Water Resources and Rural Development in Arid Lands: The History of Qanats in Central Iran

Nasser Arzani
Payame-Nour University, Esfahan, Iran
(arzan2@yahoo.com)
Aims

1- To discuss the history of Qanats in the arid lands of central Iran and answer the question: Why and how the long-profile Qanats build upon the alluvial megafans in arid lands?

2- To report the general geology and sedimentology of alluvial megafans in arid lands.

2- What to learn from the past and predict the future of short and long profile Qanats in arid lands.
Outline of the Presentation

(1)- History of Qanats in central Iran

(2)- Alluvial fans as water resources in arid lands

(3)- Long and short profile Qanats in alluvial fans

(4). Conclusions
Qanats

- *Qanat* is a type of underground irrigation canal between an aquifer on the piedmont to a garden/village or city on an arid plain.

- *Qanat* is one of the most sophisticated traditional irrigation system.
A Qanat is constructed by tunneling into a cliff, scarp or base of a mountainous area, following a water-bearing formation.

The book by Mohammed Karaji, a Persian scholar of the 10th Century AD, has a chapter on Qanat construction.

(1)- History of Qanats

*Encyclopedia of Modern Asia:*

Kariz (also known as kareze or qanat) invented in Persia (Iran).

*In 714 BCE, when the Assyrian King Sargon II invaded Armenia, he saw an irrigation system not yet known in Bet-Nahrain, called by its Arabic name qanat or the Farsi kariz. He brought the secret back to Assyria.*

Qanat irrigation was then spread over the Near East, as far as North Africa, and is still used.
(1)- History of Qanats in the arid lands of central Iran

Location
(1)- History of Qanats in the arid lands of central Iran

Location: Central Iran
(1)- History of Qanats (cont.)

- Mehraby, R. (Destination Iran Tour & Travel)
  - old Zavareh kari (central Iran) dating back to 5000 years ago.
  - 350m depth master well of Gonabad Qanat dating back to 2500 years ago.
  - 40km long a aqueduct of Chogha Zanbil water refinery installation dating at least back to 3250 years ago.
2-Qanat Types

Various types of Qanats are categorized according to the flow, depth of the mother well, type of construction, geographical environment, etc.

There are Qanats in the plains and those from springs (mountains), those that run parallel or those that run successively (Ghiyoor, 1991).
2-Qanat Types (cont.)

- From a structural point of view Qanats can be divided into three main types:

  1- Mountain type: These are simple Qanats that use water resources from mountainous regions (Mountain-front Proximal-Fan Qanats).

  2- Plain type A: These Qanats branch out from rivers.

  3- Plain type B: These Qanats use water resources from alluvial megafans (Medial to distal-Fan Qanats).
2-3-Plain type B Qanats, built upon alluvial megafans

What are the alluvial megafans?

Why and how the long-profile, plain-type B Qanats build upon the alluvial megafans??
Alluvial Fan
Death Valley
A semi-conical, downstream fining, sediment accumulation predominantly of alluvial origin. It is resulting from loss of transporting capacity due to horizontal flow expansion.
PROXIMAL-DISTAL FACIES VARIATIONS

(c) SCHEMATIC MODEL

- Sands
- Gravels
- Debris flows
- Proximal: Coarse Boulders - cobbles
- Distal: Fine Sand - gravel
- Mtn Front

Alluvial Fan Sediments
Alluvial fan Size

1. Mountain front, small alluvial fans (less than 6 km in fan radius, an example from Death Valley).

2. Alluvial megafans (more than 30 km in fan radius, an example from Central Iran)
Debris flow fan

Stream dominated fan

From Blair & McPherson 1994
Plain-type B Qanats, built upon alluvial megafans

As an example:

Qanats in Abarkoh Basin, central Iran
Location
Abarkoh Basin
Abarkoh Basin

1- It is a fault-bounded depression.

2- The catchment of this megafan is the Abadeh Basin.
Satellite images of the Abarkoh Basin
Alluvial megafan, Abarkoh Basin (see Arzani, 2005)
In the Abarkoh Basin, >880 water wells & 19 (originally 103) Qanats pump out the water from aquifers of the Abarkoh megafan (see Arzani, 2005).

What about the future of Qanats in this area??
Plain-type B Qanats in Abarkoh Basin
Plain-type B Qanats in Abarkoh Basin
Plain-type B Qanats in Abarkoh Basin
How hard it was to build a Qanat
The Future of Qanats

Well Test
(24h pumpage)
Horok Village, 1383
The Future of Qanats

At present, many factors threaten the Qanat systems in Iran as well as worldwide.

- Climate change and increasing risks of desertification,
- Over-consumption of freshwater resources,
- And introduction of new technologies, as well as inadequate policies have all contributed towards the degradation of ingenious system of Qanat construction and maintenance.
The Future of Qanats

- Qanats can not compete in water discharge with the deep tube wells.

- As an example, more than 103 Qanats with about 270 Km of tunnel, which were active since 1971 in the Abarkoh Plain are presently active as less than 19 Qanats.

- They replaced by tube and dug wells, the number of which increased to 850 since 1971.
Qanats & Water Wells
Conclusions

- Ancient methods of groundwater management, such as the qanats system, provide an excellent demonstration of human ingenuity to cope with water scarcity.
- Groundwater management, particularly in arid regions, should be viewed holistically and linked to the sustainable management of the ecosystem.
- The geomorphology and facies association of the alluvial fans mainly controlled the position and discharge of the aquifers.
- Alluvial megafan, which provide the best water resources for long-profile, plain-type B Qanats, are very sensitive areas to discharge of aquifers.
Save the Qanats and be aware of the future of water crisis in arid lands and desert borders!!

THANK YOU