

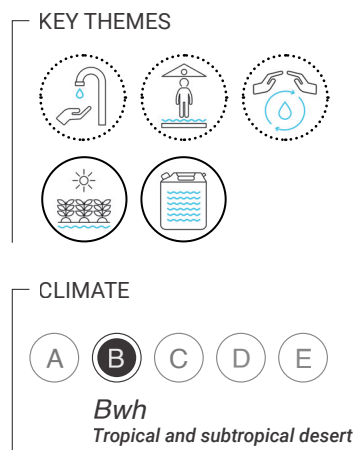


An Ingenious Heritage System for Collecting and Distributing Flood Water in the M'zab Valley of Algeria

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Foggaras are traditional Algerian water systems, which historically have made it possible to collect and redistribute water in the Sahara Desert. Although threatened by climate change and unsustainable urbanization, foggaras are still in use today and for hundreds of years have been managed by the same customary laws and groups. They are an example of tangible water heritage and ingenious water works, adapted to the needs of an arduous environment along with local society and culture. Such structures can inspire future ways of engaging with nature.

“These are not human settlements that are valued only because of the effort made to maintain them and the relative degree of production and well-being, these are settlements valued for their absolute perfection. They represent the best we can imagine and achieve as an oasis culture.”
(Quoted in Parvard 1974).



< Fig.1 M'zab Valley (Source: D. Sloan, 2017; Creative Commons Attribution-Share Alike 2.0).

Historical Introduction

The M'zab Valley is a region in the northern Algerian Sahara that consists of a vast rocky plateau cut by four deep major valleys. Ghardaia, the main city, is located at a distance of 600 km south of the capital Algiers. It is the capital of the *wilaya* (administrative division, translated as "state" or "province") of the same name. It runs along the M'zab River over an area of 25 kilometers. The inhabitants have largely preserved the same lifestyles and construction techniques since the eleventh century, adapting both spatially and socially to the demands of this unique environment. This traditional human habitat, created in the eleventh century by the Ibadites, ancestors of the current Mozabite population, has been preserved intact in the M'zab Valley. The M'zab River crosses the valley from northwest to southeast. This configuration is known as the "Chebka" (network) (Cataldi and Al 1996). Between the eleventh and fourteenth century, urbanization led to the creation of five *ksour*, or fortified oasis towns: El-Atteuf (1012), Bounoura (1046), Ghardaia (1048), Ben-Isguen (1347) and Mélika (1350). Each contains a system of irrigation, cemeteries and a palm grove. The distribution of private land, divided into garden plots assigned in the palm grove, was based on an agreement made among the co-founding families (Diafat and Madani 2019; Babanedjar 2008). The town structure reflected the social structure with a series of interconnected spaces with various functions: *ksar* (attached dwellings) for urban life, cemeteries for the dead and palm groves as agriculture (Cataldi et al. 1996).

As unlikely as it may seem, the scarcity of water was the primary draw of the M'zab Valley. The Mozabites retreated to this difficult, uncultivated and inhospitable area of the Sahara Desert to hide from enemies. They established an urban civilization that includes fortified towns

with a mosque, a minaret that also serves as watch tower, grain storage and arsenal. Living in this area is made possible by a very complex ancestral hydraulic system that exploits and regulates floods for irrigation purposes and recharges the aquifers. The Mozabites have implemented a technical and social organization to manage the danger of floods and take advantage of the floodwaters to supply the *ksar* and meet the demand for irrigation. The Mozabites have conserved practically the same way of life and the same building techniques since the eleventh century, ordered as much by a specific social and cultural context, as by the need for adaptation to a hostile environment, the choice of which responded to a historic need for withdrawal and a defensive imperative.

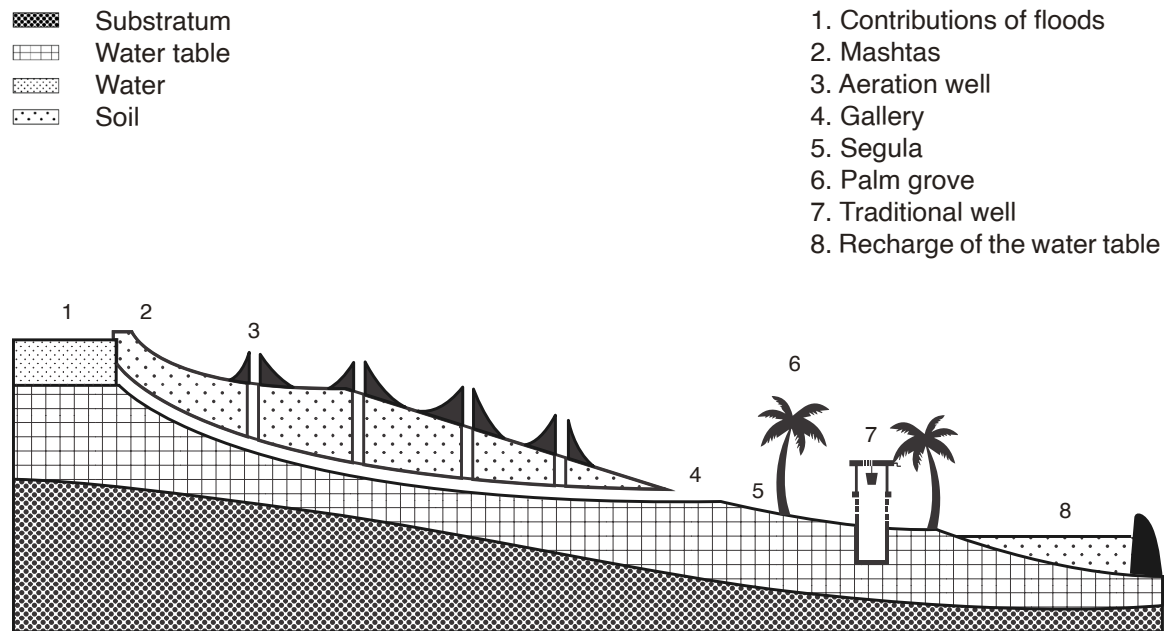
Water System Characteristics

The M'zab Valley, as a hyper-arid region, suffers from drought (Atlas of Ghardaia 2004). The scarce rainwater is exploited in an innovative and useful way. The Mozabites have invented a hydraulic system unique in the world, a network of underground tunnels for collecting and managing floodwater, called *foggara*.

As a collection system of galleries and wells, *foggara* have similarities across the region. They are found in many parts of Algeria, and in Iran there is the similar *qanat*, the *khattara* in Morocco and *falj* in Oman. In the Algerian Sahara there are seven types of *foggara* that differ in terms of the source of the water and the technique of water sharing. The Mozabite *foggara* serves the oasis of Ghardaia, in the M'zab Valley, and is a unique example of water management in Algeria. Once it is collected at the *bouchene* (reservoir), the water is channelled by four galleries, approximately 200 meters long, equipped with ventilation shafts.



^ Fig. 2 Sharing waters of the flood foggara at Mزاب (Source: Remini 2007).



^ Fig. 3 Diagram of flood foggara (Source: Remini, Achour and Kechad, 2010).

This distribution system allows all existing gardens and orchards to receive the same amount of water. In addition, this network allows the city of Ghardaia to avoid flooding of the river. During floods, the water flows through the valley directly to the reservoir (*Tissembath*). Once the reservoir is full, it feeds the groundwater of the region. From the reservoir, the water flows through underground channels to reach the paths between the gardens. In times of high water, the paths act as canals. In times of drought, they act as a walkway. Each canal feeds a specific area of the gardens, which are equipped with various rectangular openings. The width of an opening is different from one garden to another depending on several parameters: the distance of the garden from the arrival of the underground canal, the surface of the garden and the number of palm trees. When the garden is flooded, excess water flows into the M'zab Valley (Khelifa and Remini 2019). This *foggara* system of floodwater sharing, mainly composed of dams, dykes, gullies and underground canals, is characterized by very high precision, allowing a rational use and an equal distribution of water. The ingenuity of the process lies in its design and its adaptation to the conditions of Saharan life and climate.

The water system represents an ancestral technique bequeathed for more than seven centuries which was structured – and is still structured – by the socio-cultural system of the region. The urban and spatial organization of the *ksour* (fortified oases) of the M'Zab includes integrated social and political structures and religious buildings with urban components. They are a balanced ecosystem, a projection in space of a particular way of living and thinking. A *ksour* is the organization in a delimited space of a homogeneous population in the form of clans and fractions. *'Achiras*, *notables*, *'arsh* and *'azzabas* are the institutions (religious and secular) that

ensure the management of the *ksar* and various aspects of life (political, economic, social and moral), while guaranteeing total autonomy from the other *ksour* (Naidja 2022).

Water and Heritage Management

Water is managed according to written Ibadite legislation established in the twelfth century. The system is still managed by a group of controllers called *Oumana Essayl*, under the authority of the *Djemaa*, called *Halqa Azzaba*, the Committee of the Wise, which guides the *Mozambites* spiritually and advises. The *Oumana Essayl* monitor weather and climate change with their local expertise, which helps to prevent floods. They use a system of signs with mirrors or fire to allow communication between the different water diversion points to the gardens, while their watchtowers also function as warehouses. Their role is to enhance this ancestral heritage (the watershed system in the M'zab), to preserve the place as a site of history and civilization, as well as to aid related ecotourism activities. They are called upon to shed light on all the ancestral hydraulic works and to determine possible actions to preserve this heritage in close collaboration with the Office for the Protection and Promotion of the M'zab Valley (OPVM), in accordance with the regulations and the law concerning the preservation of cultural property (APS 2018).

The Algerian government recognized the region (particularly the M'zab Valley) as “national heritage” in 1971. In 1982, UNESCO designated the whole M'Zab Valley as a UNESCO World Heritage Site in recognition of its *ksourien* urbanism, a (pyramidal) shaped oasis in an arid area and its ancestral hydraulic system (<https://whc.unesco.org/en/list/188>). Following this classification, a permanent plan to safeguard and



^ Fig. 4 Devastating floods of 2008 in the M'Zab valley (Source: Smail Babaousmail).

develop the protected area (P.P.S.M.V.S.S) was launched. The OPVM committed to an ambitious program of restoring historic monuments such as religious and defensive buildings as well as a few water structures (<https://whc.unesco.org/en/list/188>).

The OPVM has created a number of technical guides, educational materials and brochures on traditional water management systems and wells. The technical guides include clear explanations of construction principles, materials and techniques, in an accessible format and language, with large illustrations. The publications aim to raise awareness about cultural heritage values and guide residents in the maintenance and restoration of their buildings. In 2001 UNESCO approved \$25,000 USD to fund the rehabilitation of the traditional hydraulic system in M'Zab Valley and the organization of training

workshops. In 2002 during the "Elaboration of a Preliminary Plan of Conservation and Development of the M'Zab Valley," UNESCO approved \$35,000 USD and requested the World Heritage Centre to coordinate the implementation of the activity in close collaboration with the national authorities concerned (UNESCO 2001).

Contemporary Challenges

This oasis system has functioned well for centuries and the *djemâa* has supervised the free supply of drinking water to the *ksar* until today. The Mozabites have managed to face floods and maintain the balance of the ecosystem, on which sustainable life in this region of the Sahara absolutely depends. However, the balance of this system is currently disturbed by uncoordinated human actions, aimed at responding

quickly and in an unsustainable way to a social and economic demand. Accelerated urbanization, significant population growth and the lack of urbanizable space inside the valley have led to vertical extensions, the occupation of part of the palm grove, and the degradation of the landscape, further altering the natural oasis ecosystem. The water quality is increasingly suffering from pollution produced simultaneously by the accumulation of infiltration by sewage from the Albian aquifer in the Algerian Sahara, the largest freshwater reserve in the world, and the retention of dams built upstream, which reduce floodwater and the periodic washing of the aquifer (Dahmen and Kassab 2020).

Furthermore, climate change considerably increases the risk of flooding, drought and desertification (fig. 5). There is a need for better-adapted amenities and suitable developments in this hyper-arid zone. These developments require consideration of prior impact studies, taking into account the increase in population, urban sprawl and climate change scenarios, to ensure sustainable development that recognizes the value of the foggara heritage.

Takeaway Points

The M'Zab Valley is not only a simple urban site that must be protected from flooding: the particularity of this remarkable space and the need to safeguard this World Heritage Site must also be taken into account. The heritage of the M'zab Valley is not only historical and architectural, it is also cultural and intangible. Its classification as a World Heritage Site is an additional asset for the economic development of the region based on tourism (Zafane 2022). Today, several elements of the system have been destroyed, putting this heritage in danger. The actors concerned must save what remains of the ances-

tral hydraulic system, which reflects the genius of the ancestors of the Mozabites.

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