International Journal of Research and Review
www.gkpublication.in E-ISSN: 2349-9788; P-ISSN: 2454-2237

Review Article

Review on Studies, Research and Surveys on Rainwater Harvesting

Sunil J. Kulkarni

Datta Meghe College of Engineering, Airoli, Navi Mumbai, Maharashtra, India.

Received: 18/08/2016 *Revised: 10/09/2016* *Accepted: 10/09/2016*

ABSTRACT

Water scarcity is a major problem faced by the world. Increasing demand of water because of growing population and rapid industrialization is unavoidable. Proper and sensible use of available water resources and recycling of water in domestic and industrial applications can help to reduce water demand. Rainwater harvesting (RWH) can solve the water problem to considerable extent. Roof top RWH in domestic household structure can fulfill more than 50 percent water demand. The educational and business complexes are also implementing RWH successfully. It is envisaged to make the RWH technologies more effective and economical. Many times initial investment becomes limiting factor in adopting RWH technology. So technological up gradation and awareness among people based on long term benefits of RWH can drive more people to adopt RWH. The current review summarizes research, studies and surveys carried out to study, analyze and implement RWH.

Key words: Water resources, capital investment, runoff, catchment, water quality, utilization.

INTRODUCTION

Water is the most important and most precious compound on earth. Human being and all living things cannot survive without water. In chemical engineering water is used as heating, cooling utility, process material, washing liquid, solvent, diluents and many more application. The water supplies and reservoirs needs to be protected. The discharge of polluted water can cause various diseases and health problem in man and environment. [1-4]

Various organic and inorganic impurities should be treated prior to its discharge. [5-10] Water can be treated for removal of impurities by various chemical, physical and biological methods. [11-15] The dissolved oxygen level of water drops because of organic matter which affects aquatic life. [16-18] It is important to monitor the discharge water quality continuously. The reuse and recycle of water can reduce the water demand in industries. [19,20]

Rainwater harvesting (RWH) can solve the water problem to considerable extent. Rooftop RWH in domestic household structure can fulfill more than 50 percent water demand. Technological up gradation and awareness among people based on long term benefits of RWH can drive the people to adopt RWH. The awareness among people about water use and need for rainwater harvesting are two important aspects in water conservation. The current review summarizes research, studies and surveys carried out to study, analyze and implement RWH.

RAINWATER HARVESTING: AN INSIGHT INTO RESEARCH AND STUDIES

Shadeed and Lange carried out investigation on rainwater harvesting to avoid water scarcity in dry condition. [21] Their work was aimed at evaluating the potential for rainwater harvesting in the arid

to semi-arid Faria Catchment, in the West Bank, Palestine. Demand supply gap of water is increasing due to increasing population. According to them, it is essential to manage the potential available surface water supplies in the catchment.

Dwivedi et.al carried out an investigation on rainwater harvesting at roof top of educational complex. [22] Their work was aimed at studying rainwater harvesting for all buildings, planning and designing the rooftop rain water harvesting system. They proposed integrated rainwater harvesting for all the educational complexes together. The cost for 100 percent usable and 40 percent water usable systems were almost same. The environmental and water conservation aspects call for use recycled water to maximum potential. Khilare et.al studied rainwater harvesting for Dahivadi college building and campus in Man Tahsil of Satara district. [23] They made an attempt to examine the present status of water requirement. They proposed rooftop RWH potential in the college campus. According to these studies it was possible to mitigate about 70 percent of annual drinking water demand. Also 43 percent of the domestic water demand can be mitigated by rainwater harvesting.

Farreny et.al carried out comprehensive studies on selection of roof top for rainwater harvesting. [24] They monitored clay tiles, metal sheet and polycarbonate plastic and one flat gravel roof for two years. They offered a model for the estimation of the runoff volume and the initial abstraction of each roof. It was also possible to check physicochemical contamination of roof runoff. They found that selection of smooth roof can provide 50 percent better results than rough roofs or surfaces. Ariyananda explored the rainwater harvesting for water supply in Shrilanka. [25] They carried out study on domestic water supply situation in Shrilanka. According to his studies, rainwater harvesting has increased the use of water per ca [pita 28 lpcd (liters per capita per day) in non-beneficiary households to 43 lpcd in beneficiary households. Requirement of capital investment is limiting factor in rainwater harvesting. According to him the use of an appropriate tank size and use of less and cheaper materials, less labor and simple construction aids are important factor in rainwater harvesting.

Jebamalar and Ravikumar carried out a comparative analysis of hydrologic responses to rainwater harvesting. [26] They analyzed and investigated the implementation of rainwater harvesting (RWH) structures. They also analyzed its hydrologic responses in two hydro-geologically different localities of Chennai city in Tamil Nadu state, India. They observed that the recharge and quality have improved due to the implementation of RWH. Pande and Telang carried out investigation on rainwater harvesting potential by surface runoff and catchment area and mean annual rainfall. [27] According to their estimates, 26, 36,374 Liters of water can be harvested by Indira Paryavaran Bhawan.

Shittu et.al carried out an investigation on rainwater harvesting in Ibadan, Nigeria. [28] According to them, because of deep digging, the groundwater table would have been falling, causing hydrological imbalance. They analyzed water samples from the RWH system and shallow well. They observed that the value of parameters like hardness, alkalinity, chloride, iron and nitrate were well below the WHO norms. They concluded that RWH technology was a viable and reliable water supply option in both urban and rural areas for domestic purposes. Khan carried out a case study on rainwater harvesting in Gujarat. [29] She discussed various aspects of rainwater harvesting like check on the declining water table, avoids flooding, improvement in the quality of groundwater through the dilution of fluoride and prevents soil erosion etc. For collection of data, they carried out the primary survey using the schedule technique and focused group discussions.

Lade and Oloke carried out an investigation on rainwater harvesting potential in Ibadan, Nigeria. [30] According to them, the increase of population, social and economic activities has led to increase in water demand. They conducted a desk to review of various RWH technologies locally, regionally and globally. They carried out hydrological analysis by analyzing data for last 30 years. According to them, it is important to treat rainwater properly before using it, as it passes over rooftops.

Kimani et.al carried out an investigation on rainwater harvesting in Makueni County, Kenya. [31] In their studies, they evaluated drain water harvesting technologies and the factors contributing to adoption of the technologies. They used statistical package for social scientists (SPSS) for analyzing the data. According to their studies, the major rainwater harvesting technologies used in the region are macro-catchment (earth dams, sand/sub-surface dams), micro-catchment (Zai pits, strip catchment, tillage, contour and semi-circular bunds) and rooftop rainwater harvesting technologies with rooftop catchment.

Saleem et.al analyzed groundwater quality improvement using rainwater harvesting. [32] According to him, the extraction of excessive qualities of ground water has resulted in drying up of wells. They made an attempt to analyze the impact of rain water harvesting on ground water quality. They carried out case study of Jamia Millia Islamia campus rainwater harvesting. According to them, the rainwater recharge improves the quality of groundwater. Rainwater harvesting for agricultural purpose in Tanzania was studied by Hatibu and Mahoo. [33] They showcased brief treatise, of rainwater harvesting, and its historical perspectives. According to them, major techniques of rainwater harvesting is classified into In-situ, Internal (Micro) and External (Macro) catchment RWH. They also studied current approaches and the role of RWH in Dodoma region.

Welderufael et.al investigated hydrological impact of rainwater harvesting in the Modder river basin. [34] The river is based in South Africa. Patel et.al studied rainwater harvesting in educational campus. [35] They analyzed present water use at Sankalchand Patel Sahakar Vidhyadham (S.P.S.V.) Campus, Visnagar, and S.P.S.V. campus. They also carried out feasibility study for rainwater collection. With the same rainfall data they analyzed rainwater harvesting capacity of different buildings. Dwivedi and Bhadauria carried out case study on rooftop rainwater harvesting. [36] In their paper, they presented the development of the framework for domestic rooftop harvesting for drinking water. They also developed a mathematical equation expressing the relationship between the required size of water tank and different rooftop areas.

Esguerra et.al studied rainwater harvesting for quality assessment and utilization. [37] In their project, they also assessed system's technical soundness, environmental dimensions, economic feasibility as well as its social and political acceptability. According to them, rainwater harvesting is capable of fulfilling 6 month requirement of water for household of 6-10 people family. The RWH for household system includes rooftops, gutters, down spouts, filter and storage tank. According to these studies, the cost of the rainwater harvesting system could be recovered in two years at most.

Julius et.al carried out review on rainwater harvesting. [38] They discussed issue of water scarcity and importance of rainwater harvesting. The research and studies on RWH in the globe and India were discussed. The studies carried out by Kumar et.al revealed the study of low cost traditional water harvesting structures. [39] They carried out studies in North Western Himalayan Region. According to their estimates, 40 per cent of the total geographical area of Himachal Pradesh, Uttrakhand and Jammu and Kashmir is

degraded very badly. In- situ runoff management, according to them was best method of rainwater harvesting for the farms. They achieved excellent results by using ferro-cement water storage structures of different dimensions. Charles prepared a comprehensive report on rainwater harvesting in developing countries. [40] He defined feasibility of RWH in terms of the physical, social, and technical environments of developing countries.

CONCLUSION

Rain water harvesting can fulfill more than 50 percent water demand of 8-10 member family if implemented in the domestic households. The school complexes, commercial hubs and office premises have large potential for rainwater harvesting. The use of proper technology for rainwater harvesting needs to be considered as an important factor. The communities should be made aware of the water scarcity issues and importance of RWH. Along with RWS, there is need to create awareness about proper use of water. The government and regulatory bodies play major role in RWH. It can be concluded that RWH, though needs initial investment, helps in preserving most precious gift from the nature, which is priceless and most valuable asset.

REFERENCES

1. Sunil Jayant Kulkarni, Dr. Jayant Prabhakarrao Kaware, "A Review On Health Effects Of Phenol", International Journal Of Research, 2015, 2(5), May 2015, 968-974.
2. Sunil J. Kulkarni, Sonali R. Dhokpande, Dr.Jayant P. Kaware, "A Review On Studies On Effect Of Heavy Metals On Man And Environment", International Journal For Research In Applied Science & Engineering Technology, 2014, 2(10),227-229.
3. Khayatzadeh J., Abbasi E., "The Effects Of Heavy Metals On Aquatic Animals", The 1 St International Applied Geological Congress, Department Of Geology, Islamic Azad University-Mashad Branch, Iran, 26-28 April 2010, 688-695.
4. Sunil J. Kulkarni, "Removal Of Organic Matter From Domestic Waste Water By Adsorption", International Journal Of Science, Engineering And Technology Research,, 2013, 2(10),1836-18840.
5. Pallavi Amale, Sunil Kulkarni, Kavita Kulkarni, "A Review on Research For Industrial Wastewater Treatment With Special Emphasis On Distillery Effluent", International Journal Of Ethics In Engineering & Management Education, 2014, 1(9), 1-4.
6. Sunil J. Kulkarni, Ajaygiri K. Goswami, "Applications and Advancements In Treatment Of Waste Water By Membrane Technology- A Review", International Journal Of Engineering Sciences & Research Technology, 2014, 3(9), 446-450.
7. Sunil Jayant Kulkarni, "Removal of Zinc from Effluent: A Review", International Journal of Advanced Research in Science, Engineering and Technology, 2015, 2(1), 338-341.
8. Sunil Jayant Kulkarni, "Solute Uptake, Kinetic and Isotherm Studies For Copper Removal: A Review", International Journal of Research, 2015, 2(1), 718-723.
9. Kulkarni Sj. Research and Studies On Cobalt Removal From Wastewater. Int J Res Rev. 2016, 3(7), 41-44.
10. Sunil Jayatn Kulkarni, "A Review on Studies and Research on Iron Removal", International Journal of Science & Healthcare Research, 2016, 1(2), 49-52.
11. Sunil J. Kulkarni, Modeling For Adsorption Columns for Wastewater Treatment: A Review, International Journal of Innovative Research in Engineering & Multidisciplinary Physical Sciences, 2014, 2(2), 7-11.
12. Sunil J. Kulkarni, Pallavi M. Kherde, "Research on Advanced Biological Effluent Treatment: A Review", International Journal of Research and Review, 2015, 2(8), 508-512.
13. Sunil J. Kulkarni, Pallavi M. Kherde, "A Review on Advanced Oxidation Method for Waste Water Treatment", International Journal of Engineering

Sciences & Management Research, 2015, 2(8), 33-38.
14. Mahdi Ahmed, Azni Idris, Aofah Adam, "Combined Anaerobic-Aerobic System for Treatment of Textile Wastewater", Journal of Engineering Science and Technology, 2007, 2(1), 55-69.
15. Rashmi Vinod Dahake, A.K.Goswami, Dr. V. Kalyanraman, S. J. Kulkarni, "Performance Evaluation of Hybrid Membrane Bioreactor for Low Strength Wastewater Treatment", International Journal of Science, Engineering and Technology Research, 2013, 2(2), 2167-2169.
16. Sunil J. Kulkarni, Suhas V Patil, And Y. P. Bhalerao, "Flyash Adsorption Studies For Organic Matter Removal Accompanying Increase In Dissolved Oxygen", International Journal Of Chemical Engineering And Applications, 2011, 2(6), 434-438.
17. Sunil J. Kulkarni, Ajaygiri K. Goswami, "Adsorption Studies For Organic Matter Removal From Wastewater By Using Bagasse Flyash In Batch And Column Operations", International Journal Of Science And Research, 2013, 2(11), 180-183.
18. Kulkarni Sunil J., Patil Suhas V., Tapre Ravi W., Goswami Ajaygiri K., "Adsorption Of Chromium From Wastewateron Different Adsorbents", International Journal Ofresearch In Chemistry And Environment, 2013, 3 (1), 231-236.
19. Sunil Jayant Kulkarni, "Recycle And Reuse Of Water- A Review", International Journal of Research, 2014, 1(11), 802-805.
20. Suraj Kumar, "Study On Waste Water Recycling and Reuse", International Journal of Applied Engineering Research, 2014, 9(3), 329-334.
21. Sameer Shadeed, Jens Lange, "Rainwater Harvesting To Alleviate Water Scarcity In Dry Conditions: A Case Study In Faria Catchment, Palestine", Water Science And Engineering, 2010, 3(2), 132-143.
22. Dr. Arun Kumar Dwivedi, Virendra B. Patil, Amol B. Karankal, "Rooftop Rain Water Harvesting For Groundwater Recharge In An Educational Complex", Global Journal Of Researches In Engineering Civil And Structural Engineering, 2013, 13(1), Version 1.0, 21-31.
23. C. J. Khilare, S. N. Pawar, D. D. Namdas And V. P. Gaikwad, "Rooftop Rain Water Harvesting Potential: A Case Study Of Dahivadi College Building And Campus In Man Tahsil Of Satara District", Proceeding Of International Conference Swrdm-2012, Department Of Environmental Science , Shivaji University, Kolhapur, 86-89.
24. Ramon Farreny A.B, Tito Morales-Pinzo´N A, C, Albert Guisasola D, Carlota Taya,Joan Rieradevall A,D, Xavier Gabarrell, "Roof Selection For Rainwater Harvesting: Quantity And Quality Assessments In Spain", Water Research, 2011, 45, 3245-3254.
25. Tanuja Ariyananda, "Domestic Rainwater Harvesting As A Water Supply Option In Sri Lanka", Hydro Nepal, 2010, 6, 27-30.
26. A.Jebamalar And G. Ravikumar, "A Comparative Analysis Of Hydrologic Responses To Rainwater Harvesting - A Case Study", Indian Journal Of Science And Technology, 2011, 4(1), 34-39.
27. Puskar Pande, And Shailesh Telang, "Calculation Of Rainwater Harvesting Potential By Using Mean Annual Rainfall, Surface Runoff And Catchment Area", Global Advanced Research Journal Of Agricultural Science, 2014, 3(7), 200-204.
28. Shittu O.I, Okareh O. T And Coker A.O., "Development Of Rainwater Harvesting Technology For Securing Domestic Water Supply In Ibadan", Nigeria, International Research Journal Of Engineering Science, Technology And Innovation, 2015, 4(1), 032-037.
29. Nilu Khan, "Contribution Of Rainwater Harvesting In Agriculture Of Gujarat: A Case Study Of Ahmadabad District", Iosr Journal Of Economics And Finance, 2014, 5(5), 30-36.
30. Omolara Lade, David Oloke, "Assessment Of Rainwater Harvesting Potential In Ibadan, Nigeria", Environ. Eng. Res., 2013, 8(2), 91-94.
31. M. W. Kimani, A. N. Gitau and. Ndunge, "Rainwater Harvesting Technologies In Makueni County,

Kenya", Research Inventy: International Journal Of Engineering And Science, 2015, 5(2), 39-49.
32. Mohd. Saleem, Muqeem Ahmed, Professor Gauhar Mahmood, Dr. S.A.M. Rizvi, "Analysis Of Groundwater Quality Improvement Using Rainwater Harvesting: A Case Study Of Jamia Millia Islamia", International Journal Of Modern Engineering Research, 2012, 2(5), 3912-3916.
33. N. Hatibu And H. Mahoo, "Rainwater Harvesting Technologies For Agricultural Production: A Case For Dodoma, Tanzania, 1999", Conservation Tillage With Animal Traction. A Resource Book of the Animal Traction Network for Eastern and Southern Africa (Atnesa). Harare. Zimbabwe. 173p. a Publication Supported By French Cooperation, Namibia. For Details Of Atnesa And Its Resource Publications, See Http://Www.Atnesa.Org.
34. W. A. Welderufae, Y. E. Woyessa, And D. C. Edossa, "Hydrological Impact Of Rainwater Harvesting In The Modder River Basin Of Central South Africa", Hydrol. Earth Syst. Sci. Discuss., 2011, 8, 5051-5081.
35. Utsav R. Patel, Vikrant A. Patel, Manjurali I. Balya, Harshad M. Rajgor, "Rooftop Rainwater Harvesting (Rrwh) At Spsv Campus, Visnagar: Gujarat - A Case Study", International Journal Of Research In Engineering And Technology, 2014, 3(4), 821-825.
36. Arun Kumar Dwivedi and Sudhir Singh Bhadauria, "Domestic Rooftop Water Harvesting- A Case Study", Arpn Journal of Engineering and Applied Sciences, 2009, 4(6), 31-38.
37. Adriano T. Esguerra, Antonio E. Madrid And Rodolfo G. Nillo, "Rainwater Harvesting, Quality Assessment And Utilization In Region I", E-International Scientific Research Journal, 2011,3(2), 145-155.
38. J.R.Julius, Dr.R.Angeline Prabhavathy, Dr. G.Ravikumar, Rainwater Harvesting (RWH) - A Review", International Journal of Scientific & Engineering Research, 2013, 4(8), 276-282.
39. Rohitash w Kumar, Thaman S., Agrawal G. And Sharma Poonam, "Rain Water Harvesting and Ground Water Recharging In North Western Himalayan Region for Sustainable Agricultural Productivity", Universal Journal of Environmental Research and Technology, 2011, 1(4), 539-544.
40. Milagros Jean charles, "Rainwater Harvesting Systems For Communities In Developing Countries", A Report Submitted In Partial Fulfillment Of The Requirements For The Degree Of Master Of Science In Civil Engineering Michigan Technological University Summer 2007 Copyright © Milagros Jeancharles 2007, 1-70.

How to cite this article: Kulkarni SJ. Review on studies, research and surveys on rainwater harvesting. Int J Res Rev. 2016; 3(9):6-11.

******