Water flowing through a traditional channel system (acequia) towards almond terraces (Joris de Vente)

Water harvesting from concentrated runoff for irrigation purposes ( )

Boqueras (Spanish)

Water harvesting from intermittent streams towards nearby fields and terraces during runoff events.

Water shortage is one of the most limiting factors for sustainable agriculture in large parts of SE-Spain. Part of the solution of this problem may come from the restoration of traditional water harvesting structures. Many of these structures were widely used in SE-Spain already during Arab and Roman times, and are also widespread in N-Africa and the Middle East. However, nowadays in Spain many of them are abandoned and forgotten. Here, we describe the technology of a small earthen- or stone- built bund that diverts flood water from intermittent streams towards cultivated fields with almond orchards and/or cereals. The diverted water will temporarily flood the fields and provide the crops with water. Depending on the slope gradient and the amount of water to be harvested, the fields are organised as single terraces, or as a staircase of terraces. On fields with gradients above ~3%, terraces are necessary to reduce the gradient and to retain the floodwater as long as possible. Water is diverted from one terrace to the next through small spillways in the terrace. The spillways can best be fortified with stones to prevent bank gully formation. The extra input of surface water can double the almond yield. The use of these water harvesting structures is only possible under certain environmental and topographic conditions. The cultivated fields should be at a relatively short distance from an intermittent stream (<~50m), and the stream should have a sufficiently large upstream contributing area to provide significant amounts of runoff water during rainfall events. With these systems, water can be harvested up to 8 times per year, mostly in spring and autumn during high intensity rainfall events. A well designed Boquera system may provide up to 550 mm of additional water, in areas with an average annual rainfall of 300 m.

Purpose of the Technology: The goal of this technology is to increase crop yield. In addition, these structures help to reduce the intensity of floods and reduce the damage caused by them by reducing runoff volume in intermittent streams.

Establishment / maintenance activities and inputs: Water harvesting requires the identification of a suitable location for the construction of a diversion structure. This requires assessment of expected water inflow, which can usually be based on simple field observation during rainfall events and based on local knowledge of land users. It is, however, important to consider whether there are activities upstream that possibly affect the water quality (e.g. farm animals) and to assess the implications the water harvesting might have downstream. Permission is required from the water authorities to construct any type of water harvesting structure. Such structures are built by creating a small bund (<1m height) in the centre or to the side of a stream. Depending on the size, the bund can be built with a shovel or a tractor. The water harvesting structure will require control and some maintenance after each important runoff event. When strengthened with concrete, maintenance will be reduced to approximately once every 5 years.

Natural / human environment: Soils are mostly of shallow to medium depth (20-60 cm), and slopes are gentle to moderate (5-15%). The climate is semi-arid with a mean annual rainfall around 300 mm. Droughts, centred in summer commonly last for more than 4-5 months. Annual potential evapotranspiration rates larger than 1000 mm are common.

: Guadalentin catchment, Murcia,

:

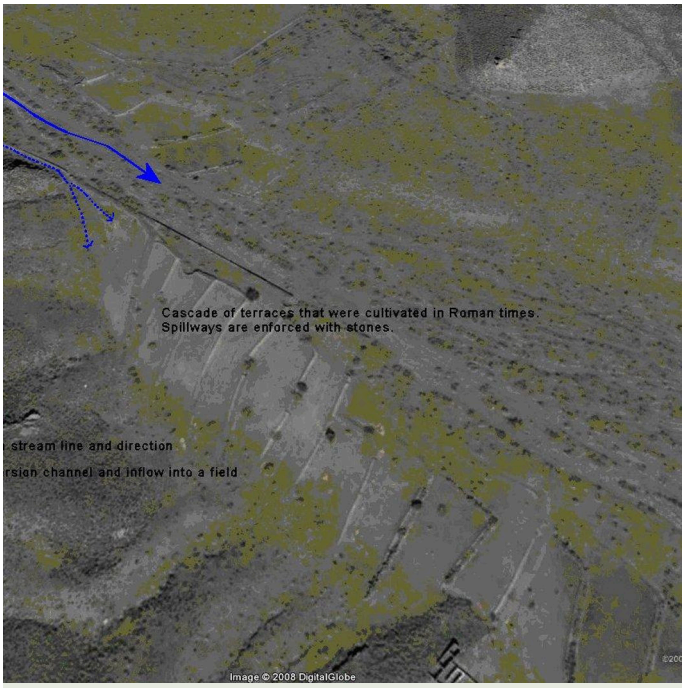
- -1.7076, 37.7931

: (approx. < 0.1
2 (10))

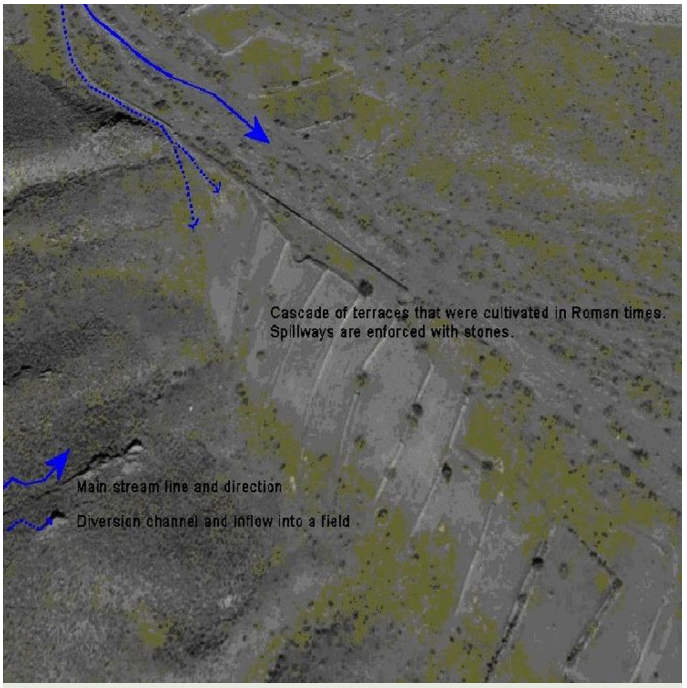
?:

: 50
( )

(> 50)
/



Aerial photograph of a water harvesting structure. A dyke in the lateral part of the stream diverts the water through a short channel towards a cascade of terraces that were cultivated during Roman times.



Aerial view of a traditional water harvesting system (boquera) in SE-Spain (Goggle Earth)

,

,

/

/

/

/

-

:

-

: 1

✓

✓

/

- Wo:

- Ha:

SLM

SLM

- S1:

, S4: , S11:

Sketch of a water harvesting structure consisting of an earthen- or stone- built dyke that diverts water into cultivated fields. Several terraces are present in the fields in order to reduce slope gradient and retain water longer within the fields to allow maximum infiltration. Depending on the expected inflow of water several spillways can be made per terrace to prevent excessive concentration of flow in each spillway.

Technical knowledge required for field staff / advisors: moderate (Selection of the proper location and assessment of up- and downstream linkages.)

Technical knowledge required for land users: low (Practical implementation of the water harvesting structure does not require a high level of knowledge)

Main technical functions: control of concentrated runoff: retain / trap, control of concentrated runoff: impede / retard, control of concentrated runoff: drain / divert, increase of infiltration, water harvesting / increase water supply

Secondary technical functions: increase of groundwater level / recharge of groundwater, water spreading

Spillway
Spacing between structures (m): 50
Depth of ditches/pits/dams (m): 0.5
Width of ditches/pits/dams (m): 1-3

Structural measure: water harvest dyke
Depth of ditches/pits/dams (m): <1
Width of ditches/pits/dams (m): <2
Length of ditches/pits/dams (m): <50

Construction material (earth): Soil from the stream banks is used to built the dyke and provide an opening into the cultivated fiel

Construction material (stone): Stones are used to fortify the dyke and spillways against the impact of flow.

Construction material (concrete): Potentially concrete is used to fortify the dyke and spillways against the impact of flow.

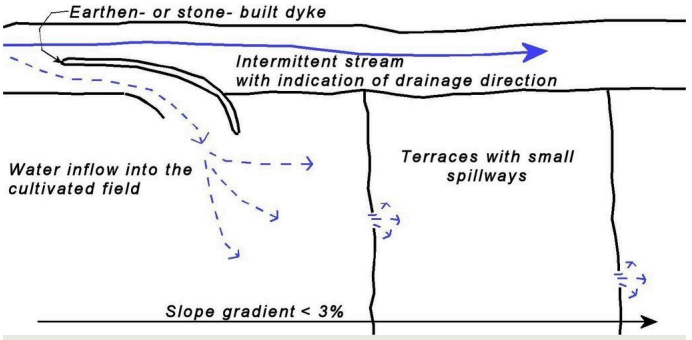
Specification of dams/ pans/ ponds: Capacity 5m3

Catchment area: >0.5km2m2

Beneficial area: 1-2 ham2

Slope of dam wall inside: 100%;
Slope of dam wall outside: 100%

Dimensions of spillways: 1-3m wide and <50 cm deep



Author: Joris de Vente

- **EURO**
- ( ) 1 USD = 0.63 EURO
- 79.00

Labour costs and price of concrete are the most determinate factors affecting the costs.

1. Construction of a dyke (dam) (/ : summer or winter)

			(EURO)	(EURO)	%
Labour	5 meter dyke	1,0	150,0	150,0	100,0
Machine use	5 meter dyke	1,0	350,0	350,0	100,0

Concrete	5 meter dyke	1,0	400,0	400,0	100,0
				900.0	
				1'428.57	

1. restoration of the dyke (/ : once in 5 yr (after important events))

			(EURO)	(EURO)	%
Labour	5 meter dyke	1,0	4,0	4,0	100,0
Machine use	5 meter dyke	1,0	12,0	12,0	100,0
Concrete	5 meter dyke	1,0	25,0	25,0	100,0
				41.0	
				65.08	

< 250
✓ 251-500
501-750
751-1,000
1,001-1,500
1,501-2,000
2,001-3,000
3,001-4,000
> 4,000

✓

300.0

Thermal climate class: subtropics

Thermal climate class: temperate. The higher parts are generally somewhat colder

(0-2%)
(3-5%)
✓ (6-10%)
✓ (11-15%)
(16-30%)
(31-60%)
(>60%)

✓

0-100
✓ 101-500
✓ 501-1,000
1,001-1,500
1,501-2,000
2,001-2,500
2,501-3,000
3,001-4,000
> 4,000

✓

✓ (0-20)
✓ (21-50)
(51-80)
(81-120)
(> 120)

( )
/ ( )
✓ (,)
✓ / ( )

(> 20)
/ ( )
(,)
/ ( )

(>3%)
✓ (1-3%)
✓ (<1%)

< 5
✓ 5-50
> 50

✓ /

( )
?
/
( )
✓
( )
/

✓

SLM

( )

10%
10-50%

Wocat SLM Technologies Water harvesting from concentrated runo for irrigation purposes 4/7

50%

/

/

/

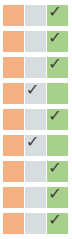
/

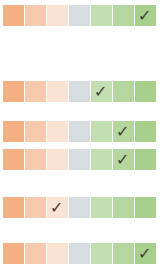
(,

)

< 0.5
0.5-1
1-2
2-5
5-15
15-50
50-100
100-500
500-1,000
1,000-10,000
> 10,000

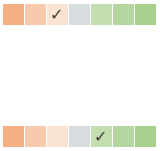
(.)





Depending on the amount of water harvested yield may be the same or increase slightly

Implementation of dykes is considered relatively expensive

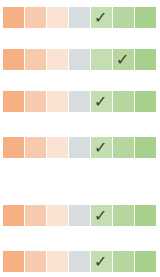


Water extraction by a water harvesting may cause less water at downstream locations, whihc may cause conflicts

Improved livelihoods and human well-being

decreased increased

during Roman and Arab times when most structures were operative they increased significantly the production. Nowadays, most of them are abandoned. However, those that are operational do cause increased crop yields.



(

)

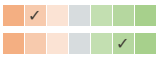
/

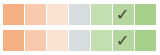
For small flood events only

Possibly a small effect

( )
(
)
/

If various structures are present in a stream and only for relatively low intensity events





Implementation of the technology is relatively expensive. Once installed, maintenance is not expensive and pays off because of higher productivity.

( )

( )

/
1-10%
11-50%
> 50%

?
0-10%
11-50%
51-90%
✓ 91-100%

?
/

?
/
( )

:

- The extra input of free water allows higher crop productivity.

:

- This technology is very effective at increasing water available for crop production and so increasing crop yield and farm income

  How can they be sustained / enhanced? Temporarily store the harvested water in a cistern to be used for irrigation using drip irrigation when most needed.
- The technology takes advantage of floodwater that is otherwise lost because of the erratic character and short duration of flow

  How can they be sustained / enhanced? Finding the optimal location for the water harvesting structures using a modelling approach

/ / :

- Farmers consider it relatively expensive to implement and there is no guarantee for water as this depends on the rainfall events. Subsidies might help to install these structures where feasible. Therefore, good assessments of expected water inflow volumes are required before construction

/ / :

- The implementation costs are relatively high when the bunds are made of concrete Use of cheap materials that are freely available (stones from the fields). However, it is important to make the structure as resistant as possible against flood events.
- The water provided by these techniques is mostly interesting for small- and medium- scale rainfed farming. Intensively irrigated farming requires more water and a guarantee for water independently of flood events Intensively irrigated farming might

use this technology as an additional source of water and may store the harvested water in a cistern for use when needed.

Editors

Joris De Vente

Deborah Niggli
Alexandra Gavilano

: 1 2011 : 23 2019

Joris De Vente - SLM
Albert Solé Benet - SLM
Jorge López Carratala - SLM
Ascensión Ibáñez Torres - SLM
Antonio Escamez -
- SLM

https://qcat.wocat.net/km/wocat/technologies/view/technologies_1517/

SLM

- Consejería de Agricultura y Agua Murcia (CARM) -
- EEZA-CSIC (EEZA-CSIC) -

- Book project: Water Harvesting – Guidelines to Good Practice (Water Harvesting)
- DESIRE (EU-DES!RE)

- rot, E., van Wesemael, B., Benet, A.S. and House, M.A., 2008. Water harvesting potential in function of hillslope characteristics: A case study from the Sierra de Gador Journal of Arid Environments 72(7):1213-1231: Internet
- Giráldez, J.V., Ayuso, J.L., Garcia, A., López, J.G. and Roldán, J., 1988. Water harvesting strategies in the semiarid climate of southeastern Spain. Agricultural Water Management, 14(1-4): 253-263.: Internet
- Hooke, J.M. and Mant, J.M., 2002. Floodwater use and management strategies in valleys of southeast Spain. Land Degradation & Development, 13(2): 165-175.: Internet
- López-Gálvez, J. and Losada, A., 1998. EVOLUCIÓN DE TÉCNICAS DE RIEGO EN EL SUDESTE DE ESPAÑA. Ingeniería del Agua, 5(3): 41-50.: Internet
- Nasri, S., Albergel, J., Cudennec, C. and Berndtsson, R., 2004. Hydrological processes in macrocatchment water harvestingin the arid region of Tunisia: the traditional system of tabias. Hydrological Sciences-Journal, 49(2): 261-272.: Internet
- van Wesemael, B., et al., 1998. Collection and storage of runoff from hillslopes in a semi-arid environment: geomorphic and hydrologic aspects of the aljibe system in Almeria (Spain). Journal of Arid Environments 40(1):1-14: Internet
- Greenpeace, 2007. El negocio del agua en la cuenca del Segura, Greenpeace.: www.greenpeace.es