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GIS Based for Identification Of Potential Ground Water Recharge Zones In Urban Area - Case Study From A Pune City

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Abstract
Ground water is the major source of water in Pune city. Shivajinagar area in Pune city is densely populated and hence creates remarkable burden on the quality and quantity of the groundwater resources. This study focuses on the recharge of the natural resources for sustainable development. With the help of GIS techniques, we create various thematic maps like Geology map, Rainfall map, drainage map, drainage density map, slope map, soil map, land use land cover map. By using weighted overlay analysis for finding out the ground water recharge zone. Final output has been classified into four different zones namely very low, low, medium and high zones.

I. INTRODUCTION

The history of rainwater harvesting in India and its management can be looked back to the classical times. This ancient technology has seen a significant change in the modern era. It is sustainable development and very useful in elimination of the threat of water crisis. It holds tremendous potential for mitigating storm water runoff and reducing ground water consumption specifically in the urban area. In the past, rainwater harvesting system were not preferred due to high cost. However, recent invention of improvised techniques has increased the long term benefits considerably. Now a day's rainwater harvesting systems are beneficial in many Indian cities by giving much more assistance to the main water supply during summer. RWH provides with an effective solution to supply the urban water request and try to stop excess runoff rain water.

Because of social issue, RWH system is not effectively run. [1] Rainwater harvesting (RWH) is commonly used nowadays, in developing countries [2], owing to its cost effectiveness. The rooftop RWH system usually collect less amount of water and it's used for domestic purpose [3], [10], [11], [13] or groundwater recharge [4], A GIS supported Hydrologic Engineering Center–Hydrologic Modeling System might be a useful model to simulate the precipitation-runoff process of an urban catchment system through featuring in an integrated environment [5].

Rainwater harvesting is a vital, technological option to improve water supply [19], [20], [21]; therefore, as an adaptation measure, rainwater harvesting is a priority for urban areas and has a history of use in semi-arid locations [22].

This study focuses on the Pune urban area located in Maharashtra state of India. This city having so many subparts however we have focused on the Shivajinagar area. Through this study, we propose to channelize the rainwater runoff from roads and open land surfaces.

STUDY AREA

The study area is located in the survey of India toposheet number E43H15, E43H11, E43H14. The total geographic area of Shivajinagar is 1094.98Hect. Shivajinagar which is the middle part of the Pune city then This city is situated along the Mula and Mutha river. The major water requirement including drinking, industry and other human needs are fulfilled by the Mula and Mutha river. Because of metro city population density increasing day by day so water demand also increases. Obviously, PMC water supply is not fulfilled and so, many new societies takes deep borewell. PMC has made rule stating that rainwater harvesting is compulsory from 2007. However, many societies cannot run it efficiently and hence the groundwater level is depleting day by day. So water crisis is a major problem in this city.

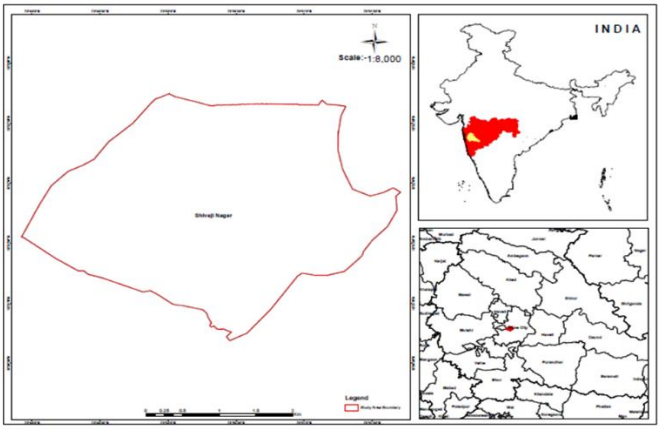


Fig. No.1 Location map of Shivajinagar

II. MATERIALS AND METHODS

GIS technique is used to determine the ground water potential of Shivajinagar area in Pune city. Identification of rainwater harvesting site for groundwater recharge was explored using rainfall, lineament density, slope, geology, drainage density, soil type, land use/land cover.

Table No: 1

Factors	Data source	Source location
Toposheet	Survey Of India	https://surveyofindia.gov.in/
Lineament	Bhuvan	https://surveyofindia.gov.in/
Rainfall	Global Climate Data	http://www.worldclim.com/version2
Landuse and Landcover	Landsat 8 Oli 06-Mar-19	https://earthexplorer. usgs.gov
Soil	National Bureau Of Soil Survey (NBSS)	https://www.nbsslup.in
Geology	Geological Survey Of India	https://www.gsi.gov.in

At first the Toposheet was georeferenced. From this toposheet generate the contour and stream density. From contour generate the DEM and from DEM generate the slope map. Lineament density data was obtained from Bhuvan and further with the help of ARC –GIS georeferenced was done and lastly it was digitized. Last 30 years Rainfall data was obtained from worldclim and raster was calculated and then classify in ARC – GIS. Land use and land cover map has been created by using Landsat 8 . First done the layer stacking and then digitized. Geology map generated by digitization

from the district resource map of the Geological survey of India using ARC –GIS software. From the National Bureau of Soil Survey (NBSS), the soil map was acquired and digitized.

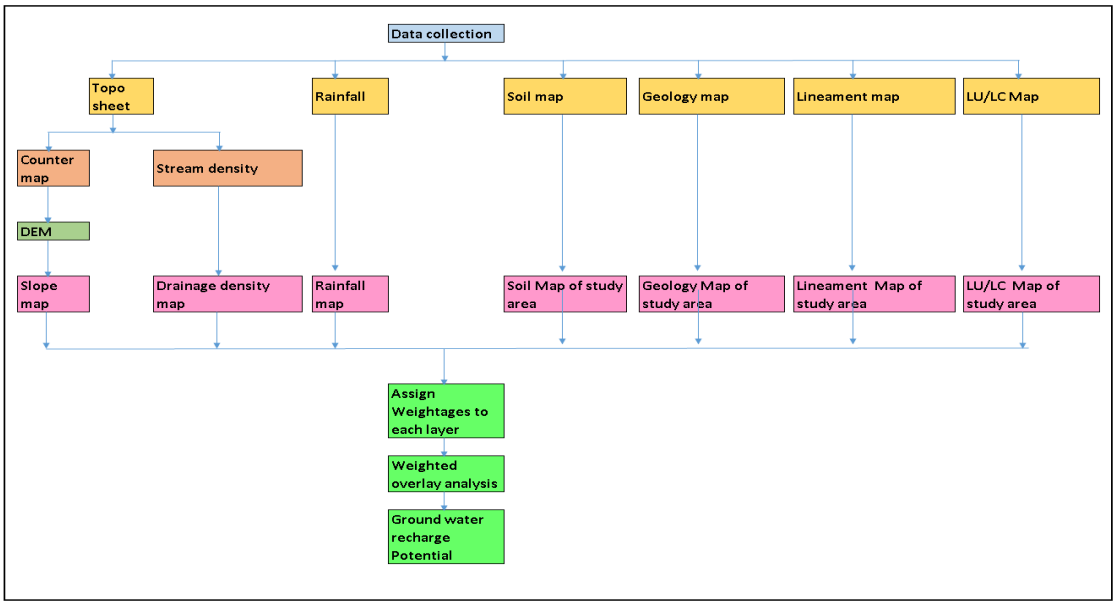


Fig. No.2 Methodology Flow Chart

III. RESULT AND DISCUSSION

After weighted overlay analysis, Shivajinagar area is divided into four different zones like very low, low, medium and high water recharge zone. The high recharge zones are found mostly around the boundary side of Shivajinagar towards East and west side.

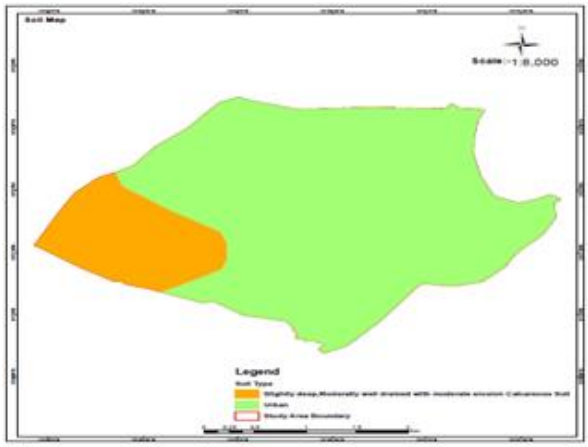
Table no 2: Noted the rank of each parameter with weightages

Factors	Rank	Weightages	Factors	Rank	Weightages
Rain		15	**Geology**		15
741 – 762 mm	2		Basalti lava flow 150-220m	2	
762 – 786 mm	4		Basalti lava flow 50-350m	4	
786- 808 mm	6		**Slope**		15
808 – 857 mm	8		0 - 11	8	
857- 901 mm	10		11 - 22	7	
Drainage Density		20	22- 33	6	
1	2		33 - 44	5	
201	4		44- 55.	4	
324	6		55 - 66	3	
442	8		66 - 77	2	
534	10		77 - 89	1	
Soil		10	**LU/LC**		25
Calcareous Soil	3		Agriculture	6	
Urban	1		Built up	2	
			Scrub land	4	

	Vegetation	8
	Waterbody	10

4.1 Soil Map

The soil is significant element for recharging the ground water in rural areas but in urban areas it is less important because mostly open land is very less for infiltration. Shivajinagar has slightly deep moderately well drain with moderate erosion calcareous soil. In Shivajinagar approx. 80% area is the urban only 20% area has calcareous soil. The scale of this map is 1:8000



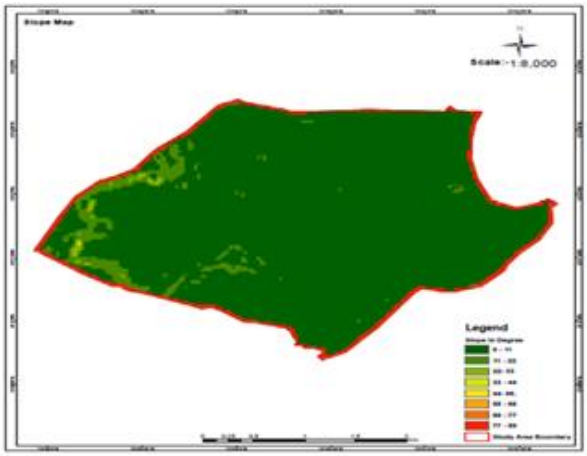


Fig. No.3 Soil Map Of Shivajinagar Area Fig. No.4 Slope Map Of Shivajinagar Area

4.2 Slope Map

For a slope map, first generate the digital elevation model (DEM) from the contour layer and then obtain a slope map from the DEM layer. Slope has a major role in infiltration of ground water recharge.

4.3 Lineament

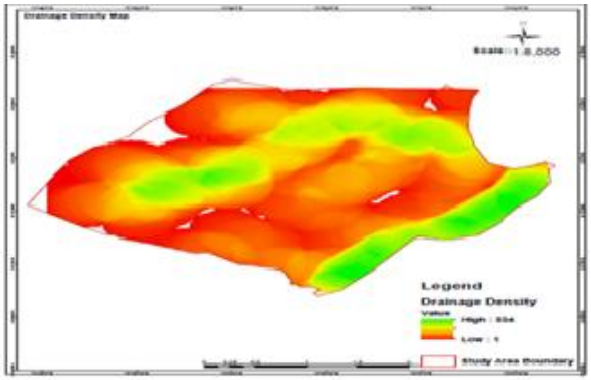
A lineament represents the fundamental geological structure like fault. It is often superficial in geological or topographic maps and can appear obvious on aerial or satellite photographs. In Shivajinagar area there is no lineament.

4.5 Drainage

For drainage density map we need drainage map. In drainage map we need the digital elevation model and stream network file. In this case Shivajinagar is having 5 types of stream order. Shivajinagar region shows that the area is mostly with two order streams draining into the region as shown in fig. Third and fourth order stream only in one region and fifth order in two regions.

4.4 Drainage Density

The drainage density map set from the drainage map. The Shivajinagar area is divided in 5 types stream order but maximum area is low drainage density. Drainage density= total length channel (m)/ Basin area (m2)



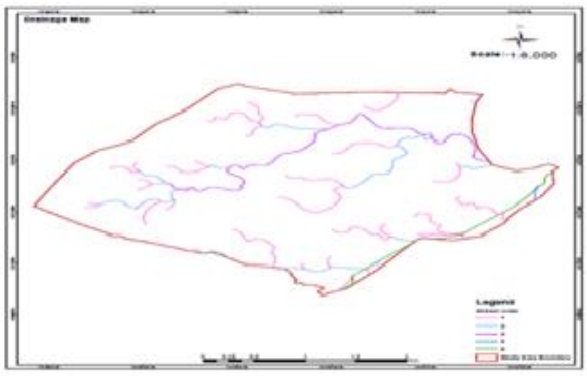
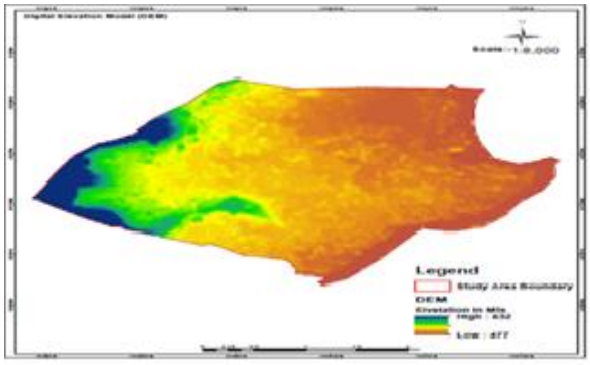


Fig.No.5 Drainage Density Map Fig. No.6 Drainage Map

4.6 DEM

DEM should be created from contour layer and from DEM we create the slope map for that we required DEM. For creation of DEM first we scan the toposheet, then geo referencing, then digitized and interpolation. For the same, we required topographic map of our study area and ARC GIS software. A digital elevation model is a digital file consisting of terrain elevation for ground position at regularly spaced horizontal interval. Geo referencing refer to the process of assigning map co-ordinates to an image data. This data converting spatial feature (point, line, polygon) from a paper based source into a digital form by tracing and then interpolation is done. Interpolation is a process of assigning value of unknown points by using values from usually scattered set of known points.



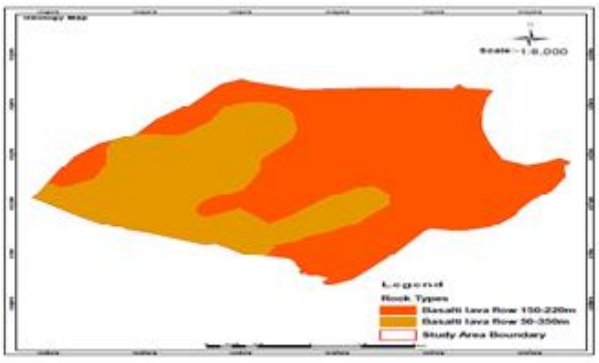


Fig. No.7 DEM of Shivajinagar Area Fig. No.8 Geology Map of Shivajinagar Area

4.7 Geology map

Pune surrounding area has the wide range of Deccan basalt of upper cretaceous to Eocene age. The area resembles different layer of lava flow which are of compound and simple flow. At the lower elevation it shows compound flows whereas at higher elevation, simple flows are observed. The Shivajinagar area has wide range of compound lava flows. It also shows the greater variety of vesicular and amygdaloidal basalt. The area comprises 50-350m depth at the western part of the area whereas remaining part is at 150-220m depth.

4.8 Rainfall Map

Rainfall and its intensity is the major factor, for the ground water recharge. Rainfall data obtain from the worldclim mention in table no 1. For this case study, used last 30 years' rainfall data. Rainfall is classified into five classes. The highest rainfall in Shivajinagar area was 857- 901 mm and lowest was 741–782mm.

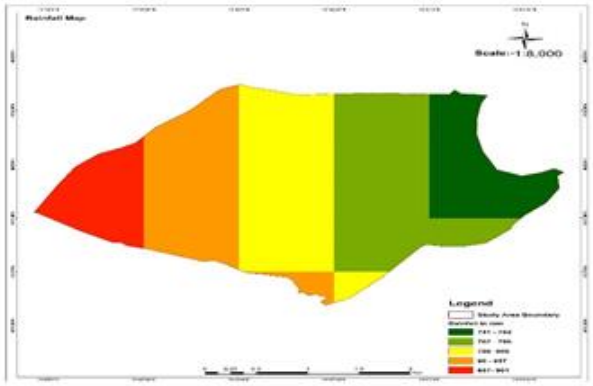


Fig. No.9 Rainfall Map of Shivajinagar Area

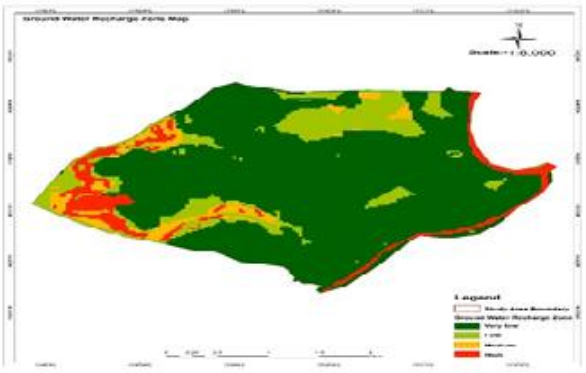


Fig. No.10 Groundwater Potential Zones

4.9 Weighted overlay analysis

Rainfall, geology, soil, lineament, digital elevation model, drainage density, slope etc. are important factor for finding rainwater harvesting site in urban area but all are not having similar weightages for analysis. It depends upon the type of city, topography, density of population according to that we decide the weightages. For this case study Shivajinagar area of Pune city is heavily dense populated. So LU/LC map having more weitage as compared to other. Then second highest weight is given to drainage density because drainage density shows the runoff water so it is preferred. geology, slope, and rain having similar weights and soil having less weight as compared to other because soil play less important role in urban area. Because it is dense populated area so soil is less available.

In this case study initially data required from various sources are given in table no 1. By using this various sources, generate various thematic maps using GIS tools. Initially create Geology map, Rainfall map, drainage map, drainage density map, slope map, soil map. Then apply weights according to their importance.

CONCLUSION

This study emphasis on the application of GIS techniques to map the groundwater prospective and further identify rainwater harvesting sites in Shivajinagar area located in Pune city.

Parameters such as drainage density, soil, slope, lineament density, geology, land use/land cover and rainfall are vital for this perspective. In a part of this study, it was observed that the area having low slope was more compatible for recharge as compared to that of higher slope. This is an important parameter to note in the urban areas against rural areas as continuous contour trenching can be done in the rural areas. This research would encourage the effective utilization of rain water in the urban areas.

This groundwater potential map can be utilized for groundwater resources management in Shivajinagar area and can assist concerned officials to frame effective plans. The assessment of groundwater potential would support decision-makers in groundwater management and the selection of appropriate locations for drilling wells based on demand.

Furthermore, augmentation of available water resources by effective channelization can be done in order to maintain the sustainability of the aquifer management.

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