A REVIEW ON RAINWATER HARVESTING IN CHANDIGARH

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Abstract- Water is the most vital natural resource which is either mistaken for its abundance or miscalculated for its presence. With the advancement in every sector of technology there is still a least investment of minds in developing water synthetically using substances other than water at a rate consumer can pay to, hence the only way for water security is to collect, restore, reduce and reuse water for a synchronized and sustainable utilization of water. Water is hence an essential resource depleting far from its existing natural state. Its overexploitation and wastage has put many regions in a state of stress and more than a billion populations is suffering from the water scarcity. Urbanization abruptly has put even more pressure on the water feeding deep underground wells and canal systems. This all together with more erratic construction of paved cities and infrastructures engendered water shortage, drying of underground wells as well as non economical method for water transportation by means of canal systems and pumps. A suitable method to overcome this is rainwater harvesting, which is a technique of collection and storage of rainwater into natural or manmade storage tanks. This technique has been proven in many sectors across various parts of the world, in rural areas it helps in improving the crop production and ultimately food security. And in urban sector it secured households and communities by improving the water supply. The rainfall capturing is a traditional practice and many further improvements have been made scientifically in technology for solutions in water scarce regions where climate is totally arid and receives rainfall less than 200 mm per year resulting in more efficient and managed water distribution and savings.

1. INTRODUCTION

Rainwater harvesting or collection of monsoon showers for future utilization has been proven since ages but it is becoming strongly practiced method all over world from the last 4 decades. The advancement in the research and technology in terms of filtering, disinfecting, collection and storage has led to better and more capable rainwater harvesting systems where many sectors are now less dependent on the municipal fed water supply for domestic and commercial water needs.

Shivalik mountain range is sitting crown in the northern hemisphere of India and in the footsteps of these hills lies Chandigarh, the first developed city of India. Developed over an area of 114sqkm this union territory receives about 700-1200mm of annual rainfall, i.e. 900mm on average. Around 75-80% of what is received as precipitation goes out as surface runoff in water removal structures. With an estimated decennial population growth 17.19% and hasty overexploitation of water and nearly drying underground wells, the city needs a disparate approach for water solutions.

With the help of rainwater harvesting recharging, retention and reutilization of the rainwater can call forth to more sustainable approach of water management in Chandigarh. This city depends upon the 200 wells feeding the overall population of the city and the augmented water from the Beas channel.

With rainwater harvesting structures specifically designed for small buildings and markets which covers most of the area of individual sectors, the additional pressure on the wells for water pumping can be limited and various areas can be developed where the rainwater can recharge those wells, the parks or the green areas can also be helpful in recharging with right plant choice. This will also help in finding adequate zone for water harvesting catchment and storage

2. LITERATURE REVIEW

Boers & Asher (1981) addressed the design aspects of MCWH befitting the size of collecting area and layout to the contributing area owing to kinematic wave equation and dynamic equation with picturing the rainfall inducement and collection. The advantage of MCWH over RFWH is that threshold retention is much greater than RFWH and has high specific runoff yield than other small catchments whereas RFWH is limited to just farming and agro based needs. The factors determining the various features of MCWH and RFWH are determined for model development IB and SR

Goel & Kumar (2004) proposed a generalization to find the best suitable economic analysis of watershed in rain water harvesting. The purpose was to increase the agricultural productivity and minimize soil erosion I the mountainous region of India. With an estimated life of water retaining structures of different sizes ageing 25 to 40 years, the ratios were found out to be 0.41 to 1.33. The PVANR i.e. valuation of construction and maintenance for present value was $215/ ha. Made on the basis of sizes and the value decreased with the increase in the size of the structure. It was projected that the overall expenditure projected was around 15.15-2.20 m US$ and the net income from the proposed catchment plan would be around 1.18-3.86 m. hence it underlined that projected cost will be recovered in 13.17 years if the minimum life span of structure is 25 years.

Gupta & Sisodia (2019) showed that how the rain water can be used for different purposes and how its utilization can decrease load on the underground aquifers. The area of design was in a university in a semi-arid region of Rajasthan which receives rainfall less than 669 mm annually. The study was conducted over three surfaces concrete roof, hard pavement and garden respectively and was found that the overall system was efficient 70% for the concrete roof, 60% for the hard pavements for total rainfall. To predict the exact amount of water collected and its efficiency adequate runoff coefficients according to the surface and its material are selected. In the analysis, the system improved 10% of the daily inefficiency per student in the summer for around 4 months.

Helmreich & Horn (2008) gave general model of the RWH in semi-arid region n of sub Saharan Africa where discrete water flow components are used for the rainfall partitionings. The soil evaporation accounts for 30 50% of the losses and 10 to 25% is surface runoff whereas the surface runoff is subsequently increased when the surface is hard and paved. It was then combined with the statistical data depicting the demand satisfied with the tank size and was found that the graph tends to get linear with the increase in the size of the tank.

Jasrotia et al. (2009) proposed a method for a water balance approach of rain water harvesting using GIS techniques and remote sensing techniques. Judicial of the depleting and limited fresh water resources the study was conducted in Devak rui watershed in J&K where the remote sensing and GIS approach was taken to resurface information about watershed boundary drainage and network boundary by the integration of land use map a defined map was laid out to redefine RWHS by mapping the soil texture, runoff potential and slope and contours of the region. The Thornthwaite and Mather's model was used to determine runoff and actual evapotranspiration. The overall data was then presented as monthly variation of precipitation, potential evapotranspiration, actual evapotranspiration and runoff

Jothiprakash & Sathe (2009) determined the number of structures and the suitable RWH method by the application of analytical processes such as analytical hierarchy process determining volume of water to be stored using mass balance method ripple diagram method, analytical method and sequent peak algorithm method. The research is also elaborated by considering economy in action if the site is considered with the site size and all the other parameters the recharging of groundwater will be the best suitable option. The area of study is a large automobile factory in Nasik Maharashtra India which has a large area of catchment. It was identified by the process the identical volume was 55000m^3 resulting in four RCC cubical tank of 4m height as an appropriate choice for the catchment.

Kadam et al (2012) identified the RWH sites in part of Deccan volcanic province, India using SCSCN method which showed the high runoff potential from water body agricultural land followed by settlement open forest areas. Physical parameters were also considered for identification of structures. The study area described the hydrological soil group with physical features specific to site such as slope and runoff. It resulted in average accuracy of SCSCN 86.25% considering various structures accuracy.

Kumar et al. (2006) considered the critical issues for basin planning and research for rain water harvesting identifying them as water supply potential in water scarce regions, complexities in assessment due to deficiency of inflow runoff data evaluation of RWH, maximizing the hydrological benefits and cost benefits trading hydrology, optimizing upper and lower water basins, improvement in locally harvested water and reduction in the utilization of augmented water integrating the surface-ground water. The paper shadows the dark regions where economic evaluation of the water harvesting system poses several complexities on the basis of economic studies where problem is in quantity of hydrological benefits and directed to view of action where water harvesting can be made efficacious by developing better catchment hydrology, improving wet saving and enhancing green water for harvesting.

Mishra & Tembhurkar (2018) discussed the application of filters such as sand and foam filter in combination for rooftop RWHS in buildings such that the water shortage and scarcity can be minimized with sustainable approach in storing and collection of water for the needs of future. The area selected was a girls hostel building in VNIT Nagpur campus covering 4980

m^2. The per capita consumption of water in a day was calculated in litre/day for all activities washing, cleaning and flushing. According to the experiments, it was found that the dual media filter combination is acceptable for treating rainwater with addition of little disinfectant like chlorine during its utilization. From experiments it was found that in this dual media filter single layer of foam works better than double layers.

Patel et al (2014) defined the process of collecting and storing the rainwater and use it for domestic use in the S.P.S.V. campus and analyzed the problems with current distribution system and water use at campus. The average monthly rainfall data was stipulated in tabular form to generate the data for hydrological analysis, volume of runoff per year, rainfall potential & catchment area of building. It was found that the RWH project on the campus can fight water scarcity and can reap benefits from financial point of view.

Rahman et al (2010) examined the sustainability of rainwater collection by harvesting in multi storey apartments taking a hypothetical approach to create various scenarios related to site area and floor arrangement. The water demand was assumed that it would be only used for flushing laundry and irrigation. The life cycle costing was developed assuming material cost, maintenance and operation cost. The operation cost was estimated following pump running time and pump operating cost. It was possible to achieve "payback" under most favorable financial condition and the benefit to cost ratio is smaller with the BASIX approach than non BASIX approach.

Shrivastava et al (2019) purposed design of the rooftop harvesting system in a sea coast high rainfall zone of south Gujarat, due to nearness to the sea the area suffers ingress water supply and overexploitation of the groundwater. The study is a four year extensive and the water studied is stored for more than 2 years for physical chemical and micro bacterial quality assurance. The roof water was collected from 6 rooftops of the campus measuring around 3085m2 in total. In the first year of study it was concluded that the water's physically had peculiar rotten smell and black residue carbon from atmosphere. The chemical quality of harvested water using RBD methods showed that the quality of water in terms of TDS is far better than ground water i.e. 1440tds. The micro bacterial quality of the water in terms of MPN of faecal coliform/100ml was observed to be less than municipal water supply however it increased with the first year of storage and then decreased extensively due to enclosed conditions of the tanks. The efficiency of different bacterial removal methods was also studied with an achievement where E.coli bacteria was not found out in any treatment

3. METHODOLOGY

The methodology that will be followed for the economic social as well as long term benefits of rainwater harvesting in the city of Chandigarh are as followed

Step 1: Design of the site suitability map

Step 2: The areas of interest

- 2.1 Collection of Data
  - 2.1.1 Rainfall Data Collection
  - 2.1.2 Calculation of catchment area

Step 3: Reviewing the ground water in the site
Step 4: Analysis for selection of catchment
Step 5: Storage and conservation of water
Step 6: Optimum design of the tank
Step 7: Detail analysis & designing of rainwater harvesting system component
Step 8: Water quality for treatments and potential water related diseases
Step 9: Results
Step 10 Benefit-Cost ratio projected

4. CONCLUSIONS

It is absolute with the review of literature that water as an essential resource for survival is depleting day by day, the most efficient and easiest method is to harvest it for reutilization and ground water recharge. It is clear with the experiments and studies conducted that if water is properly stored after harvesting the quality of the water remains same and basic applications can be used to remove impurities from the water. Further it is observed that it all depends upon the catchment area selected e.g. roof, parking etc. A suitable rainwater harvesting design can help in meeting a city's future needs and boost the economic productivity of the city.

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