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# Rainwater Harvesting Potential of NIIT region of Greater Noida using GIS

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## Abstract

A global problem is water shortage for commercial and industrial usage and even for drinking purposes. The depletion of resources, decimated ecosystem, dwindling of wells, saltwater intrusion and land subsidence has resulted due to the extraction of excessive withdrawal of groundwater. The current decline in the availability of groundwater in India requires the formulation of a sustainable groundwater management plan by properly evaluating the available resources. One of the solutions to solve the groundwater issue is rainwater harvesting for groundwater recharge. Rainwater harvesting is a technique of harvesting, collection and storage of rainwater and aims at conserving, storing and utilizing every drop of rainwater for various users and recharging groundwater reservoirs. The present paper proposes a GIS approach to assess the total area of available catchments for rainwater harvesting in NIIT region of Greater Noida and evaluate the amount of water that may actually be harvested for groundwater sources to be replenished. Google earth images are used for the digitization and georeferenced with the help of ArcGIS. Rooftops, roads, vegetation and bare land are included in various types of catchments. Finally, the catchment area is determined in order to determine the overall rainwater harvesting potential of the study area.

Keywords: GIS, NIIT, Rainfall, Rainwater, Rooftop

## Introduction

Water is an integral and essential aspect of our life support system. Due to increased demand from our ever increasing population, water is a valuable resource. It is highly probable that a point will come when the supply of water will no longer be able to fulfill the needs of our increasing population. Rainwater harvesting can be measure to increase access to water for the vulnerable sections of the society in arid and semi-arid parts in countries where water resources are inaccessible. The water harvested can be utilized for different purposes such as domestic, livestock, agricultural production, industrial and groundwater recharge. It aims to optimize water storage without making any use of it and to mitigate runoff through drains or to the rivers. Because of the ever rising demand for water, groundwater levels are increasingly reducing. Accordingly, the goal of rainwater harvesting and conservation is to allow efficient use of rainwater.

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Geographic Information Systems (GIS) techniques are increasingly being used at the regional, national and international levels to prepare, build and manage natural resources. They were implemented for the assessment of various water related environmental problems, such as contamination of surface and ground water, soil erosion, soil contamination by water logging, and ecosystem changes. ArcGIS has been used to provide digital data importation tools and to perform GIS analysis. Rainwater harvesting for improved crop production has received great attention in the 1970s and 1980s mainly due to the widespread variability of rainfall with the associated effects of crop failure or reduced yield and threat to livestock and human life in semi arid and arid regions of Africa (Hatibu et al., 1999). The application of GIS as an integrating tool to store, analyze and manage spatial information and linking it to hydrological response models, to facilitate decision making by providing catchment level identification, planning and assessment of runoff harvesting sites has been applied by De Winnaar et al., (2007). Ward et al. (2008) evaluated the design evaluation based on the rainwater harvesting model in which the rate of accumulation of rainwater harvesting in the UK has been slow to date, but it is expected to boost momentum in the near future. Economic analysis has shown that rainwater harvesting systems can be more financially feasible in large commercial buildings than in smaller domestic systems. Kumar et al. (2011) revealed on the Rain Water Harvesting and Ground Water Recharging in North Western Himalayan Region for Sustainable Agricultural Productivity. The study of conventional low-cost water harvesting systems that helps to improve the socio-economic status of poor hill-area farmers. Dwivedi et al. (2013) assessed rooftop rainwater harvesting for groundwater recharge in an educational complex and rainwater harvesting approaches effectively capture and store rainfall through various technologies for potential use to meet the human requirements.

## Rainwater Harvesting Potential Methods

### 1. Surface runoff harvesting

Surface runoff is drained into rivers, lakes and reservoirs due to rain. Runoff harvesting is a greater alternative to the issues of water shortage, flooding and drainage. It also facilitates recharging of groundwater.

### 2. Rooftop Rainwater Harvesting

Rainwater falling on rooftops is collected, transported and preserved either for direct use in surface water bodies or for groundwater recharge. Capturing rainwater from the rooftop is an easy and cost-effective solution that enables sustainable use of water.

## Study Area

NIIT is one of the region of Greater Noida located in Gautam Buddha Nagar district of Uttar Pradesh state, India (Fig. 1). It is located at latitude of 28.411120 and longitude of 77.515698. The region comes under NCR region of Delhi. The total land use cover is 64.6 hectares comprising of concrete roof, concrete road, vegetation and bare land. The water supply in the area is done through tube wells, overhead tanks and other water supply lines. On an average, the study area receives 620 mm of annual rainfall but this can vary considerably.

Fig. 1: Google pro earth map for digitization of rooftops

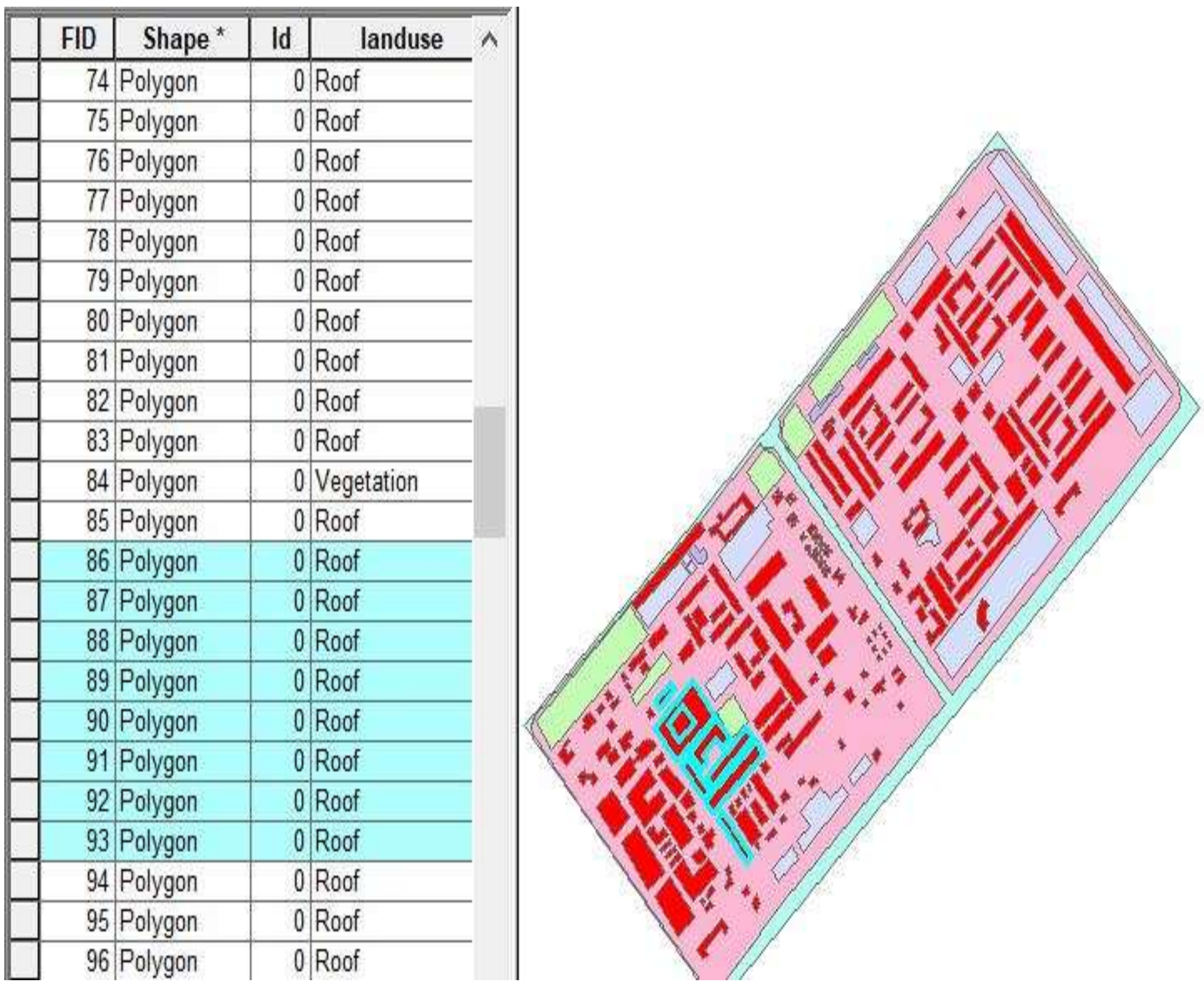
## Methodology

Data on households, climate, rainfall and temperature are collected from the related departments. Calculating the area and type of catchment occurring for the purpose of rainwater harvesting is rather tedious work and hence the GIS method has been adopted. The Google satellite image has been used for various types of catchments to digitize (Fig. 2). For the estimation of the possible rooftop runoff, average annual rainfall data is considered. Google Earth Pro digitized files are saved in the kml file format and exported to ArcGIS. In the GIS kml files, the shape file is converted and the area of each catchment available in the study area is determined to determine the total rainwater harvesting capacity of the study area. Runoff coefficient is a dimensionless factor that is used to convert the rainfall amounts to runoff. It reflects the integrated impact of catchment losses and thus depends on the existence of the surface of the soil, the slope, the degree of saturation and the strength of rainfall. It is also influenced by water table proximity, the degree of soil compaction, soil porosity, storage of vegetation and depression.

## Results and Discussion

The total area of concrete rooftop is calculated to be 331002.874 $m^2$. Apart from this area the area of concrete roads is found 117389.466 $m^2$. The total area of bare land is calculated 130641.314 $m^2$ (Fig. 3). The formula used to evaluate the amount of rain water harvested in any region is as follows:

Rainwater harvested = Rainfall X Area of catchment X Runoff coefficient



| FID | Shape * | Id | landuse |
|---|---|---|---|
| 74 | Polygon | 0 | Roof |
| 75 | Polygon | 0 | Roof |
| 76 | Polygon | 0 | Roof |
| 77 | Polygon | 0 | Roof |
| 78 | Polygon | 0 | Roof |
| 79 | Polygon | 0 | Roof |
| 80 | Polygon | 0 | Roof |
| 81 | Polygon | 0 | Roof |
| 82 | Polygon | 0 | Roof |
| 83 | Polygon | 0 | Roof |
| 84 | Polygon | 0 | Vegetation |
| 85 | Polygon | 0 | Roof |
| 86 | Polygon | 0 | Roof |
| 87 | Polygon | 0 | Roof |
| 88 | Polygon | 0 | Roof |
| 89 | Polygon | 0 | Roof |
| 90 | Polygon | 0 | Roof |
| 91 | Polygon | 0 | Roof |
| 92 | Polygon | 0 | Roof |
| 93 | Polygon | 0 | Roof |
| 94 | Polygon | 0 | Roof |
| 95 | Polygon | 0 | Roof |
| 96 | Polygon | 0 | Roof |

Fig. 2: Rooftop catchments map with attribute table

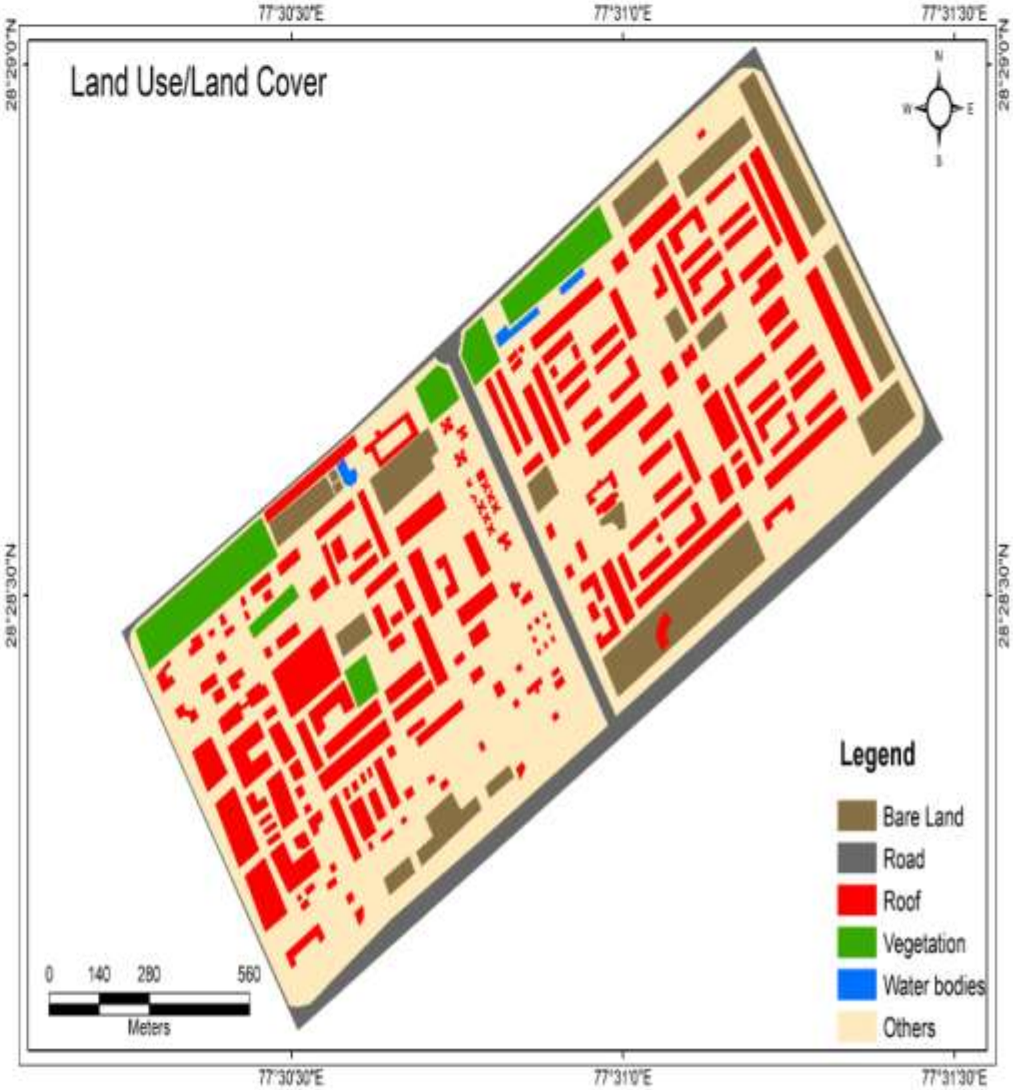



Fig. 3: Land use/ Land cover model of NIIT, Greater Noida

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**Table 1: Rainwater harvesting potential calculation of NIIT region**

| S.No | Different type of catchments | Area (A) $m^2$ | Runoff Coefficients (C) | Annual Rainfall (I) (m) | Volume of the water collected (Q=CIA) (cu.m) |
|---|---|---|---|---|---|
| 1. | Concrete Roof | 331002.874 | 0.95 | 0.600 | 188671.638 |
| 2. | Concrete Road | 117389.466 | 0.95 | 0.600 | 66911.996 |
| 3. | Vegetation | 67287.513 | 0.10 | 0.600 | 4037.251 |
| 4. | Bare land | 130641.314 | 0.3 | 0.600 | 23515.436 |
| | **Total** | **646321.167** | | | **283136.321** |

Volume of water collected from concrete roof = 331002.874x0.95x0.600

= 188671.638 $m^3$

Volume of water collected from concrete road = 117389.466x0.95x0.600

= 66911.996 $m^3$

Volume of water collected from vegetation = 67287.513x0.1x0.600

= 4037.251 $m^3$

Volume of water collected from bare land = 130641.314x0.3x0.600

= 23515.436 $m^3$

Total volume of water collected = 283136.321 $m^3$

## Conclusion

The present study has been carried out to assess the rainwater potential that can be harvested from the concrete rooftop, concrete road, bare land and vegetation. Google earth images are used for the digitization and georeferenced with the help of ArcGIS. It is clear that the quantity of water that can be harvested is adequate in the study area to resolve water scarcity. The total quantity of rainwater can be collected in the study area is around 283136.321 $m^3$. The best alternative for addressing water shortage in the study area is rainwater harvesting. At an accelerating rate, the levels of groundwater are depleting. This issue can also be addressed by groundwater recharging techniques.

## References

[1] Chenini. "Groundwater recharge study in arid region: An approach using GIS techniques and numerical modeling". Computers & Geosciences. 36, 801-817, 2010.

[2] De Winnaar, G., Jewitt, G.P.W. and Horan, M. "A GIS based approach for identifying potential runoff harvesting sites in the Thukela River basin", South Africa. Physics and Chemistry of the Earth, Parts A/B/C, 32 (15-18), 1058-1067, 2007.

[3] Dwivedi, Kumar, Arun, Bhadauria, Singh, Sudhir. "Domestic rooftop water harvesting- a case study" ARPN Journal of Engineering and Applied Sciences, 4(6), ISSN: 1819-6608, 2009.

[4] Hatibu, N. and Mahoo, H. "Rainwater harvesting technologies for agricultural production: A case for Dodoma, Tanzania". Kaumbutho P G and Simalenga T E (eds) (Conservation tillage with animal traction), 161-171, 1999.

[5] Jasrotia, A., Dhiman, S., and Aggarwal, S. "Rainfall-runoff and soil erosion modeling using Remote Sensing and GIS technique-a case study of tons watershed", Journal of the Indian Society of Remote Sensing, 30(3), 167-180, 2002.

[6] Kumar, Rohitashw. S., Agrawal, G. and Poonam, S. "Rain Water Harvesting and Ground Water Recharging in North Western Himalayan Region for Sustainable Agricultural Productivity", Universal Journal of Environmental Research and Technology, 1(4), 539-544, 2011.

[7] Radha, K. D. and Ramamoorthy P. "Delineation of Groundwater Recharge Potential zones in Mailam Block", Villupuram district, Using GIS. International Journal of Water Research Universal Research Publications. 2(2), 71-75, 2010.

[8] Ramasamy and Anbazhagan. "Remote sensing and GIS are playing a rapidly increasing role in the field of hydrology". International journal of pure and applied research in engineering and technology, 2(9): 21-34, 2014.

[9] Ravi Shankar, M.N. and Mohan, G. "A GIS based hydrogeomorphic approach for identification of site-specific artificial recharge techniques in the Deccan Volcanic Province". Journal of earth system science 114, 505-514, 2005.