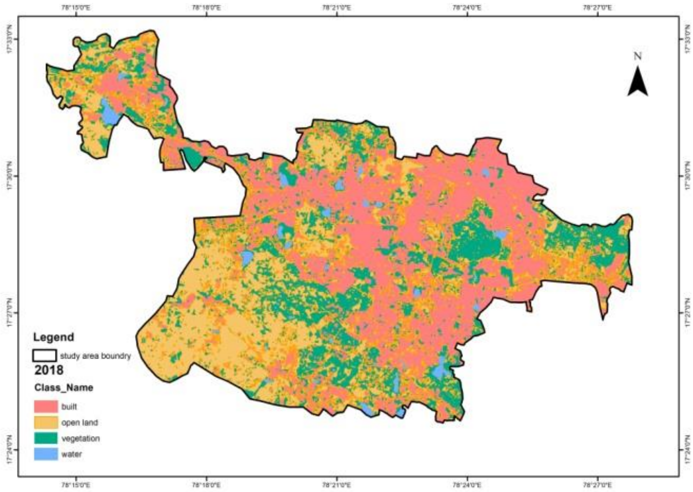

Figure 4-Landuse Landcover classification 2018

The quantitative changes in the Landuse Landcover categories from 2005 to 2018 are shown in the graph below

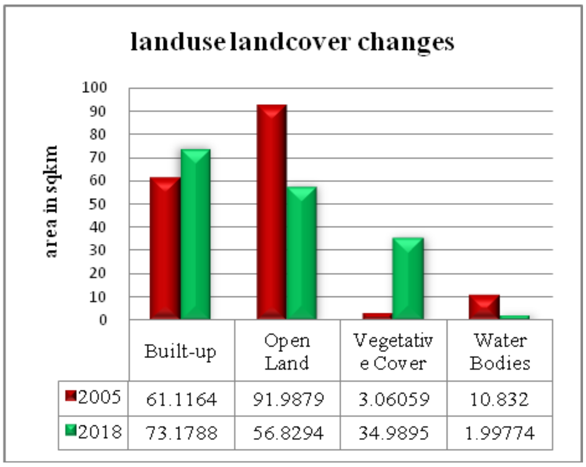

Figure 5-graph of changes in Landuse Landcover from 2005 to2018

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Thematic maps:

For the downloaded data to be efficient all depressions have to be filled. Such depressions are called sinks which was performed using the fill tool. After using the fill tool flow direction, flow accumulation, drainage basin, stream order, slope maps were created.

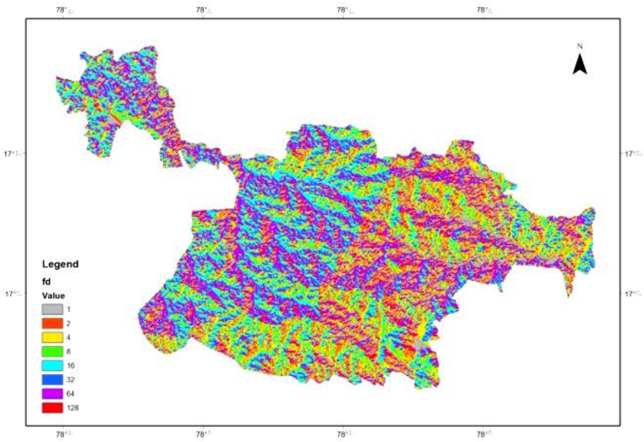

Figure 6-flow direction

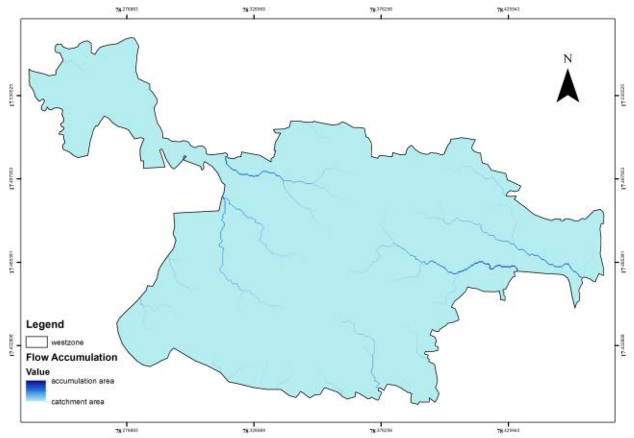

Figure 7-flow accumulation

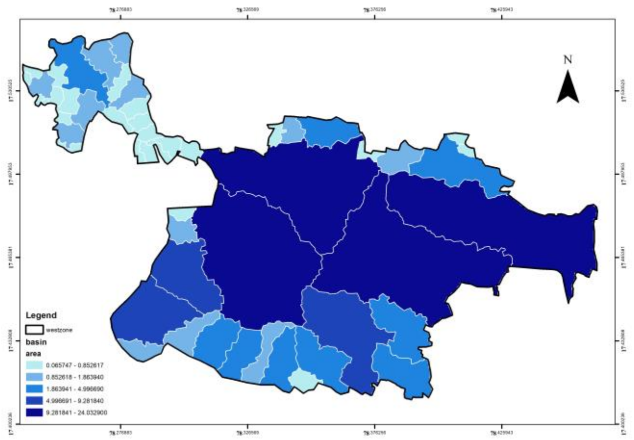

Figure 8-drainage basin

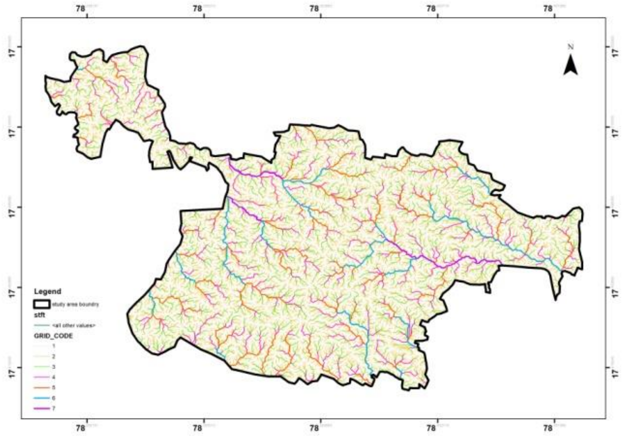

Figure 9-stream order

A buffer map of radius 500 meters for higher order streams is created to eliminate all the lower order stream areas as they do not encounter heavy outflows as compared to higher order streams.

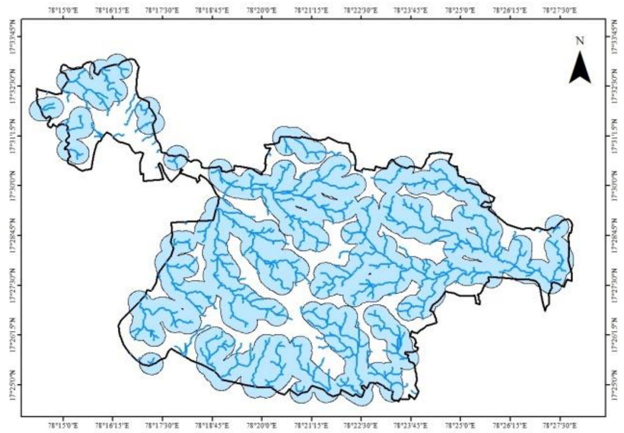

Figure 10-stream buffer map

Slope map was generated using the spatial analyst tools and reclassification was done to divide the slope into three major categories consisting of high slope, medium slope and low slope.

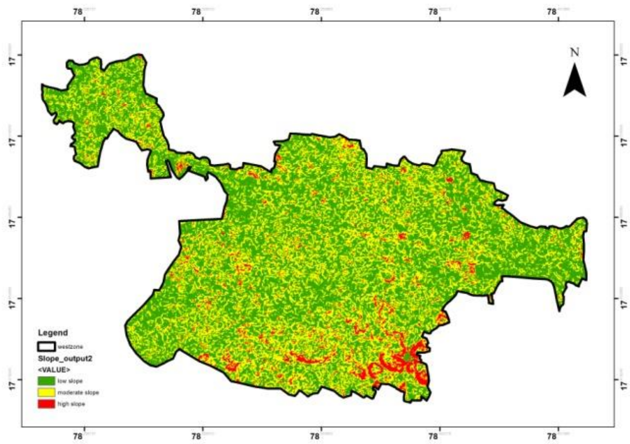

Figure 11-slope map

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Generation of outputs:

The flood risk maps present the areas within the study area that are most likely and unlikely to be inundated with water in a flooding event.

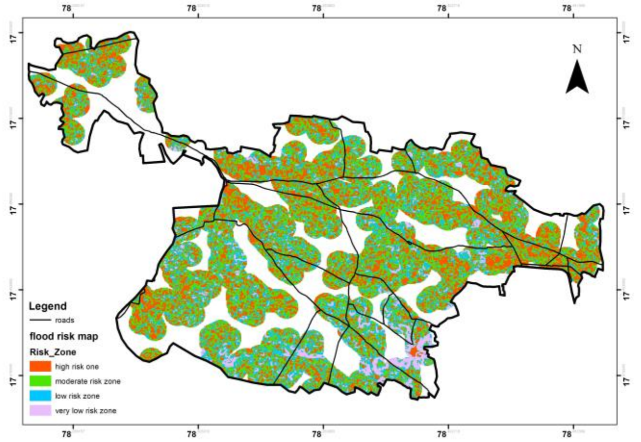

Figure 12-flood risk zones

This flood risk map with the generated three risk zones added to the Landuse Landcover map using the raster calculator gives us final estimated Landuse categories which are at risk of flooding.

The results of the estimated area covered by flood within the different flood risk zones are given in the table below.

RISK ZONE	LANDUSE CATEGORY	TOTAL AREA (sqkm)	AREA OF RISK (sqkm)
HIGH	BUILT-UP	73.1788	19.25048
	VEGETATION	34.9895	8.0682
	OPEN LAND	56.8294	13.084369
MEDIUM	BUILT-UP	73.1788	21.134775
	VEGETATION	34.9895	8.613839
	OPEN LAND	56.8294	14.912882
LOW	BUILT-UP	73.1788	11.886375
	VEGETATION	34.9895	4.93257
	OPEN LAND	56.8294	8.631604

IV. CONCLUSION:

The area under high risk zone sums up to **24.49%** and the area in the medium risk zone constitute to **27.07%** and the area under low risk zone is **15.42%.** These figures give us a rough idea about which areas to concentrate in case of a sudden cloudburst. Based on the results and the analysis done in this study it can be understood that Remote Sensing data and Geographic Information System can be used as effective tools in mapping and analysis of flood risk zones in different urban cities.

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