Rainwater Harvesting To Improve Groundwater Level Using LU/LC Classification In Telephone Colony, Saroornagar, Hyderabad

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Abstract: The management and distribution of water has been centralized. People are much dependent on government system, which has collapsed the tradition of water harvesting system and has resulted in disruption of community participation in water management. As the crisis of water continues to be increasing day by day, direct reformation is being required in water management system. In this present scenario scientific and technological studies must be carried out for assessing the present status for suggesting the suitable mitigation measures (1). The urban regions are being paved and built, resulting in reduction of groundwater recharge area. Consequently, large amount of good quality water that rains over the cities is withdrawn from recharge as it is directed into the municipal drainage system. Moreover, in extreme rain events the drainage systems may be over-flooded which may lead to ecologic and economic hazards. This work reviews the history of rain water harvesting and discusses the impact of rain water harvesting in modern-urban environments on the hydrological system. Two types of rain water harvesting methods are being discussed and compared with the help of Land Use and Land Cover classification (LU/LC). LU/LC of telephone colony has been done., that indicates the rain water harvesting may increase the direct infiltration and can contribute to the ground water recharge .Water management and rainwater harvesting are increasing their prominence with the alarming growth in population and urbanization as well as severity in droughts (2). Land use and land cover leads to mitigating climate change which includes a forestation and modification of city building and organization and changing agricultural management practices to increase carbon in soil and to accelerate removal of carbon from the atmosphere.

IndexTerms- Water harvesting system, hydrological system, urbanization, a forestation

I. Introduction: Global warming and depletion of fresh water sources has increased the practice of rainwater harvesting (RWH). The scarcity of fresh water has resulted in the need to utilize and identify other sources of fresh water that could satisfy the growing water demand (3). The contamination of groundwater, has given rise to the necessity of groundwater recharge. RWH is the method of assembling and storing rainwater for later favorable utilization. With an increase in population, the water demand increases linearly. In every two decades the global water consumption becomes doubles the population growth rate. As an upshot, optimum and efficient management of fresh water are paramount to counter the concerns caused by the observed diminishing trends of the water resources (4). RWH is a tools used to collect, store and convey rain water for future use from reasonably clean surfaces like roof, land exterior or rock catchment. We can use this technique to recharge depending groundwater also. RWH structures are relatively cheaper as compared to other structures like Well, Canal, Dam and Diversion etc. It reduces dependency on well and other sources and provides soft, high quality water. Because of its low cost and simple execution in addressing the water emergency and other water-related problems, many specialists, non-specialists and academicians have promoted the use of RWH techniques (5). Collected rainwater is stored in ponds, tanks and underground storages of groundwater (fig no.1).

Fig.1

According, to World Bank report water scarcity will increase by 2050. The unique features of ground water render it appropriate for public water supply (6). It is broadly distributed and can be develop over and over again at points near the water demand, thus avoiding the need for huge water storage, treatment and distribution system. In many places the extraction of huge quantities of ground water has resulted in reduction of ground water, drying of wells, injured ecosystem, salt water intrusion, land subsidence and running down of the resources. Reduction and worsening of groundwater level and its quality is a growing concern for major cities and towns of the country (7). Being a Capital province, Hyderabad is facing comprehensive problems about availability, quality and quantity of water. The rapid urbanization and population growth in and around the city led immense pressure on basic emanate such as water supply. The rainfall pattern of a city is highly variable because of the climate and land mountain topography. The city is experiencing maximum dry and hot months and most of the area of city like telephone colony is facing water scarcity problem. Availability of land or open ground is shrinking day by day, which prohibit the ground water recharge in such areas. This work is an attempt to analyze the impact of rainwater harvesting on ground water quantity using LU/LC study of Hyderabad.

3. Methodology

3.1. Study Area:

Among the largest cities of India, Hyderabad holds 5^{th} position. It has twin cities - Hyderabad and Secunderabad. City is situated in 78º11’ N and 78° 27’ E. 542 Meters above MSL. Banjara hill is the highest point in the city, 623 mts above MSL.The contour level falls steadily from west to east creating almost a through near the Musi River which runs through the city. This natural feature has facilitated water supply by gravity. The area of study is telephone colony where RWH structures were installed by Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB), Telangana state government. Telephone colony has a spread of 20 acres of land at saroornagar, Hyderabad. Where 90% of area is built-up and 10% includes Nature Park and spitual places. Based on LU/LC classification of study area, it has been divided into seven zones for the installation of rainwater harvesting structures (fig -2).

Fig no -2, Identified area for RWH structures

City is experiencing maximum dry months with the varying humidity and temperature from 17%- 89% and 3º C to 48º C respectively (12). According to Meteorological Department the average rainfall is about 611.0 mm per year and evaporation recorded as 1.7 m. The Specific Yield varies in the study area from 16% to 20%.

3.2 Groundwater Status

Due to over exploitation of groundwater resources since the number of tube well and minor spacing between them has increased and also because of the less infiltration, due to amplification in covered areas by buildings road networks etc, the water level has been taken a declining trend. Most of RWH structures are made on land used areas which cannot contribute much in ground water recharge and maximum rain water is going in storm water drain, assembling in major drains and ultimately joining Musi River- by virtue of which Musi gets flooded and this decreases the recharge potential of groundwater. All these forbade aquifers to saturate sufficiently, which is affecting the quantity and quality of groundwater.

3.3 Materials

Satellite Data

- Landsat Thematic Mapper (Enhanced Thematic Mapper) data for Land use/Land cover map.

Ancillary Data

- Topomaps to prepare Base map, DEM, Stream Network, watershed map
- Soil Map from NBSSLUP.
- Rainfall data from Bureau of Economics and Statistics department.
- Geomorphology Map
- Land use / Land cover Map

Software used - ArcGIS9.3

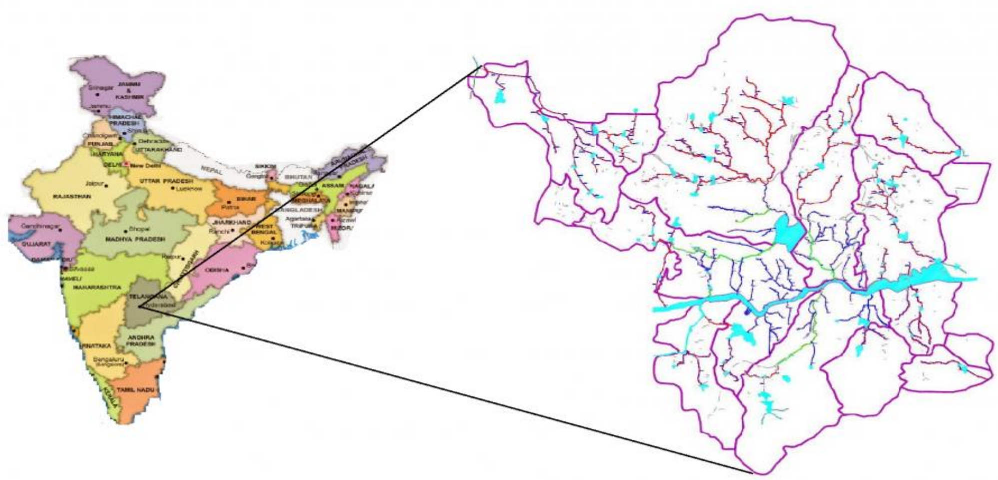


Fig. 3 study area

Thematic Layers Geo Referencing and Creation of Spatial Database

Toposheets of study (56 K/7NE, NW, SE, SW) area has been taken from survey of India and scanned. Thematic layers like drainage network stream ordering, settlements and contours are created after georefrencing and rectification of toposheets.

Soil Map

Soil map of study area has been taken from NBSSLUP (National Beuro of soil survey land use planning).

Types of Soils in study area

Loamy Soils, Clayey Soils, Stratified loamy Soils, Gravelly loam soils. 55 soil Unit is the major leading soil unit in the area. 41 soil unit is jacketing least area.

Drainage Network Map

With the help of drainage network toposheet, stream ordering map has been prepared for the study area. Four orders have been identified, Table 2.

Soil units	Area in sq km	% Area
10	30.09	14.4
19	3.96	1.90
41	2.91	1.40
55	165.33	79.55
Water Bodies	5.50	2.64

Table 1.

Sl no	Stream order	Length in meters
1	1st order	95565
2	2nd order	48718
3	3rd order	18610
4	4th order	8725

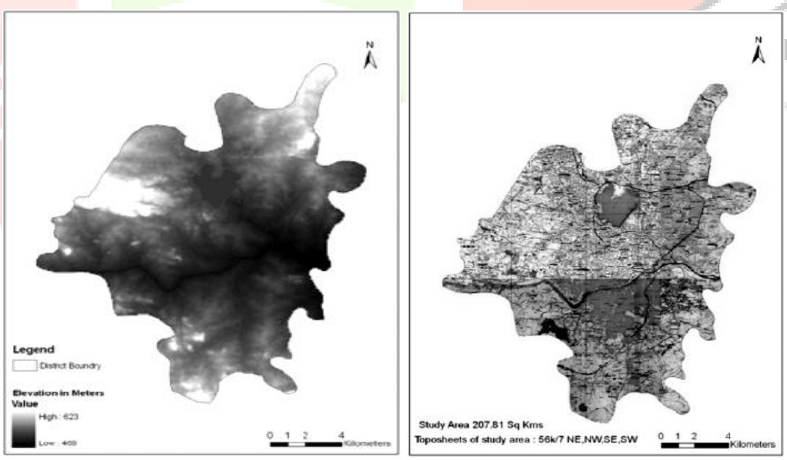
Table 2. Stream Ordering Map

Taking various attribute, like tone, texture, size, shape, location and pattern, in consideration image interpretation was done and LU/LC limits were demarcated as polygons. The cynical areas were marked for ground proofing. Care was taken to envelop all types of features acknowledged on image.

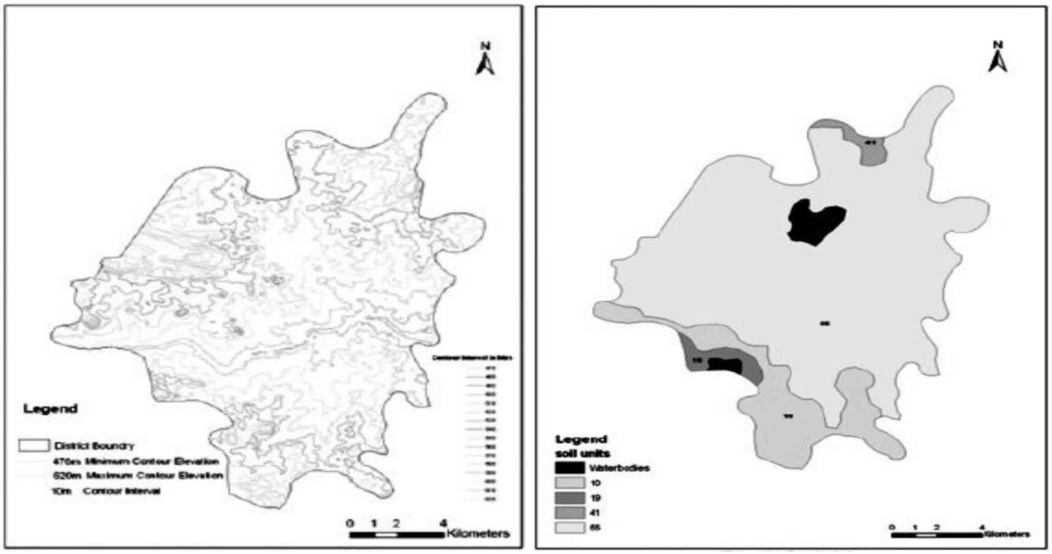
Sno	Description	Area in sq km	Area in %
1	Open area	7.44	3.5
2	Open area+settlements	19.51	9.30
3	Parks+ settlements	1.65	0.79
4	Settlements	148.09	71.28
5	Land with scrub	10.36	4.98
6	Rivers/tanks/Lakes	12.60	6.06
7	Others	8.1	3.89

Table 3. Land use/Land cover map

DEM of the study area has been taken from NRSC .Based on map, slope ranges has been defined which helps in identifying the flow of water in particular zone(8).



DEM and Subsetted Toposheets of Hyderabad



Contour and Soil map of Hyderabad

3.4 Methods

In addition to the general information on topography , LU/LC, drainage pattern ,vegetation, soil texture and profile , ground water knowledge of geology is the first and foremost priority given in this study .Ground water potential of a area is controlled by the lithography, climate, topography and recharge. LU/LC data of study area has been taken from NRSC (National Remote sensing Centre) and the possible places for installing rainwater harvesting structures have been identified. The area experiences semi-arid climate and the effects of temperature on evapotranspiration are rather extensive. The depth of water table at telephone colony, saroornagar is 8 to 12 meters below the existing ground level. Water table depth is less in the northern part of the colony and it increases towards the south. Northern part of colony experiencing drying of tube wells. To overcome this water scarcity problem, RWH structure has been installed in many houses (fig.4). Many times HMWSSB did artificial recharge to shoot the problem.

Fig 4. Individual RWH structure

Making RWH structure at roof top or somewhere in house will not be a permanent solution for this problem. Open area of low water table has been identified with the help of LU/LC and installment of RWH structures has been proposed (fig. 5).

Fig.5- Open area of low water table, where RHW structure has been made

To increase the ground water level, more storm water has been collected and stored in a tank. Well connected pipe is fitted from the tank to RWH structure (fig 6). Maximum utilization of storm water can be done in this way.

Fig 6

4. Result and Discussion

The rainwater harvesting system suggested for telephone colony is designed for rooftop and open space harvesting by adopting injection well method. The design of shaft, ponds and foundation are given in Figure 7. The Location of proposed Injection Wells for Rooftop Harvesting and Open Space Harvesting has been taken from LU/LC. The double - bore well harvesting structures is used for open space harvesting with the pipe diameter of 4 inches. Rainwater harvesting structures are designed with filter media (9).

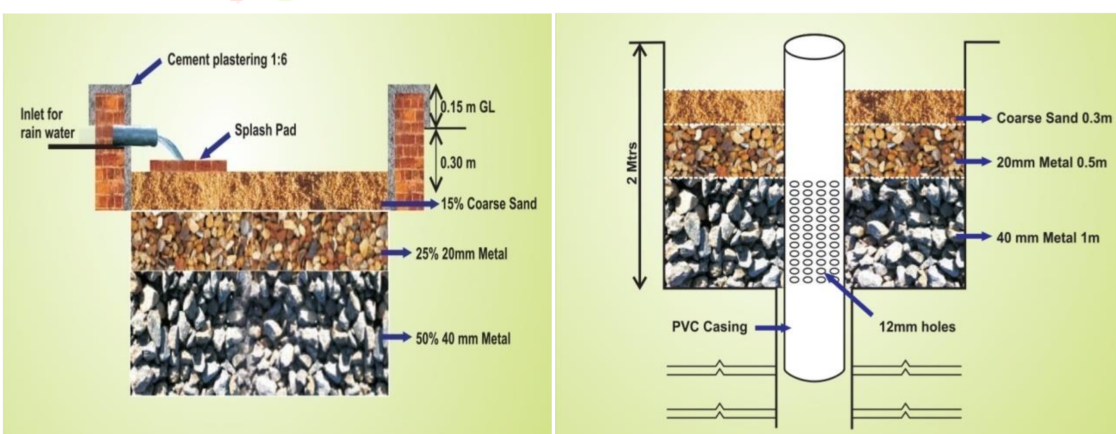


Figure. 7

4.1 Computation of additional recharge to ground water

Factors considered for roof top assortment of storm water and its diversion to recharge designed for 100 m^2 individual house and 500 m^2 apartments are Rainfall 20 mm in single event , Roof top area, and Total annual rainfall about 780 mm (11).

Percent of rainfall considered for harvesting is 70% of annual rainfall, 550 mm. (780/20*2000=78000; 78000*70/100=54600 or say 55000)

Sl no	Description	Apartments	Individual houses
1	Roof top area	500 m^2	100m^2
2	Available roof top water for 20mm rainfall	10m^3	2.0m^3
3	Available rooftop water for additional recharge per annum @ 70% of total annual rainfall	275m^3	55m^3
4	Available rooftop water for additional recharge from 2000 houses of 100 m^2 each		1,10,000 m^3

As a result, the storm water harvested from every house of 100 m^2 of roof area (55 m^3) can satisfy the demand of five members for 100 days @ 110 liters / day / person.

5. Conclusion and Future Scope

Entire vector layers are converted into raster by overlaying all thematic layers. Constant cell size has been maintained for all the layers. The thematic layers are LU/LC, Drainage network, soil map and Geomorphology. This reflects that the result can be effectively used in the analysis of ecosystem at watershed level and is very particular for analyzing the site suitability for various rainwater harvesting structures. The project will cut down the time spent on investigating of catchment area and on conventional survey to recommend the RWH structure. The site suitability map of an area can also be prepared (10) in future which can help field staff in locating the site for harvesting structure on the field. This project can be used in the field in such a way that the utilization of funds will become optimum and the level of confidence in execution of works at lower level field staff will increase.

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