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Water Harvesting with Special reference to Egyptian Experience

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Abstract

Water harvesting is an ancient method of obtaining water. The term "water harvesting" used to describe the process of collecting and storing water from an area that treated to increase precipitation runoff.

A water-harvesting system is the complete facility for collection and storing precipitation runoff. It is composed of a catchment or water-collecting area, a water storage structure, and various other components such as piping, evaporation control, and fencing. Collecting runoff from the roofs of buildings and storing the water in cisterns or tanks still used in some places as a means of domestic water supply.

No single method or system is best suited for all sites or water needs. In the Northwest Cost Zone, Arab republic of Egypt, there are two main storage structures, i.e. Cisterns and Reservoirs, depending on the type of soil as well as the environmental conditions.

The cisterns are constructed below ground at the lowest level of a collection basin or of a small stream to entrap surface or stream runoff, while the concrete reservoirs are constructed in friable soils not suitable for cisterns excavation.

Introduction

Water harvesting is an ancient method of obtaining water that has received renewed interest in recent years as a viable water supply practice for many regions of the world. Water harvesting is believed to have been developed in ancient Iraq, 4.000 to 6.000 years ago, for supplying water to trade caravans.

Definitions:

The term “Water harvesting “is used to describe the process of collecting and storing water from an area that has been treated to increase precipitation runoff. The collected runoff from rain or snow is stored in some types of tank to supply drinking water for animals and humans or for supplemental irrigation of crops.

A water–harvesting system is the complete facility for collecting and storing precipitation runoff. It is composed of a catchment or water-collecting area, an eater storage structure, and various other components such as piping, evaporation control, and fencing. A water-harvesting system must supply the quantity and seasonal distribution of water required.

No single method or system is best suited for all sites or water needs. Variability of climate, soils, topography, and water requirements requires that each system be specifically designed to fit local sites conditions.

General Consideration:

There are many different elements in the design of a water-harvesting system. A change in any one of the system components can change the selection or performance of the other components. Accordingly, in the process of making preliminary choices prior to final design, all system design components must be given simultaneous consideration.

Prior to final site selection and design of the catchment and storage tanks, consideration should be given to all possibilities to make sure that lowest cost and most effective system components are not overlooked. Simultaneous consideration must be given to the construction site, construction materials, the type of storage tank, and all other elements involved in the system design.

Other factors must also be considered. Accessibility and availability of equipment, materials, and labor will often determine choices that can be made. General land topography and distance to alternative water sources will influence final system design and should be included in preliminary considerations.

The effort required to prepare a catchment site can often be minimized by locating the catchment to take advantage of natural surface topography. Shallow natural depressions draining to a central location are such one topographic feature that is usually desirable.

Approximate size of the water-harvesting system should be considered in preliminary site surveys.

Collecting runoff from the roofs of building and storing the water in cisterns or tanks is still used in some places as a means of domestic water supply.

Site Selection:

The site selected for a water- harvesting system will significantly affect the installation costs, performance, and utilization of the facility. Factors to be considered when selecting a site are: alternate water sources, quantity of forage, soil type and depth, land topography, accessibility, and precipitation patterns.

The Water harvesting system:

1- The Catchment Area:

The Catchment area is the component of a water harvesting system that collects and concentrates precipitation. Any area reasonably impermeable to water can be used as a catchment. Large rock outcroppings are natural surfaces potentially suitable for a catchment.

Most catchment surface, however, consist of land that has been cleared of vegetation, smoothed as necessary, and then chemically treated to stop water infiltration or covered with an impermeable sheet of rubber, plastic, asphalt-impregnated fabric, or metal.

Soil type is one of the main criteria of site selection. If the required soil type is not present within the general area the soil of catchment must be treated.

Before installing a catchment treatment, the soil surface should be cleared, smoothed, and compacted, dikes should be constructed around the edges; and a soil sterilant should be applied to prevent any plant regrowth.

1-1- Catchment slopes*:*

The slope of a catchment surface should be only as steep as necessary to cause runoff.

1-2- Clearing of catchement area*:*

The Catchment surface must be cleared of vegetation, stones, or other debris that might reduce the durability of the treatment or retain water on the surface.

1-3- Dike construction*:*

Dikes around the perimeter of the catchment area are usually necessary to contain the collected water and direct it to the catchment outlet.

1-4- Smoothing and compacting:

A smooth, firm catchment surface makes installation of the treatment easier, improves the runoff efficiency, increases the life of the treatment, and reduces potential problems of mechanical damage. Following the initial clearing and raking, the catchment surface and dikes should be smoothed and compacted.

1-5- Soil Sterilization:

After clearing and smoothing, the catchment area should be treated with a soil sterilant to prevent recurrent growth of plants. The sterilant should be a type that is immobilized within the soil profile and will not contaminate the runoff water.

1-6- Dike construction:

Metal sections could be placed directly on the soil surface. Various other materials, such as concrete, tar paper, and asphalt cement, were used as catchment treatment with limited degrees of success. The effective life of many of the installations did not justify the cost of the materials. As an example, using artificial rubber (butyl) is relatively expensive, while using vinyl and polyethylene sheeting for exposed catchment covers failed because of damage by solar radiation and wind.

2- The Storage Tank:

The storage tank is the component of a water-harvesting system that stores the collected water until it is needed. Any container that prevents water loss by seepage is a potential means of water storage. Typical storage tanks are earthen reservoirs, lined pits, and various steel plastic, concrete, or wooden tanks. The tanks may be completely enclosed or, as on many installations, open at the top. Open-top tanks for water-harvesting system usually require some means of reducing or preventing water loss by evaporation. Typical evaporation control measures are roofs over the tanks or covers floating on the water surfaces.

The soil type and depth also affect the kind of water-storage structure that can be installed. For example, if insufficient soil depth and rocks prevent the installation of a partially buried tank near the catchment, an above-ground tank may have to be constructed at some distance from the catchment.

Although the unit cost of materials and labor for installation of many water-harvesting system may not be best for proper management of animals. To promote better distribution of animals, it may be better to build several small systems spaced throughout the grazing area.

The quantity of water for domestic household use will vary depending upon the number of people, uses of water, and amount of water conservation practiced.

Storage tank selection should also be based on the lowest cost structure that fit the site and store water with minimum loss.

3- Miscellaneous:

The conservation of the water collected as well as the use and maintenance of the water harvesting system will need some other elements which have to be considered during on the design such as:

1- Roofs.
2- Conveyance of harvested water.
3- Sediment traps.
4- Screens.
5- Fences.
6- Diversion Ditches.
7- Piping, valves and drinking troughs.

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EGYPTIAN EXPERIENCE

Rainfed Agriculture in Egypt is concentrated mainly in the North West Cost region which has a rather special climate which differs from the inland desert area of the south.

General Description Of The Dry-Area Production Systems:

Location :

The North West Coast of Egypt extends westward about 600 km from Alexandria in the east at longitude 29^{o} 50' to El-Sallum (the Libyan border) in the west, at longitude 25^{o} 10' .It is bounded on the north by the Mediterranean Sea and on the South by The Sahara Desert, some 50 to 80 km in land.

The area is composed of a narrow, almost uninterrupted strip of coastal and inland sand dunes and an interdunal plain, of an alluvial plain which slopes gradually upwards to the Libyan plateau, and part of the plateau itself.

Climate:

The climate of the area varies from a moderate Mediterranean coastal climate in the north to a desert climate in the south. The rainfall of the area is low. The average annual rainfall along the cost and inland for about 20 km ranges from about 170 mm in the east to 100 mm the west. Beyond 20 km from the coast it drops to about half that amount. Through the area, rainfall is characterized by extreme annual variations.

Topography:

The region is bounded in the north by the Mediterranean Sea and in the south by the escarpment of 200 m elevation .The region consists of a narrow, almost uninterrupted, band of coastal and inland sand dunes and interdunal plains. Further inland there is an alluvial plain that slopes gradually upward to the Libyan plateau. The area is bisected by numerous wadis formed by runoff water from the northward sloping plateau and eroded escarpment.

Soils:

Soils suitable for agriculture are found in small areas isolated by unsuitable land. Generally the soils are underlain by cliché or rock determining the depth of the soil.

Water Resources and Utilization (Water Harvisting):

The main source of water is rainfall and natural watering is the main system. This natural watering is very irregular, depending mainly on the topography. At the same time there is an artificial watering done on small scale by water harvesting as follows:

- Constructing dikes to prevent the flow of the runoff of wadis to the sea.
- Constructing dikes, in the spreading zones, diverting the runoff of the wadis. In some cases, spreading is facilitated by the opening of small channels by which the runoff water reaches some isolated fields.
- Constructing traversal stone or earth barrages in the beds of the small wadis to facilitate sedimentation and create terraces which, in general, receive abundant runoff from the wadis.
- Constructing small dikes (earth, stone and/or cemented) parallel to the contour lines to retain the surface runoff.
- Storage of Sheet Runoff in Cisterns and/or Concrete Reservoirs:

Also, sheet runoff in the area can be stored in the numerous cisterns, existing in the coastal region, once they have been cleaned and repaired. Large numbers of cisterns dating to the Roman period exist in the region. These cisterns have been excavated in the rock and their capacity varies from 100 to 3000 m^3. There are also many new cisterns that have been excavated in the last forty. They are also the cemented constructed water reservoirs in the areas not suitable for cisterns excavation; in friable soils. The stored water can be used for human and animal consumption and, in some cases, for establishing tree plantations. Some small dikes or ditches are sometimes necessary to lead the sheet runoff into the cisterns.

✓ Cisterns: The cisterns are constructed below ground at the lowest level of a collection basin or of a small stream to entrap surface or stream runoff. Cisterns are excavated near the houses within the primary farm unit. The excavation is done with chisels and hammers or other hand tools in hard to rocky soils. Care is taken not to fracture the surrounding rock and to avoid cracks or fissures in the cistern's walls.

The cistern is usually bottle-shaped and is divided in three parts: (i) the inlet which includes water collector to direct water into the cistern opening and a silt basin, (ii) the shaft, composed of the mouth and the neck of the cistern through which the water reaches the main storage area; and (iii) the storage chamber which is below ground level and retains the collected runoff water for later use.

A cross section of a "typical" cistern is illustrated in the attached figure 1. The mouth of the cistern has a diameter of 0.5 to 0.75 m and a depth of 1 m. The inside surface is smoothed and sealed. The portion of the chamber between the mouth and the main chamber has a depth of 1 to 1.5 m. This section is bell-shaped, increasing in diameter with depth. The main chamber is form 5 to 10 m deep and narrows at the base ending in a round bottom. The opening is covered with a wooden plank to prevent pollution of water and cracking of the walls due to successive drying and wetting. The silt basin filtration of the water is 1 to 1.5 m long and 0.5 to 0.75 m deep. The bottom of the basin is lower than the intake opening and the connection with the cistern is made in such a way so that collected water falls directly to the cistern's bottom to reduce erosion of the walls.

After excavation is completed, the cistern wall is compacted with a flat hammer and sealed with a coating of cement material. The opening is covered to prevent evaporation and to protect the purity of stored water. Cleaning occurs every three to four years. Water stored in cisterns in used very efficiently because evaporation is avoided and water lost to seepage is negligible. Generally, buckets are used to raise water from these excavated cisterns, but recently farmers are using water lifting devices such as windmills, hand pumps and gasoline or diesel pumps.

- ✓ Concrete Reservoirs: These cemented water reservoirs are constructed in the areas not suitable for cisterns excavation; in friable soils. These reservoirs are excavated and encased with concrete or masonry walls. The floor is made of concrete and reinforced concrete is used for the covering. The cover is slightly elevated from the ground level so that water can be captured in the reservoir through small windows. The capacity of these reservoirs is assumed to be the some as of the cisterns i. e. in average 300 m^3. On the other hand, some of these reservoirs are of a capacity of 20000 m^3.

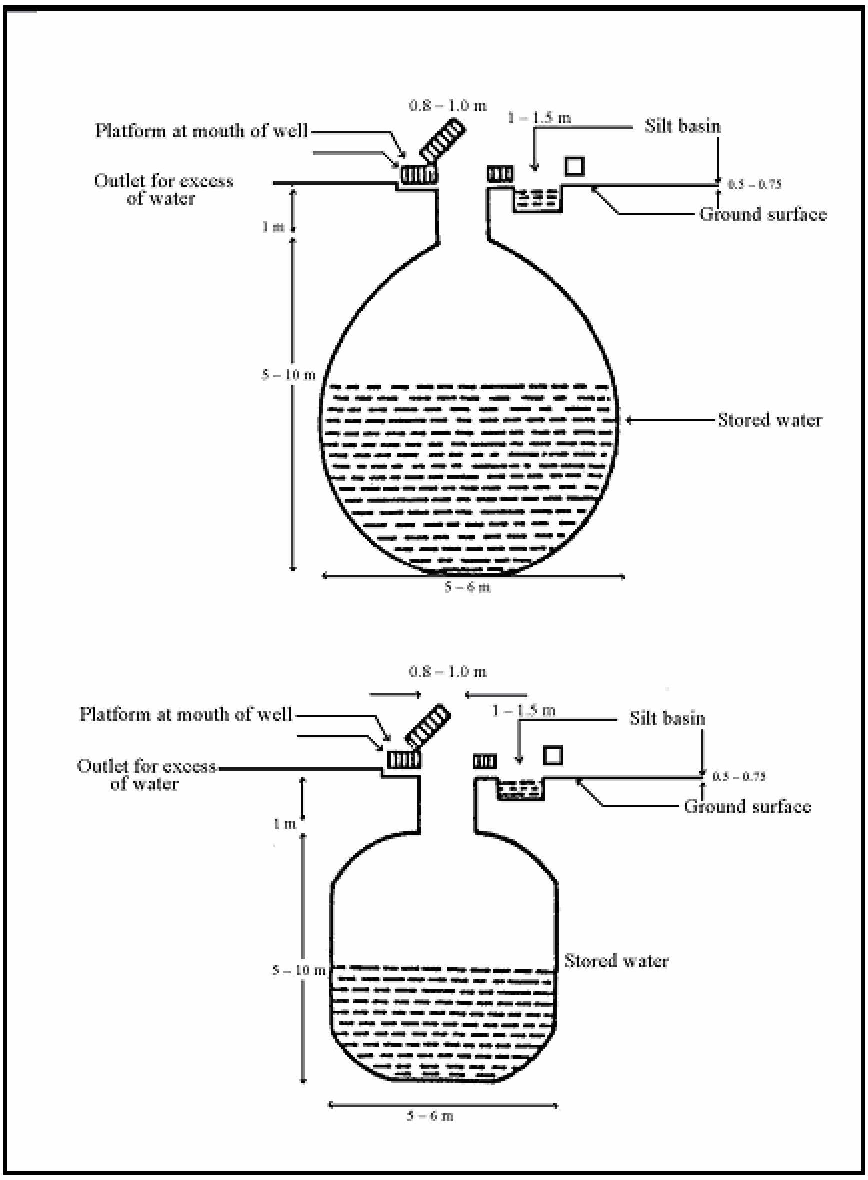

Figure 1. Typical Cistern