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The role of water harvesting in the development of vegetation cover and reducing desertification within the desert dry areas

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Abstract

It has become necessary to find harmony between the need to exploit rainwater and increase agricultural production, while continuing scientific creativity, especially in the field of multiple techniques for harvesting rainwater. This is for human use, irrigation of crops, and preservation of the environment within the drought that affected the ecological balance. The study addresses the importance of water harvesting in the development of pastoral and medicinal vegetation, the advantages of water harvesting techniques, benefiting from available land resources in the Iraqi desert, maintenance of existing wells, and the role of Arab research centres in supporting and settling the local population. The water yield of the valleys was calculated using the SCS method. This method was applied in calculating the volume of water yield prepared by the US Soil Conservation Service. The state of water harvesting in the plateaus of the Kingdom of Morocco was discussed, as natural resources are available within the region represented in its biological environment, despite the existence of a state of pastoral deterioration. This case was chosen as a model to monitor the best projects that can provide a state of environmental balance and stability of natural factors. In addition to opening prospects for balanced development within the region.

Key words: water harvesting, soil, climate ,dry areas, plant.

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Introduction

Rainwater harvesting in arid and semi-arid regions is of great importance compared to humid regions. Its importance increases in areas where there are few other sources such as groundwater or transported water. In this case, water harvesting is the most feasible means of securing human, animal and natural plant life. Rainfall is one of the most important sources of water in arid and semi-arid environments. It is the only source of surface runoff and groundwater recharge. Therefore, rainwater harvesting technology becomes more appropriate to support water resources in such desert areas. Although the rainwater harvesting operations are linked to some major factors that can be controlled, such as the prevailing climatic conditions, or the conditions of the nature of the soil, the quality of its investment secures basic sources of benefit from it. Biodiversity is defined as the diversity of all types of living organisms and ecosystems and the environmental processes within them [1].

Development in its environmental and social aspects is a complex process with a high cost that cannot be achieved without the full commitment of the state to grant funds to finance water harvesting projects and other development projects. The development process needs a continuity of time to achieve its goals, and the lack of sustainability of these projects leads to failure to achieve the required goals. The financial aspect represents a major obstacle to the non-continuity of these development projects [2].

Water harvesting methods have proven successful in many environments around the world. Australia and Mexico are among the most countries in adopting water harvesting methods to increase their agricultural production and develop water resources and grazing [3].

[4] Mentioned that water harvesting technologies have an important role in agricultural development. It has been emphasized on its effect on vegetation and soil stability, and its role in reducing conflicts between tribes over pastoral resources.

[5] The importance of water increases in arid and semi-arid countries due to its restrictions, as stated in, which is why it is vital to expand water resources and rationalize their consumption. Water is also a basic factor for the formation of every part of life. Desert regions experience a severe water shortage due to fluctuating precipitation and its scarcity combined with the lack of surface water sources. As a result, the growth of pasture plants and other uses is negatively impacted, necessitating the use of water harvesting techniques in those regions.

[6] discussed in their study the Al-Saqqaye Dam in Yemen's Taiz Governorate and the use of its waters to promote the growth of the local agricultural and tourism industries, The study concluded with proposing some modern techniques for water harvesting that are commensurate with the geography of the governorate, with presenting some methods and ideas that contribute to preserving the dam's water as a basis for the developmental change of the study area.

[7] studied the geographical capabilities of rainwater harvesting in Jabal Saber in Taiz Governorate in Yemen using geographic information systems. It dealt with an evaluation of existing rainwater harvesting systems and techniques and developed a map for new water harvesting techniques and systems in the region.

[8] Outlined that the increase in population size rates requires an increase in the amount of water, and water has become a constant concern for all countries of the world, and what is known as water security.

[9] discussed the methods used in Australia to capture water, summarizing them as using corks to prevent evaporation, hay mixed with the soil, synthetic rubber, berms around the fields, and table salt to break up the soil.

A study by [10] dealt with the microbiological quality of drinking water in North Carolina in the United States, and dealt with water harvesting and confining it to ponds. [11] study on the importance of water harvesting in providing drinking water for the rural population and developing vegetation cover, dealt with the most important water resource technologies in the United States, which consist of two parts: the area designated for water harvesting and the area allocated for the use of stored water. Among the experiences that have been mentioned for water harvesting techniques in Colorado and Arizona are treatment using sheet metal and rubber, and the use of asphalt.

[12] has approximated water harvesting accounts for the Iraqi Western Desert region of Green Valley. It was concluded that (7700) dunums could be cultivated in the light of the net stock for the month of November, as it is the least month of the seasons of the year for the growth of the rainy wheat crop. The need to irrigate that area by sprinkler irrigation amounted to (7,064,800) m^3 during the crop growth season. As for the second goal, it was to meet the various other human needs in the remaining volume of harvested water, which is (1339706.8) m^3.

On this level, [13] evaluated the use of water harvesting techniques for the purpose of irrigation, as is the case with [14] research on the importance of water harvesting in arid and semi-arid regions. Sudan's experience in harvesting rain in sandy areas for drinking purposes, and integrated plans to combat hydrological drought. [14], [15] and [16] dealt with the diversity of water harvesting techniques and the method of selecting the appropriate technique for each region according to the topographical conditions.

The low rainfall in the arid environment makes cultivation difficult, but if other factors of production such as soil and crops are suitable, water harvesting makes it possible to grow plants in these areas. The process of providing these lands with water through harvesting can improve the vegetation cover and help in addressing environmental degradation and combating desertification [17].

The article aims at the possibility of benefiting from water harvesting techniques in developing the vegetation cover of the dominant species in the region. Especially endemic species and medicinal plants for the purpose of combating desertification and improving the ecosystem, in addition to restoring balance in the vegetation cover, and developing pastoral plants within the dry areas in the environment of the Iraqi western desert.

Water Harvesting Concept:

In general, water harvesting is the activity of direct collection of rainwater. The rainwater collected can be stored for direct use or can be recharged into the groundwater. Rain is the first form of water that we know in the hydrological cycle, hence is a primary source of water for us. Rivers, lakes and groundwater are all secondary sources of water [18]

The term water harvesting refers to any morphological, chemical or physical process carried out on the ground in order to benefit from rainwater, by preparing the soil to store the largest possible amount of rainwater falling on it and reducing the velocity of runoff. Water harvesting is defined as the collection of surface runoff water for useful productive purposes, and it can be considered (from the perspective of soil conservation) as a means of collecting rainwater and surface runoff in a specific place [19]. What is meant by water harvesting is to benefit from rainwater by exploiting every drop It falls on the ground for irrigation purposes such as building dams and water barriers and preserving rainwater underground.

[19] mentioned that water harvesting is not a new concept, rather it is a concept that has been practiced since ancient times, and the idea of water harvesting is based on collecting rain water during its fall seasons and storing it to benefit from it during the rain interruption. It requires work to harvest the surface runoff water in areas with more rainfall. The water harvesting process takes place in areas where the annual average rainfall is not less than 100 mm in areas with winter rains [20].

[21] emphasized the value of rainfall in arid areas, and research of the most significant methods and techniques for collecting rainwater in dry areas was done. In an integrated system that incorporates all feasible methods and technologies, the study discovered some new ideas regarding the ways and means of utilizing rainfall and its use in boosting soil moisture or supplementary irrigation in various forms of the surface of dry areas.

[22] Land and water productivity in rain-fed agriculture can be improved through water harvesting and supplemental irrigation, in lands

with annual rainfall less than 300 mm and can be cultivated through appropriate water harvesting techniques, especially in semi-arid and arid countries and promising regions.

[23] stated that water harvesting involves multiple methods of directing surface runoff, collecting it from different sources, storing it, and preserving it for use for different purposes.

[24] indicated that water harvesting in Australia goes back a long time and that their studies were intensively active through a private centre that performs public services, the most important of which is interest in improving and developing water harvesting techniques [25].

The rainwater harvesting process is defined as that technique that is used to reserve and store rainwater in periods of its fall in different ways and reuse it, whether for drinking, supplementary irrigation, irrigation of wild plants, or feeding groundwater [26], [27].

–According to Al-Samurai (2014), the following are the most crucial considerations for building water harvesting systems:

–Rainfall distribution throughout the agricultural season.

–The intensity of the rain.

–Surface runoff characteristics of the surface soil.

–Soil capacity to store water (soil depth).

–Topography of the area.

–Type and size of the benefit.

Components of water harvesting systems [28]:

1- Water catchment area: It is a section of the land that supplies rainwater to a particular location.
2- Storage area From the time it is collected until it is used, running water is stored there. Underground or aboveground tanks may be used for storage. In order to cut costs and labor requirements for any water harvesting projects, the placement of the storage facility—whether it be in the soil itself or in aquifers—must be determined [28] and [29]، In the past, in many places, water harvesting was the only way people could obtain water. The survival of communities was based on it. Therefore, people have adopted these systems previously developed by others, and used them with great success[30].
3- Targeted area: It is the area in which the harvested water is used, whether for agricultural production or domestic use, as in Figure 2. It is worth mentioning that the technology of rainwater harvesting and soil moisture preservation is multiple and varies from one location to another according to the natural soil characteristics and the rate of precipitation intensity; and depends on the slope.
4- Surface runoff: We need surface runoff from the catchment towards the target area in order for the process to be described as a water harvesting process. Figures 1 and 2 represent water harvesting systems.

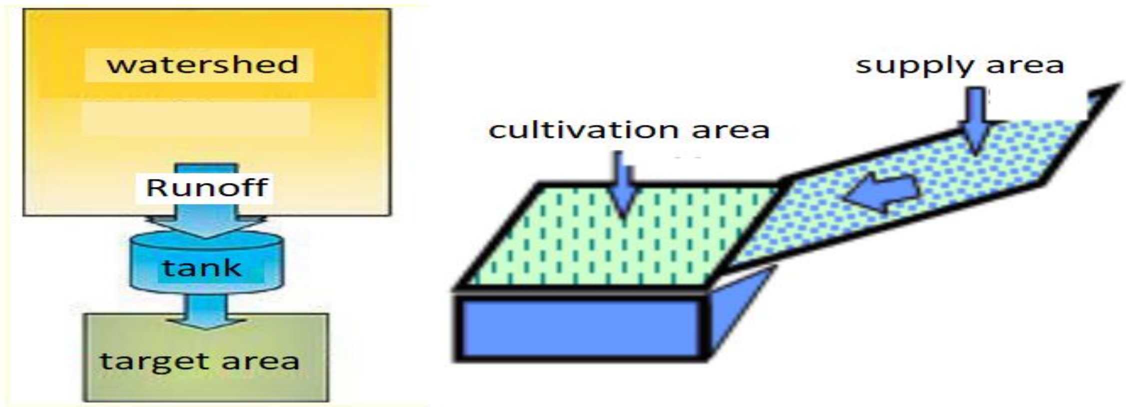

Figure 1: A diagram showing the components of a water harvesting system

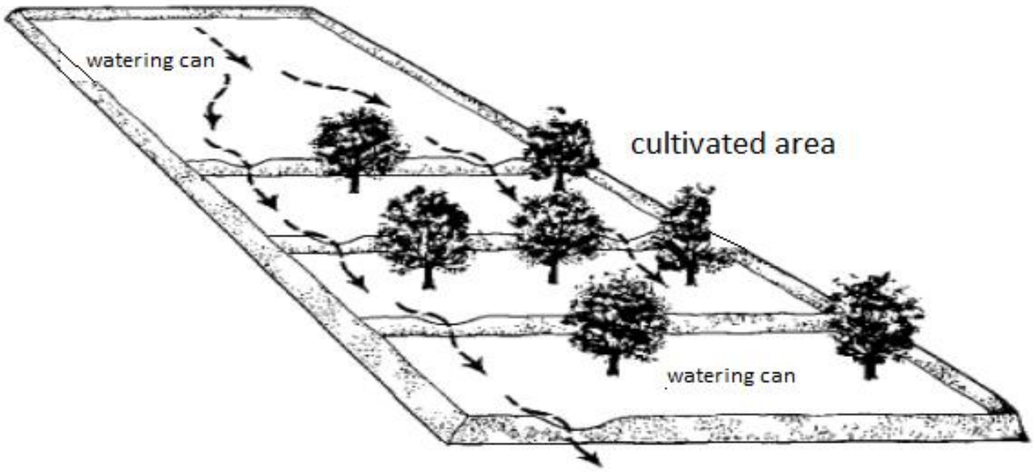

Figure 2. Watering can system

Objectives of the water harvesting process:

1- Raising the productivity of lands that are exposed to insufficient and irregular rainfall, by increasing the water recharge of cultivated land and developing pastures, thus combating desertification through supplementary irrigation resulting from water harvesting.

2- Supplying drinking water for human settlements and animals, and raising groundwater levels.

3- The need for water harvesting to be a complementary source of supplementary irrigation (for the lack of water resources, and not the only source for crops with high water needs).

4- Reduce floods and erosion of the soil: By holding rainwater, it lessens surface runoff. This lessens the erosion of the surface. The problem of flooding during heavy rainstorms is also lessened by collecting rainwater in reservoirs.

Water Harvesting Process:

A- Under normal conditions, water is naturally harvested by flowing into low-lying areas after rainstorms, creating land that farmers can use for farming.

B. Through human intervention: this involves initiating the flow, which is subsequently collected, directed, or used in conjunction with both to benefit a specific area.

Water Harvesting Systems:

In general, water harvesting systems can be divided into two parts [28]:

1-Micro-catchment systems: Micro-catchment water harvesting systems (Micro WH) are designed to trap and collect runoff from a relatively small catchment area, usually (10 – 500 m^2) within the farm boundary.

2- Macro-catchment systems: Most Macro WH practices have a catchment area of less than 2 ha, in some cases however runoff is collected from catchments as large as 200 ha.

Rain water harvesting systems and technologies:

Several water-harvesting systems have been used [31]:

1- Obstacle dams: These are earthen or stone barriers that are built in a way that is intended to preserve soil and water while lowering the rate of surface runoff and the associated risks. On the hills, they are built at high places. According to [32], the earthen dam technique, which involved constructing dams that across valley streams, channelled water to the maximum possible area of land.

2- Excavations: They are reservoirs for storing part of the run-off water that occurs in rainy areas through channels that transport water to leak-proof excavations.

3- Maintenance and development of springs and wells: Increasing the productivity of well water by carrying out some works such as repairing and rebuilding the springs and wells, and building reservoirs that lead to storing surplus water within the valleys.

4- Maintenance of old wells: These are old, excellent wells that have served both people and animals for a very long time. They are considered to be one of the main techniques for gathering and storing rainwater so that drinking water is available. Previous governments have paid attention to these wells, which are situated in the western desert of Iraq. It restored the historic oasis and carried out upkeep and proper management of a sizable number of these wells in order to utilize them in the processes of developing vegetative cover and crops in those locations. Several systems, including the following, could be suggested for use in the growth of vegetative cover:

1- The semicircular and trapezoidal septum system:

They are earthen barriers in the form of a semi-circle, crescent or trapezoid directly facing the top of the slope, and they are constructed at distances that allow a sufficient catchment to include the required runoff water, so they gather in front of the barrier, which is the place where plants are grown. These barriers are usually constructed in the form of uneven rows, and these barriers are mainly used for the revival of natural pastures, but they can also be used for planting trees and shrubs. When this system was used in planting shrubs in the Syrian desert, the planted bushes showed a survival rate of more than 90%, compared to a survival rate of 10% without water harvesting.

2- Small runoff pond systems:

These tiny runoff ponds, also known as "negarim," are enclosed by low-height earthen walls and comprise a few tiny buildings in the shapes of rhombuses and rectangles. Water flows to the lowest corner, which is where the plant is grown, because the basins are positioned so that the slope is parallel to the longitudinal diameter. Small ponds can be built at any degree of incline, including plains with a slope of 1% or less, but erosion may still happen. The size of these ponds range from 5 to 10 meters in width and 10 to 25 meters in length. An increase is needed for the soil over slopes of greater than 5%.

3- Mesqat (watering catchment) system:

Mesqat is a local system for harvesting water in some Arab countries, This system mainly supports olive trees, figs, and other fruit trees with water. Catchment areas may sometimes be surrounded by small earthen embankments to make runoff flow between cultivated plots of land without causing erosion.

4-The terraces:

It is one of the well-known techniques for harvesting rainwater in the slopes of the hills. Terraces are considered one of the most efficient methods used in soil maintenance work, especially in slopes ranging between 10-35%. It is preferable that their lower end be high by about 10-15 cm to prevent soil erosion.

5- Water dissemination systems:

One of the significant catchment areas located outside the valley is this one. In this technique, part of the flowing water of the valley is forced to divert from its natural course to nearby areas and is used for irrigation. This water can be stored in the root zone of plants. The diversion of water is accomplished by a diaphragm that raises the water level in the valley basin, allowing the runoff to be distributed by gravity over one or both ends of the valley. The runoff is directed out of the valley by slightly skewed sluices. The process of water distribution requires a relatively homogeneous land with a low slope and deep soils with sufficient water-holding capacity. This method relies on the construction of a storage dam, so the water is withdrawn from the storage lake by diversionary constructions to the area where the water is to be disseminated, and the water path is regulated through the dissemination area and the surplus water is disposed of from the dissemination process. The permanent and semi-permanent irrigation system falls under this method [33], figures (1-6).

Classification of water harvesting:

It was used by the inhabitants of the high areas on the surface of the mountains by digging channels and diverting the surface runoff resulting from rainfall and preserving it in store tanks to benefit from it for drinking for humans, animals and agriculture. This is very important for the regions that receive rain in a few months .

Water harvesting can be classified into two main groups [34]**:**

The first group consists of methods for variously collecting rainwater and storing it so that it can be used for a variety of purposes for a set amount of time throughout the year. This group's patterns vary depending on how much water is harvested, from rainfall collecting to the amount of water that needs to be stored.

The second category of technologies includes those that seek to utilize surface water, whether it is in its early stages as rain or as torrents in valleys. Runoff is managed to accomplish this, Other classification[35], in which water harvesting divided into two categories as shown in Figure 3.

1-Harvesting running water

2-Harvesting rainwater

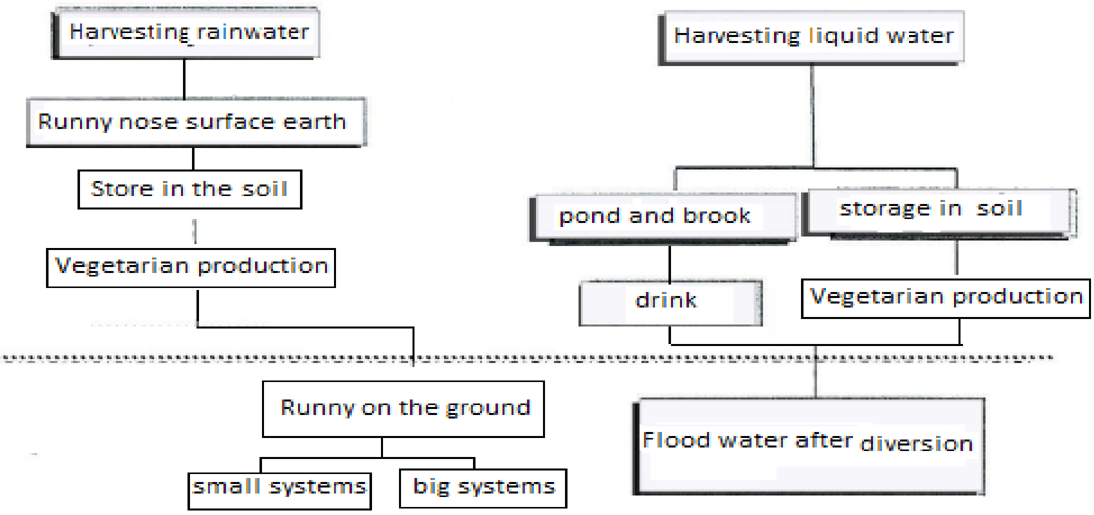

Figure 3: Water retention methods [36].

The experience of using Valerani's rainwater harvesting model to improve pasture quality in Morocco :

[36] Provided an analysis of the open grasslands on the high plateaus of the Moroccan province of Figuig, which are crucial areas for raising livestock. These areas are fragile, lacking in pastoral resources, and challenging to meet the growing demands of animal herds, especially during dry years. The initiative is a component of the state-adopted program (PDPEO), which aims to enhance the standard of these pastures, stop desertification, and lessen poverty on the high plateaus. The innovative technology employed in this project was first introduced to Morocco and is based on the usage of mechanisms that allow surface water to be stored in the soil and utilised for beneficial purposes.

This technology was used in India, Syria, Jordan, Lebanon and China and had beneficial results for improving pastures and cultivated lands in dry areas. The inhabitants of those areas contributed by using water harvesting technologies in addition to the contribution of the World Environment Fund and the United Nations Industrial Development Program. [36] Documented the steps taken to implement this rain harvesting technique, which was carried out in a number of Moroccan regions. An effort was made to assess the preliminary findings from this experiment and data processing, as well as to contribute to the realization of this model's objectives to enhance and develop pasture plants and make it possible for this system to address the needs of the populace. Along with the improvement of cattle, which is the primary means of subsistence. The region this project covers is shown in Figure 4.

The objectives of this project are to:

- Introducing the experience through its success in some areas where this technology has been applied.
- Study models of water collection experiments.
- Monitoring the sources of seeds that can be re-germinated along the high plateaus.
- Evaluation of the experiment and its positive and negative results and the extent of its contribution to reducing soil fragility and the movement of sand layers within the region.

Figures 4-6 relate to a project using the Valerian model to collect rainwater to improve pasture quality. Figures 8-16 show the technologies used for harvesting in different regions.

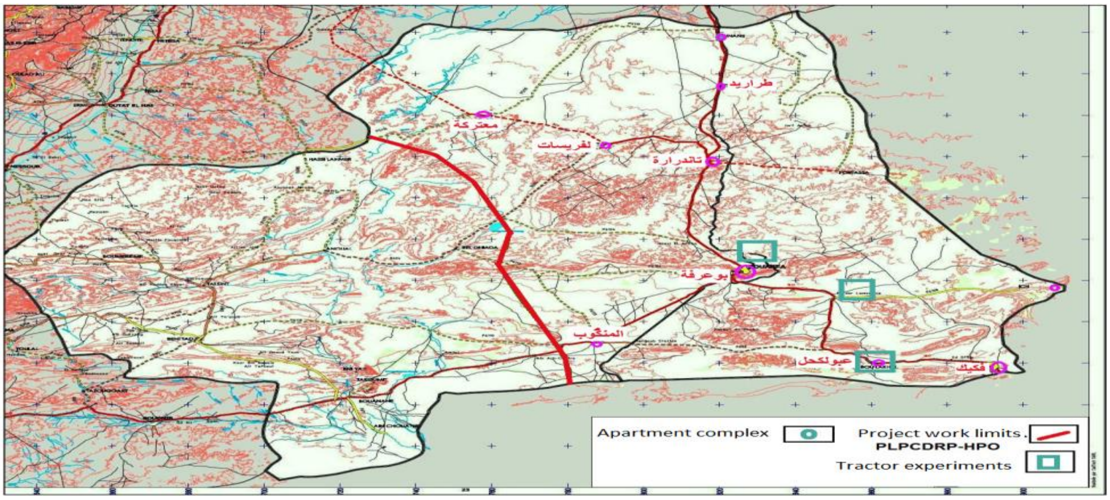

Figure 4. Locations of the research field in the high plateaus in eastern Morocco

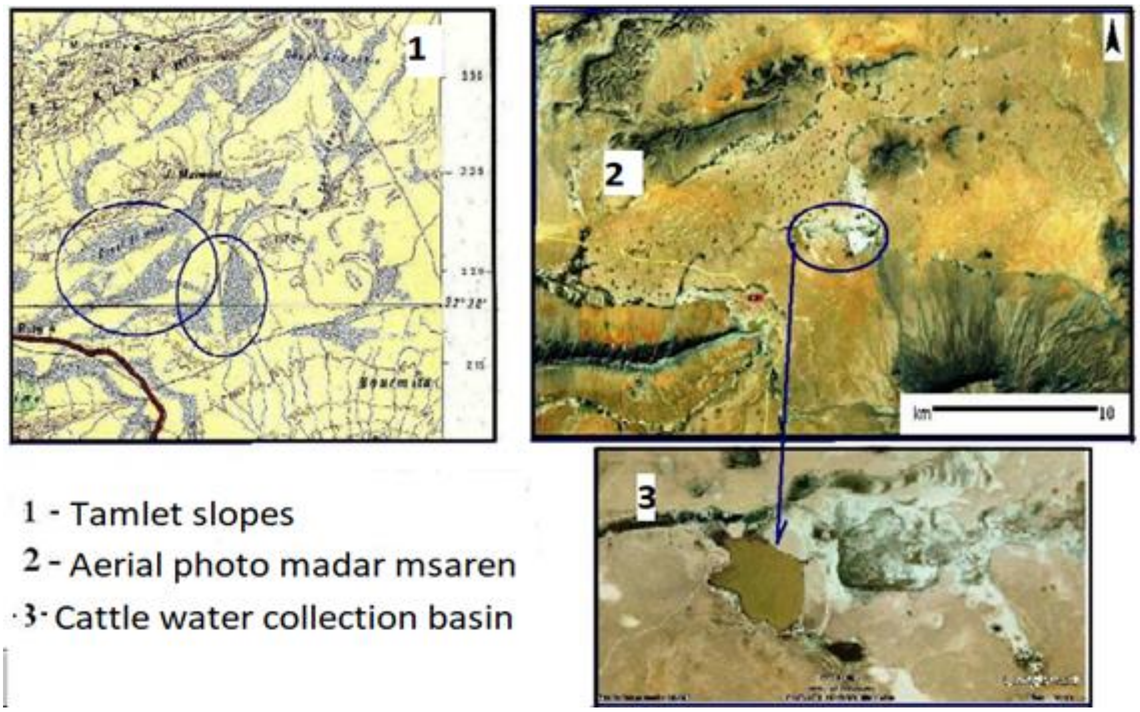

Figure 5. Shows drainage zones in platau regions

Figure 6. Mechanisms used in the water harvesting project in the eastern Moroccan plateaus

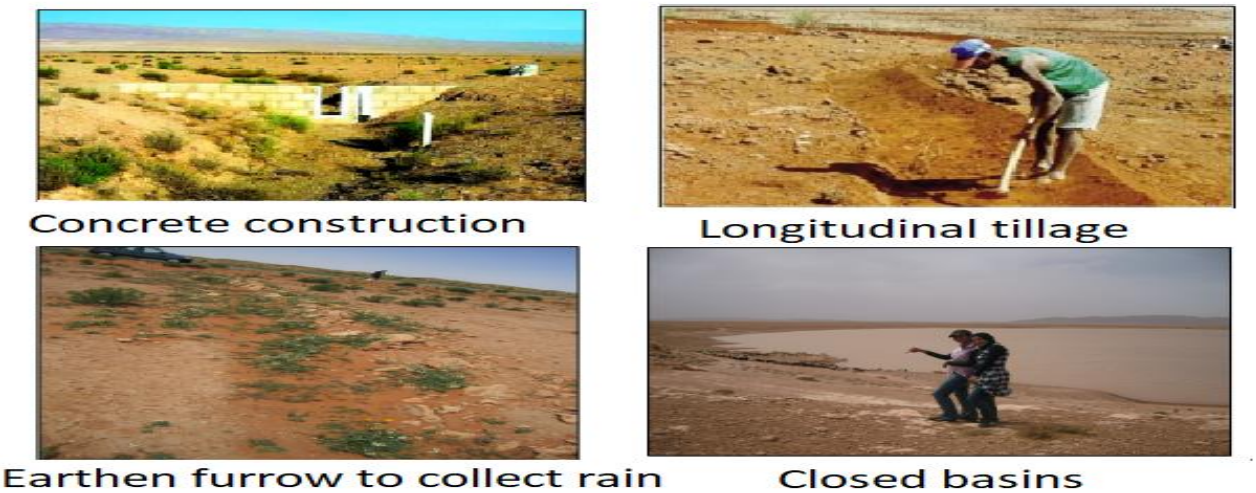

Figure 7. Some works and technologies for water harvesting and the development of pastoral plants in eastern Morocco

Figure 8: represents water harvesting within the course of the Dry Valleys

Figure 9: Construction of pits to harvest water within the flat areas

Figure 10: Constructing stone dams to hold and harvest water within arid regions

Figure 11: Construction of earthen dams to hold and harvest water within arid regions

Figure 12: Conserving water within the site to harvest rainwater and prevent surface runoff within arid areas

Figure 13: Technologies for holding water towards ground tanks to harvest rainwater in dry areas

Figure 14. The water pool in the Syrian desert and the growth of natural vegetation

Figure 15. Areas suitable for water harvesting in the Kingdom of Saudi Arabia, but they are not exploited and the growth of natural flora is sparse

Figure 16. Suitable areas for water harvesting within the shoulders of Wadi Hauran - Al-Hussainiyat area, but they are not used for rainwater harvesting (Photo from Omar Al-Sheikhly 2009)

Calculating the water revenue of the valleys using the SCS method:

This method was applied in calculating the volume of water revenue prepared by the US Soil Conservation Services [37], where the (S) is extracted in terms of the number from the soil table (CN) and according to the land use. The equation excludes the percentage of water losses through evaporation and ground leakage, according to the following equations:

$$Q = \frac{(P-I_a)^2}{(P-I_a)+S}, Q = \frac{(P-0.2S)^2}{P+0.8\,S}$$

$$\mathrm{CN} = \frac{1000}{10+\mathrm{S}}$$

Whereas:
Q: The volume of direct runoff, m3
P: cumulative rainfall depth, mm
S: potential storage depth in the soil, m3
CN: type of ground cover for the collection area

The equation has one variable, which is the (P). As for the coefficient (S), it is related to the curve number by the relationship:

$$\mathrm{CN} = \frac{1000}{10 + \mathrm{S}}$$

Since (CN) is a variable and its value ranges between 0-100 for the minimum and maximum surface runoff, respectively. It can be found by relying on the table of the hydrological soil group, land use and treatments, and the hydrological condition.

The size of the rain revenue is calculated by applying the precipitation equation after converting the value of the output from inches to mm. The SCS method, which is now called the Natural Resources Conservation Service, NRCS This equation is widely used in the world to estimate surface runoff of rainwater from valleys.

This method requires rainfall amount and curve number which depends on the area's soil quality, land use, vegetation cover and soil precipitation moisture, Antecedent Moisture Content, AMC.

Soils are classified according to a special table into four hydrological groups A, B, C, and D that depend on the type of soil, land use, and requirements for estimating vegetation cover, which depends on the surface runoff. The (rain-runoff) equation used by SCS to predict the depth of runoff for a rainstorm is:

$$Q = \frac{(P - 0.2S)^2}{P + 0.8\,S}$$

As an example of calculating the amount of water in Wadi Al-Mubdad [38]. The results of the application of the SCS method showed the identification of the volume of rainwater revenue in cubic meters for rainstorms, which were recorded in the valley.

Benefits of using water harvesting:

There are many benefits associated with dryland water management by rainwater harvesting method including:

- Harvesting rainwater gives the inhabitants of dry and semi-arid lands valuable opportunities to establish agricultural and pastoral economic activities in areas that were previously unsuitable for this.
- The use of water harvesting contributes to preserving the vegetation cover and leads to biodiversity and limits environmental degradation that leads to desertification, in addition to protecting the soil from erosion.
- Provides water harvesting in water-scarce areas to sufficient quantities of water for human and animal use.

In conclusion, to ensure the success of water harvesting projects for the purpose of developing vegetation in dry desert areas, we recommend the following:

1.Coordination and integration between state institutions related to the development of desert areas and water resources.

1. Raising institutional capacities at the regional and local levels.
2. Capacity development in the field of surface water management.
3. Involving the stakeholders (beneficiaries) and the neighboring residents of the forest and pasture areas in such projects.
4. Taking into account the economic and social dimensions when planning and implementing these projects.
5. Spreading water awareness, its importance and sustainability among the sectors of society.
6. Promoting the use of modern technologies such as remote sensing systems and geographic information systems.

References:

[1]IDRC, 1994 – People, Plants and Patents: The Impact of Intellectual Property on Biodiversity. Ottawa, Canda, 166 p.

[2] Abdel-Razek, Mohamed Abbas 2006. Sustainable Rural Development and Food Issues in the World. Sudan.

[3] Hamida, Ibrahim Hassan. 1992. Hydrology and Groundwater, Cairo University Press.

[4] Hussein, Al-Amin Muhammad Ali. 2018. Traditional methods of water harvesting and their role in agricultural development - a case study of Sennar locality, Sennar state, Sudan 2004-2017

[5] Al-Banna, Ali. 1970. The foundations of climatic and vegetative geography - Dar Al-Nahda Al-Arabiya for printing and publishing, Beirut.

[6] Salem, Essam, Hana Daaqan, 2007. The Frost Dam and its effects on the development of agricultural and tourism investment in the surrounding areas. Republic of Yemen.

[7] Governorate, using geographic information systems, master's thesis - physical geography.

[8] Fares, Nabil. 1993. The Water War in the Arab-Israeli Conflict, Dar Al-I'tisam, Cairo.

[9] Dutt, G.R. and McCreary, T.W., 1975. Multipurpose salt-treated water harvesting system. Proc. Water Harvesting Syrup., Phoenix, AZ, ARS W-22. USDA, pp. 310--314.

[10] Ciesielski S, Handzel T, Sobsey M. 1991. The microbiologic quality of drinking water in North Carolina migrant labor camps.

[11] Elal Ali. 1997. Specifications and Efficiency of Water Harvesting Techniques, Arab Organization for Agricultural Development, Khartoum.
[12] Farhan, Mahdi Hamad. 2012. The economic importance of water harvesting by building dams on valleys in dry areas (Wadi Al-Akhdar, an applied study) - Al-Ambar University Journal of Human Sciences, p. 2
[13] Ibn Mishliyyah F. 1993. Harvesting water for irrigation. Training course in water harvesting, Tunisia 1-11/11/1993
[14]. Asaad Sh. 1989. Notes on Hydrological Drought and Strategy, Integrated Response Plan. Workshop on the strategy for developing water resources under drought conditions, Damascus. From 25–27/10.
[15] Owais D Prins, Hajem D 2003. Water harvesting Traditional technologies for the development of drier environments. Publications of the International Center for Agricultural Research in the Dry Areas (ICARDA).
[16] Haddou m. 1997. Diversity of water harvesting techniques in the Tafilalat region to cope with droughts. Publications of the Arab Organization for Agricultural Development, Khartoum.
[17] Nafeh, Faisal Abdel Fattah. 2017. Using water harvesting technologies to develop Iraqi water resources. Al-Mustansiriya Journal of Arab and International Studies, Issue 70 - Baghdad.
[18] Hajem, Ahmed Youssef, Theeb Owais, and Dieter Prinze. 2002. Water Harvesting, Traditional Technologies for the Development of Drier Environments, International Center for Agricultural Research, ICARDA.
[19] Oweis, T. Y. and Taimeh, 1996, Evaluation of small basin water harvesting system in the arid region of Jordan. Water Resources Management 10: 21-34.
[20] Noman, Fahmy Saeed, 1996. Rain in Yemen - Master's thesis. Yemen Arab Republic.
[21] Qutrib, Hussein Ibrahim. 2007. An integrated system in the means and techniques of utilizing rainwater in the surface forms of dry lands.
[22] Oweis T., Hachum A., Kijne J.,1999, Water harvesting and supplementary irrigation for improved water use efficiency in dry areas. SWIM Paper 7. International water Management Institute, Colombo, Sri Lanka.
[23] Spencer, G., and Garder, D. J, 1964- Building contour bank with adsc plough. West. Austral. Dept. Agr. Jour. 5(4): 278-285.
[24] Prout, A. L, 1969- Water storage has not kept pace with stock numbers. West. Austral. Dept. Agr. Jour. 10(12):495-499.
[25] Al-Sheikh, Abdul-Malik bin Abdul-Rahman, 2006. Harvesting rainwater and floods and its importance to water resources in the Kingdom of Saudi Arabia. The Second International Conference on Water Resources and Arid Environment, Saudi Arabia.
[26] The Arab Organization for Agricultural Development. 2002. Promoting the use of water harvesting technologies in the Arab world, Khartoum.
[27] Critchley, W., Siegert, K., Chapman, C., Finkel, M. 1991. Water harvesting. A manual for the design and construction of water harvesting schemes for plant production.
[28] Geddes, H. J, 1968- Water harvesting. Water Res. Found. Austral. Rpt. 25: 1-4.
[29] Garder, D. J., Spener, G. W,.1971- Water conservation handbook. West Austral. Dept. Agr.,63 pp., illus.
[30] Oweis, T.Y. 2004. Rainwater harvesting for alleviating water scarcity in the drier environments of West Asia and North Africa. Presented at the International Workshop on Water Harvesting and Sustainable Agriculture, Sept. 7th, Moscow.
[31] Abdoun, Abdel Latif, Salah Abdullah Makki, 2006. Rainwater Harvesting Technology, The Future of Water in Sudan, Khartoum.
[32] Othman, Mohamed, Khaleda Ahmed. 1998. The environmental impact of biomass use in the East Butana region, master's thesis in geography, University of Khartoum.
[33] Shawky, Ibrahim Asaad. 1989. The Importance of Water in Arab Arid and Semi-Arid Regions, Arab Center for the Studies of Arid Zones and Dry Lands, Damascus.
[34] Al-Heiba, Mustafa. 1997. Agricultural development by water harvesting, Arab Organization for Agricultural Development, Khartoum.
[35] FAO.1994. Water Harvesting for Improved Agricultural Production. Water Reports 3, Proceedings of the FAO Expert Consultation, Cairo, Egypt, November 1993, FAO, Rome, Italy.
[36] Jabari, Aziza. 2012. Rainwater harvesting technology and its role in improving the quality of pastures (Valerani experiment model) - Professional License J.A.M. The Kingdom of Morocco.
[37] Soil Conservation Service (SCS) (1972) National Engineering Handbook, Section 4: Hydrology. Department of Agriculture, Washington DC, 762 p..
[38] Al-Jubouri , S . A . 2014. Water Harvesting for Wadi Al-Madad Basin in Salah Governorate Religion. Ph.D. thesis, thesis, Department of Geography, Tikritz University . Iraq .

دور حصاد المياه في تنمية الغطاء النباتي والحد من التصحر ضمن المناطق الجافة الصحراوية*

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المستخلص

لقد اصبح من الضروري حاليا وجود تناغم ما بين الحاجة إلى استغلال مياه الامطار وزيادة الإنتاج الزراعي والغذائي والرعوي والاستمرار في الإبداع العلمي وخصوصا في مجال التقنيات المتعددة لحصاد مياه الامطار للاستخدام البشري وري المزروعات لتوفير الغذاء والمحافظة على البيئة ضمن حالة الجفاف التي نعصف بالمناطق الصحراوية والتي اثرت على حالة وتدهور البيئة واختلال التوازن الأيكولوجي ، تتطرق الدراسة إلى اهمية حصاد المياه في تنمية الغطاء النباتي الرعوي والطبي ومزايا تقنيات حصاد المياه وكذلك الاستفادة من الموارد الارضية المتاحة في الصحراء العراقية وصيانة الابار الموجودة ذات النوعيات الجيدة المتوفرة وانعكاساتها على ديمومة النظم الزراعية ضمن المواقع الملائمة ودور مراكز البحوث العربية في دعم وتوطين السكان المحليين لإقامة نواة للتنمية الزراعية ضمن حالة التغير المناخي وارتفاع حالة الجفاف .

تم حساب الإيراد المائي للأودية بطريقة SCS وطبقت هذه الطريقة في احتساب حجم الإيراد المائي والتي أعدتها خدمات صيانة التربة الأمريكي (U.S. Department of Agriculture, 1972)

تناول المقال تجربة رائدة في مناطق هضاب في المملكة المغربية حيث توفرت ضمن المنطقة موارد طبيعية تتمثل في محيطها الاحيائي ووجود حالة تدهور استوجبت التدخل من قبل جهات حكومية ومنظمات دولية لمساعدة الساكنين المحليين في تلك المناطق المتأثرة من حالة الجفاف والتذبذب المطري ، ان هذه الحالة الصعبة اختارت على رصد افضل المشاريع التي بإمكانها توفير حالة التوازن البيئي واستقرار العوامل الطبيعية وفتح افاق التنمية المتوازنة ضمن المنطقة اخذت بعض العوامل مرتبطة بمعالجة بيئية من خلال عمليات حصاد وتجميع المياه لتنمية الغطاء النباتي الرعوي في تلك المناطق والحد من حالة التصحر التي عصفت بتلك المناطق بسبب الرعي الجائر وحالة الجفاف التي عصفت بتلك المناطق .

الكلمات المفتاحية: حصاد المياه ، التربة ، مناخ ، المناطق الجافة ، النبات.