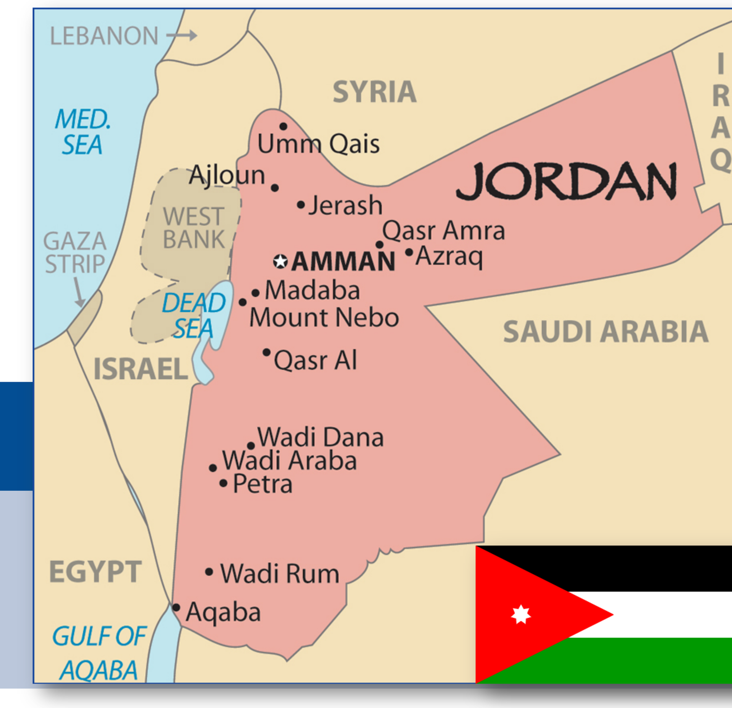
Summer 7-3-2014

# Water/Soil conservation in Jordan

Andrey Yun
*Andrews University*, andrey@andrews.edu

# Water/Soil conservation in Jordan




Andrews University

**Andrey Yun**

*Agriculture Department & Landscape Design Program, Andrews University*

andrey@andrews.edu

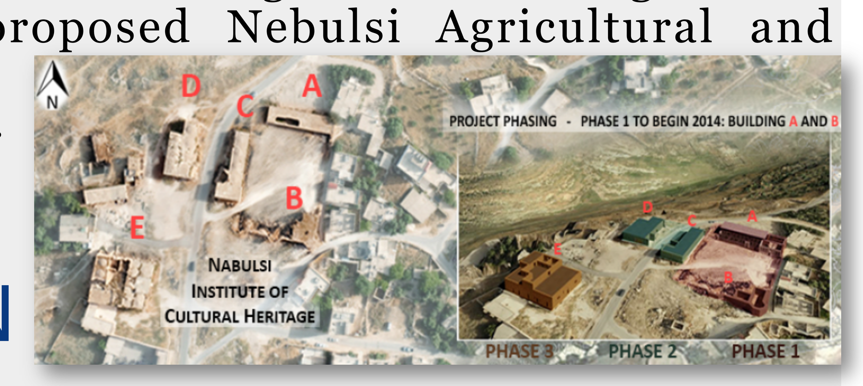
*Acknowledgments: Professor Stan Beikmann*

*Dr. Oystein LaBianca*

## ABSTRACT

According to The Millennium Project (Global Future Systems) the first two global challenges are Sustainable Development, Climate Change and Clean Water. Jordan-Arab region could face severe water crisis by 2015. (7)The indigenous methods of harvesting and storing of rainwater in Jordan have been practiced for 4000 years. Archaeologists working in Jordan confirmed that in the past, the local population depended on cisterns, terraces and dams to obtain their annual water needs which included agricultural irrigation and domestic supply. This research provides a design of landscape exhibits with educational "storyboards" for indoor exhibit. Design of models of reservoirs and water conservation holding areas will be part of interpretive educational signage to incorporate archeological investigation and promote information for Jordanian people in their quest for solutions of this problem.

The models will also serve as site drawings for constructing outdoor demonstrations at the proposed Nebulsi Agricultural and Archaeological Center during the 2014 Jordan Field School.



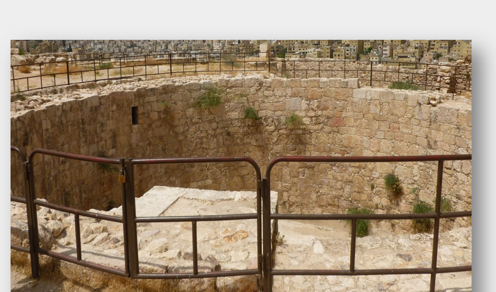
## INTRODUCTION

Jordan is characterized by a pronounced scarcity of renewable fresh water resources, which averages–about 680 MCM per year, or approximately 135 m3 per capita for all uses. Thus, Jordan's water resources are, on a per capita basis, among the lowest in the world. (5) The per capita domestic uses in Jordan is the least among the middle east countries. It is 85 liters per day. (6)

The subject of rainwater harvesting methods in Jordan has been studied before, but little has been improved about rural small scale management systems because they have been dramatically changed in modern times with introduction of deep well drilling in 1962 by Bert De Vries. (3).

The Disi is the only remaining significant aquifer. When Jordan's last major potential water sources, Disi groundwater and the Al-Wuheda dam, are fully developed, there will be no alternatives except the use of non-conventional water resources and/or importation of water from other countries. (4)

Excavations at Tall Hisban have covered all periods of human occupation of this site, from 1200 BC up to the present. Catchment channels and cisterns for collecting and storing rainwater were practiced through all historical periods and different occupations. Reservoirs of different sizes from small to tremendous capacity (2,000,000 litres). (3)



The Open Cistern "Birka"
ca. 730 AD
Amman, Citadel
(1370 cubic meters or
over 48,000 cubic feet)
Water was diverted there
from the roofs of
surroundings buildings
and from the paved surfaces.

## METHODS

1) Annual water demand = Mean daily water use per person x the number of AAC members x 365 days + Water demand for watering the garden.

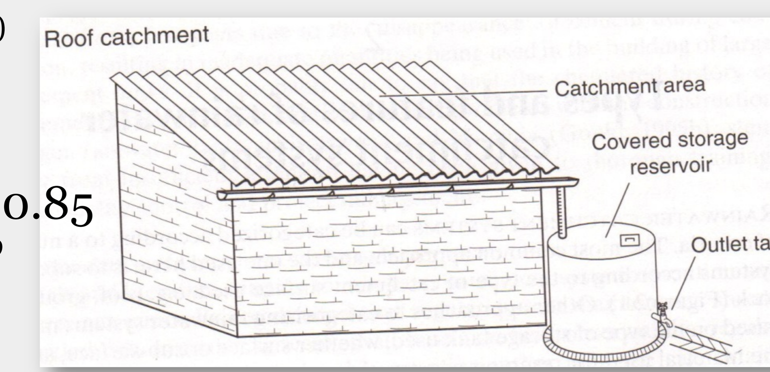
2) Potential rainwater supply by estimating runoff. (2):

$$S = R \times A \times C_r$$

**Supply = Rainfall x Area x Coefficient (Runoff)**

S = Mean rainwater supply in cubic metres ($m^3$)
R = Mean annual rainfall in millimetres (mm/a)
A = Catchment area in square metres ($m^2$)
$C_r$ = Runoff coefficient

| | |
|---|---|
| *Roof catchments* ($C_r$) | |
| Sheet-metal (estimate) | 0.8 – 0.85 |
| Cement tile | 0.62 – 0.69 |
| Clay tile (machine-made) 0.30 - 0.39 | |
| Clay tile (hand-made) | 0.24 – 0.31 |
| *Ground catchments* ($C_r$) | |
| Concrete-lined | 0.73 – 0.76 |
| Cement soil mix | 0.33 – 0.39 |
| Buried plastic sheet | 0.28 – 0.36 |
| Compacted loess soil | 0.13 – 0.19 |




The lower figure is for areas receiving just 200 – 300 mm. (Zhu & Liu, 1998)

3) For estimating storage cistern size "the dry season versus supply" method is used .

4) Appropriate system components and design consideration.

## RESULTS


### BUILDING A

***1) Water Demand = Household + Garden***

Household: 17 L x 3 x 365 = 18615 L per year (17 L per person – mean daily consumption) (Gould & Petersen, 2003)
Garden: (1 m x 35 m) + ( 2(2.5 m x 20 m)) + (4 m x 7 m) + (7 m x 7 m ) = 212 $m^2$
(100 $m^2$ require 50000 L (50 $m^3$))
X = (212 $m^2$ x 50000L) / 100 $m^2$
X = 106000 L (106 $m^3$)
Total Demand = 18615 L per year + 106000 L per year

**Total Demand = 124615 L per year = 341 L/day**

***2) Potential rainwater supply***

Roof: Square = 7 m x 27 m = 189 $m^2$
S = 352 mm/a x 189 $m^2$ x 0.8 = 53.222 $m^3$/annuum = 53222 L/annuum = 0.14 $m^3$/day = 140 L/day

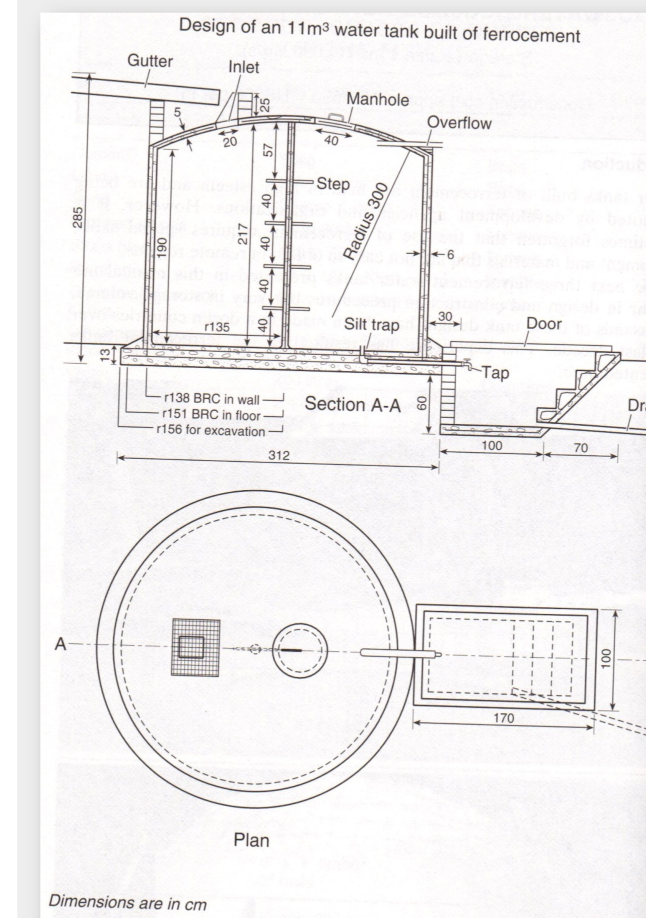
(352 mm/a is a total annual precipitation in Madaba) (6)

Ground: Square = (8 m x 7 m) + (7 m x 35 m) = 301 $m^2$
S = 352 mm/a x 301 $m^2$ x 0.73 = 77.345 $m^3$/annuum = 77345 L/annuum = 0.21 $m^3$/day = 140 L/day

**Total Potential = 130567 L/annuum= 350 L/day**

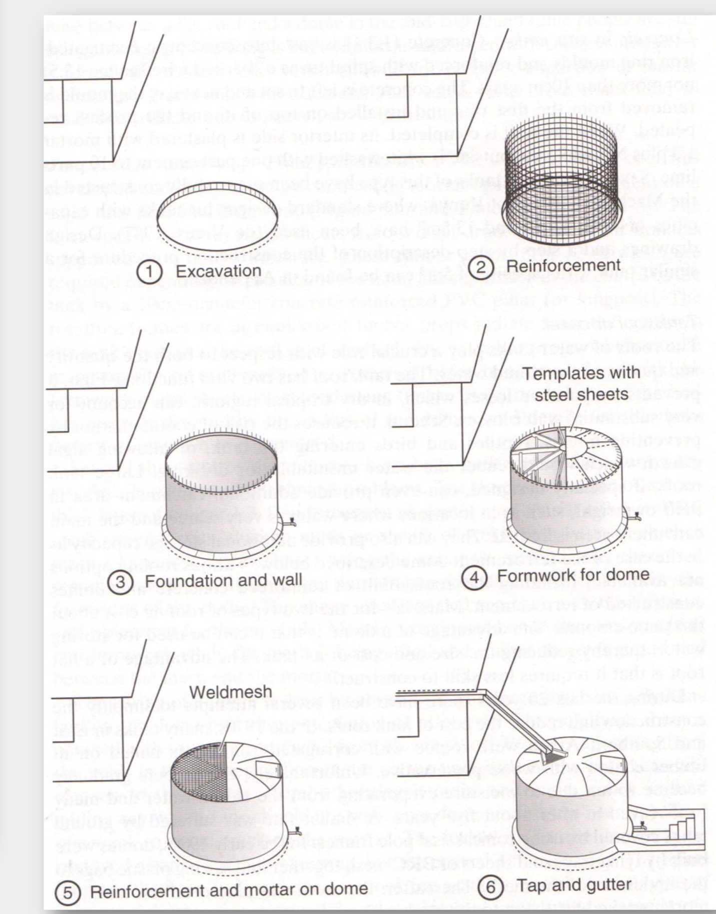
3) In Madaba the dry season lasts for almost 4 months, 120 days. Estimated daily household water demand is 314 L/day, a reservoir with a capacity of at least 314 x 120 = 37680 L would be required.

4) Water tanks built of ferro-cement are held in high esteem and are being promoted by development agencies and organizations. Design of an 11 m3 water tank built of ferro-cement is similar in design and construction procedures of 3 tanks presented in manual (2) but they vary in storage capacity. Thousands of these tank designs have been made in a dozen countries. According to our demand to provide water for 4 dry months we will need 4 tanks of this size or we can build 2 tanks of a 23 m3. Final decision will be made particularly on the site after excavations because there are abandoned reservoirs under the building and around the site.




Stages of construction

for 11 $m^3$ ferro-cement water tank




We can also use an approach of constructing sub-surface tank by building a surface tank in an excavation which is then back-filled.

## DISCUSSION

Water Projects which involved the local community from the outset in the planning, implementation and maintenance have the best chance of enduring and expanding. Those projects which have been predominantly run by local people have had a much higher rate of success than those operated by people foreign to an area. Successful water projects are generally associated with communities that consider water supply a priority. (1)

This project has the ability to show and encourage local people and Jordanian citizens how to collect amd stpre water. We can demonstrate that process at Nebulsi Center as an example of indigenous methods of rain water harvesting which are sufficient to provide enough water for domestic and agricultural utilization. Calculation methods which can be easily applicable for any household in Jordan which will give the opportunity for Jordanians to use it as a model.

### REFERENCES

1) Fardous, A-N., Mudabber, M., Jitan, M. & Badwan, R. (2004). Harnessing salty water to enhance sustainable livelihoods of the rural poor in four countries in West Asia and North Africa: Eqypt, Jordan, Syria and Tunisia. Jordan National Report, National Center for Agriculture Research and Technology Transfere.

2) Gould, J. & Nissen-Petersen, E. (2003). Rainwater Catchment Systems for Domestic Supply. Design, construction and implementation, Short Run Press Limited, Exeter.

3) LaBianca, O. S. (1994). Project Rainkeep: A Plan for Increasing On-Site Retention and Utilization of Rainwater in Jordan.

4) Murakami, M. (1995) Managing water for peace in the Middle East: Alternative strategies, United Nations University Press, Tokyo,

5) Raddad, K. (2005). Water supply and water use statistics in Jordan, International Work Session on Water Statistics, Vienna, June.

6) Tarawneh, Q. & Kadioglu, M. (2002). An analysis of precipitation climatology in Jordan, Theoretical and Applied Climatology, 000, 1-14. Published online. doi: 0.1007/s00704-002-0705-5

7) Tashima, R. (2013). Water scarcity restricts Jordan's agricultural sector, The Jordan Times. Retrieved form http://jordantimes.com/water-scarcity-restricts-jordans-agricultural-sector

8) Zhu, Q. & Liu C. (1998). Rainwater Utilization for Sustainable Development of Water Resources in China, Paper presented at the Stockholm Water International Symposium, Stockholm, Sweden, 8p.