PROPOSAL FOR A TYPOLOGICAL, TOPOGRAPHICAL AND MORPHOLOGICAL ATLAS OF QANAT

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Abstract
Qanat, known locally by various names, are very ancient structures, built in desert or arid areas, to bring water to the oasis. In the zones surrounding oases, water is used for irrigation to support the agricultural production necessary for the community of the oasis. Sometimes the water of qanats is also used to help small local crafts beyond water supply. The qanats are present in large parts of Central Asia, the Middle East, North Africa and in some small areas of Mediterranean Europe. The qanats appear with very different topographic types and construction techniques. The realization of a typological Atlas aims to study the different characteristics of the qanats in relation to the territories in which they were built.

The qanat is, generally, an old hydraulic system designed for irrigation of desert areas. According to encyclopedic definitions, the qanat is referred to as *a hydraulic system to conduct, by gravity, the waters of an aquifer to an arid site often located tens of kilometers away, in order to make it cultivable*. This term is also transcribed as *kanat* or *Ghana* throughout Iran and neighboring areas. Qanat becomes *foggara* or *rettara* in the African regions as Libya, Algeria, Morocco, Tunisia or Egypt. Another translation used is the word *manafis*, or the word *afla* used in Oman, the word *karez* (or *kariz*) used in China, in the area of Turphan depression. Other structures similar to the qanat and with the same features, have been reported in Iraq, Syria, Lebanon, Yemen, Turkey, Turkmenistan, Afghanistan, Pakistan.

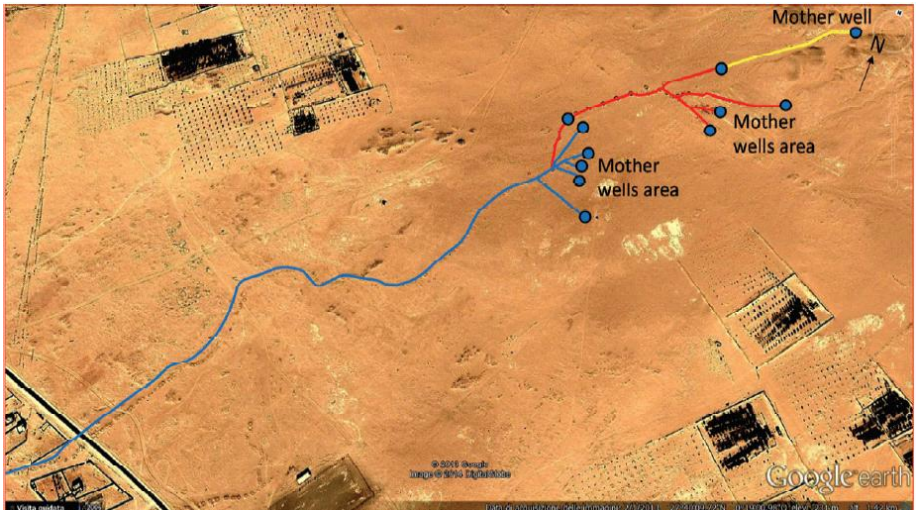

Fig. 1 - The qanat of Ben Henni, Algeria, Adrar Province

Called with different local words, other structures similar to a qanat have been identified also in Mexico, in the local desert areas. In Central America the qanat are similar to those in the Middle East as regards structure and functionality. This technology was imported with the Spanish colonization. The Spanish knew the technique to build the qanats because the Arabs had built qanats in Andalusia. Qanats have all details that make them similar: they are located in desert areas and appear as underground ducts, often long tens of kilometers. These underground tunnels are easy to find outside by an ordered sequence of wells in close succession. Caught the aquifer through a mother-well, frequently several tens of meters deep, the waters are conducted in the nearby plain through a gallery which is, in its first part, less than two meters high. Sometimes, this gallery is lined with clay or concrete rings of varying thickness, known as the Persian word "*kawals*". Their function is to support the vault and the walls of the tunnel, especially in the presence of sandy soils. The underground path prevents the evaporation of water and leads it directly into the oasis to irrigate. Here, according to ancient rules, techniques and procedures, water is used with rational and prudent methods. In other words, oasis, desert and qanats are elements of a unique set and represent a particular characteristic of desert civilizations; a situation not found in other places.

The aim of the project is to carry out a classification of the various types of these hydraulic works, placing them in their geographic space with the needful diachronic support. Furthermore, to outlining, as far as possible, a typological fairly defined area, either for the type of territory, either for resource use. Aim of the project is also to highlight the complex relationships between different social and economic contexts in the evolution of the territory. Some territorial areas in the Mediterranean region and in neighboring zones have been taken into consideration, such as Italy, Iran, Turkey, Tunisia and Jordan. Other areas are expected to be involved in the program of the project: Syria, Oman, Yemen, Egypt, Libya, Morocco, Algeria, China, Pakistan, Afghanistan, Uzbekistan, Kazakhstan, etc..

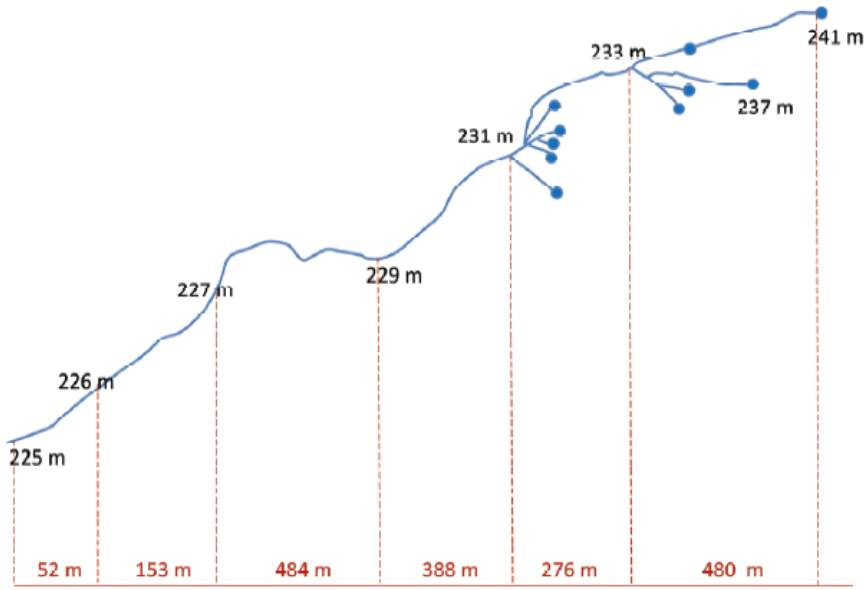

Fig. 2 - Qanat of Ben Henni: the length of the main tunnel is 1.833 m. and, with the secondary tunnels, the overall length is 2.541 m.

CATALOGUING

The work of cataloguing, in advanced progress, involves three distinct phases.
a) Identification of qanats paths through the detailed examination of aerial photographs taken from Google Earth. This simple procedure, rather boring in its application, allowed to identify a number of sites through which over 4,000 qanat were surveyed. It was also possible to identify and separate the various hydraulic structures, which in some cases extend in parallel at a distance of a few tens of meters from each other. These special cases are found in China, close to the oasis of Turphan and in Morocco at the oasis of Fezna Ouled Jellal. Such a type of analysis is not sufficient to understand if a qanat is new or whether it is a restoration of an ancient structure1. When a large-scale cartography is available, more or less recent, a further survey feedback is subsequently carried out. Finally, a careful analysis is carried out of the suggestions taken from historical surveys or scientific contributions. As a matter of fact, information about the presence of disappeared qanat are only possible through these sources2. The topography of large areas is then divided into large squares and the ducts are numbered with alphanumeric codes, which refer to a card similar to those used successfully in the Italian catalogue of artificial cavities.
b) Typological analysis of the structure of the wells. It was possible to observe that the casuistry is quite wide and often within the same tunnel you will find different types of wells. Especially when there are several successive restorations over time, when it was necessary to protect the entrance to the well with small walls or, in more recent cases, with concrete lids.
c) Bibliographical database with reference keys. It's the logical completion of the summary sheet on the presence of a qanat in a specific territory.

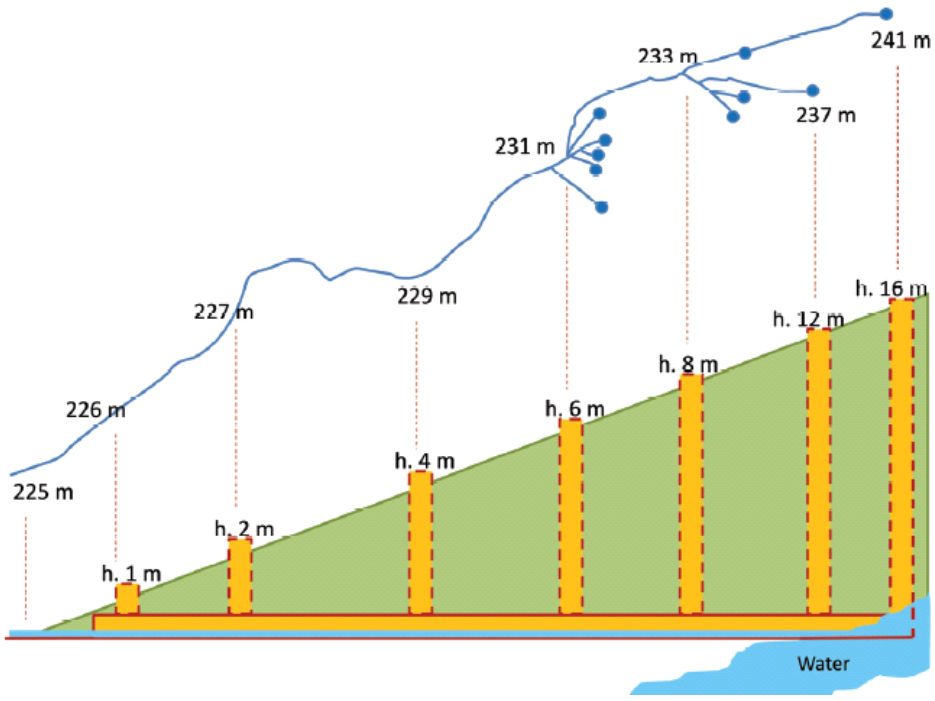

Fig. 3 - Qanat of Ben Henni: synthetic scheme of wells

QANAT CENSUS

As attachment to the typological Atlas a census of qanat was created using a form able to summarize their main features. This form is similar to the one used for decades for the Census of artificial cavities in Italy. This record card has been used in numerous applications according to the cartographic support and the development of the satellite detection. The one presented here is a shorter version of the more complex cataloging card, but it was drafted specifically for the particular type of qanat.

-*1) Inventory Number* – Is the number assigned to the single hydraulic work and is divided into two sectors: the sequence number and the territorial area number;

-*2) Country where the qanat is located;*

-*3) Region or geographical reference area;*

-*4) Name of the structure.* As it has been said, the word *qanat* is widespread only in some areas and elsewhere is present with a different name;

-*5) Topographic Localization.* The topographic coordinates are expressed in latitude and longitude and sea level. The point considered is the outdoor outlet of the channel. If that point is no longer detectable, the last well further downstream is taken into account;

-*6) Length.* The total length is considered, i.e. including the branches, from the main shaft or mother-well;

-*7) Presence of branches or descendants.* The total number of branches and their length calculated from the relevant mother-well is indicated;

-*8) Number of wells.* They must be distinct between those open and those closed;

-*9) Depth of the main shaft or mother-well;*

-*10) State of preservation.* Divided into excellent, good, bad;

-*11) Functionality.* Divided into: functional, desultory, abandoned;

-*12) Use.* Divided into irrigation, social, mixed use;

-*13) Further data.* Water flow, chemical/physical parameters of water, radon gas values etc.;

-*14) Description;*

-*15) Additional notes;*

-*16) Photographic reference documentation;*

-*17) Reference Bibliography;*

-*18) Compiler Name and his reference frame*.