Optimally Locating Rain Harvesting Pits Using GIS as A Tool

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Abstract
The conventional means to record hydrological parameters of urban flood often fail to record the operation of flood mapping and flood risk assessment. GIS plays a major role in the management of multi-dimensional natural hazard with an inherent spatial component. GIS generates a visualization of flooding and also creates possibilities to analyze probable damage estimate of the urban flood. Hence, there's got to review the present literature with a holistic read of managing varied prospects and constraints of using the technology of remote sensing and GIS of flood management. This study focuses on identifying the least elevation point for locating rain harvesting pit optimally using GIS.

Keywords: Urban Flood Control, Rain Harvesting Pits, GIS.

I. INTRODUCTION

Urban flooding is the most common problem arising in an urban area during the monsoon season due to high-intensity rain falls. Improper drainage system, defective flood water disposal techniques do not have the necessary capacity to drain the amounts of rainwater that is falling. Sometimes the water disposed of in sewage system leaks on the roads through the drainage manholes results in foul smell, growth of bacteria and other sewage troubles.

Urban flooding creates immense troubles like traffic congestion due to water stagnation on roads, roads accidents, economic damages, etc. During heavy rains, the water slowly rises on roads and flows towards slopes resulting in water stagnation at lowest points. Quick rainwater disposal from the road surface is essential to maintain the quality and lifespan of the road. The installation of a suitable drainage system is an essential part of urban road design and construction.

Disposing of rainwater is an important feature in the determination of pavement ability to withstand the traffic and environmental effects. Other than the rainwater pavements experience poor conditions due to many other reasons out of which poor drainage is one of the reason. The strength, ability, and performance of pavement decrease with increase in moisture content. Defective drainage system causes premature failure of the pavement. Due to the lack of supportive infrastructure, the rainwater is not quickly getting disposed of resulting in damage of road structure.

Greater Hyderabad Metropolitan City with 10 million population is the most urban flood-affected areas is specific in the fact that has a lack of drainage issues and rainwater disposal problems. To overcome these problems a keen observation is needed hence this study focuses on identifying the optimal location for rain harvesting pits for Mansoorabad area by analyzing the three-dimensional data using Arc GIS software as a tool.

II. GEOGRAPHICAL INFORMATION SYSTEM

Geographical information system is an application of acquisition satellite data remotely which contains earth information. Through this information one can study, access and analyze various topographical parameters of earth. Recent advancements in this technology helping the researchers to utilize the application for studies related to transportation planning, flood monitoring, land use planning etc.

Various GIS software's are available in the market applied for wide varieties of data. For carrying out this study Arc GIS 10.1 Software is utilized to study the DEM (Digital Elevation Model) of the study area.

III. DATA COLLECTION

Greater Hyderabad is recognized as the most populated urban area in our country experiencing heavy urban flooding during monsoon. Heavy traffic congestion, delays, and economic losses. Mansoorabad area comes under the zone where the rainwater stagnation percentage is high. The 3 Dimensional data of the chosen study area is gathered using Arc GIS 10.1 in the following steps:

Fishnet

Create a fishnet tool generates a feature class of a rectangular grid cell creating three sets of basic information. a fishnet is created of grid size 200m X 200m covering an area of 9 Sqkms for the chosen study area as shown in figure 1.

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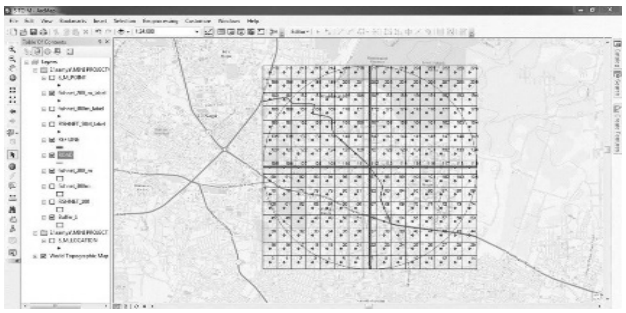

Fig. 1 Fishnet Created of grid size 200m X 200m

From the generated fishnet a total of 200 fishnet label points are produced along with it for which the elevation values and X, Y coordinate values have to be extracted. Usually, the X,Y coordinates are taken as latitudes and longitudinal values, here in this study the X, Y values are taken are the distances of the fishnet label point from the axis to identify the path the water flows during the flood.

Slope calculation

The slope can be calculated from elevations extracted from fishnet grid cells. The slope is defined as an angle. Slope measure the steepness of the surface at any particular location is often measured in percent rise of ground from MSL. In this study, the slope of the ground is estimated from an online web tool called GPS Visualizer.

From the generated fishnet label points, label point layer is convertedtoKMLformat for the extraction of three-dimensional data covering the latitude, longitude and elevation data using GPS Visualizer. The extracted elevation points are labeled on map and bifurcated into 4 quadrants anti-clockwise direction for easy identification of rain harvesting pit location as shown in figure 2.

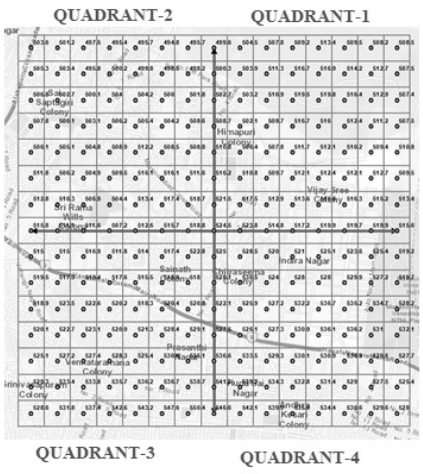

Fig. 2 Labelled elevation points in the map

IV. METHODODOLOGY

The optimal location is found out by adopting a statistical equation called the method of moments. In this methodology, the feasible location for a Rain harvesting pit is identified by using the formula, elevation values of the nodes E_1, E_2, E_3… multiplied by horizontal and vertical distances i.e. X1, X2, X3… and Y1, Y2, Y3.... taken from the reference line (0,0). The optimal location points can be calculated from the below-presented formula.

$$X = \frac{E_1x_1 + E_2x_2 + \cdots..}{E1 + E2 + E3 + \cdots}$$

$$Y = \frac{E_1y_1 + E_2y_2 + \cdots..}{E1 + E2 + E3 + \cdots}$$

The x and y coordinate values obtained in four quadrants for each point are a substitute in the formula mentioned. The outputs received are mentioned in table 1

Table 1 Output Values after substituting in the method of moments formula.

QUADRANT	X^-	Y^-
1	798.290306	806.220242
2	-799.848895	796.111672
3	-798.2903	-806.2202
4	799.0301	-818.519

From the result obtained the value of X^-, Y^- are known from 4 node points. Hence it will be opted as low-level land and used as the optimal location for facility location. Comparing with the graphical real-time data the values X^-, Y^- gives the exact locality for placing a pit rather than any other methods. Hence, it can be taken as a feasible location for locating a Rain harvesting pit. Below figure 3 shows the map plotted with values of identified X and Y values

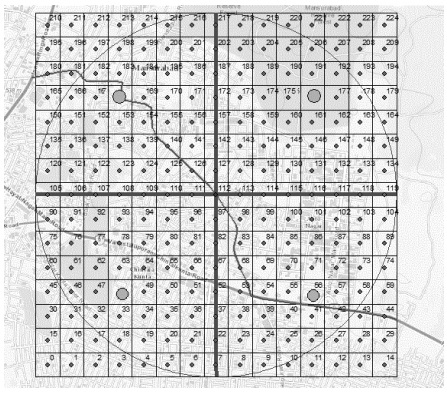

Fig. 3 Optimal locations of rain harvesting pits

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V. RESULT

The obtained X^-, Y^- satisfy as the lowest elevation points which represent the flow direction of water during the flood. Hence these location points serve as the optimal places to place the rain harvesting pits for disposing of the flood water in various methods and helps in avoiding traffic congestion, delays and pavement surface failures.

VI. CONCLUSION

This study concludes that through GIS-based analysis of land slope analysis and positioning of rainwater harvesting pits is very much useful in future planning of the decision support system of rainwater harvesting. This kind of GIS-based analysis helps in identifying the water flow path to plan accordingly the supportive infrastructure for its easy disposal and storage.

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