

Traditional Irrigation installations in the M'zab Valley**منشآت الري التقليدية في وادي مزاب**

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• Abstract:

The M'zab region is rich in a significant collection of archaeological sites left by Islamic civilization in particular, Its material heritage plays an important role in preserving the memory of the nation, its cultural depth, and the distinctiveness of its local culture, Islamic societies, including the Ibadi Mouzabite community, have acquired several civilizational and social aspects in the rational exploitation of water without resorting to waste. They created several facilities, considering them a civilizational product that highlights the extent to which the population has adapted to the harsh natural environment in which they live. They worked and overcame the challenges they faced in creating these facilities, which did not come easily in this region. These facilities are of great importance in the Mouzabite community as they are the only refuge for adapting to the harsh desert region to ensure living in it.

Keywords:

M'zab Valley, Desert Architecture, Water, Traditional Irrigation Installations.

• الملخص:

تتخزن منطقة مزاب بمجموعة مهمة من المعالم الأثرية التي خلّفتها الحضارة الإسلامية على وجه الخصوص، فتراثها المادي يؤدي دورا مهما في الحفاظ على ذاكرة الأمة وعمقها الحضاري وتمايز ثقافتها المحلية، بتجليها في مدنه الخمس وما تشتمل عليه من نسيج عمراي غني تمّ تصنيفه ضمن التراث الوطني سنة 1971م ثمّ ضمن التراث العالمي سنة 1982م. اكتسبت المجتمعات الإسلامية ومن بينها المجتمع المزابي الإباضي عدة مظاهر حضارية واجتماعية في استغلال الماء استغلالا عقلانيا دون اللجوء إلى تبذيره، فأوجدوا عدة منشآت تضمنه، باعتبارها نتاج حضاري يبرز مدى تأقلم السكان مع البيئة الطبيعية القاسية التي يعيشون فيها، وكيف عملوا وطوّعوا الصعاب التي واجهتهم في إيجاد هذه المنشآت التي لم تولد بسهولة في هذه المنطقة، حيث تكتسي أهمية كبيرة في المجتمع المزابي لكونها الملجأ الوحيد للتأقلم مع المنطقة الصحراوية القاسية لضمان العيش فيها .

كلمات مفتاحية: وادي مزاب، العمارة الصحراوية، الماء، منشآت الري.

• Introduction

Water is of great importance in the system of human life, as the Holy Quran highlights its significance in many verses that make water the secret of the continuity of all living beings, In His

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saying: "And We made from water every living thing. Will they not then believe?"¹, In His saying also: "Do you not see that Allah sends down water from the sky and makes it flow as springs in the earth"², and other verses that clearly highlight the role of water in the system of the universe, Based on sources of Islamic legislation, Islamic societies, including the Mouzabite and Ibadite communities, have acquired several civilizational and social aspects in the rational exploitation of water without resorting to wastefulness, They established several facilities to ensure that.

The M'zab Valley region is considered one of the most important desert areas that has many irrigation facilities of various types and functions established for the purpose of wise and prudent exploitation of the water resources available in the region, Based on this, we can say that these establishments are a product of civilization that highlights the extent to which the inhabitants have adapted to the harsh natural environment in which they live, And how they worked to challenge the difficulties they faced in finding these facilities that did not come easily to this area, as they were the refuge and the only solution to adapt to the harsh desert region to ensure living in it, Our issue revolves around: what do traditional irrigation facilities in the M'zab Valley represent? We aim to achieve a set of objectives through studying them:

- Highlighting the functional differences of the water facilities in the M'zab Valley region as well as their historical and archaeological characteristics.
- Highlighting the technical and artistic aspects of irrigation facilities.
- Reviving and recognizing these archaeological landmarks due to the neglect and erosion they suffer by delving into their depths and hidden secrets preserved in popular memory, as well as highlighting their status in society.

Our study is concerned with providing a scientific archaeological study to extract the contents of the irrigation facilities in the M'zab Valley area and how water was distributed in them, By bringing it into the field of scientific research and providing the opportunity for all those interested in the M'zab material heritage to get to know it and understand its implications.

1. Water in the Ouad M'zab area:

The M'zab Valley area is one of the most important oases where the surface water flow system is manifested only after rainfall³, Capot-Rey pointed out that desert area and oases generally rely on surface water at times and on groundwater at other times, and sometimes on both, which is further divided into several types according to the geographical nature of each area⁴, as follows:

¹- Quran- Surah Al-Anbiya- Verse: 30.

²- Ibid- Surah Al-Zoumar- Verse: 21.

³- Fourtanet B, study of the palm grove of Ghardaia after the floods of October 2008- As part of an end-of-study internship in the professional degree in conservation and restoration of built heritage Ghardaia- Algiers, 2009, p. 06.

⁴- Capot Rey, The French White Africa- The French Sahara -Vol. 2- (University Press), Paris, 1953, p. 76

- Permanent river waters.
- Oases that rely on the ordinary aquifer, from which water is extracted using wells.
- Oases that depend on the artesian layer, where water rises to the surface automatically.
- Oases that rely on Al-fogharats, which are underground channels that bring groundwater to points located at a lower level.
- Oases that depend on surface water that flows only after rainfall.

For this reason, the Mouzabites are keen to exploit as much as possible of the water resources available in their region, which is characterized by scarcity due to the harsh and dry nature of the area, similar to other desert regions, The M'zab region does not contain springs or surface water flowing throughout the year, but at a depth of between 20 and 40 meters, there is groundwater that forms water pockets, fed by the flow of surface valleys, It is a series of underground valleys whose effects are visible on the surface, so the water level varies from year to year depending on the abundance or scarcity of rainfall. It is considered the main source of this water⁵, Based on this, we can divide the water sources in the region into two types: rainwater, which leads to floods, and groundwater.

2- The regulatory framework for water in the M'zab Valley:

Due to the importance of water in the daily life of the Mouzabite community and the difficulty of obtaining it, the Mouzabites consider it more precious than anything else. They conserve and economize its use, which is why they thought of establishing a dedicated authority in this field, to organize the exploitation and management of water and to enact laws related to water in accordance with what is stipulated by the righteous Sharia, This body is represented by what is called the Flood Trustees Authority, which is a specialized body comprising experts specialized in monitoring flood affairs and upholding the laws that regulate them according to established customs. Locally, this body is known as "Al-laoima", It is an organization affiliated with the bachelor system, concerned with distributing flood waters to the orchards and monitoring the dams. It exists at the level of the Kosours of the M'zab Valley, where a special body has been formed in each Kaser, The Ghardaia kaser is considered one of the most important Kosours that still preserves this organization.

Each committee consists of five to ten people, chosen from the wise individuals of the region, They must also be trusted by the people, as they are of sound and prudent opinion, and are more knowledgeable about matters related to the flood, its necessities, and its division according to the traditional customs of the region, The authority is headed by a person among them, who possesses piety and righteousness, and has experience in the field, referred to as the trustee. He is responsible for everything along with his assistants; he is the one who distributes and organizes matters related

⁵- Félin patient, Study on the Water Legislation in the M'zab Region- I. A- Blida, Algiers, 1908, p. 27.

to irrigation, such as building a water inlet or creating a canal or dam, It also resolves disputes among people in the field of water, by consulting with his assistants.

3- Traditional irrigation facilities in the M'zab Valley area:

We find that the Islamic city in its inception was based on essential axes in planning, which Ibn Abi al-Rabia' articulated in eight conditions that the ruler must follow when planning the city, among the most important of which is to supply it with fresh water⁶, and this is evidence of the importance of water in human life, especially if one settles in a dry and desert area like the M'zab Valley, where water is very scarce, which mainly relied on the flowing floodwaters produced by rainfall, so the residents of the area were concerned with finding facilities and structures for irrigation, And to innovate an effective system that utilizes as much rainwater as possible flowing in the surrounding valleys, It is stored to supply the groundwater layer and used when needed on one hand, and to control river flow and prevent the risk of floods on the other hand, I found several facilities there, including those dedicated to collection and distribution, such as dams, guide walls, channels, and conduits for water of all types, In addition to what is designated for storage and utilization, such as wells, tanks, and reservoirs.

3.1 Dams in the M'zab Valley:

Dams or valley walls are considered one of the most important means used to exploit the waters of rivers and valleys as they block their courses, thus trapping the largest amount of water and placing it under control⁷, The residents of the M'zab Valley and its tributaries have built various dams of different importance and function, to capture and direct water, giving the soil enough time to absorb the water and supply the aquifer that feeds the wells, These dams have multiplied to the extent that we find in each kaser of the M'zab Valley network a group of dams, whether at the level of the M'zab Valley or at the level of the streams and valleys present in each kaser.

⁶- Ibn Abi al-Rabia, The Conduct of the Ruler in Managing Kingdoms- Edited by- Aref Ahmed Abdel Ghani- Dar Kanan, Damas, 1996, p.106.

⁷- Slimani Souad, Ancient Irrigation Facilities in the Hodna Region- a thesis submitted for obtaining a Master's degree in Ancient Archeology- (Institute of Archeology- University of Algiers), Algiers, 2005, p. 33.

Pho.1. Remains of the Teuzouz Dam.



3.2 Wells in the M'zab Valley:

A well is a deep hole in the ground from which water is drawn, or a deep pit from which liquids stored in the earth's interior are extracted. The well is referred to by several different names in the Amazigh dialect, the common term among the Mouzabites is the word "Tirest," and there is another term "Ighersan," with its singular form being "Ighers." It means a deep well and may be derived from the Berber word "Arsan," which has the same meaning, that is, a well, Al-Bikri referred to this name while mentioning the wells spread throughout the Maghreb, where he said, "They are numerous wells built of cedar wood... and they are called in Berber Arsan...", The term "khattara" is used to refer to the well in the M'zab region, and this designation was mentioned in a document containing the agreement of the High Council of the M'zab Valley⁸, (The Higher Council of the M'zab Valley is a legislative, religious, social, and political council known as the "Council of Ba abd Rahman al-Kourthi." It includes representatives from all the villages of M'zab and was established before the year 1245 AD. It is responsible for enacting laws and rulings) In the year 1247 AH / 1832 AD regarding the exploitation of wells, it states: "The council of M'zab Valley agreed, both students and the public... whoever has a piece of land and it has a water source and wishes to cultivate it...", In the western regions of Maghreb, "khattara" refers to the device used as a means of extracting water from the well⁹.

Wells in the M'zab region are a fundamental element of urban development, and their distribution has been subject to both natural and security conditions. Wells are dug within the walls of the kosours to ensure a water source during times of war and siege, To facilitate the process of obtaining water for daily use, as the kosours were built in elevated places that are difficult to supply with water, while the wells suitable for drinking are spread along the riverbed.

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3.2.1 The architectural form of the well:

⁸- Ouaouchat Bakir, The M'zab Valley in the Shadow of Islamic Civilization- Al-Matba'a Al-Arabiya, Ghardaia, Algiers, 1991, p. 109.

⁹- Moullias D, The Hydraulic Organization of Saharan Oases, Algiers, 1927, p. 191.

The well in the M'Zab Valley area consists of two main sections: the superstructure, which represents the external shape, and the infrastructure, which represents the internal shape that is below the well, Due to the impossibility of accessing this part of the well because of the high level of the groundwater table, it can only be accessed during dry periods.

Pho.2. The superstructure of the well.



3.2.2 Types of Wells:

Wells in the M'zab Valley area can be divided into two main types based on shape, function, and water quality: public wells and oasis wells, both of which have other types branching from them.

A. Public wells:

It is affiliated with the "Habous" mosque, which is responsible for digging and maintaining them. Some volunteers from the community may also dig them and endow them to the mosque. They are of two types: wells suitable for drinking, located outside the walls of the kaser, In the riverbed, it consists of surface reservoirs for groundwater where rainwater or floodwater collects when the valley flows, and it quickly dries up because it is shallow, This is what made its waters fresh; based on its characteristics, we can say that it is a type of "aḥsā'" according to the definition provided by Ibn Mendour for "aḥsā'", It states that it is a deep pit with stones at the bottom and sand above it, and when it rains, water seeps through the sand and collects in the stones, and these wells are used only for drinking, Some are designated for men and others for women and children¹⁰.

As for the architectural design of public drinking wells, they feature vertical supports made of stone, sometimes topped with a semicircular arch, in which horizontal and vertical wooden beams are installed to support the pulley, On the front and back sides, it is protected by two stone slabs at the well's opening, with a diameter not exceeding one meter. It is equipped with a rope suitable for the depth of the well and a container or leather bag for drawing water.

¹⁰- Ben Youcef Brahim, The M'zab- A Millennial Journey- Alpha, Algiers, 2010, p.120.

Pho. 3. Public wells in the Salamo Ouaisa area of Ghardaia Kaser Dating back to around: 1930.



Source: opvm.

B- Animal watering wells:

These are wells found in oases and forests with private ownership, known as earth wells or animal watering wells. "Tirest Enoijbad" is used for irrigation and watering orchards, The taste of its water varies from place to place, and the water is extracted from it using animals, This method may have been transferred to the M'zab Valley through the mass migrations that some Ibadite regions in North Africa experienced following the extinction of the Bani Medrar state in Sijelmasa in the year 366 AH / 976 AD, the arrival of the Bani Hilal in the Islamic Maghreb in the year 443 AH / 1050 AD, where many Ibadi people migrated to the M'zab Valley and settled there¹¹, These wells are built from stones to support the lifting device represented by the supports and pulley, in addition to the basins, channels, and the camel's alley "Aghlad elam," and they are divided into three types:

- Wells that receive floodwater: These are wells that receive floodwater through a rear opening or "Lamsarif" from which the floodwater flows into the well, so a special channel is designated to transport floodwater to it, with the aim of storing it in the groundwater layer, The selection of this type of wells is often by chance, and it is noted that they absorb floodwaters without filling up, and their effect is seen in the neighboring wells, as their water level rises immediately after the flood, They are called "swallowing wells" because they absorb floodwaters; not all wells perform this function, only some of them¹², Thus, they serve two functions: irrigation and replenishment, Irrigation is supplying nearby areas with water, and recharge is supplying groundwater layers with water.

- Highland irrigation wells "Ajam": They are wells designated for irrigating elevated areas where the rocky lands beneath the mountain are reclaimed by building a wall at its base and then filling the space between them with fertile soil, To be utilized for agriculture, and to irrigate these elevated lands, the landowner must raise the water to a higher level, which is achieved through this type of

¹¹- Mammar Ali Yahya, Ibadism in the March of History- Ibadism in Algeria- Vol. 2- Arab Printing House, Ghardaia, Algiers, 1985, p. 423.

¹²- Delheure J, traditional hydraulics in Ouargla and M'zab- Water as a primary and vital necessity- Algiers- [n.d.], pp. 64-67

well, which is a hole not exceeding two meters in depth, It does not differ in shape from a regular well except that it is surrounded by a circular wall that rises about two meters above ground level, so that the pumping device and the basins are in the elevated ground, The well is supplied with an opening at the bottom so that water can be poured in and it fills up. The water is drawn from it in the same way used in a regular well, However, the process is repeated twice, so that in the first instance, water is extracted from the lower well, then poured into this well, and then raised a second time to the top in the same manner, It is also used to lift floodwaters to higher lands¹³.

- Unfailing wells (Al-Warwara): They are wells that do not dry up during times of drought and are few in number compared to regular wells, with about 20 wells by the end of the 19th century, and they do not differ in shape from other wells¹⁴.

3.3 Ways to extract water from the well:

Some methods and machines used to extract water from wells in the Maghreb region have been mentioned in Arabic sources, Some of it was extracted through wheels, a collection of wheels, meaning a water bucket, which is a water wheel with buckets. This is what Al-Bikri (4th century AH / 10th century AD) mentioned in his book, where he said: "And likewise, it draws water near Mananish from wells with wheels and pours it into a reservoir which flows into a canal that empties into a cistern in Mahdiah, from which it is raised with wheels to the palace of the caliph ebayd Allah al-Mahdi."¹⁵, There are other machines known as "the anjaqa" or "the anjafah," referred to in the Maghreb as "the khattar." This machine is specifically designed for lifting water or weights, and its literal meaning is "that which goes down and rises" or "a scoop." Al-Idrisi mentioned it in the Fezzan region, where he said: Its waters come from wells and there are date palms... they irrigate them with machines they call 'anjafa', which are called 'khattara' in the lands of Maghreb"¹⁶, in addition to the machines called 'sawani', the plural of 'saniya', The "asaniya" is the she-camel used for irrigating crops, and its literal meaning is "the one that raises water." It is an animal that raises water from the well¹⁷, The same source refers to it in the Tripoli area and said: "It has crops irrigated with water extracted from wells using the sawani"¹⁸.

Based on the spread of machines and the different means of raising water from wells, some foreign orientalist have divided the wells suitable for irrigation into two main types: The wells of the

¹³- Lieutenant- ch, The Palms of M'zab- In bulletin of the society of geography of Algiers, 1905, p. 43.

¹⁴- Ibid, p. 44.

¹⁵- Al-Bikri Abu Ubaid Allah, The Maghreb in the Account of Ifriqiya and the Maghreb- is part of the book -The Paths and Kingdoms- published by Dar Al-Kitab Al-Islami- Cairo (n.d.), p. 30.

¹⁶- Al-Sharif Al-Idrisi, The Delight of Those Who Yearn for the Horizons- 1st edition- Dar Al-Kitab for Printing, Beirut- 1989, p. 93.

¹⁷- Ibn Mansour al-Ifriki, Lisan al-Arab- Vol. 3- Dar Sader for Printing and Publishing- Beirut- 2005, p. 225.

¹⁸- Al-Sharif Al-Idrisi, op cit, p. 215.

mules and the wells of the pulleys or animal traction, sometimes referred to as bucket wells¹⁹, are specialized in the oases of the M'zab Valley for animal traction wells, Where the vertical load of a person is compensated by the horizontal load of an animal such as a mule, donkey, or camel, This method consists of a bucket open on both sides, with one side open like a bucket, and it is equipped with a rope raised to the pulley located at the top of the supports to rotate around it, On the other side, it ends with a tube that connects to a rope that turns on a wooden cylinder fixed at the mouth of the well, and then the ropes are directly tied to the animal, The one that pulls the bucket using the two ropes by following an inclined path that eases the effort of pulling, so the animal goes down when the bucket is rising and goes up when the bucket is descending, And when the bucket tube reaches the level of the cylinder, the rope is pulled and the water flows into the basin, A person accompanies the animal back and forth to encourage it to walk and assist in hauling and unloading the bucket at the right time. The bucket's load ranges between twenty and thirty liters, and the drainage rate is twice per minute, There are some wells that are equipped with two buckets pulled by two animals driven by one person.

The wells in the M'zab Valley are characterized by joint ownership among five to ten people, and it is rare to find them owned by a single individual, except for the public wells that are spread along the riverbed or within the walls of the palace, which are Collective ownership, The ownership of the well is independent of the ownership of the land²⁰, and the well is usually dug in one piece of land while the camel path extends to another piece of land, and the basins are built on another land, All partners participate in digging and preparing it, and the exploitation of the well's water is divided among the partners by time duration, with the day divided into time units, which are: twenty-four takhroubt, equivalent to twenty-four hours, It is divided into eight eighths, then the eighth is divided into 3 weighted parts, and the weighted part is divided into 30 dirhams, except in the Qaser of Ghardaïa, where it is divided today into sixteen khroubas instead of twenty-four khroubas²¹.

These units are divided among the partners in a single well according to each one's contribution to the drilling and preparation of the well²², To determine its beginning and end, the shadow of a person and their height is used during the day, while at night it is through the positions of the stars in the sky. This phenomenon is widespread in many desert kosours, As for the determination of the locations of the stars, the Mouzabites are more famous for it than other kosours, and it is said that they inherited it from the arrivals from the Ibadi regions because this phenomenon was well-known among the Rostoumids in Tihert²³.

¹⁹- Ibn Amira Mohammed, water resources and methods of exploiting them in the land of Maghreb from the conquest to the fall of the Almohad state- doctoral thesis in the history of Islamic Maghreb- (Department of History- University of Algiers), Algiers, 2005, p. 234.

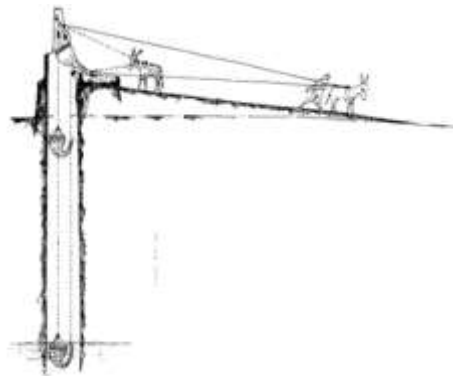
²⁰- Moullias D, op cit, p. 194.

²¹- Félin patient, Study on the Water Legislation in the M'zab Region- I. A- Blida, Algiers, 1908, p. 31.

²²- Moullias D, op cit, p. 197.

²³- Félin patient, op cit, p. 189.

Fig.1. Method of extracting water from the well



Source: Opvm.

4. The water distribution system in the M'zab Valley:

The M'zab Valley area is among those regions that primarily rely on surface water that flows after rainfall, even though it is characterized by scarcity²⁴, Therefore, the residents of the area thought of finding an effective way to utilize the floodwaters that pass through the valley from time to time, The urgent need for water from the stream to irrigate the orchards and supply the wells with groundwater led to the establishment of what is known as the system of water allocations from the flood more than eight centuries ago, It is an operation to regulate the flow of river water that flows after heavy rainfall, aiming to direct, store, and utilize it and distribute it equally to the orchards, This is in accordance with the established rules and regulations in the area, and it will be under the supervision of the Flood Trustees, whose task is to monitor the floods, manage them, and maintain their facilities and services.

We can divide these facilities into two sections: control facilities and distribution facilities, regarding water control facilities, which are represented by guiding walls, It is a type of dam used to direct floodwaters to irrigation channels and orchards; it also helps to reduce the intensity of water flow and calm it, as well as to settle the soil and prevent the digging of the watercourse or irrigation channel, As for the distribution facilities, they include the irrigation canals, where the canal irrigation system is one of the most important features that characterize desert areas²⁵ and particularly the M'zab Valley area, The watercourse is the place where water flows and is usually made of stone or dug into the ground, to which floodwaters are directed according to the slope, To end up at the exploited land or at one of its collection or storage facilities in the basins, gardens, or dams, which is referred to in the local dialect as "Tarja", Through the field visit to these facilities in the M'zab Valley region, we can classify the channels into several types and forms that vary from

²⁴- Ibn Amira Mohammed, op cit, p. 105.

²⁵- Ibid. p. 106.

one place to another according to the function they perform. These types are as follows: Tunnels, openings, sidewalks, outlets:

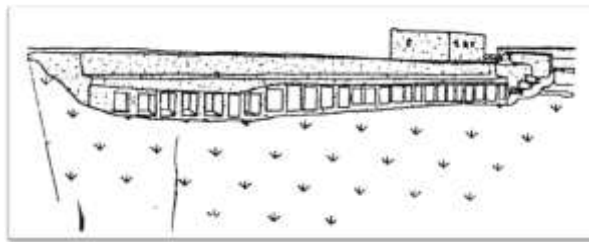
4.1 Tunnels:

The collision of the waterway with rugged terrains such as mountains and sand dunes forces engineers to cut and dig a tunnel, These channels are constructed from stone and covered with stone slabs, equipped with ventilation openings in the form of wells for filtering and purifying the channel, and they also allow air to escape when water enters, These channels have been used in the oases of Ghardaia, which are considered an extension of the Bouchamjane canal, where the canal branches into three branches through these channels. This channel was used because the canal has collided with the sand dunes, As for the dimensions of this channel, they vary from one place to another, with a height ranging between 1.50 m and 1m, and a width ranging between 70 cm and 40 cm. Regarding the ventilation openings, there are about twenty openings or wells, Its height increases as we move inward, and its diameter ranges between 75 cm and 85 cm.

4.2 The openings:

Its plural is "kawat, and "kawaa", In the M'zab Valley region, the term "Tisenabad" is used to refer to these openings, which are the gaps through which the floodwater flows into the irrigation channels and orchards, and they are quite precise, This opening is built with stone slabs where the piece is placed vertically from top to bottom, and the opening is kowat from above, As for its dimensions, they vary from one region to another and from one orchard to another, depending on the number of shares owned by the orchard owner in its width, and they also vary according to their function. As for their height, it is based on the height of the flood or more.

Fig.2. The control panels of the Bouchamjane Canal (eastern side).



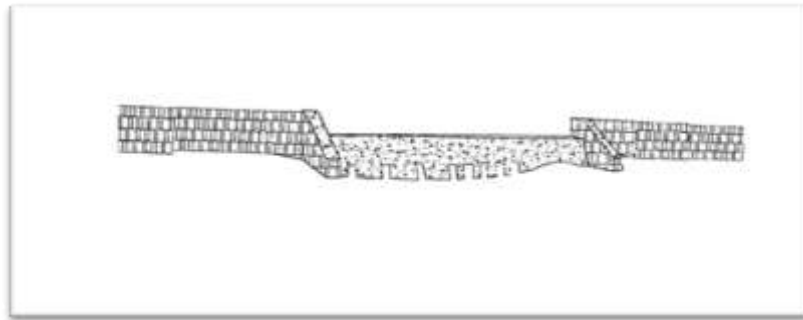
Source: AR.S.E.T. P. 09.

4.3 The embankments:

They are small water barriers built in front of the openings designated for irrigating orchards or at the entrance of the canal that branches off from the main street, This pavement is at the width of the street, where it helps to reduce the speed of water at the entrance of the channels so that the water does not wash away the ground of the irrigation ditch, This pavement is at the width of the street, where it helps to reduce the speed of water at the entrance of the channels so that the water does not wash away the ground of the irrigation ditch.

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Fig.3. Water barrier for draining water to the gardens of Ghardaia Kaser.



4.4 Sumps:

Sumps in the water distribution system are small dams built into the walls of the channels branching from valleys and earthen dams; The benefit of it is to direct excess water outside the canal or dam where the water flows through, in order to protect the wall of the canal from collapsing due to the water flow, The outlets should be lower than the wall of the channel to prevent the water level from rising above the wall if the water flow is heavy.

The fundamental principle followed in the water distribution system in the gardens: The water distribution system in the M'zab Valley relies on the principle of total and optimal exploitation of rainwater and on the fair distribution of this water among the entire oasis, where the river's water was first used for irrigating the orchards, and the surplus was automatically directed to various dams, Which in turn feeds the groundwater layers for use through wells, and the surplus of that water is automatically directed to the natural course of the valley, The share of the garden from the floodwaters depends on the owner's participation in the construction of the flood channels that pass through his garden, starting from the first day they began work until completion, The number of shares of the orchard owner is estimated based on the duration of time they participated in the work, calculated from the total days of work and the number of participants, each according to their contribution.

To convert one share into a specific unit of length, follow these steps:

The width of the stream is divided by the number of shares of the people participating in the work. If the width of the stream is 240 cm and the number of shares is 120 shares, The length of one arrow is equal to $240 \text{ cm} / 120 \text{ arrows} = 2 \text{ cm}$, and to find the width of the orchard opening, we multiply the length of one arrow by the number of arrows of the orchard owner.

The division at the level of a single orchard among the partners is based on the number of date palms, not the trees, The term "the coupled" refers to two palm trees that are joined together, and when there are three or more, all of this counts as one palm tree, Newly planted trees and the location of the palm tree are not counted, The presence of breaks in the shares of orchard owners is attributed to sale, purchase, or inheritance.

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• Conclusion

Water is a vital and strategic element for any city, especially desert cities, which are characterized by its extreme scarcity, making its impact on the course of political, social, and economic life very significant, The M'zab Valley area has witnessed unparalleled activity in this regard, giving the region a unique image of how well humans adapt to their dry environment and tailor it to their needs, His expertise in exploiting the natural and geographical specifics related to the rainfall system and runoff, and its relationship with the terrain and soil, makes us proud and boastful of the ingenuity and excellence of irrigation techniques and engineering in the region of M'zab Valley.

The division of water in the region was based on legal rulings established by Islam, which is evident in the jurisprudential books related to water law, particularly in the book of division and the principles of land by Abi Albbas iben Bikr al-Forastai al-Nafousi.

The M'zab area primarily relies on two main types of water sources: rainwater, which leads to the flow of valleys and streams surrounding the region, in addition to groundwater, which is considered the primary water source in the area, The surface groundwater layer (la nappe phrétique) was being exploited, which is also fed by rainwater and is located at a depth ranging from 15 m to 70 m, varying according to the nature of the area.

As for the roles that water played and the reflections that stem from it, they are multiple, including social and political aspects, as it had a significant impact on organizing society, One of its most important effects on society is the organization of the Trustees of the Flood, which still exists to this day, in addition to its role in the urban aspect, where it had a significant impact on the construction and distribution of kosours in the region.

The water facilities in the M'zab Valley, in general, emerged as a result of the different sources of water. Therefore, we notice that dealing with these sources in reasonable and logical ways helps to challenge the harsh desert nature, They created means to deliver water to every place they desired in easy ways, and they also excelled in finding alternatives during periods of rainfall interruption, Water facilities in the M'zab Valley are divided into two types based on water sources: dams and wells.

The water system in the M'zab Valley is the result of the expertise shared by successive generations that worked on developing and adapting it to water scarcity and maximizing control over the few

available resources, even if they are irregular, The difference in water structures in the region indicates that this architecture was following theories, the most prominent of which was the functional theory, The importance of these establishments lies in their representation of the collective memory of the M'zab Valley community, and they serve as a living source for writing history, which necessitates the need to preserve and enhance them as they are an important part of the Algerian cultural heritage.

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