



RAINWATER HARVESTING A CASE STUDY OF PRATEEK GRAND CITY, GHAZIABAD, U.P.

Dileep Kumar*

Environmental Engineering Student, Rain Water Harvesting, India. *Corresponding Author

**Anupam Kumar
Gautam**

Asst. Professor, Department of Environmental Engineering, Maharishi University of Information Technology Lucknow, U.P..

ABSTRACT As per current situation the whole world population increasing rate is very fast, the demand increases for quality drinking water. Surface and groundwater resources are being utilized faster than they can be recharged. Rainwater harvesting is a practice that is being adopted by many nations as a viable decentralized ground water source. National Capital Region is water scarce region. The rainfall is irregular in nature. Ground water and river are major source of water and that's why ground water is declining day by day. It has resulted in the alarming depletion of ground water level & drastic deterioration in ground water quality. In Delhi National Capital Region average rainfall is below normal rainfall. This research paper describes a collaborative & development of affordable technologies for capturing & retaining runoff including that from roof tops, green and roads using this as a valuable sources of water and artificially recharge the water by the percolation well and ultimately increase the under ground water level. This technique can be helpful as a valuable water source infuture and resolve the problem of water for coming generations.

KEYWORDS : Rainwater harvesting; Ground water recharge; Roof top rain water, Paved area rain water and green area rain water.

INTRODUCTION

Rain water harvesting is the method of accumulation, collection & deposition of rainwater for reused before it reaches the natural ground water aquifer. Around third century BC, the farming communities in Baluchistan & Kutch use rainwater harvesting for irrigation purposes. In Delhi NCR region, rainwater harvesting was made compulsory. Rain water harvesting means collecting the rain water from the roof top or building, open space surrounding the buildings, greens-areas, etc by the rain water pipe network. And then storing it for a later used or diverting it to existing rain water harvesting well for recharging in ground water aquifer. Generally two type of water tanks are utilized- underground water tank and over head water storage tank. Individual rainwater harvesting systems are one of the many tools to meeting the growing cumulative drinking water demand. Rainwater harvesting is an environmentally good sound solution to solve issues brought forth by large projects utilizing centralized ground water management approaches. Population growth all over the world is causing similar problems and concerns of how to supply quality of drinking water to all. There is now increasing interest in the low cost alternative- generally referred to as 'Rain Water Harvesting'. Rain Water harvesting is the activity of direct method of collection of rainwater, which can be stored for direct use or can be recharged into ground water. Water harvesting is the collection of runoff for productive purposes uses.

According to Kim et al. (2005), rainwater harvesting may be most of the best methods available to recovering the natural hydrologic cycle and enabling urban development to become sustainable. The harvesting of rainwater has the potential to assist in alleviating pressures on current water supplies and storm water drainage systems. Rainwater collection has the potential to impact many people in the world. Demand for water is growing in most cities 7 rural area as every urban citizen requires almost double the amount of water that a rural citizen requires. Moreover, India is rapidly urbanizing. Urban population in India has grown almost five times in five decades from 1951 to 2020. Not long ago, most of our cities were self-sufficient in meeting their water needs from the extensive urban water bodies to supply domestic water to citizens. Today these water bodies have completely disappeared. Rain water harvesting is practical only when the volume and frequency of rainfall and size of the catchment surface can generate sufficient water for the intended purpose.

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Need of Rain water Harvesting:-

- As water is becoming scarce, it is the need of the day to attain self-

sufficiency to fulfill the water needs.

- As urban domestic water supply system is under tremendous high pressure for supplying water to ever increasing the population.
- Groundwater is getting depleted and contaminant.
- Soil erosion resulting from the unchecked runoff.
- Large numbers of Health hazards due to consumption of polluted water.

Advantages of Rain Water Harvesting:-

- Provision of supplemental domestic water
- Increasing soil moisture level for urbangreenery areas.
- Increase Ground Water table (by artificial rechargewell)
- Mitigating urbanflooding by nature.
- Rainwater is a comparatively clean and totally free source of pure water.
- It can supplement other sources of water supply such as groundwater or municipal line water connections.
- It lower the water supply present cost.
- It can provide an excellent back-up source of water for emergencies services.
- It is socially acceptable and environmental esponsible for the same.
- It uses simple technologies that are inexpensive and easy to maintain the system.
- It is used in those areas which face insufficient water resources in India.
- To meet ever increasing demand for water in urban areas.
- This is an ideal solution of drinking water problem where there is inadequate ground water supply or surface resources are either lacking or insignificant.
- To utilize the rainfall runoff, which is going to sewer or storm drains lines.
- Rainwater is pure, free from organic matter and soft in natural minirals.
- It will help in reducing the flood hazard in cities.
- To improve the quality of existing ground water through dilution of water.
- Rainwater may be harnessed at place of need and may be utilized at time of need & emergency.
- The structures required for rain water harvesting the rainwater are simple, economical and eco-friendly method.

The drainage system shall be led to various percolation wells catering to different parts of the catchments area. Silt traps will be provided at inlet to each percolation well. The overflow from percolation wells will either be inter connected or will be pumped to the existing storm water disposal line.

Disadvantages of Rain Water Harvesting:-

- Unpredictable rainfall-Rainfall is hard to predict and sometimes

little or no rainfall can limit the supply of rainwater

- Initial cost of rainwater harvesting system is too much high.
- Regular Maintenance- Rainwater harvesting systems require regular maintenance as they may get prone to rodents, mosquitoes, algae growth, insects and lizards.
- Certain types of roofs may seep chemicals, insects, dirt or animals droppings that can harm plants if it is used for watering the plants.
- Storage limits- During the heavy downpour, the collection systems may not be able to hold all rainwater which ends in going to drains and rivers.

Methods Of Rain Water Harvesting:

Roof-top Rainwater Harvesting:-

Rooftop rain water harvesting is the technique through which rain water is captured from the roof catchments and stored in sub-surface ground water reservoir. The main objective of rooftop rain water harvesting is to make water available for future use. Capturing and storing rain water for use is particularly important in dry-land, hilly, urban and coastal areas. The first rain drains the dust, bird droppings, leaves, etc. which are found on the roof surface. To prevent these pollutants from entering the recharge well, the first rain water containing the debris should be diverted or flushed. Screens are also provided to retain larger debris such as leaves can be installed in the down and vertical pipe system.

Surface Rainwater Harvesting:-

The storage of rain water on surface is a traditional technique and structures used are small dams, ponds, tanks, lakes etc. Check dams are constructed in natural channels to impound the runoff water up to certain depth in the channel the excess water is allowed to flow over the dam. The impounded water slowly infiltrates into the soil and recharges the ground water aquifer. Storage reservoirs for rainwater harvesting are surface or above ground tanks and sub-surface or underground tanks. The storage reservoir is usually the most expensive part of the rainwater harvesting system such that a careful design and construction is needed. The reservoir must be constructed in such a way that it is durable and watertight and the collected water does not become contaminated.

Artificially Recharge The Wells(ground Water Recharge Well):-

Recharge to ground water is a new concept of rain water harvesting and the structures generally used are: pits, trenches, dug wells, hand pumps, recharge shafts, lateral shaft with bore wells, spreading techniques, underground reservoirs.

Description Of Study Area

Prateek Grand City is located at distance of 10kms from Ghaziabad Railway Junction, state-Uttar- Pradesh (India). Prateek Grand City is just on the outskirts of Ghaziabad. The population of township is around 22500. Entire Prateek Grand City contains 25 acres. Entire Township is divided in two phases but, currently we are study only Phase-1. This sector holds various types of buildings 1BHK, 2BHK, 3BHK, Mercantile, Medical facilities, Club House, Police Chowki, Gym centre, etc. This city is unique to compare to another project at located in Ghaziabad district or NCR region.

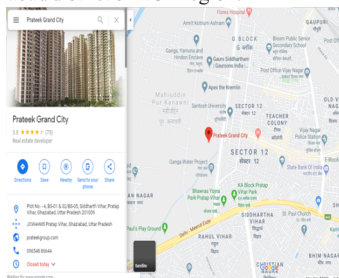


Fig-1 Location Of Study Area (Source: Google.map)

Table-2 Monthly Average Rainfall Data Of Ghaziabad

| Sr.No | Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-------|------|-----|-----|------|-----|-----|------|-------|-------|-------|-----|-----|-----|
| 1 | 2015 | 29 | 22 | 16.2 | 8 | 11 | 52.2 | 191.2 | 213.9 | 115.2 | 22 | 4 | 8.2 |
| 2 | 2016 | 20 | 12 | 13.2 | 10 | 13 | 46.2 | 201.2 | 215 | 110 | 18 | 7 | 12 |
| 3 | 2017 | 30 | 20 | 17 | 6 | 16 | 55 | 203.2 | 221 | 109 | 22 | 9 | 7.2 |
| 4 | 2018 | 27 | 15 | 21 | 12 | 15 | 63 | 165 | 214 | 110 | 22 | 5 | 11 |
| 5 | 2019 | 29 | 22 | 16.2 | 8 | 11 | 52.2 | 191.2 | 213.9 | 115.2 | 22 | 4 | 8.2 |



Fig- 2 ,Prateek Grand City, site plan.(Source: www.prateekgroup.com)

Total Terrace Area of Phase-1 = 5000Sq.m
 Total Road Area of Phase-1 = 22000Sq.m
 Total Landscape Area of Phase-1 = 50000Sq.m
 Total Area of Phase-1 = 77000Sq.m

The total area of roof top of all buildings in Prateek Grand City is 5000Sq.m and average annual rainfall in NCR region is 695mm. Prateek Grand City is 15 kms away from the National Capital Delhi, so there is no any water supply from Municipal of Ghaziabad. There is no any reliable source of water in Prateek Grand City. So there is need to dug a private bore wells in Prateek Grand City. But day by day buildings are constructed and population of city are increasing as faster way. Due to this, water demand is also increase.

Population:

So, in next 3 year the population of Prateek Grand City is increase in this manner:-

Table-1 Population Data

| Sr. No. | Years | Population |
|---------|-------|------------|
| 1 | 2020 | 10000 |
| 2 | 2021 | 20000 |
| 3 | 2022 | 22500 |

Source:-Prateek Grand City.

So, in future the city will face large water problems. Because ground water is depleted too much due to increase in water demand day by day So, to solve this problem Rain Water Harvesting is an only low cost harvesting technique to resolve this problem of drinking water for coming future.

Rainfall And Climate:

Ghaziabad, UP has a tropical wet and dry climate with three main seasons: summer, monsoon, winter. The climate is generally dry and hot outside of the monsoon season. The weather is hot to severely hot from March to June when maximum temperature is 46°C and minimum temperature is 03°C.

The rain fall data of last 5 years is:-

(Sources:-Hydromet Division, New Delhi Indian Meteorological Department)

Total average annual rainfall of Ghaziabad = 695mm

WaterDemand:-

As per IS Specification NBC-2016 (IS 1172: 1993), Total water demand for one person = 135lit/day

Total water demand= 135*4500*5

Annually total water demand= 365*135*4500*5

Annually total water demand= 1108687500 lits

Rain water harvesting system:-

1. Catchment area
2. Coarse mesh / leaf screen
3. Conduits or pipes
4. Storm Drainage Network (Road Network)
5. Rain Water Percolation Well tank.

- Catchment area is the surface on which the rain Water falls. In this study all building's roof and all roads are taken as catchment area. This water can be used for recharging ground aquifers after proper filtration.
- Coarse mesh / leaf screen is used to prevent the entry of leaves and other debris in the system.
- Drainage system shall be designed on the parameters setup by the metrology department and various statutory codes. Surface drainage consisting of surface drains and underground storm water disposal pipes will be provided so that there is no accumulation of rain water. In addition to this Rain Water Harvesting and Ground Water Recharge structures will also be provided to make optimal use of the rain water so collected.



Fig-3 Prateek Grand City, site .(Source:- site visit)



Fig- 4 Actual pipe network in building (Source:-Prateek Group site visit)

- Rain Water Pipe can be of any material like PVC, uPVC, GI or cast iron. In every building pipe network is such that, all the water from roof of buildings can collect and flow on road surface as a drainage way. In Prateek Grand City all roads levels are maintained such that water can flow by gravity from higher elevation to lower elevation.
- Conduits are pipelines or drains that carry rainwater from the catchment or rooftop area to the harvesting system. Commonly available conduits are made up of material like polyvinyl chloride (PVC) or galvanized iron (GI).



Fig-5 External Drain Network Of Prateek Grand City (source:- site visit)

- Drainage Network is the network of road which can permit the easy flow of rainwater.
- Percolation well is the well which collects rain water and stores it as a ground water. Percolation tanks are artificially created surface water bodies, submerging a land area with adequate permeability to facilitate sufficient percolation to recharge the ground water. These can be built in big campuses where land is available and topography is suitable.
- Surface run-off and roof top water can be diverted to this tank. Water accumulating in the tank percolates in the solid to augment the ground water. The stored water can be used directly for gardening and raw use. Percolation tanks should be built in gardens, open spaces and roadside green belts of urban area.



Fig-6 Actual Percolation well at site (Source:-Prateek Grand City)

In Prateek Grand City in Phase-1 there are presently 22 Percolation well. Which collect all surface water and store it into ground water. There are in Prateek Grand City which also collect rain water through road network so all the water are flow into direction towards main percolation well. So that's way ultimately main percolation well should be recharge.

Calculation:-

Total Area of Phase-1 A = 77000Sq.m

Artificial recharge to ground water is a process by which the ground water reservoir is augmented at a rate exceeding that obtaining under natural conditions or replenishment. Any man-made scheme or facility that adds water to an aquifer may be considered to be an artificial recharge system. Based on the above factors, the water harvesting potential of site could be estimated using the following equation:-
 Rain Water harvesting potential = Amount of Rainfall * Area of catchment * Runoff coefficient

Table 3:- Runoff Coefficient Table

| Area description | Runoff coefficient (K) |
|------------------|------------------------|
| Roof Top | .75 to .95 |
| Paved | .65 to .75 |
| Green | .15 to .25 |

Rain Water Harvesting By Terrace Areas:-

Total Terrace Area of Phase-1 A = 5000Sq.m
 Average Annual Rainfall in mm I = 693.3mm = 0.693 m
 Runoff co-efficient for a flat terrace C = 0.8

Annual water harvesting potential through out of a terrace = C*I*A
 = 5000 * 0.693 * 0.80

= 2772 Cubic meter
= 2772000litrs.

Rain Water Harvesting By Surface Drainage:-

Total Road Area of Phase-1 A = 22000sqm
Average Annual Rainfall inmm I = 693.3mm = 0.693 m
Runoff coefficient for a R.C.C road C = 0.7

Annual water harvesting through total Surface drainage = $C * I * A$
= $22000 * 0.693 * 0.7$
= 10672.2Cubicmeter
= 10672000 lit

Rain Water Harvesting By Landscape/ Green Areas:-

Total Road Area of Phase-1 A = 50000sqm
Average Annual Rain fall inmm I = 693.3mm = 0.693 m
Runoff coefficient for a R.C.C road C = 0.15

Annual water harvesting through total Surface drainage = $C * I * A$
= $50000 * 0.693 * 0.15$
= 5197.5meter
= 5197500 lit

Annually Total Rain water Harvesting

Annually Total Rain water Harvesting = Total Rain water harvesting
By Roof-top + Total Rain Water harvesting

By paved/ road areas + Total Rain Water harvesting By Landscape
areas.
= 2772000 + 10672000 + 5197500

Annually Total Rain water Harvesting = 18641500Ltrs.

RESULT & ANALYSIS

Here we study only for Phase-1. Which collect annually 18641500Ltrs. water and this much amount of water can be absorbed by 23 percolation well and if there is high intensity of rainfall then excess.

Amount of runoff can be flown towards the main percolation well through the road network as shown in figure-5 (A, B). So this way we can harvest the rain water and increase the ground water.

We can harvest annually 18641500Ltrs. water which is approx 2% of total water demand. So by using Rain water harvesting methods we can harvest and store the rain water into ground aquifer or into percolation well.

Benefits of rain water harvesting by recharging well:-

- This is an ideal solution of domestic water problems where there is inadequate ground water supply or surface resources are either lacking or insignificant.
- To utilize the rainfall runoff, which is going to sewer or storm drains lines.
- Rainwater is bacteriologically pure, free from organic matter and soft in natural.
- It will help in reducing the flood hazard of the city.
- To improve the quality of existing ground water through dilution.
- To remove bacteriological and other impurities from sewage and waste water so that the water is suitable for use.
- Rainwater may be harnessed at place of need and may be utilized at time of need.
- The structures required for harvesting the rainwater are simple, economical and eco-friendly system.

CONCLUSION

We can see that, we can obtain 18641500 liters of water annual. One of the most logical steps towards this goal would be acknowledging the importance of the rainwater harvesting system. This should not only encompass rooftop rainwater harvesting system but also storm water harvesting systems. Hence, an equal and positive thrust is needed in developing and encouraging the rain water harvesting systems. We have to catch water in every possible way and every possible place it fall. It can be concluded from above findings that rainwater, if conserved and utilized using the rainwater harvesting technology and system, can be an effective tool of replenishing the ground water natural resources. We can harvest totally annually 18641500 liters water which is 2% of total water demand of the society. So by using Rain water harvesting methods we can harvesting and storing the rain water into natural ground aquifer or into percolation well systems.

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