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Preparation of Water Resources Augmentation Plan through Rainwater Harvesting for VNIT Campus, Nagpur using Geoinformatics Approach

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Abstract—*Rainwater harvesting (RWH) is the technique of collecting rainwater instead of allowing it to flow as runoff. One of the major problems being faced nowadays is the scarcity of fresh water. Also, with increased requirement of water for domestic, gardening and other purposes, the rainwater harvesting technique is getting more importance, since rain water is one of the purest forms of water available. The construction and operation of rainwater harvesting system is simple and cost effective if scientific aspects of the process are followed. The size of the rain water harvesting system depends upon how much water is available as runoff and also the water demand and daily consumption of the water during summer season. This study was conducted to calculate the potential surface and roof top rainwater harvesting and hence to propose water harvesting systems in VNIT campus, Nagpur, India using satellite remote sensing and Geographic Information system (GIS).Satellite Google earth images and Arc-GIS 10.1 software were used to estimate the available catchment area. Runoff from the catchment is calculated by using SCS Curve number method. Land use and land cover classification was done using ERDAS imagine software and from this, curve number for each land use classes were found out. It is observed that the total runoff available from the catchment was 246409.52m^3. A plan of usage of the harvested rainwater for its storage in the surface and subsurface domain has been proposed through the present research work. Two wells and one artificial pond were proposed based on the available runoff and the slope of the site.*

Keywords: *ArcGis, Curve number, Water harvesting, Surface runoff.*

1. INTRODUCTION

Water is one of the basic needs for all life and it also have important role in the socio-economic development of all country [1]. One of the major problems being faced nowadays is the scarcity of fresh water. The need of water for domestic, gardening and other purposes is also getting increased day by day. To meet these needs, water should be available with low cost and also with high quality. Rain water harvesting is one of the best methods for collecting and supply good quality water with low cost. In ideal condition, rain water is one of the purest forms of water; however it will carry several contaminants, impurities, plants and animal wastes, along its path [2].So suitable cost effective water purification methods should be adopted in these water harvesting system.

RWH is the technique of collecting rainwater instead of allowing it to flow as runoff. It is one of the oldest method, which will supply water for domestic purpose, agriculture purpose etc. [3].There are mainly two methods of rainwater harvesting. They are: 1.Surface runoff harvesting 2.Roof top rainwater harvesting. The construction and operation of RWH system is simple and cost effective if scientific aspects of the process are followed. The size of the RWH system depends upon how much water is available as runoff and also the water demand and daily consumption of the water during summer season.

In urban areas; rain water falls on road, paved surfaces etc. will flow as surface run off. The method of collecting and using this water for recharging aquifers are called surface runoff harvesting. Roof top rainwater harvesting is the method of collecting rainwater that falls on roof of houses or other buildings. So here the roof top will act as a catchment. This water can be stored in tank or can be diverted to an artificial recharge system.

RWH system consists of three main elements. They are collecting area, conveyance system and storage facilities. Collecting area can be roof for roof top RWH and road or pavement surface for surface runoff RWH. Conveyance system consists of gutters or pipes, which will be made with some inert material. Finally these water will get collect in storage tank or cistern [4].

The main aim of this study was to calculate the potential surface and roof top rainwater harvesting and hence to propose water harvesting systems in VNIT campus, Nagpur, India. For this, remote sensing and Geographic Information system (GIS) technique were used. Satellite Google earth images, and Arc-GIS 10.1 software were used to estimate the available catchment area. Runoff from the catchment is calculated by using SCS Curve number method. Land use and land cover

classification was done using ERDAS imagine software. A plan of usage of the harvested rainwater for its storage in the surface and subsurface domain has been proposed through the present research work. Two wells and one artificial pond were proposed based on the available runoff and the slope of the site.

2. STUDY AREA

VNIT campus of Nagpur, Maharashtra, India has been selected as the study area for this work. It has a total area of 217 Acres out of which 80235Sq.mtr.is covered by built up area. It extends from 21˚12′29″ longitude to 79˚04′99″ latitude. Area is covered with black cotton soil. Nagpur has tropical wet and dry climate with an annual rainfall of 1,205mm.Location map for the study area is shown in Fig.1.

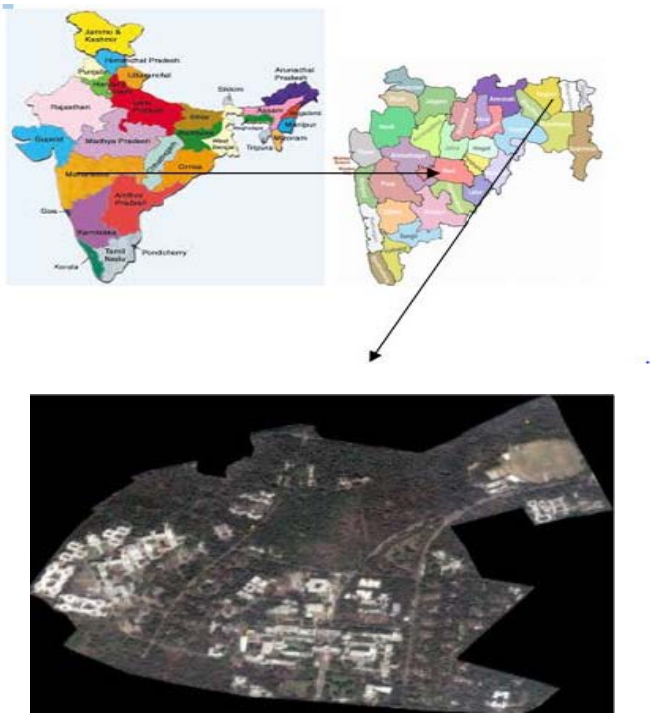


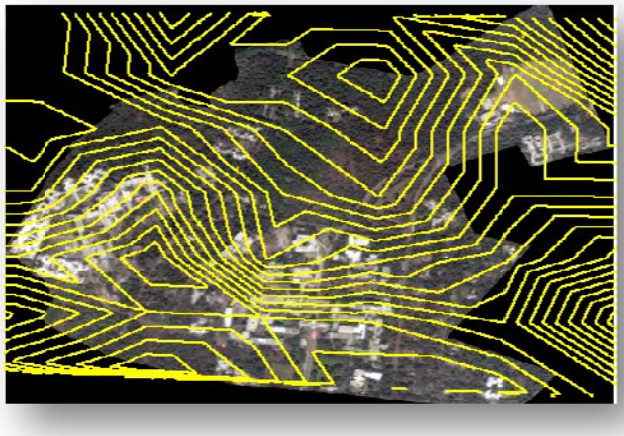
Fig. 1: Location map of VNIT campus

3. METHODOLOGY

Boundary of the study area was delineated from Google Earth image by using Arc-Gis 10.1 software. Elevation values were obtained and contour map was generated. By using these contour values and contour map , digital elevation model (DEM), for the study area was also generated. Slope map of the area is also prepared. Roof tops and roads were digitized and their areas were calculated. Land use and land cover classification were done by using Erdas imagine. Runoff values for the study area were calculated by using SCS-CN method ,using daily rainfall data. Rainfall-runoff graph were plotted for 5 years and regression value were found out.

4. RESULTS AND DISCUSSION

Contour map generated for the study area is shown in Fig.2. Highest contour value was found to be 323 and the lowest value was 310.5. DEM generated was shown in Fig.3.From this, an idea about the slope of area is shown in Fig.4. Whole area was divided in to five classes namely Buildup areas, vegetation, scrub, road and open spaces. Curve numbers were assigned to each land use class and run off for the catchment were obtained. For roof top harvesting system ,total roof top area were calculated and it was found to be 66867m^2 .Land use map for the study Total catchment was found to be 246409.52m^3.Rainfall-runoff correlation is shown in Fig.5. From the graph, regression value of 0.819 was obtained.



Fg. 2: Contour map generated in 0.5m interval for the study area

5. CONCLUSIONS

By understanding the terrain of the study area from DEM and the calculated runoff values, two wells and one artificial pond were proposed. One well was proposed near the hostel section which will collect and store water from the roof top of hostel buildings. Other well was proposed near the academic section, were water from the roof tops of all college blocks will collect. All other water from roads, staff quarters etc. will get collected in the artificial pond proposed at the back side of health centre; where DEM showing the lowest elevation. Water collected in the artificial pond will be of less quality so that either it can be used by giving some purification technique or can be used for gardening purpose.

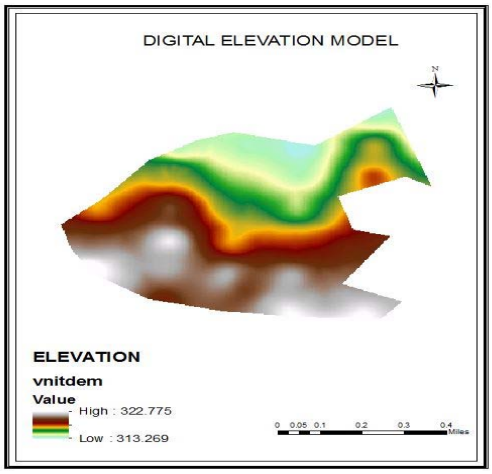


Fig. 3: Digital Elevation model for the study area

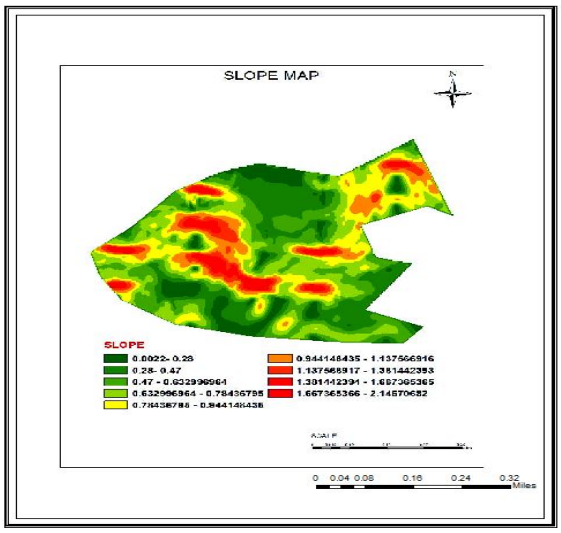


Fig. 4: Slope Map

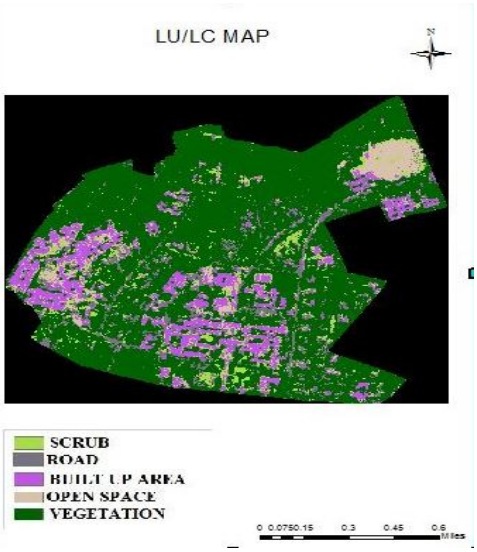


Fig. 5: Land use and land cover map

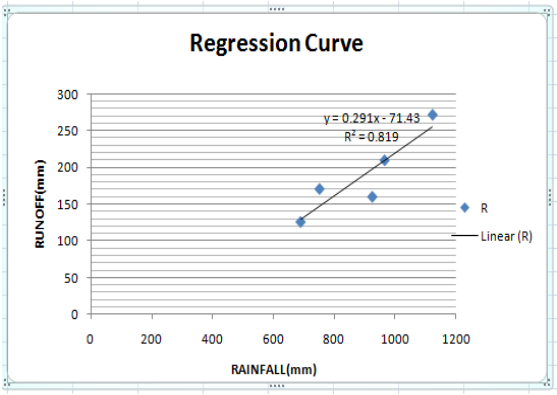


Fig. 6: Regression Curve

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