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EVALUATION OF DYKES AS WATER HARVESTING SYSTEM IN WADI SHEBITY WEST MERSA MATROUH, NORTHWESTERN COASTAL ZONE – EGYPT.

[4]

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ABSTRACT

The main objective of this research is evaluating dykes as rain water harvesting activities to maximize rainwater utilizing in drainage basins in the northwestern coast of Egypt which receive amount of water and have a population growth and agricultural activities. Wadi bed cultivation is the water harvesting system in the chosen wadi. It is usually done through construction of stone dykes to store surface runoff coming from tableland in the south, the main problems associated with this type of water harvesting are unequal water distribution through the wadi, where less runoff water reaches the wadi beds in downstream, with the result that downstream crops become increasingly water-stressed, moreover storing volume of water higher than fig water requirement the results in delaying agricultural development. To maximize rainwater use, 50 stone dykes of 50 cm spillway height were evaluated in term of water distribution efficiency and the percentage of stored water volume to plant water volume requirement/season. And depending on the storage capacity of dykes, fig water requirement and the runoff volume of the average season of rainfall data for 17 years from October to march (one season) estimated by Soil Conservation Service (SCS) method and Geographical information system (GIS)

The results of the present study show that wadi Shebity watershed receives average annual rainfall volume of 435217 m^3, 121922 m^3 from it by percentage of 28 % run on ground while the residue percentage of 72 % distribute among evaporation and infiltration in soil, 118590 m^3 of surface run off by percentage of 97 % stored by dykes by water distribution efficiency of 3, 12, 100 % for rainfall of 12, 20 and 53 mm respectively, and 3332 m^3 by percentage of 3 % is lost in the sea. The percentage of the stored water volume to the cultivated areas water volume requirements is 118 % with difference of 18168m^3. The study reveals that the end of wadi shibty is in safe from flood hazard, where the runoff coming from the table land at the south is stored completely by dykes even with the maximum rainfall of 53 mm. The spillway height of 50 cm is not suitable to distribute surface runoff through the wadi for low and medium rainfall which is more frequency, moreover stores water volume higher than the fig water requirement with 18168 m^3. Further the methodology followed in this study can be applied in all other wadis watersheds but designing new or modification of the existing water harvesting system of dykes will depend on its watershed area and its physical Characteristics, rainfall, the cultivated land area and crop/fruit type. The present study reaches out for some recommendations to maximize rainwater utilizing

Keywords: Rainwater, Drainage basin, Dykes, SCS Curve Number, GIS.

INTRODUCTION

The Nile River is the main source of water in Egypt, as Egypt's annual share of it is currently about 55.5 billion cubic meters, which represents about 90% of Egypt's water resources (Abdel Shafy & Aly, 2002) and at present this amount of water is not sufficient for the desired horizontal agricultural expansion in the Egyptian country to face the continuous increase in the number of people and to achieve the optimum distribution of the population to occupy about 25% of Egypt's area instead of the present ratio of 5%.

Because of the limited available water resources and the stability of Egypt's share of Nile water and the presence of restrictions on the re-use of low quality water and the high costs for achieving the safe use of it and high costs of salt water desalination the importance of collection and using of rainwater that falls in winter on the north western coast in shows up as one of the important sources that can be relied on especially it is often characterized as better quality than other water sources (Thomas & Greene, 1993). In December 1996, Egypt had issued its framework program of Integrated Coastal Zone Management (ICZM), The program covered the coastal area that lies between the village of Fuka and the town of Marsa Matrouh, approximately 70 km wide, Regional information on the hydrogeological conditions of the Northwestern coastal zone of Egypt can be found in several publications and theses such as El Shamy (1968), Hammad (1966, 1972), Misak (1974), El Shazly *et al.* (1975), Ezzat (1976), Hilmy *et al.* (1978), Sewidan (1978), Guindy (1989) and El Maghraby (1997). Also, some reports were prepared such as FAO (1970), Mudallal (1990) and El-Raey (1998)

In order to meet the water needs in coastal areas, the rainwater harvesting is the main procedure that used for storing the water. The main components of water harvesting systems are: Catchment area, Storage facility and target area (Oweis *et al*. 2001, 2012), Patil (2006), these groups could be recognized to Macro catchment water harvesting systems and Spate irrigation systems. (Tauer and Humborg, 1992; Critchley and Siegert, 1991):

Wadi-bed cultivation is the main water harvesting technique used in wadis of Northwestern Coastal Zone depending on construction of stone dikes across the wadi to reduce the runoff speed and allow soil particles to settle creating good agricultural land. The main problem associated with this type of water harvesting is less runoff water reaches the wadi beds in downstream, with the result that downstream crops become increasingly water-stressed So the good design of rainwater harvesting activities as dykes became a vital and necessary to increase the rainwater use efficiency

In this paper, the dykes as rainwater harvesting activities, were evaluated in terms of the water distribution efficiency and the percentage of the total stored water volume to total water volume required for all cultivated areas per season to reach the suitable design of dykes for maximizing rainwater utilizing.

MATERIALS AND METHODS

Description of Study Area:

<u>Location</u>: The study area is located on the Northwestern coastal zone. Wadi Shebity, chosen for the present study, is located at about 70 km west of Marsa Matrouh bounded by latitudes 31 26 30 ,31 29 30 N and longitudes 26 37 45, 26 40 15 E, Figure 1.

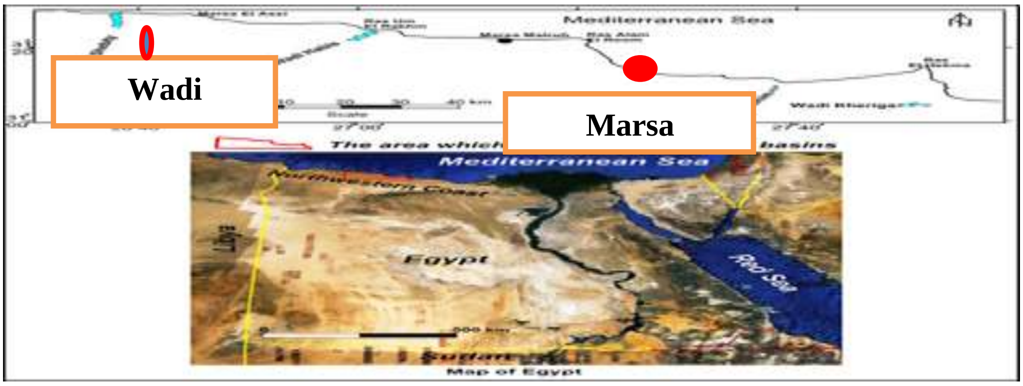

Figure (1): Location of study area

<u>Rainfall</u>: The Mediterranean coastal zone of Egypt receives noticeable amounts of rainfall, especially in winter, the average annual rainfall equal 117.5 mm (Ministry of Irrigation and Water Resources 2001), ranges from

100 to 190 mm (Khalifa and Beshay, 2015), (DRC staff, 2010); about 97% of this amount falls between October and March.

<u>Geomorphology</u>: Depending on field observation, digital elevation model, and topographic maps and according to previous studies, (Hammad, 1966 - 1972), (Sharkawy, 1998), (Yousif *et al.*, 2013) (Sabet *et al.* 2017) the study area can be differentiated into three main geomorphologic units, these units from south to north are: the tableland, Piedmont plain and the coastal plain, Figure 2 **.**

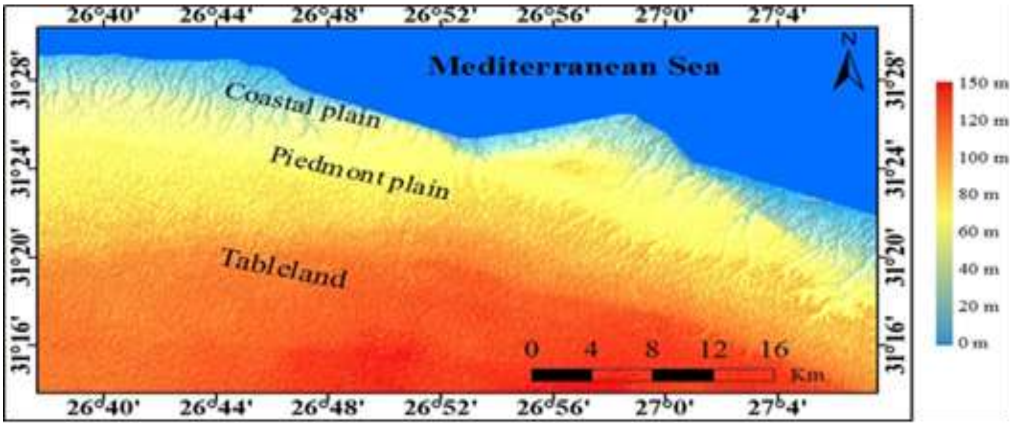

Figure (2): Geomorphology of study area (Sabet *et al.*, 2016)

Water Storage Dykes: Dykes are engineering structures with heights ranges from (0.5-1) m constructed in wadi bed cultivated macro catchment system to distribute water through wadi, reduce the runoff speed to protect soil from erosion and store surface runoff to increase the water content in the soil profile to be used by fruit trees when needed at drought where there is no rainfall. In this study 50 stone dykes existing in sequence across the main stream in wadi bed were used for evaluation, figure They are constructed using local materials such as stones connected together by cement mortar, built on a layer of rock located at a depth of 1 to 2 meters, distances between dikes along the wadi bed range from 50-100 m constructed usually in mountainous regions on wadis with narrow cross-sections, their lengths range from 30 to100 m and constructed in shape of terraces of 60 cm width and 60 cm height as average values.,

The Spillway: The spillway is a recess in the crest of the dyke and located in the middle or on one of the sides of the dyke to control the stored water volume for the fig water requirement of the area in the front of dyke, figure 3. The height of it affects the storage capacity of dykes and consequently water distribution efficiency, the percentage of stored water to the fig water requirement. In this study the examined spillway height was 50 cm

Figure (3): Spillway of the dyke

Evaluation aspects: The evaluation aspects included in this study are:

- Water distribution efficiency.
- -The percentage of stored water to the fig water requirement.

***<u>Evaluation Requirement</u>*: Following are the main information required to do the evaluation:-**

- Storage Capacity of Dykes: Storage capacity of dykes Were determined depending on cultivated land areas in front of the dykes measured using total station device and the spillway height of every dyke measured by grid leveling performance using optical level and staff.
- Fig Water Requirement: According to (Matrouth Resource Project Management (MRMP) 1995-2002), the water requirement for fig trees cultivated at 10*10 m apart (42 trees/fed.) is 2100 m3 /fed /year.
- The runoff volume at every dyke: Runoff volume at the end of every cultivated area at the dyke (Qt) was calculated as follows:

Qt = Q1 + Q2

Where:

Q1: runoff volume coming from upstream watershed directly to this area (m3)

Q2: runoff volume resulting from rain falling directly on this area

The surface runoff was estimated depending on the watershed characteristics, its natural components in what is known land use/cover and hydraulic group of soil, rainfall depth and by using the SCS curve number method and Geographical Information System (GIS).

The digital elevation model (DEM) used in this study was extracted from the SRTM data base (90m spatial resolution) from the United States Geological Survey website (http://www.usgs.gov). DEM was employed to offer varieties of data that assist in produced landforms map and hydrology information. Drainage networks and watershed boundary of the studied wadi were extracting from DEM and using arc GIS software.

The rainfall data used in this study is average season rainfalls data from season 1998/1999 to 2014/2015 for (17 years) obtained from the meteorological weather stations that were installed by the Desert Research Center since 1998.

The conventional land use/land cover maps of the watersheds were obtained by the land survey technique using (GPS). The land cover maps was prepared depending on N-E geographic coordinates of every area of different land use and topographic map using ArcGIS. Boundaries of different land use class were digitized in the (ArcGIS.10.1), and the attributes were linked to them.

The Unified Soil Classification System (USCS) was adopted in this study for soil classification Sieve analysis; dry sieving and pipette method were carried out to classify the collected soil samples. The infiltration rate was measured using Double Ring Infiltrometer manufactured for this purpose.

One of the most popular methods for computing the runoff volume from a rainstorm is The SCS Curve Number Method. It accounts for many of the factors affecting runoff generation, incorporating them in a single CN parameter ,the SCS-CN method is based on the water balance equation and two fundamental hypotheses, the first hypothesis equates the ratio of actual amount of direct surface runoff Q to the total rainfall(P) or maximum potential surface runoff to the ratio of actual infiltration (F) to the amount of the potential maximum retention (S), the second hypothesis relates the initial abstraction (Ia) to the potential maximum retention S (Deshmukh, 2013).

RESULTS AND DISCUSSION

Land use / Cover: Three land use and land cover classes were categorized in the watershed, Figure 4.

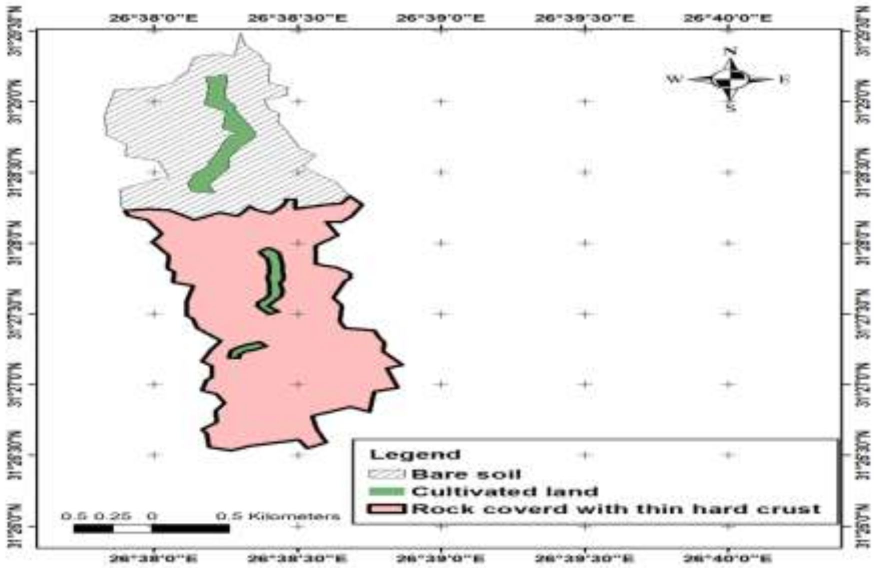

Figure (4): The land cover map of wadi Shebity watershed

Hydrological Soil Group: Depending on texture and Infiltration rate of soil results and according to the hydrologic soil group division by USDA, watershed of wadi Shebity was classified into only two groups: A and C. The hydrologic soil group classification listed in table (1).

Table (1): Hydrological soil group of wadi Shibty watershed

Land Cover	Soil texture	Infiltration Rate (In/hr)	Hydrological Soil Group (HSG)	Area (m^2)	Percentage of area (%)	CN
Rock covered with thin hard crust	S L	0.11	C	2662325	58.97	91
Agricultural land	S L	2.36	A	200844	4.45	77
Bare Soil	S L	2.13	A	1651810	36.58	63
Sum				4514979	100	

The curve number (CN) values were determined depending on the land use / cover and hydrological soil group according to USDA. The composite curve number (CNc) of every watershed was calculated by using the equation:

$$CN = \Sigma\ (CNi \times Ai)\ /A$$

Where,

CNi: curve number from 1 to any no. N.

Ai: area with curve number CNi (m^2)

A: the total area of the watershed (m^2)

The results of composite curve numbers (CNc) of Sub-Watersheds in wadi shipty are shown in figure 5.

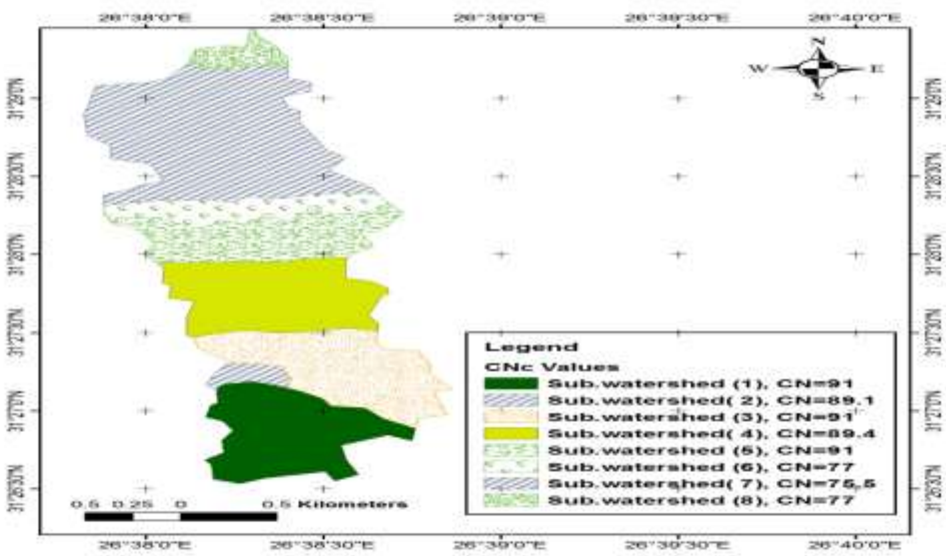

Figure (5): The Composite Curve Numbers (CNc) of the sub watersheds of wadi Shebity

Depth and Volume of Rainfall and Runoff: The rainfall and runoff volumes were obtained by multiplying every sub watershed area with the depth of rainfall and runoff.

Evaluation of Dykes:

<u>Water Distribution Efficiency</u>: The water distribution efficiency (W.D.E) was calculated by subtracting the storage capacity of every dyke from runoff volume and calculating cumulative runoff volume of the difference and using the relation

W.D.E (%) = Af/At*100

Where: Af = the cultivated area completely filled with water (m^2)

At = the total cultivated area.

Figure 6 shows the behavior of runoff through the cultivated areas between dykes; figure 7 shows the water distribution efficiency (W.D.E) of every average monthly rainfall

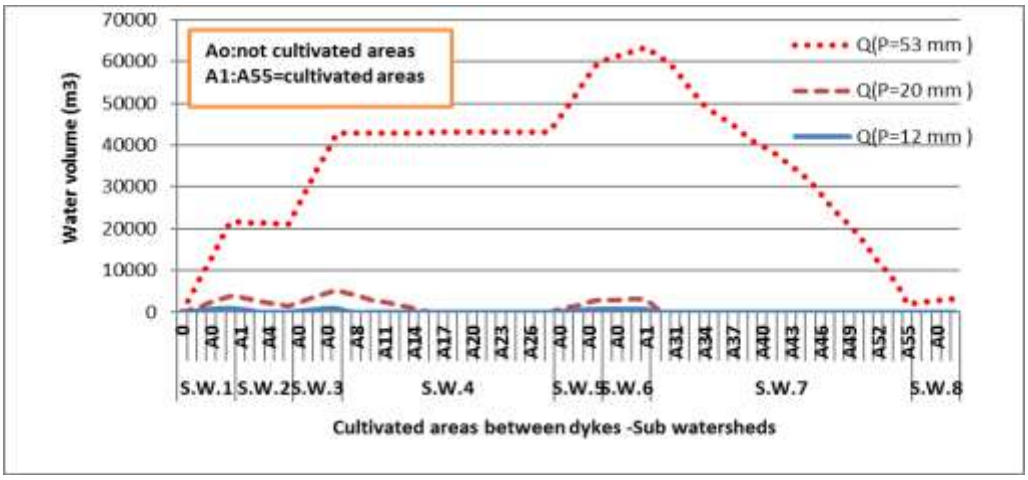

Figure (6): The behavior of runoff through the cultivated areas between dykes

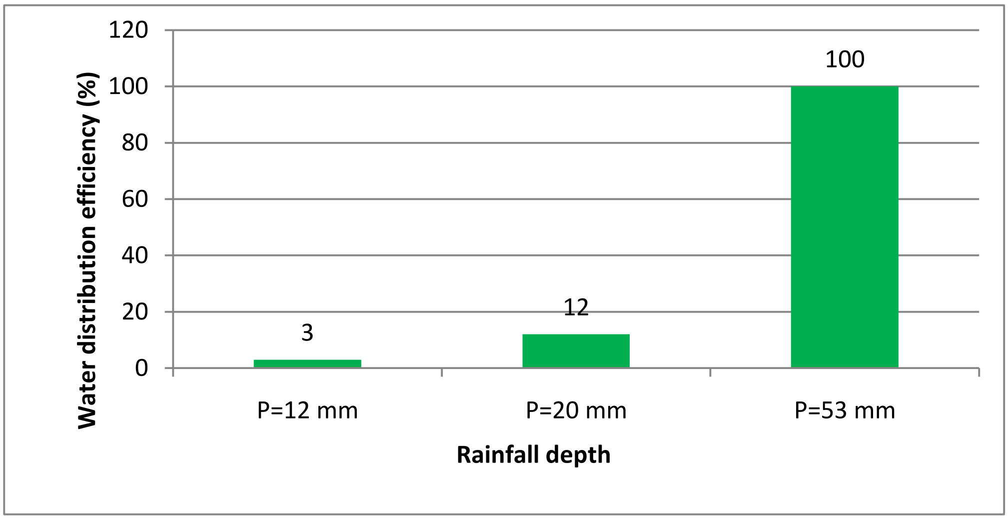

Figure (7): The water distribution efficiency for season in wadi Shibt

The results show that the water distribution efficiency was 3, 12, and 100% for rainfall of 12, 20 and 53 mm respectively, the water distribution efficiency is directly proportional to rainfall depth where the maximum and minimum percentages of 100 and 3 % were at the maximum and minimum rainfall depths of 53 and 12 mm respectively, water distribution is affected not only by the runoff volume coming from upstream but by local runoff either due to vertical rainfall or rainfall on both sides of cultivated areas.

Runoff volume Increases in sub watersheds number 1, 3 and 5 (SW1, SW3, and SW5) for all rainfall depths, and in sub watershed number 8 (SW8) for the rainfall of 20 and 53 mm but with different amount depending on the rainfall depth because there are no dykes to store water, and increases in sub watershed number 4 (SW4) for the rainfall of 20 and 53 mm because the storage capacity of the dyke at every cultivated area is lower than its local runoff volume, consequently difference of volume between them is added to the runoff volume coming from upstream.

Run off volume decreases in sub watersheds number 2 (SW2) for rainfall of 20 and 53 mm, in sub watersheds number 4 (SW4) for the only rainfall of 20 mm, and SW7 for the only rainfall of 53 mm because the storage capacity of the dyke at every cultivated area is higher than its local runoff volume, consequently difference of volume between them is subtracted from the runoff volume coming from upstream.

Run off volume is almost constant in SW4 for the rainfall of 53 mm because the storage capacity of the dyke at every cultivated area equals its local runoff volume.

Percentage of stored water volume to plant water volume requirement / season: Water volume required for every cultivated area was calculated by multiplying its area by the fig water requirement of 500 mm. The volume of stored water per season was calculated by summation of the stored water volumes for every monthly rainfall / season.

The results of actual stored water depth/ volume and water depth / volume required for every cultivated area per season are shown in figures 8 and 9.

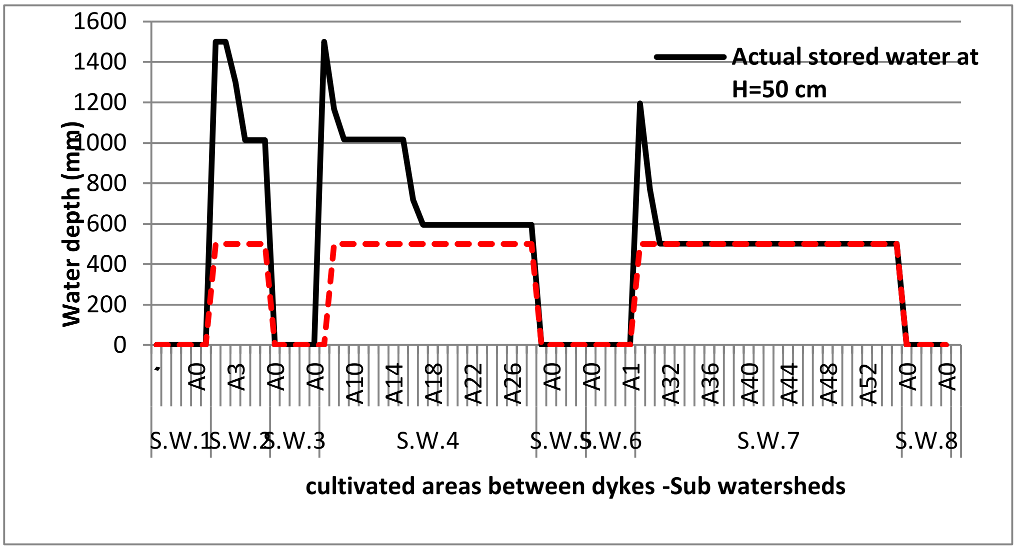

Figure (8): The depth of Stored Water /Water depth required for Cultivated Areas

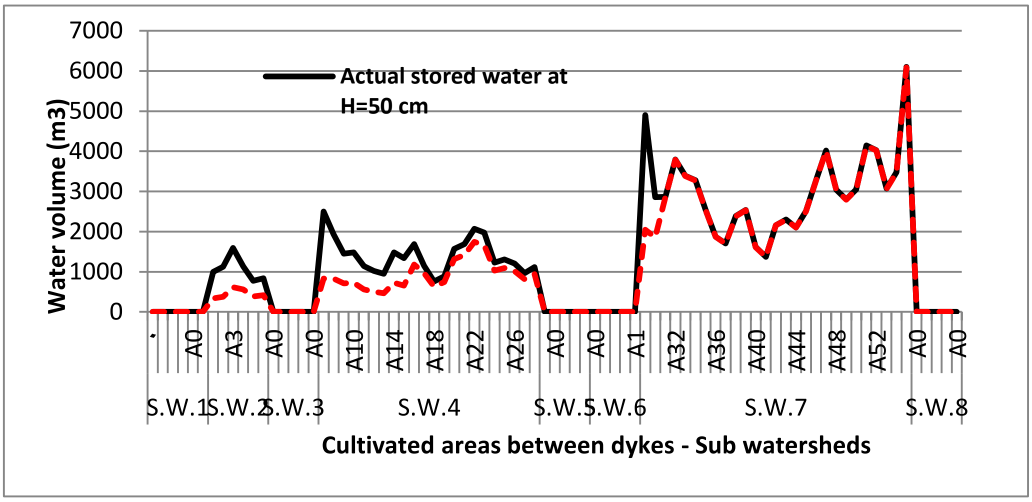

Figure (9): The volume of Stored Water / Water volume required for Cultivated Areas

The results show that amount of 118590 m^3 from the surface run off of 121922 m3 by percentage of 97 % is stored by dykes with average depth of 590 mm; the maximum depth is 1500 while the minimum depth is 500 mm. The percentage of the total stored water volume to total water volume required for all cultivated areas = 118 % with difference of 18168 m^3.

The maximum value of water depth of 1500 mm was in the first two areas of SW2 and the first area in SW4, because these areas are directly next to collecting runoff and non-cultivated areas (SW3), so they were completely filled with runoff 3 times at rainfall of 12, 20 and 53 mm with depth of 50 cm which gives 200 mm. The minimum value of water depth of 501.2 mm was in the last 25 areas from A31 to A55, because these areas were completely filled only once with depth of 50 cm due to the runoff of 53 mm which is the only reach them this gives 500 mm in addition to the local runoff of rainfall of 20 which gives 1.2 mm, while there is no local runoff for rainfall of 12 because its value is lower than the initial abstraction of SW7 which is 16.5 mm.

CONCLUSION

The main objective of the present study is to maximize rainwater utilizing in study area. To achieve this objective, field investigations, laboratory and office work were carried out. 50 stone dykes of 50 cm spillway height were evaluated in term of water distribution efficiency, and Percentage of stored water to plant water requirement/season. The calculations and results show that that wadi Shebity watershed receives average annual rainfall volume of 435217 m^3, 121922 m^3 from it by percentage of 28 % run on ground while the residue percentage of 72 % distribute among evaporation and infiltration in soil, 118590 m^3 of surface runoff by percentage of 97 % stored by dykes by water distribution efficiency of 3, 12 and 100 % for rainfall of 12, 20 and 53 mm respectively, and 3332 m^3 by percentage of 3 % is lost in the sea. The percentage of the stored water volume to the cultivated areas water volume requirements is 118 % with difference of 18168 m^3. Based on previous results it may conclude that the end of wadi Shebity is in safe from flood hazard, where the runoff coming from the table land at the south is stored completely by dykes even with the high rainfall of 53 mm. The spillway height of 50 cm delays the agricultural development, because it does not distribute surface runoff through the wadi with high efficiency at low and medium rainfall, which is more frequency, moreover it stores total water volume higher than total fig water requirement for the cultivated areas between dykes/season. Further the methodology followed in this study can be applied in all other wadis watersheds, but designing new or modification of the existing water harvesting system of dykes will depend on its watershed area and its physical Characteristics, rainfall, the cultivated land area and crop/fruit type.

RECOMMENDATION

According to the results of the present study, the following recommendation must be taken into consideration:

1. Installing meteorological stations in all watersheds to have spatial and temporal rainfall data which can be used for hydrological modeling.
2. Construction of cisterns at the end of wadi to collect the runoff, which will also reduce losses to sea.
3. Increasing the number of fig trees / fed in upstream cultivated areas with percentage depending on difference between the stored water volume and fig water requirement to increase the productivity, consequently the water use efficiency, where the stored water volume is generally higher than the water requirement of fig trees cultivated with numbers of 42 trees/fed.
4. Management of land, water and plant must be controlled by government not by the owners to achieve maximum water use efficiency and agricultural development.
5. Researchers are required to study the effect of decreasing the spillway height on water distribution efficiency and the Percentage of stored water to plant water requirement/season to determine the best that achieves maximizing rainwater utilizing.

6. Carrying out field measuring of runoff volume at many positions and comparing the measured with the estimated volumes.

REFERENCES

Ahmed, A. S. (2012): Evaluation of the land resources for agricultural development - case study: El-Hammam canal and its extension, NW coast of Egypt. Thesis, Library System University of Hamburg.

Atwa, S. M. M. (1979): Hydrogeology and hydro geochemistry of the northwestern coast of Egypt. Ph.D. Thesis, Fac. Sci. Cairo Univ., Egypt, p. 225.

AL-Gamdi, S. (1991): Estimating Runoff Curve Numbers of the Soil Conservation Service in Arid and Semi-arid Environments Using Remotely Sensed Data, A dissertation Submitted to the Faculty of the University of Utah, USA.

Al-Jabari, S.; Sharkh, A. M. and Al-Mimi, Z. (2009): Estimation of Runoff for Agricultural Watershed Using SCS Curve Number and GIS, Thirteenth International Water Technology Conference, IWTC Hurghada, Egypt.

ESRI (2010): Environmental Systems Research Institute (ESRI) Press. Redlands, California.

El Bastawesy, M.; Khalaf, F. I. and Arafat, S. M. (2008): The use of remote sensing and GIS for the estimation of water loss from Tushka lakes. Southwestern desert, Egypt, J. Afr. Earth Sci., 52. 73–80.

EL Sabri, M.A.; Masoud, M.H. and Dahab, K.A. (2011): Water Budget assessment for some Wadis West Mersa Matrouh and possibilities of sea water intrusion. Journal of the Sediment logical Society of Egypt, 19. 113 – 125.

El-Naggar, S.; Perrier, E. and Shykhoun, M. (1988): Evaluation of farm resource management in the north-west coast of Egypt. In: Proceedings of Workshop for the Northwest Coastal Region. Alexandria/Mersa Matrouh, Egypt, April 1988. ARC-SWRI/ICARDA-FRMP.

FAO (Food and Agriculture Organization of the United Nations) (2001): Water Harvesting in Western and Central Africa. RAF/Publication, FAO, Rome, Italy.

Guindy, K. H. (1989): Hydrogeology of the coastal zone between El Ameriya and El Hammam. Ph.D thesis, Fac. Sci., Ain Shams Univ., Cairo, p 151.

Hammad, F. A. (1966): The geology of water supplies in Ras El Hekma area, western Mediterranean coastal zone, Egypt. M.Sc. Thesis, Fac. Sci., Cairo Univ., Egypt, p. 109.

Hammad, F. A. (1972): The geology of soils and water resources in the area between Ras El Hekma and Ras Alam El Rum, Western Mediterranean littoral zone, Egypt. Ph.D. Thesis, Fac. Sci. Cairo Univ., Egypt, p. 162.

Kohnke, H. (1980): Soil physics. Soil Scientist, Purdue Univ., TATA Mc Graw-Hill publishing Company LTD. New Delhi, pp. 28-34.

Nandi, S.; Hansda, T.; Himangshu, H. and Nandi, P. T.: Geographical Information System (GIS) in Water Resources Engineering, International Journal of Engineering Research.5: Issue Special pp.: 210-214

Mohammadin, A. *et al*. (2003): Estimation of Runoff for East Bani Naim Watershed Using SCS Curve Number Method and GIS, Graduation Project Palestine Polytechnic University, Hebron-West Bank, Palestine.

Philip, J.R. (1957): The theory of infiltration. 2, 3 and 4 Soil Science, p 34, 83, 85, 163 and 257. 28.

Sewidan, A.S. (1978): Water budget analysis for the northwestern coastal zone of the Arab Republic of Egypt. Ph.D. Thesis, Fac. Sci., Cairo Univ., Egypt, p. 179.

Sabet, S.; Ismail, L.Y. and Hawash, F.A.S. (2017): Hydrology of Wadi El Sanab, El Qasr area, West Mersa Matrouh, Northwestern Coastal Zone – Egypt. International Journal of Innovative Science, Engineering & Technology.

Taha, A. (1973): Geology of water supplies of Matruh-Barrani area, Northwestern Mediterranean coastal zone, Egypt. Ph.D. Thesis, Fac. Sci., Alex. Univ., p. 253.

Thomas, P. and Greene, G. (1993): Rainwater quality from different roof catchment. Water Science & Technology, 28 (3-5): 291-299.

USDA-SCS (1985): Natural Engineering Handbook, section 4. Department of Agriculture, USA.

USDA-TR55 (1986): Urban Hydrology for Small Watersheds, Department of Agriculture, USA.

Yousif, M. (2015): Integration of the geomorphologic and geologic studies for water potentialities development in El Zarraqa and El Harraqa basins, East Matrouh, Northwestern coast, Egypt. Arab J Geosci 8:4603–4626.

Yousif, M.; Abd, E.S.E. and Baraka, A. (2013): Assessment of water resources in some drainage basins, northwestern coast, Egypt, 35T Applied Water Science 3, (35TI. 235T) . 439– 452.

تقييم السدود الصغيرة كنظام حصاد للمياه فى وادى الشبيتى بغرب مرسى مطروح – الساحل الشمالي الغربي

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المستخلص

الهدف الرئيسي من هذا البحث هو تقييم السدود الصغيرة كأنشطة حصاد مياه الأمطار في أحد الأحواض المائية في الساحل الشمالي الغربي لمصر والتي تتلقى كمية من المياه، ولديها نمو سكاني وأنشطة زراعية. زراعة بطن الوادي هي نظام حصاد المياه في الوادي المختار عن طريق بناء السدود لتخزين مياه الجريان السطحي القادم من الهضبة في الجنوب. ان المشكلة الرئيسية لهذا النوع من حصاد المياه هو التوزيع الغير متساوٍ للمياه خلال الوادي حيث تصل مياه الجريان السطحى بكميات أقل لبطن الوادي في المصب. علاوة على تخزين حجم مياه أعلى من متطلبات التين المائية مما يعوق التنمية الزراعية.

لتعظيم الاستفادة من مياه الأمطار تم تقييم ٥٠ سد حجرى بارتفاع ٥٠ سم من حيث كفاءة توزيع المياه والنسبة المئوية لحجم المياه المخزنة إلى متطلبات / حجم كمية المياه النباتية اعتماداً على سعة تخزين السدود والاحتياج المائى للتين وحجم الجريان السطحى لموسم متوسط للامطار خلال ١٧ سنة من أكتوبر إلى مارس (موسم واحد) والمقدر بواسطة طريقة خدمة حفظ التربة ونظم المعلومات الجغرافية.

ويمكن تلخيص أهم النتائج المتحصل عليها كالآتى: حوض التجميع لوادي الشبيتي يستقبل متوسط امطار سنوى = ٤٣٥٢١٧ م٣ و١٢١٩٢٢ م٣ من هذه الكمية، بنسبة ٢٨٪ يجرى على الأرض كجريان سطحى بينما نسبة ٧٢٪ الباقية توزع بين التبخر والتسرب في التربة. تخزن السدود كمية من مياة الجريان السطحى مقدارها ١١٨٥٩٠ م٣ بنسبة ٩٧ % بكفاءة توزيع للمياه ٣ ، ١٢ و١٠٠ ٪ بالنسبة للأمطار ١٢ ، ٢٠ و ٥٣ مم على الترتيب بينما ال ٣٣٣٢ م٣ الباقية بنسبة ٣ ٪ تفقد في البحر. النسبة المئوية لإجمالي كمية المياه المخزنة في الموسم الواحد إلى إجمالي حجم المياه المطلوبة للمناطق المزروعة = ١١٨ % بزيادة مائية قدرها ١٨١٦٨ م٣.

الخلاصة: نهاية وادي شيبتي في مأمن من مخاطر الفيضانات حيث يتم تخزين كل الجريان السطحي القادم من الهضبة في الجنوب بواسطة السدود حتى مع هطول أمطار بمعدلات عالية. ارتفاع المفيض الحالى للسدود بمقدار ٥٠ سم لا يسمح بالتنمية الزراعية، حيث لا يوزع الجريان السطحي بكفاءة

عالية خلال الوادي فى حالة الامطار المنخفضة والمتوسطة المعدل وهى الأكثر تكرارا، كما أنه يخزن إجمالي حجم مياه أعلى من إجمالي متطلبات التين المائية لاجمالى المناطق المزروعة بين السدود خلال الموسم. يمكن تطبيق المنهجية المتبعة في هذه الدراسة لتقييم انشطة حصاد المياه على جميع مستجمعات المياه الأخرى، ولكن تصميم نظام جديد أو تعديل لنظام حصاد المياه الحالي من السدود يعتمد على مساحة مستجمعات المياه وخصائصها الفيزيائية، معدلات هطول الأمطار ومساحة الأراضي المزروعة، ونوع المحاصيل / الفاكهة بها.

التوصيات: ركب محطات أرصاد جوية في جميع مستجمعات المياه للحصول على بيانات أمطار مكانية وزمانية يمكن استخدامها في النمذجة الهيدرولوجية لأحواض التجميع. انشاء آبار رومانية في نهاية الوادي لجمع الجريان السطحي لتقليل خسائر المياه في البحر. زيادة عدد أشجار التين / الفدان في المناطق المزروعة في المنبع لزيادة الإنتاجية بمعدل يعتمد على الفرق بين حجم الماء المخزن والاحتياج المائى للتين، حيث يكون حجم المياه المخزنة أعلى بشكل عام من الاحتياجات المائية لأشجار التين المزروعة. ضرورة ادارة المياه من قبل الحكومة وليس من قبل المالكين لتحقيق أقصى كفاءة لاستخدام المياه. ضرورة اجراء ابحاث لدراسة تأثير خفض ارتفاع قناة التصريف على كفاءة توزيع المياه وكفاءة استخدامها لتحديد أفضل ارتفاع يمكن أن يحقق أقصى استفادة من مياه الأمطار. إجراء قياس حقلي لحجم الجريان السطحى عند العديد من المواضع ومقارنة الاحجام المقاسة بالقيم المقدرة.