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OUED M'ZAB'S I.R.S DEVELOPMENT POPULATION AND FLOODS, LIFE IN HARMONY PART 1: HYDRAULIC STRUCTURES

L'AMENAGEMENT I.R.S D'OUED M'ZAB LA POPULATION ET LES CRUES, LA VIE EN HARMONIE PARTIE 1: LES OUVRAGES HYDRAULIQUES

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ABSTRACT

This paper evokes for the first time, an ancestral hydraulic development that has been implemented for more than 7 centuries in the M'zab valley. We baptized: "IRS development". To understand the role of existing millennia structure in the Rivers of M'zab area was conducted during the period: 1996-2020, several missions at two to three per year. Investigations and inquiries were carried out with the Ksourian population and the Oumana El Ma (Management Committee). It turns out that the IRS development of M'zab River is the largest development in the entire M'zab Valley. About 18 structures between galleries, spillways, canal, dam and well were completed. In addition, 2 control towers and 8 operating chambers have been built along the M'zab River to monitor floods and watershed operations. This demonstrates the greatness of the project and the genius of the Mozabite.

Keywords: M'zab River, IRS Development, Flood, Irrigation, East palm-grove.

RESUME

Le présent papier évoque pour la première fois, un aménagement hydraulique ancestral qui a été mis en œuvre depuis plus de 7 siècles dans la vallée de M'zab. On a baptisé : « Aménagement IRS ». Pour bien comprendre le rôle des ouvrages millénaires existants dans les oueds de la région de M'zab, on a effectué durant la période : 1996-2020 plusieurs missions à raison de deux à trois par année. Des investigations et des enquêtes ont été menées auprès de la population ksourienne et les Oumana El Ma (Comité de gestion). Il s'avère que l'aménagement IRS d'oued M'zab est le plus grand aménagement de toute la vallée de M'zab. Environ 18 ouvrages entre galeries, déversoirs, canal, barrage et puits ont été réalisés. En plus de 2 tours de contrôle et 8 chambres de manœuvres ont été bâti le long de l'oued M'zab pour surveiller les crues et les opérations de partage des eaux. Ceci démontre de la grandeur du projet et du génie du Mozabite.

Mots clés : Oued M'zab, Aménagement IRS, Crue, Irrigation, Nappe, Palmeraie-Est.

NOMENCLATURE

Amlaga: Meeting point of two Rivers

Chaabat: Tributary

Khottara: Animal-drawn well

N': of

Tardja: open channel

Oumana El Ma: Management Committee

Oumana Esseil: Management Committee

Ahbas: Dam

Seguia: open channel

Tissanbadh: Underground gallery

INTRODUCTION

Raws, floods, two scary words. Often the flood when it occurs in arid regions, it causes material and human damage. Flash floods have increased in number in recent years, especially in the early fall. This phenomenon often occurs in the arid regions of the Algerian Sahara. However, often the population of the north perceives the floods as a misfortune; conversely the Mozabites consider the floods as a gift from the sky. Only the Mozabite population who can speak to the flood. For her, the flood was never a danger, you only have to live higher and cultivate the river. A submersion of the palm grove by one to two floods per year is essential for its development. The waters of a flood are loaded with clay particles and nutrients that are beneficial to the plant. Also, the arrival of a flood causes a general leaching of the palm grove while sweeping away the quantities of salts accumulated during one to two years. The only reservoir available in the M'zab valley was the water table. Its recharge by flood water infiltration once or twice a year becomes essential to ensure permanent irrigation of 5 to 7 years of drought. So how do you take advantage of the flood? To answer this question, hydraulic installations were carried out in the oases of the M'zab valley which we called: IRS Development. In each oasis, there is an IRS Development specific to the geomorphology of the environment. This is how we find that the studies we conducted on the oases of Metlili, El Guerrara, Berriane and Ghardaïa Est (Remini, 2020; Remini, 2019; Remini, 2018; Remini and Ouled Belkhir, 2019; Khelifa and Remini, 2019). This study follows that on the Touzouz River (Remini, 2020). In the first part of this modest study, we are only interested in the description of the largest IRS development project carried out on M'zab River. It is intended for irrigation of the eastern palm grove of the Ghardaïa oasis.

STUDY REGION AND SURVEYS

Study area

The study area is the Ghardaïa oasis; capital of the M'zab valley. A city with a tourist vocation par excellence. Very well known for its millennial Ksourian architecture. Located 600 km southwest of Algiers, Ghardaïa sits today on one of the largest aquifers on the planet. This is the tablecloth of the Intercalary Continental (fig. 1). Before the discovery of the aquifer of Intercalary Continental in the early 1940s, the entire M'zab valley was fed by the water table. Unfortunately, today the waters of this aquifer are polluted. The Ghardaïa oasis has today become a large metropolis where there is a great commercial, agricultural and tourist activity. Ghardaïa is crossed by the M'zab River well known for its devastating floods. With a flow exceeding 1200 m^3/s, the flood of 2008 caused a lot of material and human damage (Ouled Belkhir and Remini, 2016; Bouamer et al, 2019; Zegait et al, 2018).

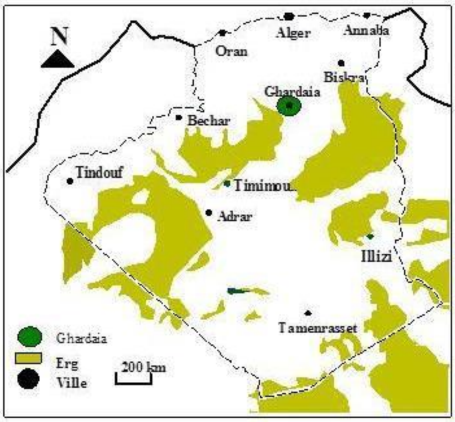


Photo 1. A view of the M’zab valley (Remini, 2020)

Photo 2. A view of the legendary Ghardaïa market (Remini, 2018)

Figure 1: Situation of the study region (Remini, 2020)

Methodology of work

Interested in the flooding in the M’zab River in the early 2000s, once on site we were impressed by the extent of the development carried out over the past 7 centuries. We liked a city and everything that the Ksour population has achieved in terms of hydraulics. With each mission, we discover new elements of the layout. This is how this work lasted until 2020.

RESULTS AND DISCUSSIONS

Presentation of the IRS development

Based on the idea that any drop of water that falls on the catchment area of the M’zab valley is captured. All the tributaries that lead to the palm grove have been arranged so that all the runoff water is used and drained towards the gardens. For this purpose, a large original and unique hydraulic development in the world has been designed on the M’zab River for more than 7 centuries. We called: I.R.S Development. It consists in annihilating the floods and making the most of these waters. In this case, the flood is divided into 3 parts depending on the priority: Irrigation, Recharge of the water table and the evacuation of excess water to the River (Safety) (fig. 2).

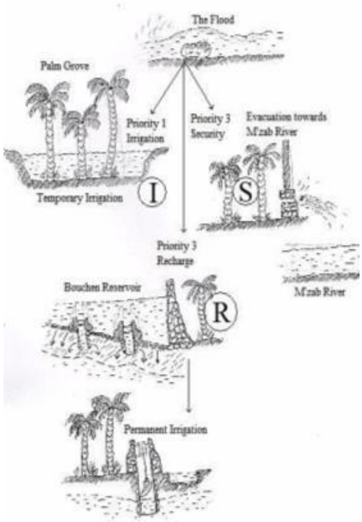


Figure 2: IRS Development concept (Schema Remini, 2020)

This development is intended to irrigate the eastern palm grove of Ghardaia with an area of 1 km^2 (fig. 3) On the other hand, the western palm grove of Ghardaïa with an area of 1 km^2 is irrigated by IRS Development of the Touzouz River (Remini, 2020).

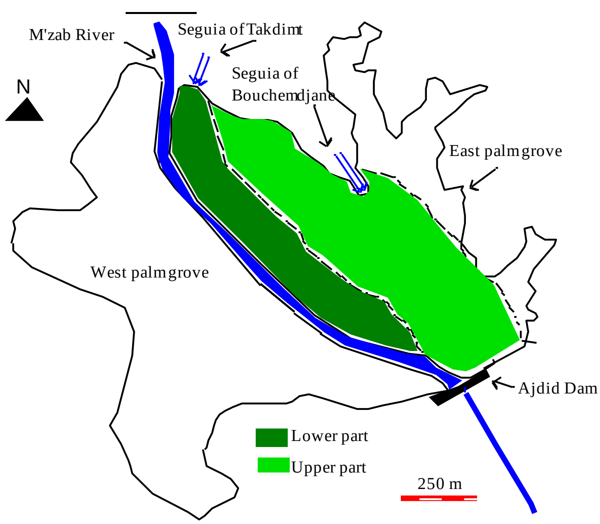


Figure 3: Delimitation of the old palm grove of Ghardaïa (Photo. Remini, 2020)

The IRS Development of M'zab River is considered to be the largest development in the M'zab valley. Different types of hydraulic structures have been designed along the M'zab River. We find spillways, canals, dams, galleries and wells. Designed to reduce the harmful effects of the flood, the IRS Development in Ghardaïa gives priority to the irrigation of the palm grove with raw water. Once all the gardens have been watered, the excess of the raw is directed towards the Bouchen reservoir (Ahbas N'Bouchen) in order to replenish the water table. If the flood still persists, the excess water will be evacuated by the downstream drainage outlets in the M'zab River. Thanks to hundreds of animal-drawn wells (Khottara), located in the eastern palm grove of Ghardaïa, the water infiltrated during floods will be used for permanent irrigation during the dry period. For the proper functioning of the IRS development, 18 hydraulic structures were designed in the M'zab River upstream from the palm grove. These are regulatory dams, diversion dams, galleries, wells, a reservoir, weirs, and sills (fig. 4). The IRS Development of Ghardaïa is managed by a water council called "Oumana El Seil" (Management Committee) which is made up of a group of people recognized by their competence in hydraulic know-how. The IRS Development is equipped with a control network made up of a dozen towers and monitoring stations. The network makes it possible to follow the floods along the River until water is shared between the gardens of the palm grove.

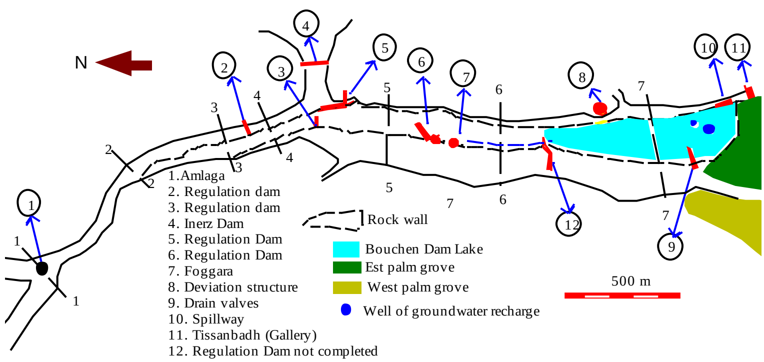
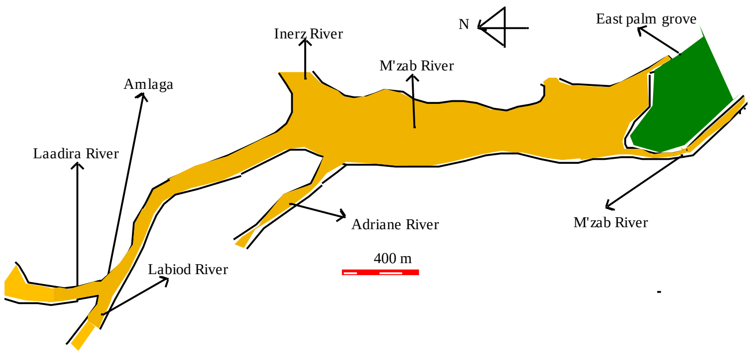


Figure 4: The hydraulic structures built in the M'zab River upstream from the Ghardaia palm grove (Schema, Remini, 2020)

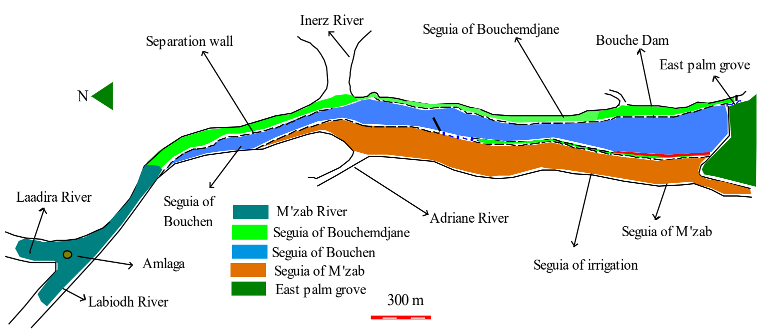
Description of the IRS development of the M'Zab river

The IRS Development of M'zab River allows the wadi to be divided into three rivers (fig. 5 (a and b)):

- Seguia of Bouchemdjane; intended to carry the first flood flow for the irrigation of the Eastern palm grove of the Ghardaïa oasis.
- Seguia of Bouchen intended to convey a quantity of water to the Bouchen reservoir for the recharge of the water table.
- Seguia of M'zab River; intended to carry excess flood and water discharged to the M'zab River; security requires.



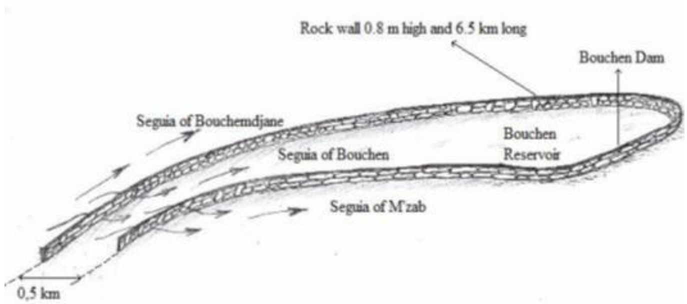
a) Prior to development



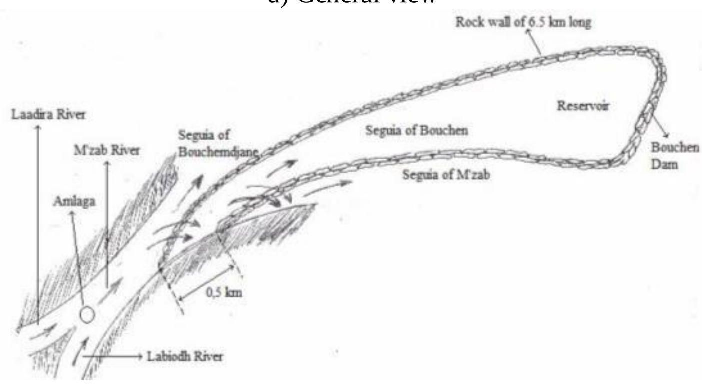
b) fter the development

Figure 5: Division of M'zab River into 3 wadi (Schema, Remini, 2020)

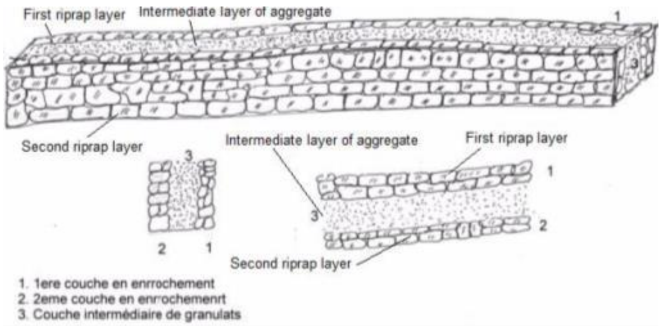
The IRS Development of M'zab River is composed of a multitude of hydraulic works that demonstrates the know-how and the Mozabite genius. The originality of this IRS Development of the M'zab River is shared in 3 wadi. The M'zab River begins from the meeting point of Laadira and Labiod Rivers called Amlaga, up to Sebkhate Sefioune over a distance of 400 km. Very known by these devastating floods by draining appreciable quantities of water. To take advantage of these waters, a riprap wall in the form of an elongated loop was built on the M'zab River in a zigzag shape in order to reduce the flow speed. The first stone was built 750 m from Amlaga. After the closure of the loop, the last stone is placed 1100 m from Amlaga (fig. 6 (a, b and c) and 7)). With a total length of 6.5 km, a width of 60 cm to 80 cm and a height of 80 to 100 cm, the loop wall which we preferred to call the overflow wall are made in duplicate rock layers with an intermediate layer of aggregate and sand (fig. 6c). Zegzag-shaped, the wall reduces the speed of the flow. It also makes it possible to divide the section of the wadi into three rivers:



a) General view



b) Top view



c) Sample

Figure 6: Diagram of the rock wall built on a section of the M'zab River (Diagram, Remini, 2020)

Figure 7: A view of part of the rock wall (Photo. Remini, 2010)

Terdja N'Bouchemdjane (Seguia of Bouchemdjane)

Intended for the irrigation of the upper part of the eastern palm grove of Ghardaia, the Terdja N'Bouchemdjane, with a length of 4 km, begins at Amlaga; the meeting point of the wadis of Laadira and Labiod to Tissanbadh; the sharing dam. The average cross section of Terdja N'Bouchemdjane before the start of the wadi division is 100 m. After the start of the wall (of partition), the average section becomes 25 m. Along the Bouchemdjane watercourse, several hydraulic structures have been built to ensure flood flow without damage. From Amlaga, the first flow first follows the seguia of Bouchemdjane. To reach the Eastern palm grove. Various hydraulic structures have been designed along the seguia, namely: a control dam, weirs and sliding valves (fig. 8).

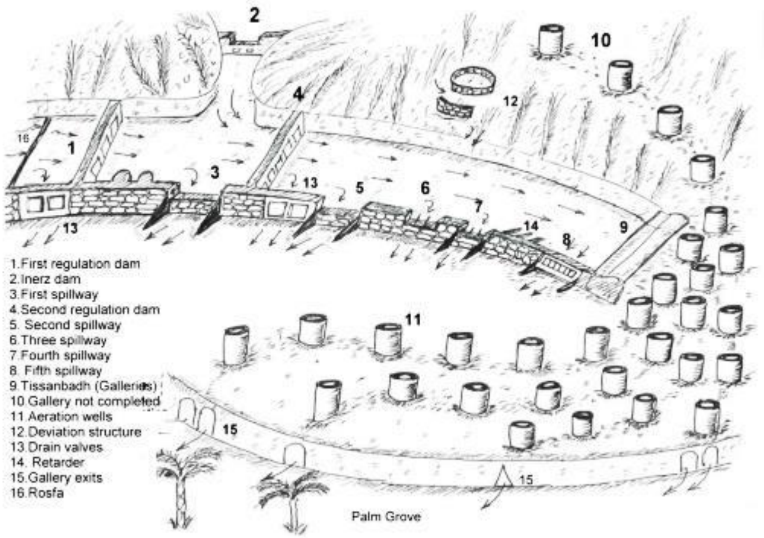
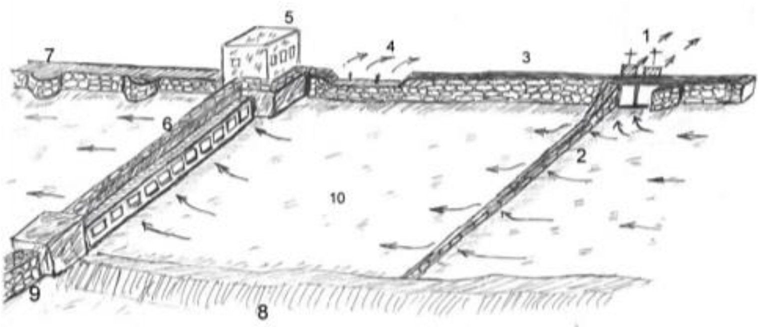


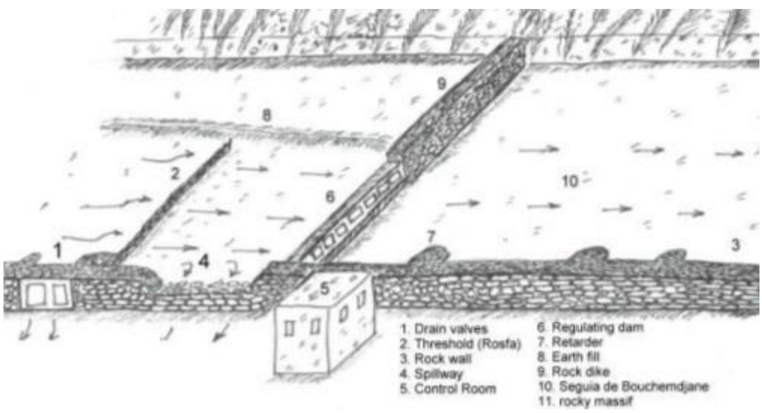
Figure 8: Diagram of the seguia of Bouchemdjane (Schema, Remini, 2020)

Control Dam

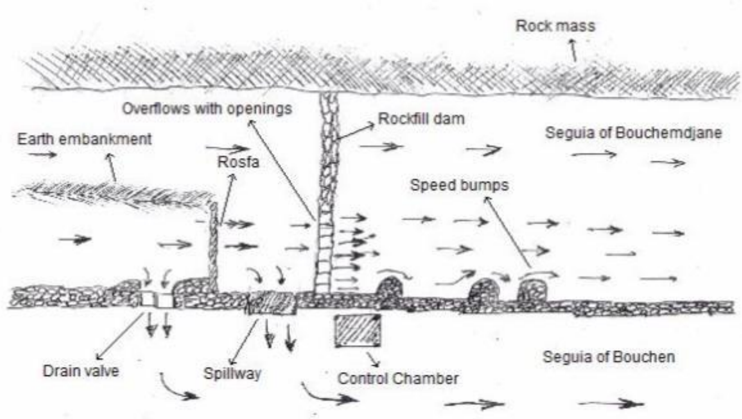
The first regulating dam is located 1200 m from Amlaga or 2800 m from Tissanbath (fig. 9 (a, b and c) and 10 (a, b c, and d)). The dam is made up of a 500 m long riprap dike and a weir with 18 rectangular openings equipped with sliding gates. The right bank wall is fitted with two discharge valves and a weir. These two structures allow water to be evacuated to the Bouchen seguia. Just after the weir, the wall is equipped with 6 supports intended to slow the flow. A 9 m2 room is located next to the structure which serves as a shelter during floods for the group of Oumana El Ma, who is in charge of operating the sliding valves.



a) Upstream view of the dam



b) General view



c) Plan view

Figure 9: Diagram of the first dam (Schema Remini, 2020)

a) Upstream view

b) Downstream view

c) Drain valve

d) Drain valve

Figure 10: First diversion dam with 18 openings to allow to adjust the flow (Photo. Remini, 2014)

Hydraulic system for the management of runoff water from the tributary Inerz

At 1800 m from Amlaga, there is a complex hydraulic system intended to manage the runoff from the tributary called Inerz River The device consists of a regulating dam with a length of 300 m, equipped with a 20 m long spillway menu with 8 openings (fig. 11 and 12)). This structure built perpendicular to the flow helps to regulate the flood. A weir dam fitted with several openings, 3 weirs and two sliding valves (fig. 13 (a and b) and 14). It regulates the water coming from the Inerz River which has a 650 ha watershed for a perimeter of 10 km; a significant amount of water that must be managed well. The valve maneuvers become essential for the orientation of this additional flow towards the seguia of Bouchen or towards Terdja N'Bouchendjane to continue its flow towards the palm grove.

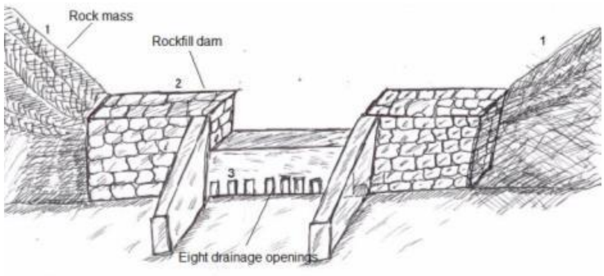
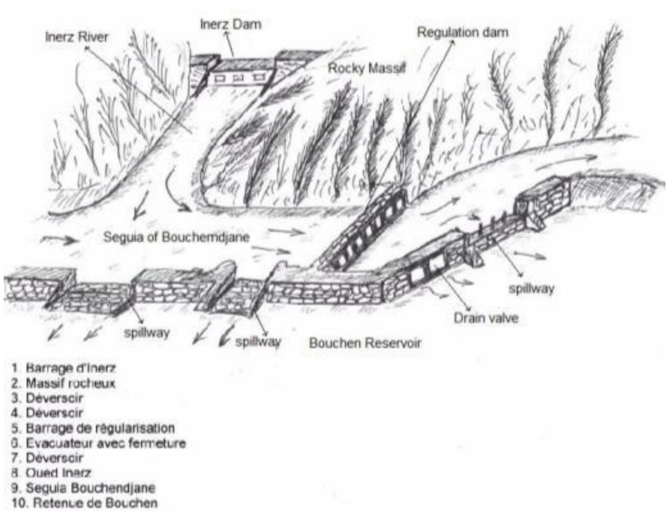


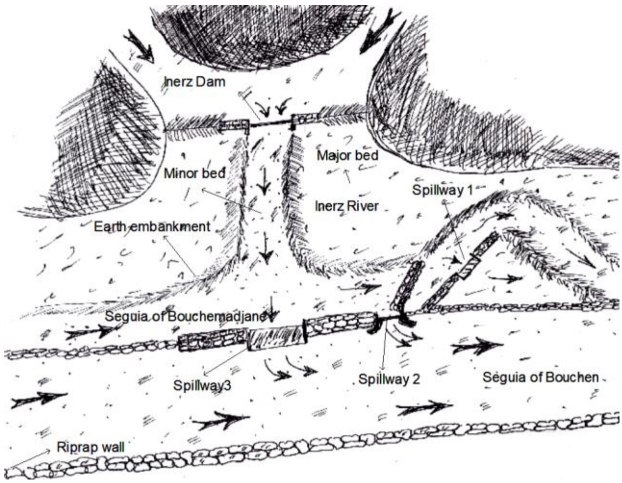
Figure 11: Diagram of Abas Inerz (Schema Remini, 2020)

Figure 12: Ahbas N'Inerz (Photo. Remini, 2011)



a) General view

b)



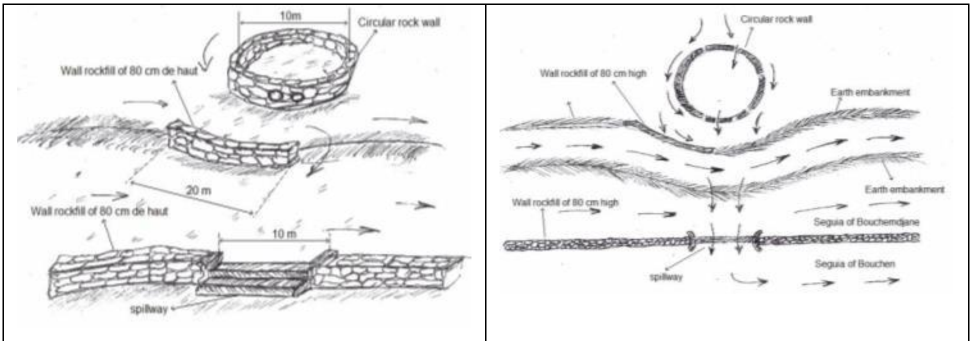
c) Top view

Figure 13: Diagram of the hydraulic system of the runoff water management of the tributary Inerz (Schema Remini, 2020)

Figure 14: One of the 4 spillways of the Inerz system (Photo. Remini, 2008)

Hydraulic system to manage runoff water from small tributaries

At 3000 m from Amlaga, a hydraulic device was found to channel runoff from a tributary of a 50 ha watershed. The direction of flow can be towards Tardja N'Bouchemdjane or towards the seguia of Bouchen. The hydraulic system is composed of a circular wall 15 m in diameter and 80 cm high and a wall in the form of an arc of a length of 20 m forming a channel which aims to channel part of the water running towards the weir (fig. 15 (a and b)) and 16 (a and b))). Evacuated to the Bouchen seguia, this addition of water is added to that from the M'zab River, this flow of water will be stored in the Bouchen dam in order to recharge the water table.



a) General view

b) Top view

Figure 15: Diagram of the system for diverting runoff water (Schema Remini, 2020)

a) Diversion structure

b) Spillway

Figure 16: Hydraulic deflection system (Photo. Remini, 2011)

Sediment deposition thresholds

200 m from Tissanbadh, a system of 15 rocky obstacles arranged one behind the other with 30 ° to 45 ° inclination relative to the spillway wall (figs. 17 and 18). This somewhat special structure allows the flow from Amlaga to slow before reaching the watershed (Tissanbadh). Flood waters generally too loaded with fine particles, deposit their materials between the thresholds. Sediment trapped between the thresholds can be removed by mechanical means in times of drought. Such an operation is necessary because it will prevent clogging of the six underground galleries of Tissanbadh. A deposit of mud in the galleries poses

enormous problems such as the lowering of the flow of exit and the stagnation of water in Terdja N'Bouchemdjane. In addition, the cleaning operations of the galleries of Tissanbadh are delicate and tiring, because they require a lot of material and human resources. Going down the galleries through the ventilation and inspection wells with an average depth of 25 m to remove the muddy deposit at the bottom of the galleries is not an easy thing. This is how the threshold system invented by the Ksour population increased the length of the period of cleaning operations at the level of the galleries.

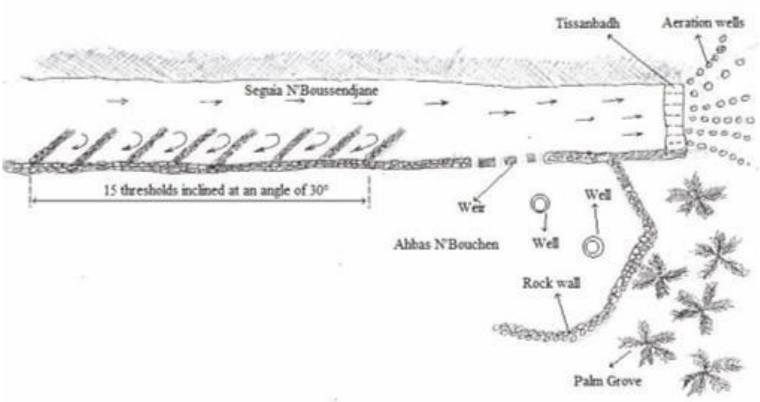


Figure 17: Diagram of the silt deposit threshold system made in Tardja N'Bouchemdjane (Schema Remini, 2020)

Figure 18: A rip-rap obstacle in the system of deposit thresholds achieved without Terdja N'Bouchemdjane (Photo. Remini, 2008)

Tissanbadh: water sharing structure

The Tissanbadh; a special work placed at the entrance to the palm grove. It controls the flow of the flood and divides it into several sub-flows in the direction of different parts of the palm grove. It is equipped with a rocky breakwater with 27 openings equipped with sliding valves. These openings are in contact with underground galleries equipped with ventilation shafts which take different directions (Remini, 2018). There are 6 of them which serve part of the palm grove (fig. 19 et 20).

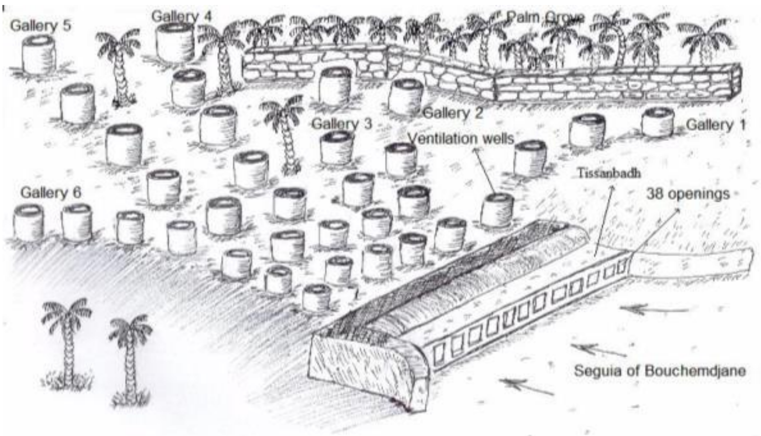


Figure 19: Tissanbadh or the rainwater sharing system from Terdja N'Bouchemdjane (Schema Remini, 2020)

Figure 20: The entrance to Tissanbadh (Photo. Remini, 2018)

Terdja N'Bouchen

The second seguia called Terdja N'Bouchen begins from the first wall located 850 m from Amlaga to the wall of the dyke which is 4000 km away. The length of the Tardja N'Bouchen is 3,150 m (fig. 21). It contains various hydraulic works of regulation and deviations.

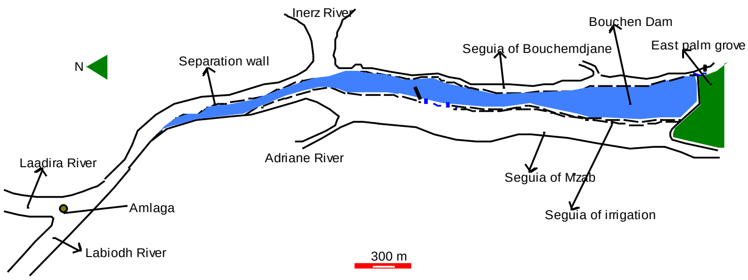
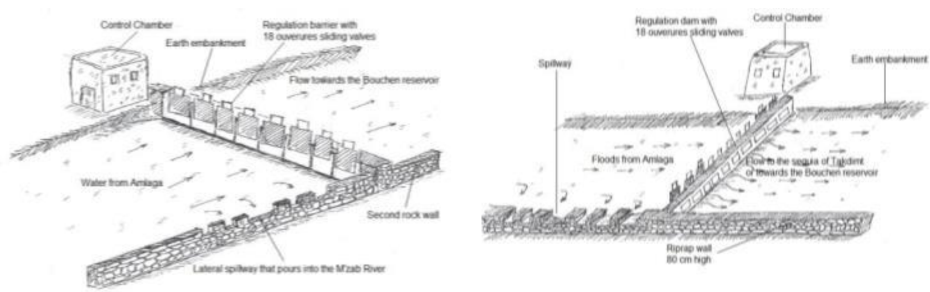


Figure 21: Schema of Terdja N'Bouchen (in blue color) (Diagram, Remini 2020)

First regulating dam

As soon as the water level exceeds the height of the wall (0.8 m), the water flows on the wall which acts as a weir to reach the first regulating dam. This structure is equipped with 18 openings with sliding valves (fig. 22 (a and b) and 23 (a and b)). With a side weir that allows water to flow to the third stream (M'zab River).



a) Upstream view b) View of the valley

Figure 22: Sketch of the first regulatory dam on Terdja N'Bouchen (Diagram Remini, 2020)

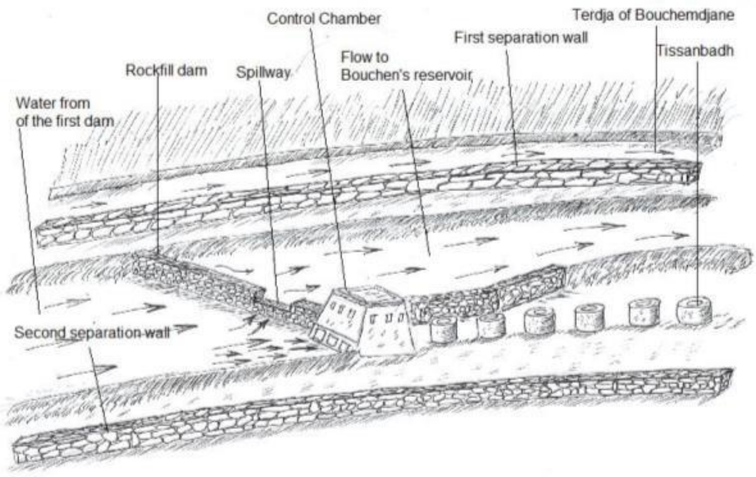
a) View from upstream

b) View from downstream

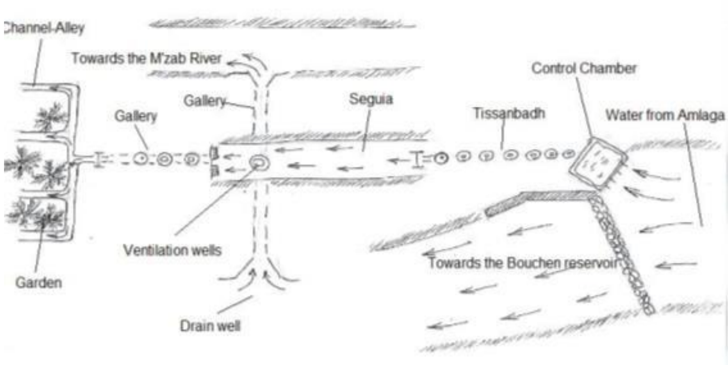
Figure 23: First control dam with 18 sliding doors (Photo. Remini, 2010)

Second regulating dam

A second overflow dam, 36 meters long, which retains water. It is fitted with draining holes for 11 sliding valves (fig. 24 (a and b), 25, 26 and 27). From this dam, the Bouchen seguia will be divided into two: the Tardja N'Tekdimt and the N'Bouchen reservoir. The principle of IRS Development gives priority to seguia N'Tekdimt which is intended for irrigation. Once the irrigation needs are completed, the water will be directed to fill the N'Bouchen reservoir.



a) A general view



b) Plan view

Figure 24: Diagram of the second control dam. It is at the level of this structure that the flow is directed either towards irrigation or towards the recharge of the aquifer (Diagram, Remini 2020)

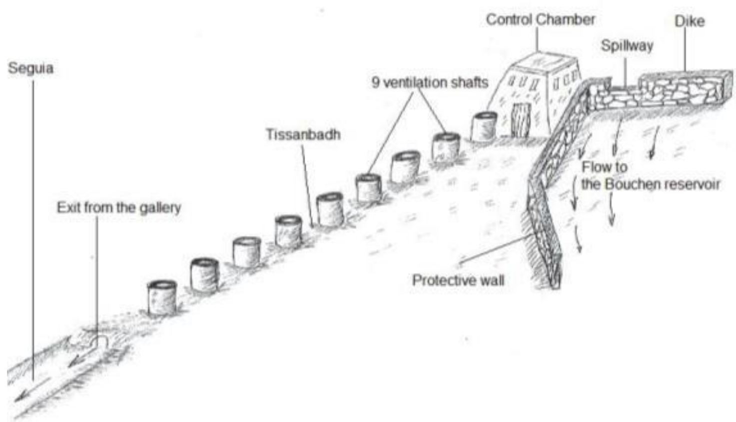
Figure 25: Second Dam - Part of the spillway (Photo. Remini, 2013)

Figure 26: Second Dam - Part of the dike (Photo. Remini, 2013)

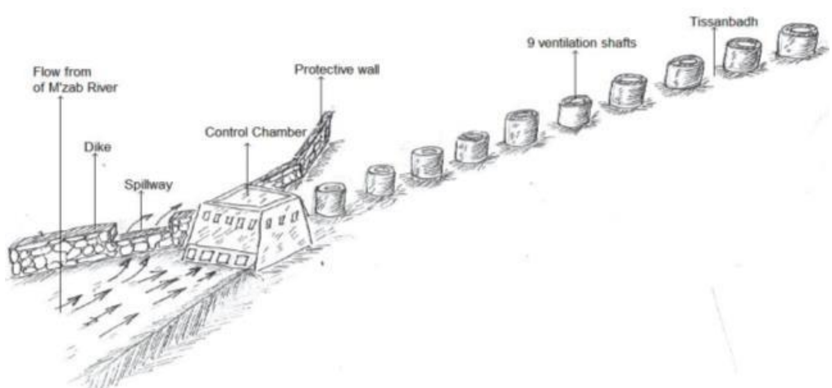
Figure 27: Drainage which allows water to flow into the Tardja N'Takdimt (Photo. Remini, 2014)

Tardja N'Takdimt

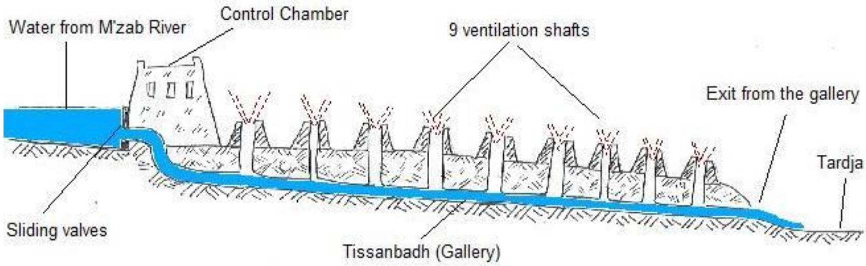
After passing the first regulating dam, the flood water drained by the seguia N'Bouchen is stored in the reservoir of the second dam, including the riprap dyke, 77 m long and 1.5 m high (Remini et al, 2012). The dam is equipped with a weir and drainage outlets composed of 6 sliding valves. For IRS development, priority is given to the irrigation of the lower part of the eastern palm grove of Ghardaïa (called Takdimt). To this end, the valve maneuvers allow the water to flow into the underground gallery 180 m long aerated by 9 vertical wells 3 m deep and 1 m in diameter (fig. 28 (a, b and c), 29 and 30).



a) Overview



b) View from an opposite angle



c) Longitudinal section

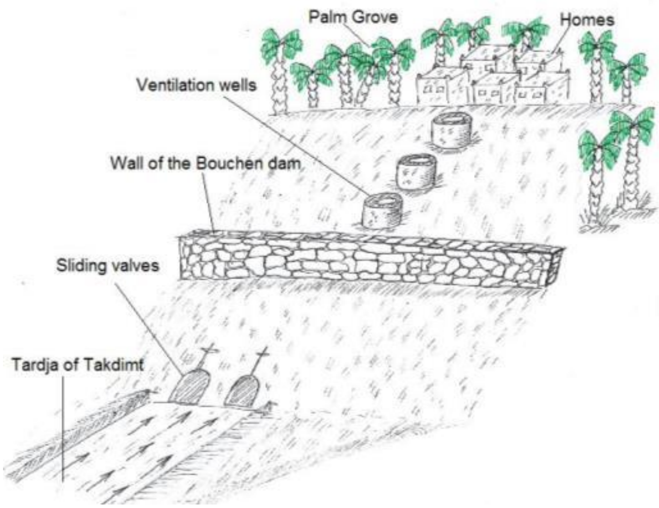
Figure 28: Schema of Tissanbadh of Tardja N'Takdimt (Diagram, Remini, 2020)

Figure 29: First part of Tardja N'Tkdimt: a Tissanbadh a 180 m gallery equipped with 9 ventilation shafts (Photo. Remini, 2013)

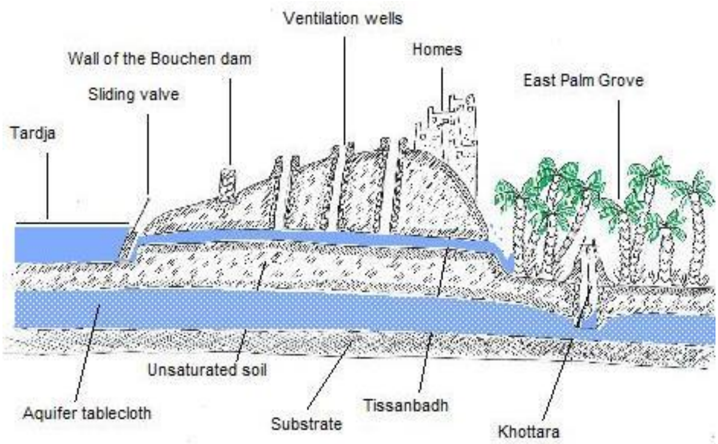
Figure 30: Exit from the Tissanbadh towards the seguia (Photo. Remini, 2012)

The section of the foggara takes the form of an ovoid. At the exit of the gallery, the water will be drained by a seguia (open-air canal) of 1200 m in length and 1.5 to 3 m in width, then it will again be channeled through a gallery of 50 m length equipped with three ventilation shafts to reach the gardens (fig. 31). This last gallery is equipped with two sliding valves to control irrigation (fig. 32 (a and b) and 33)). Once the irrigation operation is completed, the two valves can be closed and the water will be directed towards the filling of the Ahbas N'bouchen reservoir. With an estimated flow of 300 l/s, the Tardja N'Takdimt which represents the route: gallery + canal + gallery has a length of 1600 m (fig. 34 (a and b)). Once the water arrives through the gallery and flows into the network of seguias - ruels of the lower part of the eastern palm grove (fig. 35). Water enters the gardens through the koua. It should be noted that a koua is a rectangular opening arranged tangentially at the bottom of the garden wall.

Figure 31: Second part of Tardja N'Tkdimt: a canal with a length of 1200 m (Photo. Remini, 2013)



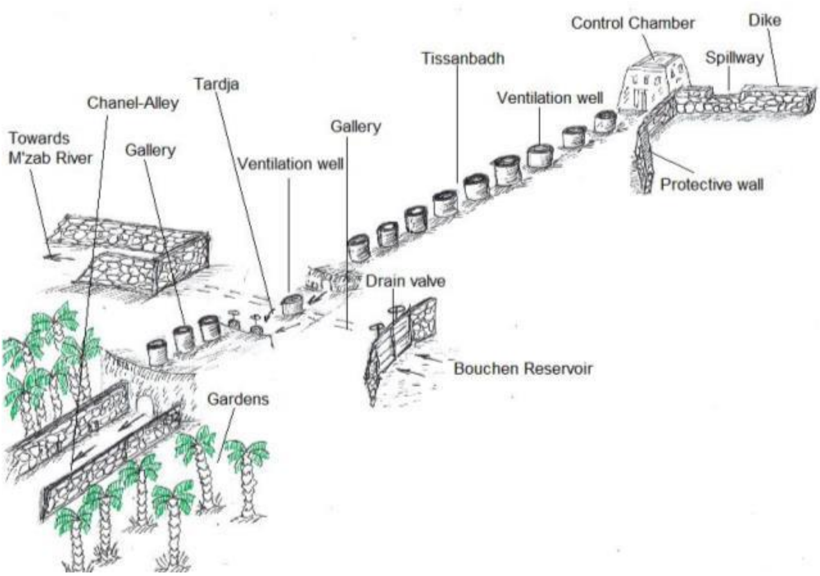
a) General view



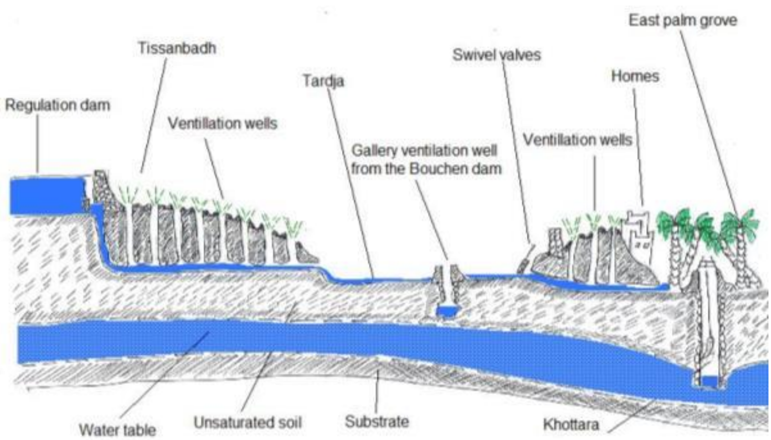
b) Longitudinal section

Figure 32: Second gallery equipped with two sliding valves (Diagram, Remini, 2020)

Figure 33: Sliding valves in the second gallery (Photo. Remini, 1998)



a) Overview



b) View of a longitudinal section

Figure 34: Diagram of Tardja N'Takdimt (Schema Remini, 2020).

Figure 35: Exit from the Tissanbadh of the Tardja N'Takdimt (Photo. Remini, 2014)

Bouchen reservoir

With a depth of 2 to 3 m, the Bouchen reservoir with a capacity of 1 million m^3 begins from the second dam to the dike, a length of 1.6 km. The water from the Tardja N'Bouchen once at the level of the second dam, the opening of the 6 valves is a priority to let the water flow into the Tardja N'Tekdimt and reach the eastern palm grove. Once the operation is complete, all the bottom valves are closed and the water flows over the weir to reach the Bouchen reservoir in order to replenish the water table (fig. 36).

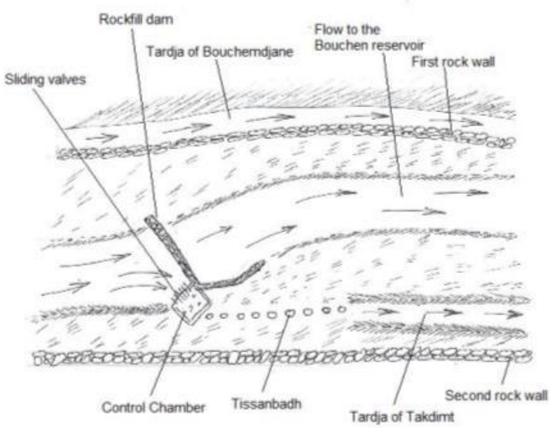


Figure 36: Schema of the operation of the second dam (Diagram, Remini, 2020)

The Bouchen dam is one of the main works of the IRS Development. With an initial capacity of 1 million m^3, it is currently silted up to more than 50% of its initial capacity (figs. 37 and 38 (a and b)). Ahbas N'Bouchen is not an ordinary dam which is intended for the irrigation or the supply of drinking water, but rather it intended for the recharge of the water table. This is exactly the type of dam that adapts in arid regions like the M'zab Valley. Ahbas N'bouchen is intended to store occasional flood water drained by the M'zab River. Such an operation accelerates the infiltration of surface water at the expense of evaporation, which remains a significant parameter in an arid region like that of the M'zab valley. The Bouchen aquifer make-up dam is made up of the following works:

A reservoir estimated at 1 million m^3 delimited by the rock wall mentioned above. The wall of the 350 m long and about 3 m high dike was reinforced.

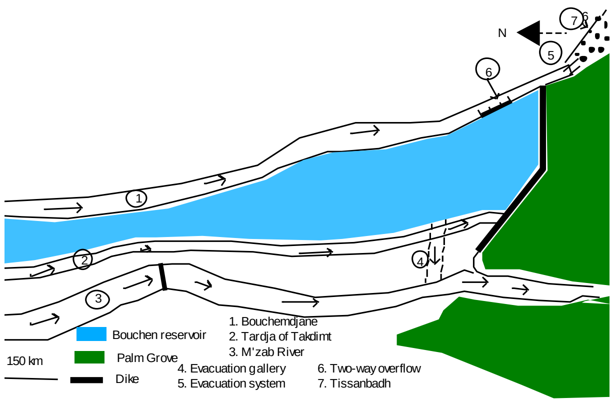


Figure 37: Schema of Bouchen reservoir (Schema, Remini, 2020)

a) During periods of drought (Photo. Remini, 2017)

b) During floods (Photo. Remini, 2014)

Figure 38: A general view of Ahbas N'Bouchen

Once the gardens are flooded with flooded water. Priority is given to artificial recharge of the water table. The 2 km^2 dam lake is used as an infiltration basin and not to store flood water. The choice of the place for this work is not by chance, but the fruit of expertise. The waters infiltrate and flow slowly to reach the water table. However, to have a good recharge efficiency, the dam was equipped with two traditional wells located in the center of the reservoir intended to directly recharge the water table (fig.39 and 40 (a and b)). According to our surveys of farmers, once Lake of Bouchen is well filled with flood water, the static level of the water table downstream in the eastern part of the palm grove rises to an appreciable level. As a result, the 500 wells will be well filled and can irrigate the gardens and supply domestic needs. So this case the amount of infiltrated water can last about twenty years of drought.

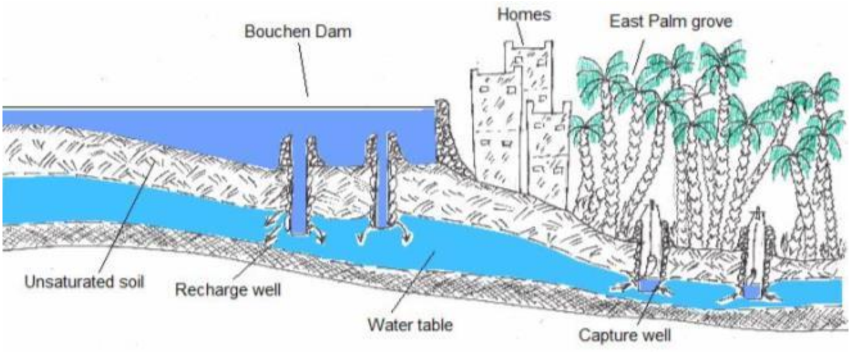


Figure 39: **Schema of the role of Ahbas N'bouchen in recharging the water table (Diagram, Remini, 2020)**

a) Well covered b) Well not covered

Figure 40: The two wells of Ahabs N'Bouchen intended for artificial recharge of the water table (Photo. Remini, 2011)

The Bouchen dam is equipped with two metal doors to evacuate the excess water from the reservoir towards the M’zab River through a 100 m gallery equipped with two conduits and a vertical ventilation well (fig. 41, 42 and 43 (a and b)).

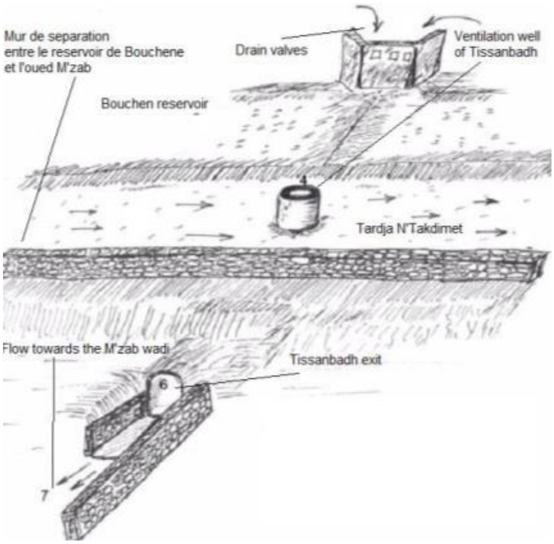


Figure 41: Schema of the water drainage system from the Bouchen dam to the M'zab River (Diagram, Remini, 2020)

Figure 42: Drain valves from the Bouchen dam (Photo. Remini, 2016)

a) Exit from the tunnel to M'zab River (Photo. Remini, 2011)

b) Tunnel ventilation wells evacuation (Photo. Remini, 2011)

Figure 43: Ancillary structure of the Bouchen dam emptying outlets

These discharge sluices act as security. Dam Bouchen is also equipped with a weir in both directions on the left side of the reservoir. This is a book that can evacuate and receive water from the irrigation channel of Bouchemdjene as irrigation water requirements. A spillway 20 with two-way openings (without sliding valve) which allows communication between the watercourse and the retaining Bouchemdjane Bouchen (Fig. 44).

Figure 44: Spillway from the Bouchen dam (Photo. Remini, 2013)

CONCLUSIONS

The IRS Development designed on the M'zab River was intended for the irrigation of the eastern part of the palm grove of Ghardaïa is an ancestral megaproject which required several years of work. As the title of the article mentions that the Mozabites have lived in harmony with the floods for centuries. The principle of the IRS Development is to divide the M'zab River into three rivers: the first is intended to transport flood water for irrigation. The second stream is designed to carry water for recharging the water table. The rest of the floodwaters are transported by the third stream downstream. The development that we have called IRS is original and unique in the world. More than 50 hydraulic structures have been built for decades. These are regulatory dams, storage dams, wells, several kilometers of seguias-alleys, underground galleries and spillway. Unfortunately, today this heritage is in a very degraded state. The cleaning up of the Ahbas and the rehabilitation of all the works of the I.R.S Development should be a priority for the departments concerned. Such an original development should be registered as a rather global national hydraulic heritage.

ACKNOWLEDGMENTS

Here we are the first results of a long work of more than 24 years of research in the ksours of the M'zab valley. What a pleasure to discover my beautiful country ALGERIA. It is thanks to an entire population that participated in the outcome of this modest study. May she find here my sincere thanks? I would also like to warmly thank my two friends, Mrs Ouled Belkhir and Dahmane, who very much encouraged me not to abandon such a project. To my little family, I took your time to do this work, thank you.

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