A Review of Criteria In Rain Water Harvesting Management

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Abstract: Rainwater harvesting has gained renewed interest in the arid and semi-arid regions since the 1970s. It is important to consider how significant amounts of water can be harvest from a single catchment location. Papers selected address a wide range of rainwater harvesting problems, including the regionalization of nature curves. The rural population has limited income, a high susceptibility to climate change, conventional agricultural activities and adversely affected water shortages. Rain Water Harvest is an alternative cause to water shortages and groundwater depletion issues. The discovery of suitable rainwater harvesting sites is an essential move towards optimizing the amount of water harvesting and mitigating the ecological effect by using remote sensing and GIS techniques. In this article, the main requirements and parameters for selecting appropriate sites for rainwater harvesting have been extract from previous studies.

Keywords: Rainwater harvesting, AHP, Water Harvesting criteria, Approach of Water Harvesting, GIS

1. INTRODUCTION

Owing to the rapid growth in the human population over recent decades, Climate changes and variety are faced by the ever-increasing water requirement in the Rainwater harvesting scheme, which is a technology of water sources that is centuries old. The world's water needs are rising twice as rapidly as the population (FAO, 215 C.E.), according to the Food and Agriculture Organization.

The rainwater harvesting system captures rainwater from impermanent surface areas such as rooftops and road floors or from natural surfaces and stores water in indoor and outdoor storage systems such as reservoirs and basins and surface dams (Lasage & Verburg, 2015) (Campisano et al., 2017). Current water sources in the country are under rising population pressure, rapid urbanization, industrial management and irrigated agriculture, which lead to water scarcity and food security issues. Water shortages are estimated to reach around 1.8 billion people by 2025, while water scarcity is predicted to be present for two-thirds of the planet (UN, 2014).

Rainwater harvesting is helping to fulfill one of the priorities of sustainable development (safety and sustainable water quality and sanitation for all in rural areas. In urban areas, the rainwater harvesting process is widely used for a number of purposes, such as agriculture, factories, cleaning and washing vehicles, etc.). Alternate systems for water supply and storm water management (Van der Sterren et al., 2012) (Hanson & Vogel, 2014). Population-enhancing farming practices can take place at an astounding level In the semi-arid climate, where water is a significant constraint on agricultural production, rainwater harvesting and management systems are becoming increasingly common (S N Ngigi, 2003). Water harvesting by rainwater structures is part of the surface water that flows downstream to the bottom of the channel (Stephen N. Ngigi et al., 2007).

The sustainable use of water supply in agriculture is essential to the food crisis. Rainwater harvesting has been a revived concern for thousands of years since 1980. Water scarcity and soil moisture problems in the arid and semi-arid regions are continually affected. These issues affect crop production and increase the risk of food production (Wu et al., 2018). (Ammar et al., 2016) indicated that rainwater harvesting could be define as a method for the collection, storage and conservation of rainwater runoff in arid and semi-arid areas. Rainwater harvesting has been extremely useful, particularly in drylands where water shortages are simultaneously approaching. In addition to growing water availability, rainwater harvesting recharges local groundwater sources and improves job opportunities. Water harvesting is widely used to solve the problems of water shortages and improve the available water supply.

Rainwater harvesting is harvesting and managing rainwater runoff to increase the availability of water for domestic and agricultural use and the maintenance of the ecosystem (Mekdaschi & Liniger, 2013). Nevertheless, it is a significant step towards maximizing water supply and land productivity in semi-arid areas to find potential sites for rainwater harvesting (Isioye, 2012). According to several parameters, rainwater harvesting sites are updated (Mahmoud & Alazba, 2015) and various technologies and/or methodologies are required for successful site selection (Ghani et al., 2013) (Al-Adamat et al., 2010) (de Winnaar et al., 2007a). The socio-economic and physical life of a specific area should also be taken into account in the correct choice of location (Al-Adamat et al., 2010). It is therefore very important to optimize the available water by collecting water to determine key factors influencing both the decision-making process and the best scale in relation to the target area around it (Wu et al., 2018).

2. METHODS FOR RAINWATER HARVESTING SITE SELECTION IN ARID AND SEMI ARID AREA

Relevant locations and technological design identification are the two key factors behind the success story of rainwater harvesting equipment (Al-Adamat et al., 2012). Various approaches can be used to combining selected parameter with the appropriated web- based rainwater-harvesting tool. Different experimental experiments in arid and semi-arid regions around the world have used two types of parameters (biophysical and socio-economic). The research group focuses on integrated biophysical components of biophysical components (Kahinda et al., 2008) and integrated socio-economic components (land, slope, land use cover, soil type) (Isioye, 2012) (Kumar et al., 2008) (Ziadat et al., 2012) (Bulcock & Jewitt, 2013) (Krois & Schulte, 2014).

Approaches and methods available to identify sites using biophysical and socio-economic parameters such as; GIS and Remote Sensing (Bamne et al., 2014) (Al-Shamiri & Ziadat, 2012), GIS and remote sensing hydrological modelling (Mahmoud & Alazba, 2015), Harvesting management and GIS techniques with remote sensing data (Krois & Schulte, 2014) (Khan & Khattak, 2012) (Tera'at El Mansuriyah St, 2012). Although, GIS and remote sensing tool is an implementation tool for appropriate site identification, better efficiency and more data-rich areas, the combination of rainwater harvesting multi-criteria analysis and GIS-based harvesting management are highly preferred methods and/or software. All methods and techniques used in previous research studies on the selection of rainwater harvesting sites have certain restrictions (Wu et al., 2018).

Many authors, for example (Campisano et al., 2017; Basinger et al., 2010; Bouma et al., 2016), examined the evolution of the rainwater harvesting system. In the wider range of climatic situations and applications for example. In Australia (Rahman et al., 2012), (Schuetze, 2013) in Germany, and in the United State (Basinger et al., 2010). While in Brazil and Italy (Ghisi, 2010), in United Kingdom (Sarah Ward & Butler, 2016), in China (GOULD et al., 2014), in addition in South Korea (Han & Mun, 2011), in West Asia and in North Africa (Bouma et al., 2016) (Ziadat et al., 2012) (Sharifi et al., 2015). The efficiency of rainwater harvesting is being demonstrated in water saving and conservation around the world. The quality of rainwater collected depends largely on the environment, tank material, and rainwater harvesting system maintenance. Heavy metals and nutrients can be present in rainwater harvested from roof catchment (Van der Sterren et al., 2013) (Hamdan, 2009). The use of properly designed first-line flush equipment and regular maintenance of the rainwater harvesting system can significantly improve the quality of the collected water (such as washing roof surfs, goose rings, tanks and first-line flush devices; inspecting the mosquito and vermin entry points; or removing overhanging trees from the roof).

The rainwater harvesting system modeling aims to fulfill the predicted water requirements for rainwater availability (Hanson & Vogel, 2014) (Hajani & Rahman, 2014). This is typically done by continuous inflow and outflow simulation (S Ward et al., 2012) (Ghisi, 2010) or by analytical (Hanson & Vogel, 2014) (Ghisi, 2010) (Eroksuz & Rahman, 2010) or stochastic analysis (Basinger et al., 2010) (Sharifi et al., 2015) or through a web-based platform incorporating geospatial plumage patterns (Fonseca et al., 2017). The rainwater portion of the rainwater system is also analyzed (Van der Sterren et al., 2009) (DeBusk et al., 2013). The inclusion in the design of rainwater harvesting can have a major effect on the determination of the acceptable size of the tank (e.g. greenhouse gas emissions, materials used to establish the rainwater harvesting system). The effect of climate change considerations could also have an impact on the size of the tank (Haque et al., 2016).

3. CRITERIA USED FOR SELECTING SUITABLE RAINWATER HARVESTING SITES

There are many parameters that can be used to determine appropriate water harvesting sites, many research studied on rainwater harvesting have been carried out by the researchers and some factors have been considered by each researcher. There are key and sub-factors, depending on the situation and method of analysis. Table 3.1 shows the study of researchers and the parameters used such as Rainfall, Slope, Soil texture, Drainage density, Land use land cover, Road distance, location, materials and discharge, Socioeconomic, Structural and Tectonic Geology and Settlement and Agriculture.

Table 3. Selection criteria of Biophysical and Socio-economic for rainwater harvesting in different references

Researcher(s)	Research Title	Rainfall	Slope	Soil texture	Drainage density	Land Use Land Cover	Distance from area, road, materials and discharge	Socio- economic	Structural geology and tectonic	Settlement and agriculture
(Noori et al., 2019)	Dam site suitability assessment at the Greater Zab River in northern Iraq using remote sensing data and GIS	•	•	•	•	•	•		•	
(Hameed, 2013)	Water harvesting in Erbil Governorate, Kurdistan region, Iraq Detection of suitable sites using Geographic Information System and Remote Sensing	•	•	•	•	•				
(Ahmad & Verma, 2018)	Application of Analytic Hierarchy Process in Water Resources Planning: A GIS Based Approach in the Identification of Suitable Site for Water Storage	•	•	•	•	•	•			•
(FAO, 2003)	Soil and terrain database for Southern Africa	•	•	•	•	•	•	•	•	
(Tumbo et al., 2006)	Determination of suitability levels for important factors for identification of potential sites for rainwater harvesting	•	•	•	•	•				
(Al-Abadi et al., 2017)	A GIS-Based Integrated Fuzzy Logic and Analytic Hierarchy Process Model for Assessing Water-Harvesting Zones in Northeastern Maysan Governorate, Iraq	•	•	•	•	•	•			
(Al-Adamat et al., 2010)	Combining GIS with multicriteria decision making for siting water harvesting ponds in Northern Jordan	•	•	•	•	•	•	•		
(Anane et al., 2012)	Ranking suitable sites for irrigation with reclaimed water in the Nabeul-Hammamet region (Tunisia) using GIS and AHP-multicriteria decision analysis	•	•	•	•	•	•	•		•
(de Winnaar et al., 2007b)	A GIS-based approach for identifying potential runoff harvesting sites in the Thukela River basin, South Africa	•	•	•	•	•	•			
(Haile & Suryabhagavan, 2019)	GIS-based approach for identification of potential rainwater harvesting sites in Arsi Zone, Central Ethiopia	•	•	•	•	•	•		•	

(Kahinda et al., 2008)	Developing suitability maps for rainwater harvesting in South Africa	•	•	•	•	•	•		•	
(Al-Adamat, 2008)	GIS as a decision support system for siting water harvesting ponds in the basalt aquifer/NE Jordan	•	•	•	•	•	•		•	•
(de Winnaar et al., 2007a)	A GIS-based approach for identifying potential runoff harvesting sites in the Thukela River basin, South Africa	•	•	•	•	•				
(Ammar et al., 2016)	Identification of suitable sites for rainwater harvesting structures in arid and semi-arid regions: A review	•	•	•	•	•	•	•		•
(Jasrotia et al., 2009)	Water balance approach for rainwater harvesting using remote sensing and GIS techniques, Jammu Himalaya, India	•	•	•	•	•	•			
(Isioye, 2012)	A multi criteria decision support system (MDSS) for identifing rainwater harvesting site (S) in Zaria, Kaduna state, Nigeria	•	•	•	•	•				
(Buraihi & Shariff, 2015)	Selection of rainwater harvesting sites by using remote sensing and GIS techniques: A case study of Kirkuk, Iraq	•	•	•	•	•				
(Gavit et al., 2018)	*Rainwater Harvesting Structure Site Suitability Using Remote Sensing and GIS*	•	•	•	•	•	•			
(Al-shabeeb, 2016)	The Use of AHP within GIS in Selecting Potential Sites for Water Harvesting Sites in the Azraq Basin -Jordan	•	•	•	•	•	•		•	
(Karimi & Zeinivand, 2019)	ntegrating runoff map of a spatially distributed model and thematic layers for identifying potential rainwater harvesting suitability sites using GIS techniques	•	•	•	•	•				
(Kumar et al., 2008)	Delineation of potential sites for water harvesting structures using remote sensing and GIS	•	•	•	•	•				
(Mahmoud & Alazba, 2015)	The potential of in situ rainwater harvesting in arid regions: developing a methodology to identify suitable areas using GIS-based decision support system	•	•	•		•				
(Paper et al., 2018)	Optimum Site Selection of Water Harvesting Structures Using Geospatial Analysis and Multi Criteria Evaluation Techniques	•	•	•	•	•			•	•
(Singhai et al., 2019)	GIS-based multi-criteria approach for identification of rainwater harvesting zones in upper Betwa sub-basin of Madhya Pradesh, India	•	•	•	•	•				•

(Ramakrishnan et al., 2009)	SCS-CN and GIS-based approach for identifying potential water harvesting sites in the Kali Watershed, Mahi River Basin, India	•	•	•	•	•				•
(Ramakrishnan et al., 2008)	Delineation of potential sites for water harvesting structures through remote sensing and GIS techniques: A case study of Kali watershed, Gujarat, India	•	•	•	•	•				
(Ahmed & Al-manmi, 2019)	Delineation of Groundwater productivity Zones with the integration of GIS and Remote Sensing methods , Bazian Basin , Sulaymaniyah , Kurdistan	•	•	•	•	•			•	
(Zakaria et al., 2012)	Rain Water Harvesting and Supplemental Irrigation at Northern Sinjar Mountain, Iraq	•	•	•	•	•		•		
(Salar et al., 2018)	Identification of suitable sites for groundwater recharge in Awaspi watershed using GIS and remote sensing techniques	•	•	•	•	•		•	•	•
(Ibrahim et al., 2019)	Suitable site selection for rainwater harvesting and storage case study using Dohuk Governorate	•	•	•	•	•				
(Singh et al., 2009)	Selection of suitable sites for water harvesting structures in Soankhad watershed, Punjab using remote sensing and geographical information system	•	•	•	•	•			•	

DISCUSSION

In this review, about 31 published research in different years from 2003 to 2019 have been review to get a good result for using the better factors in rainwater harvesting studies. Through the review found were, most effective factors that have been considered in 90- 100% of the researches are Rainfall, Slope, Soil texture, Drainage density and land use/ land cover as it is shown in table 3.1. In level two 45- 55 % of the researchers adding the factors of distance from the area, road, materials and discharge to the mentioned factors. 15-25% adding the factor of socio-economic. However, 25-35 % considered structural geology and tectonic to the above main factors. At the last 20, 25 % included settlement and agriculture with their main factors in the process of selecting a suitable site for rainwater harvesting.

However, the important factors can be classified into more precise parts, for example, a division land use/ land cover into residential areas urban and rural, public gardens, home gardens, roads, and determining the quality of materials used in construction. The classification of the factors makes the study very accurate. As well as there are a lot of things that should be studied in the future to obtain final conclusions, for example, chooses the best method between all methods that can be used in water harvesting to reduce the time and obtain a good result. Also for the future work the site visit should be included to verify the land contains, and checking the realty of the area with the remote sensing data.

CONCLUSION

The use of rainwater harvesting allows the city directly to mitigate the crisis in water in the arid and semi-arid regions. There is no location in the region defined as appropriate means this location is appropriate as enclosed spaces, small villages or other hydraulic factory structure prevention may socially affect some of these sites. Rainwater development should be apply through a field study because the spatial scope of the survey does not ensure that all sites in a region identified as low-appropriate areas.

In conclusion, the review demonstrated the importance of the main factors uses in rainwater technology work to find a suitable area for water harvesting. However, there are many methods can be used to find potential sites for water harvesting, like the Analytic Hierarchy Process, Fuzzy and Weighted Linear Combination….etc. depending on the researcher’s likelihood, there are too many reviews appear the comparison between the methods and show the important way. Depending on the study result, the main criteria that can be consider in the rainwater harvesting studies are; Rainwater, Land use/ Land cover, Drainage density, Soil texture and Slope.

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