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Rainwater Harvesting Techniques in Syrian Desert (Badia Basin)*

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Abstract: Syrian Arab Republic considers one of the limited waters resources countries, comparison by increasing demand to all the needs. Syria located on the eastern coast to the Mediterranean Sea in the arid and semi-arid zone between altitude　/ 32 - 37.5 / N and longitude / 35.5 - 42 / E. Climate is distinguished by rainy short winter and long dry summer. The rainfall is different in distribution between the coast and the inside areas. Syria divides by the rainfall quantity to five agricultural zones. The fifth area represent is the minimized annual rains rate about 150 mm which is 55% from the country square, called the Syrian Desert (Badia). This area characterized flat area included some mountain series, clayey sandy firm atoms soil, little rains, and hard wind in the summer, high rate vaporization. The relative humidity changes according to the temperature. Syrian Desert (Badia) consider suitable environment to the meadows growth, the pastoral for that it considered the main source to feeding animal wealth, for the insufficiency rains in this area, the government established many vital projects foundation to development botanical cover in the area. And that by means of the rainwater harvest projects, for drinking aims, livestock, and irrigation in some areas. For incarnation by establishment 37 dams in separate places and different sizes to reserve runoff in winter and 50 mini-reservoirs, 7 spread water dikes in the flat wide valleys, terraces, in addition to excavation many of wells, plant the suitable pastoral plants in some the areas and all these projects aim for the utilization attempt as much as possible from drop water it falls on this area to development pastoral cover And the animal wealth and the function on the tenants stability within the desert .

This paper includes study to impression Syrian Desert (the natural factors, the climatic factors, the pastoral cover, animal wealth　the tenants...). and also study water resources management in it, and the followed techniques of rainwater harvest, conditions, and methods selection suitable method and administration.

Keywords: Rainwater harvesting; Syrian desert; Techniques

1　Introduction

Water is essential to all life - human, animal and vegetation. It is therefore important that adequate supplies of water be developed to sustain such life. Development of water supplies should, however, be undertaken in such a way as to preserve the hydrological balance and the biological functions of all ecosystems. This is crucial for marginal lands. Consequently, the

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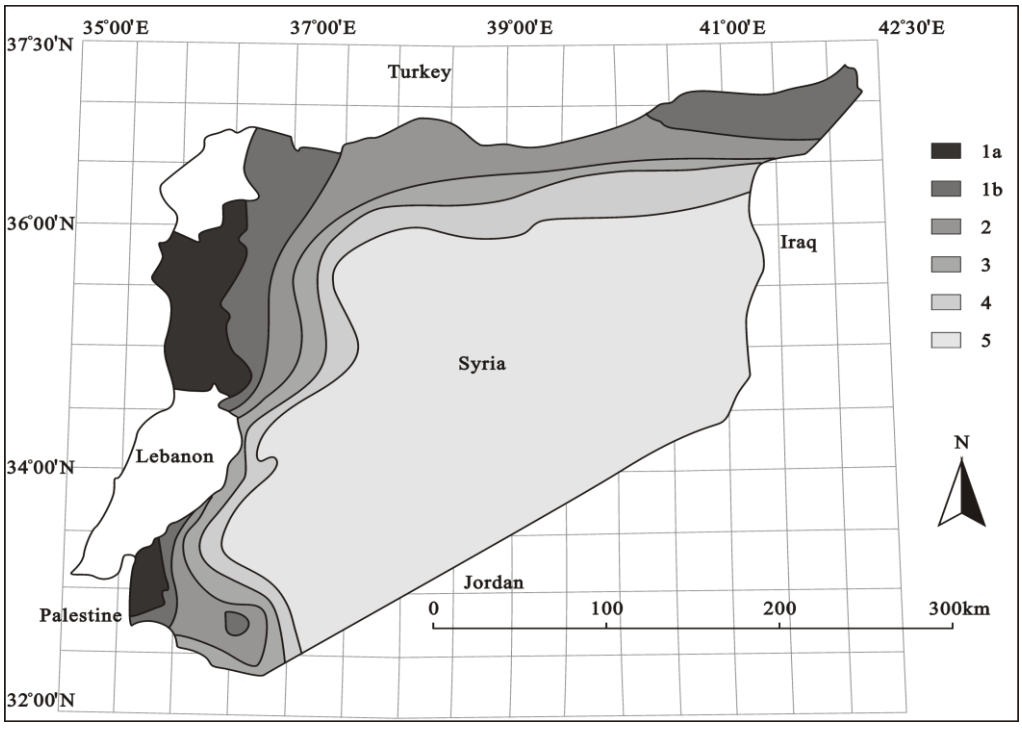
human endeavour in the development of water sources must be within the capacity of nature to replenish and to sustain. If this is not done, costly mistakes can occur with serious consequences. The application of innovative technologies and the improvement of indigenous ones should therefore include management of the water sources to ensure sustainability. So that in arid and semi-arid regions, where precipitation is low or infrequent during the dry season, it is necessary to store the maximum amount of rainwater during the wet season for use at a later time, especially for agricultural and domestic water supply.

Syria considers one of the limited waters resources countries, comparison by increasing demand to all the needs, it located on the eastern coast to the Mediterranean Sea in the arid and semi-arid zone between 32°-37.5° N and 35.5°-42° E. The area is 185000 km^2 with population of 17 million. Syria's climate is Mediterranean with continental influence: cool rainy winters and warm dry summers, with relatively short spring and autumn seasons. Large parts of Syria are exposed to high variability in daily temperature. The rainfall is different in distribution between the coast and the inside areas. The country is mountainous in the west and south-west, but otherwise largely flat. The country is divided into five distinct agroclimatic zones based on the level of annual precipitation received. These are:

1) Zone **I**: covering some 27000km^2. Average annual rainfall in zone I is normally more than 350 mm, within a range of 300 to 600 mm.



(1a:rainfall over 60mm; 1b:rainfall 350-600mm; 2:rainfall 250-350mm; 3:rainfall 250mm; 4:rainfall 150-250mm; 5:rainfall less than 150)

Fig. 1 Syria's map of the stabilization zones

2) Zone **II**: with a total area of around 25000km^2 and annual rainfall ranging 250-350 mm.

3) Zone **III**: with a total area 13000km^2 and average annual rainfall of 250 mm.

4) Zone **IV**: which is agriculturally marginal with a total area of around 18000km^2 and annual rainfall of 200-250 mm?

5) Zone **V**: (AL- Badia) which is the study area with a total area of 83000km^2 with an average of less than 150 mm of rainfall annually.

2 Study Area

The fifth area is the minimized annual rains rate about 150 mm which is 55% from the country square, called the Syrian Desert (Badia) which is a combination of true desert and steppe extending over a vast area, which takes in parts of modern Syria and also of Jordan and Iraq. This area characterized flat area included some mountain series, clayey sandy firm atoms soil, little rains, and hard wind in the summer, high rate vaporization. The relative humidity changes according to the temperature. Syrian Desert (Badia) consider suitable environment to the meadows growth, the pastoral for that it considered the main source to feeding animal wealth, specially the sheep which is counted 16 million heads sheep, many of the demographic gatherings existence within it, their number estimates 1.5 million person (called Nomadic or Bedouins). The plant cover is threatened by the very heavy grazing of nomadic pastoralists' livestock (sheep, goats and camels), which can penetrate even the remotest areas now, due to the construction of wells and of roads, which allow the transportation of water in tankers. And for the insufficiency rains in this area, the government established many vital projects foundation to development botanical cover in the area. And that by means of the rainwater harvesting projects, for drinking aims, livestock, and irrigation in some areas, incarnation by establishment 37 small earth dams in separate places and different sizes to reserve runoff in winter and 50 mini-reservoirs, 7 spread water dikes in the flat wide valleys, terraces, in addition to excavation many of wells, plant the suitable pastoral plants in some the areas and all these projects aim for the utilization attempt as much as possible from drop water it falls on this area to development pastoral cover And the animal wealth and the function on the tenants stability within the desert .

Fig.2 Livestocks in AL-Badia

3 Definitions and history of rainwater harvesting

Water being essential for life, the history of the collection of rainwater is as old as the history of mankind. In fact, most ancient civilizations evolved in cities that had vast hinterlands where water was available for irrigation and navigation. The use of rainwater-collection systems is known to have existed 4000 years ago, in the semi-arid and arid regions of the Negev desert, in Palestine, which receives less than 15 cm of rainfall a year. Hillsides were cleared to increase

runoff, and contour ditches helped collect water for crop irrigation. Rainwater harvesting (RWH) is defined as a method for inducing, collecting, storing and conserving local surface runoff for agriculture and other things in arid and semi-arid regions[1]. Also water harvesting, defined in its broadest sense as the collection of runoff for its productive use, is an ancient art practiced in the past in many parts of North America, Middle East, North Africa, China, and India. More specifically, in crop production, water harvesting is essentially a spatial intervention designed to change the location, where water is applied to augment evapotranspiration that occurs naturally. It is relevant to areas where the rainfall is reasonably distributed in time, but inadequate to balance potential evapotranspiration (ET) of crops. More precisely, water harvesting can be defined as the process of concentrating rainfall as runoff from a larger catchment's area to be used in a smaller target area. This process may occur naturally or artificially. The collected runoff water is either directly applied to an adjacent agricultural field (or plot) or stored in some type of (on-farm) storage facility for domestic use and as supplemental irrigation of crops. Water harvesting is generally feasible in areas with an average annual rainfall of at least 100 mm in winter rains and 250 mm in summer rains. All rainfall-harvesting systems have three components: a collection area, a conveyance system, and a storage area.

4 Methodology

Remote sensing and GIS techniques were significantly contributed to the activities of rainwater harvesting. Images of the Indian satellite with ground resolution of 5m×5m were used to identify tents of herders during the grazing seasons. Socio-economic surveys in the area indicate the average number of animals at each herder, also estimated daily grazing distance. These informations were used to evaluate the grazing pressure in one hand and to determine proper water harvesting sites in other hand. In addition to that T. M. images and topographic maps were used to study the watershed network in the monitoring area. The approximate amount of rainwater to be collected in the major valleys and their branches were calculated. As a result a map showing demographic gatherings distribution, grazing pressure, the remote sensing and GIS laboratory of the project produced watershed network, contour lines and roads. This map was used as a guide for the field technical team to locate sites for rainwater harvesting.

5 Rainwater harvesting techniques in Syrian Desert (AL-Badia)

As part of a wider regional weather phenomenon that has affected a number of countries in the Near East, the worst drought in four decades has seriously affected crop and livestock production in Syria. This, in turn, has had serious repercussions on the food security of a large segment of the population as incomes have fallen sharply. Although the Government has made extensive efforts to reduce the effects of the drought, especially on herders, which is in AL-Badia by providing extra resources, feed rations, water and veterinary supplies, the scale and severity of

Fig.3 AL-Badia view

Fig.4 An earth dam in AL-Badia

the problem is such that these measures have not been sufficient. Availability of water for human and animal uses in AL-Badia areas during grazing seasons is a decisive factor. Rainwater harvesting has significant importance in AL Badia due to the following reasons:

(1) Natural surface water resources (e. g. the Euphrates River) occur at a great distance from the largest grazing the area.

(2) Only a very limited number of water wells are existed in the area.

(3) The geological nature of the mountain with frequent gypsum and loose sand strata forms a major obstacle to dig new wells.

(4) Water carrying strata are several hundreds of meters deep.

(5) Absence of good roads represents another problem for vehicles transporting water from other areas.

Fig.5 Small dikes in AL-Badia

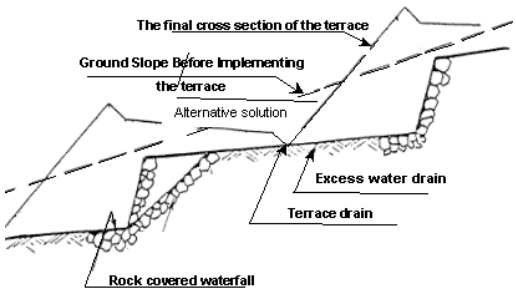


Fig.6 Terraces

Rainwater harvesting activities were mainly executed during the period (1990 -2001). They include:

(1) Consulting herders and using the maps possible sites of earth dams were identified. Final decision concerning these sites was taken after a field examination of natural conditions including soil and geology of each site. As a result, 37 small earth dams with storing capacity of about 50×10^6m3, some of it have small net irrigation like AL-Qaryateen Dam, and Wade AL-Abeead Dam.

(2) Preparation water reservoirs with various capacities of water storing as follows:

(3) Preparation of 150 small water reservoirs for family daily use. Pits with the dimensions of

3×4×10m were prepared following personal request of the herders.

(4) Preparation of 50 large water reservoir with storing capacity of /30.000-100.000/m3 to be used by headers for animal watering. Such as AL-Wazeeaia, AL-Sheheema,AL-Nazzera, and AL-Zarqa …In separate places in AL-Badia.

(5) Preparation 7 spread water dikes in the flat wide valleys, such as AL-Zaqareed in Homs, AL-Khoor and Kabaajeb on Der alzoor.

(6) Digging many wells in separate places for drinking and irrigation such as L9 well in Palmyra, which irrigates about 200 hectares of Olive and Palm trees in Palmyra Oasis.

(7) Preparation many Terraces in different places, and plant it with suitable plants. Terraces can be defined as mechanical structures comprising a channel and a bank made of earth or stone. They are systematically constructed perpendicular to the slope. Thus terraces intercept runoff, and encourage it to infiltrate, evaporate or be diverted towards a predetermined and protected safe outlet at a controlled velocity to avoid channel erosion.

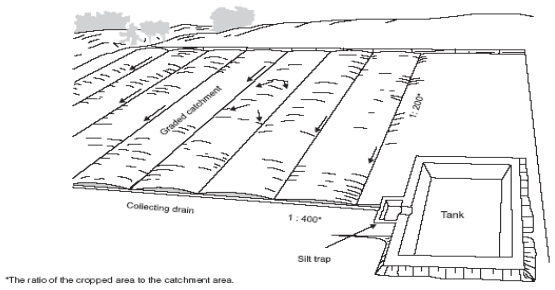


Fig.7 Small tank in AL-Badia

Fig.8 Contours farming in AL-Badia

Principal objectives of terraces are (ⅰ) To reduce the velocity of runoff; (ⅱ) To reduce the volume of runoff; (ⅲ) To reduce the losses of soil, seed and fertilizer; (ⅳ) To increase soil moisture content through improved infiltration; (ⅴ) To reduce peak discharge rates of rivers; (ⅵ) To smooth the topography and improve the conditions for mechanization.

(8) Preparation Contour farming along the lines of equal contour is one of the most simple and efficient practices for the control of erosion. It consists of planting the crops according to the curved lines which follow the land surface at equal heights above sea level, or in other words, perpendicularly to the lines of steepest slope gradient. Contour farming is only recommended as an isolated erosion control measure for limited areas where the slope is less than three percent and the slope length is not long. And thus many places were planting like this system in different areas along AL-Badia.

All these constructions were prepared to provide free water sources for herders during the grazing season, and to provide water for drinking and irrigation in some places in AL-Badia. Both direct seeding and rainwater harvesting techniques will be practiced during the coming years .There are closely cooperation with local population. Extensive training on participatory

approaches has been carried out for the local extension staff in order to coordinate field activities with local population.

6 Conclusions and Recommendations

(1) Rainwater harvesting is practiced in arid and semiarid regions, where surface runoff often has an intermittent character.

(2) Rainwater harvesting is based on the utilization of runoff and requires a runoff producing area and a runoff receiving area.

(3) Because of the intermittent nature of runoff events, storage is an integral part of the water harvesting system. Water may be stored directly in the soil profile or in small reservoirs tanks, and aquifers.

(4) Water harvesting initiatives and interventions need projects aimed at improving existing individual farmer practices on water harvesting in Syrian Desert

(5) Promotion of water harvesting should be done in conjunction with local people.

(6) Before any conservation practices to prevent erosion are undertaken, the area may need to be made more uniform by leveling. This can be done using motorized graders, harrows, ploughs, animal traction equipment or even manually.

(7) Runoff originating upslope from roads and gullies can damage any terrace system, however well planned. For this reason it is often necessary to construct storm water diversion drains, which are contour drains with a bank on the downhill side which intercept and divert the runoff into safe waterways.

(8) The efficiency of a terraces system will also depend on the adoption of other conservation practices such as contour sowing, strip cropping and soil cover. And factors which influence the selection of the type of terrace on the basis of the distance of soil movement are land slope. In the event it is necessary to establish a terrace longer than these limits, a new terrace system should be planned sloping in two directions, either towards a central or two lateral drainage canals.

(9) Before selecting a specific technique, due consideration must be given to the social and cultural aspects prevailing in the area of concern as they are paramount and will affect the success or failure of the technique implemented. This is particularly important in the arid and semi-arid regions

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叙利亚沙漠(Badia盆地)的雨水收获技术

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提 要

叙利亚阿拉伯共和国地处地中海东岸，北纬 32-37.5，东经 35.5-42，属于干旱、半干旱地区，是水资源最缺乏的国家之一. 冬季时短多雨，夏季时长干旱. 沿海与内陆降雨分布差别很大. 按降雨量分，叙利亚可以分为 5 个农业区. 第五个区（Badia 盆地）面积占全国的 55%，年降雨约 150mm，在五个区中最小，被称为叙利亚沙漠. 该地区以平原为主，另有一些山脉，土壤特性为含砂粘性土，长年少雨，夏季多风，蒸发率大，相对湿度随着温度的变化而变化. 叙利亚沙漠地区的环境适合草地生长，正因为如此，这里一直是主要的畜牧场所. 为了解决该地区雨水不足的问题，政府兴建了很多重大基础工程来改善这里的植被状况. 通过雨水收集工程来解决某些地区的饮用水，牲畜用水和灌溉用水. 在不同区域建立了 37 座不同规模的大坝、50 座小型水库和在平原谷地、梯田地区修建 7 个拦水坝，还挖掘了很多水井来储存冬季径流，因地制宜种植植物. 所有这些工程都是为了最大限度的利用该地区的降水来发展植被、畜牧业和保证沙漠里牧民生活的基本稳定.

这篇论文研究了叙利亚沙漠的多种要素（自然因素，气候因素，植被，牲畜，居民……），以及该地区水资源管理方法鹤和关于雨水收集的技术、条件、方法选择及管理等.

关键词：雨水收获，叙利亚沙漠，技术