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Urban Flood Management Using RS & GIS - A Case Study of Vrishabhavathi Sub -Watershed, Bangaluru, Karnataka, India

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ABSTRACT

Natural disaster like flooding is the commonest hazard that impacts the Vrishabhavathi River catchment (spread over a surface of 38 km2) on the upstream side of Gali Anjaneya Temple. To help and rescue the flood affected people to mitigate the matter of flood and to require necessary preventive measures in study area, flood management planning is a really important. To reduce the flood risk in the catchment, present study aims to examine and propose the structural and non-structural mitigatory measures. For finding suitable sites for structural and non-structural measures, in the present study attempts has been to reduce the peaking of floods by identifying the areas to delay the flood concentration time and develop a conclusive pattern for finding suitable sites.

Keywords : GIS, Remote Sensing, Flood management

I. INTRODUCTION

Using Remote Sensing (RS) and Geographical Information System (GIS) and data on socio economic characteristics, a planned and integrated management approach has been made to render right suggestions to the people. The study describes an efficient & scientific approach with suitable illustrations of map and real time flood inundations. The areas, which are highly flood affected, are delineated. So that, the flood affected people are often rescued from inundation and may be evacuated to different safe places.

II. GOAL AND OBJECTIVES, METHODOLOGY AND AREA OF STUDY

2.1 Aim and Objectives

Aim:

To manage flood vulnerability and mitigate it, land-use based strategies have been adopted in the Vrishabhavathi Sub – Watershed (study area), Bengaluru.

Objectives:

Following objectives have been set to achieve the said aim.:

1. To identify the flood zone and flood intensity, periodicity, irregularity and its spatial-temporal varieties.

2. To delineate the major flood risk prone areas through vulnerability analysis.
3. Flood harm appraisal to find an outline on the size of impact of the flood.

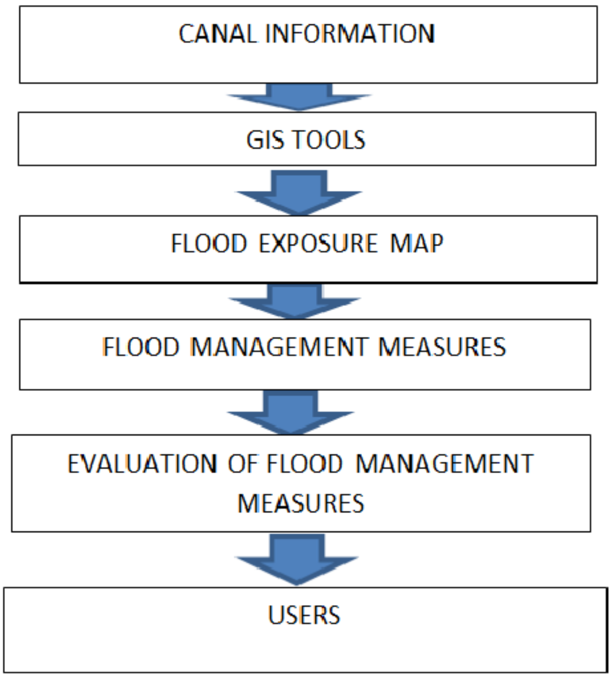
4. To propose an appropriate real time action plan to mitigate and control the calamity.

5. The goal of flood peril examination and its administration is to feature the over a wide span of time situation.

6. The preparedness condition, flood loss prevention & determine current status of evacuation routes.

2.2 Methodology

To mitigate the flood and flood management measures, the GIS based flood data gives detailed information to various users. The flow chart shows the methodology adopted in the study area for the development of flood management measures.



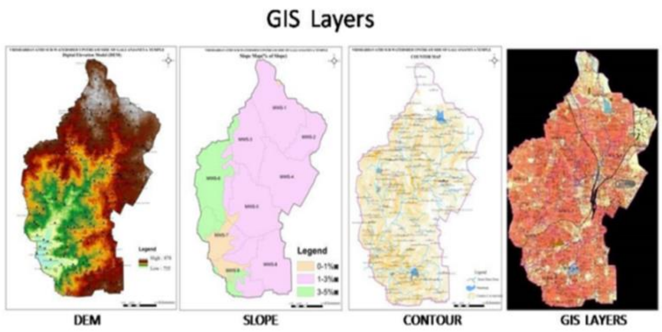


Figure 1: GIS Layers Used in the Model

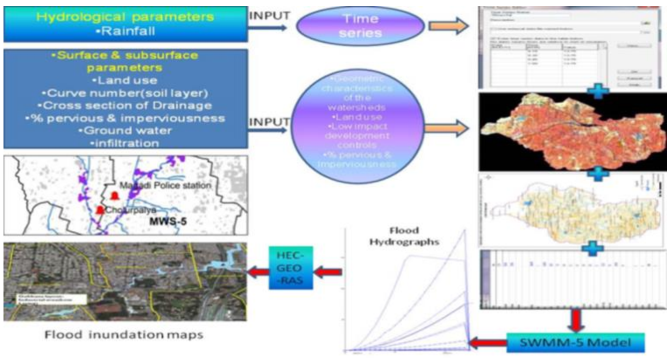


Figure 2: Flow Chart Showing Detailed Methodology Adopted for the Study

2.2.1. Flood disaster management – Conceptual and theoretical frame work characterized by undulating topography with plains and shallow valleys. The study area is located at south of Bengaluru. Bengaluru is the capital of Karnataka state however the district does not have any major river flowing, the district falls in Cauvery River basin. The study area attains maximum elevation of 940 m and a minimum of 880 m above mean sea level. The study area shows that the average depth of annual rainfall for the study area is 812 mm. Finally, the study area was divided total 09 micro watersheds, certain limitations were followed in vectorization of micro-watershed to maintain the physical area 5-10 Sq. Kms. The location map of the study area is shown in Figure 3.

2.3 Study Area

In the Southern part of the Bengaluru city, Karnataka, India, the study area Gali Anjaneya Temple sub watershed lies in Vrishabhavathi valley. Topographically, the territory is situated at latitude 13°1'11" N and 70°32'6" E longitude, covering a complete zone of around 36 Km^2 (Figure 3) and contains nine micro watersheds draining into Vrishabhavathi valley. Physiographicaly the zone is characterized by undulating topography with plain and shallow valleys. No major river is flowing in the valley and falls in Cauvery River basin. The study area attains maximum elevation of 940 m and a minimum of 880 m above mean sea level. The region is very much associated by parkways and other fundamental streets. The examination zone shows that the normal profundity of yearly precipitation for the investigation zone is 812 mm. At last, the investigation region was partitioned complete 09 miniature watersheds, certain constraints were continued in vectorization of miniature watershed to keep up the actual region 5-10 Sq. Kms. The area guide of the investigation region is appeared in Figure 3.

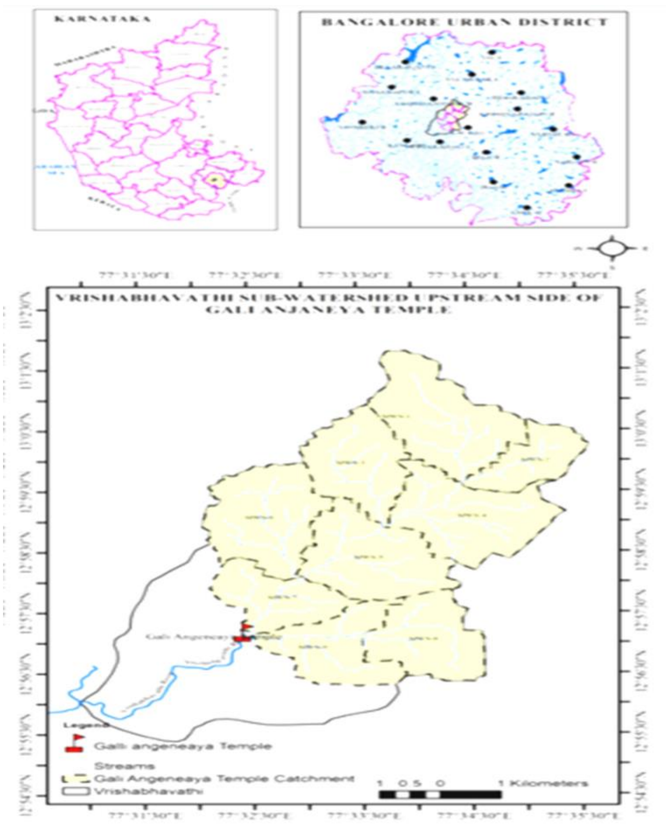


Figure 3: Study Area & prominent features include the 9 sub basins

III. REASONS FOR FLOOD

3.1 Reasons for flood in the examination region

Data analysis of the study indicates that weather variations in Bengaluru are, rise in temperature (during last few decades) is mainly due to urbanization. The increased heat waves, high levels in the carbon dioxide concentrations, change in micro climate, heat Island effects, change in Rainfall pattern its intensity has led to health disorders. Flooding occurs faster & quicker and huge loss to life and property with secondary effects of epidemics and infections. Therefore, management of urban flooding has to be tackled on top priority based on scientific approach and analysis.

3.2 Recognizable proof of flood related issues and issues

A few flood related issues and issues which add to either to agonies of flooding in the region are recognized. These are.

3.2.1 Inconsistent land utilizes, poor land use development, and Lack of zooning.

Due to rapid urbanization, Bengaluru is vulnerable to floods owed to lack of infrastructure planning and drastic land use changes. The lakes and tanks are converting into public and private layouts this has increased the runoff coefficients from existing 30%-40% to 80%-90% and has reduced the ground water storage capacity.

3.2.2 Ill-advised administration of metropolitan exercises, helpless advancement rules and control

Incomplete expansion of drainage system, unplanned drainages in new areas and reduction in the carrying capacity of the existing drains due to silting and blockage. Recent Urbanization has over exploited the groundwater resources and has resulted in depletion of groundwater levels in Bengaluru. This has led to failure of bore wells and also deteriorated the ground water quality.

3.2.3 Issues identified with flood harms

Various issues and issues have been recognized identified with the job they play in impacting flood harms, and misfortunes in the town and its encompassing territories. These are:

- Poor seepage frameworks
- Narrow channels
- Low level establishment of houses/structures at the town community
- Lack of regular clearance of channels

Channels in investigation are exceptionally arrow and shallow and this makes their conveying limit low. During heavy

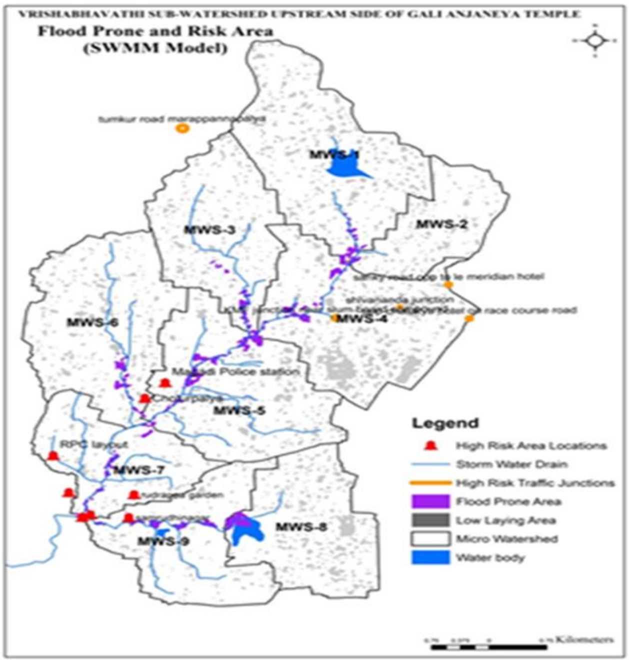


Figure 4: Flood Hazard Ranking Map of the Study Area

downpours, waters flood and run over dry land surfaces causing flooding and traffic issues. The abundance waters either from substantial downpour can't be contained by the shallow wastes in the study region and its encompassing regions.

During rains in the study area, flood water run into shops and houses situated in the low laying areas. Reports and interviews with some of the locals in the study area shows all the settlements in the catchment area were affected during floods during all set of floods in the study area at large.

So, Settlements of the town are directly adjusted along the fundamental street which is raised to be more secure from surface waters during typical downpours in the study area.

3.2.4 Impact of surrounding land uses on the flood ability of the study area.

Due to indiscriminate changes of the land uses in the surrounding areas, flood vulnerability of the area has been intensified. Runoff in the region increases as the surface pavement reduces the rain precipitation which leads to flood ability of the area.

3.2.5 Flood vulnerability and risk map

Flood Vulnerability as per the UNESCO-IHE establishment for water instruction is the investigation of flood vulnerability index (FVI) as the degree of damage, which can be considered typical under specific states of openness, powerlessness and versatility. This is as demonstrated in Fig 4.

IV.CONCLUSION

By using spatial technology, the development of flood inundation map and flood risk quantification maps are prepared for the study area (Figure 2). This study used flood depth in inundated areas, land use, population density and road networks for the evolution of flood hazards. For the effective flood management strategy, this study helps in giving information to planners and decision makers.

The spatial examination (Figure 4) showed that eight sites of occurrences lay in the high-risk zone, which has the highest vulnerability and a high probability of incurring damages. About 25 sites are situated along the main stream in low lying flood-prone areas, which shows a high vulnerability to floods. About 15 sites were located in low-risk zones and 12 sites were located in safe zones.

Rapid urbanization and the subsequent increase in floods have urged environmental researchers to think about absolute flood security along with being aware that flood risks cannot be avoided completely, but can only be reduced to a desired level. Hence, the flood risk mitigation does not strive to completely eliminate the flood risks from urban areas, but attempts to conceptualize measures to control them. This can be done by integrating structural and non-structural measures with community involvement. Additionally, the systematic and gradual conversion of urban land use to its natural stage would also contribute to the sustainable approach. In India, the flood protection program focuses on structural and non-structural measures, where structural measures deal with the hazards and non-structural measures deal with the elements of exposure and vulnerability.

Structural Measures:

Storage and detention reservoirs:

Detention ponds, also called holding ponds and storage reservoirs are suggested in all the micro-watersheds from MWS-1 to MWS-9. These ponds are useful in reducing peak flows and the subsequent frequency of overflow.

Flood embankment or Levees:

Flood embankments are suggested in MWS-5, MWS-6, and MWS-7. The most popular flood protection method is the construction of embankments that includes ring bunds and town protection works. The confinement of a river's flood banks by levees to a narrower space leads to higher flood levels for a given discharge. In the present study area, levees or flood embankments are suggested to reduce the flood peak in MWS-5, MWS-6 and MWS-7.

Retention tank:

Retention tanks are used for detaining excess water to prevent flooding of low-lying areas, roads and streets. The Mungeshpur drain, the NG Drain and the SD Drain are also used as retention basins at their outfall.

Channel improvement:

Channel improvement is suggested in MWS-3 and MWS-8. The frequency of flooding can be reduced by increasing the flow and maintaining the same water level, which can be achieved by either increasing the velocity or increasing the cross section. Deepening the channel helps to avoid the floods as the water level is lowered, but this results in a comparatively higher cost.

Diversion:

It is recommended to build diversion channels or floodways to mitigate the effects of flooding and to restore rivers to their natural water level. Diversions are man-made channels that render a different route for excess water from the main storm water drain.

In the present study area, diversion or floodways were suggested to reduce flood peak in MWS-7 to be diverted towards the downstream side of the Vrishabhavathi valley. Typically, diversion channels are built around communities or economic centers to prevent extensive flood damages.

Roof top Rainwater Harvesting:

Rainwater harvesting is a form of control by which water can be converted into a resource. In the present research work, the precipitation runoff of the study area was found to be reduced by 0.30 m^3/sec, due to roof top rainwater harvesting (RRH). The outcomes of the flood litigation measures suggested that 32% of the total runoff volume can be diverted to rainwater harvesting.

Non-structural Measures:

Flood plain management:

In order to demarcate the flood-prone areas according to various flood frequencies, flood plain management is recommended for preparing the flood risk maps.

Flood Proofing:

Flood proofing program is proposed for the flood-prone areas, more particularly for high-risk areas.

Disaster Preparedness and Response Planning:

Planning and preparing in advance is recommended for warning, disaster mitigation, emergency operations, rehabilitation and recovery.

Flood Forecasting and Warning:

Flood forecasting and warning is recommended for covering most of the flood-prone areas of watersheds.

An ideal coordinated waste bowl the executives model has been advanced looking at of 30 and odd destinations situated for capacity and detainment repositories, 7 reasonable locales for flood dikes in MWS-5, 6, 7 and 9, one area for divert improvement in MWS-3, 3 destinations of New flood channels proposed for MWS-5, 6 and 8, one redirection direct situated in MWS-7, 3 appropriate locales are situated for flood protection in MWS-1, 2 and 4 and one existing tank in MWS-8 is suggested for desiltation for better water assets the board.

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