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Dams And Drains In The South Of Aures (Algeria) - Simple But Effective Hydraulic Works- Archaeological Field Study

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Abstract

*Before and after all the extraordinary rainfall, South Aures farmers rush to their water facilities such as dams, drains, and groundwater divide to make sure they are durable to face the flow of torrential rain. Researchers have studied the effectiveness of this *system with its various small hydraulic components in towns and villages in the south of Aures. The real protection of these southern villages' farms from floods and erosion can only be guaranteed if they are maintained with small hydraulic equipment, which, as works and achievements, are the result of a centuries-old experience that we witness as timeless and continuous technology on the foothills of mountains, proven effective for generations.*

Keywords: *southern Aures, drains, Dam, extraordinary rains, erosion.*

Introduction:

(Dams), (Drains), and (Groundwater divide) have always been considered one of the most important means and water innovations and techniques implemented since ancient times in the south of the Aures Series. Because the climate does not ensure the regularity of crops, we will see these models prominently on the banks of the valleys in the south of the Aures as a technique and a method that represents practical contact and integration between all the eras and phases that the region has gone through to find possible solutions to address this drought and water scarcity.

Thus, we believe that the construction of dams and drains, the establishment of waterwheels, the extension of canals, and the sweeping of valleys are joint socio-economic activities carried out by the population and agricultural groups in accordance with familiar actions that begin with the valley's start and continue to its estuary. It was essential that these population and agricultural groups maintain their water facilities in all their equipment and components, and undertake to rehabilitate and sweep so that they always remain in a good state that would enable it to secure water access to houses and farms, as well as continue rehabilitation and reconstruction.

Study's objective:

This study aims to clarify the extent to which the inhabitants of these areas, particularly farmers, absorb the situation under difficult climatic conditions, as they are human experiences that can be valued and re-employed to overcome the issue of water and agricultural scarcity. The study also calls on state officials in the agricultural sector to assist farmers in these poor areas.

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Study's problem:

This intervention will attempt to answer several questions associated with the most important solutions and alternatives created by the local human being to address various natural and human difficulties and constraints, as well as the most significant techniques in the construction of dam , drains, and others to bring and distribute water to the areas of urban and residential agglomerations.

Approach:

Our work in this study included the combination of theoretical work related to source reviews of documents, texts, and maps, and the fieldwork imposed by this study, down to the place of these facilities to take measurements, images, and maps with archaeological identification of these models. All of the latter is in a systematic form that this study will adopt, such as the analytical, historical, and archaeological approach, which, as mentioned above, combines theoretical and fieldwork to draw the most important findings of this study.

First: Overview of environmental conditions:

If we notice aerial images taken by drones and space platforms of dams, drains, and canals, we will find them among the most visible and exploitative establishments. The Aures region and its south of the eastern Zab region are among the most important areas that include archaeological remnants related to the agricultural watering network (image 01). Topographic and climatic factors, in addition to the region's low level and the fertility of flooded soils, may be the cause. The dense remnants of irrigation work in this area indicated that the valleys' water was the most exploited, with a clear watering net emerging from the exit points of Aures mass valleys. At those narrow mountain gorges, dams were set up, which controlled and stored water throughout Mount Aures, especially in the valleys and lows between Inoughissen and the Sidi Okba oasis across the banks of Wadi Al-abyad (the White Valley). There is also Wadi Al-Arab (the Arabs Valley) from the oasis of Djellal and El Oueldja to the oasis of Chott Melrhir through the oasis of Sidi Nadji and Badis (historical oasis). This valley satisfies the thirst of these oases. The region's natural environmental characteristics are therefore remarkably commensurate with the launch of runoff. Once the intensity of the rainfall becomes significant and with the extension of the low land from the north to the south, the valleys will descend from Mount Chechar, which extends towards the south-east, and Mount Ahmer Khadou, settling in a fertile plain across the desert, where silt and sediments are gathered as a result of severe mountain erosion from these floods. (Ville. (M), 1865, p32). (choisy(a), 1885, p261).

What should be noted is the agreement of geologists that the area covered by the desert, including the Zab region and Oued Righ (Valley), was during the fourth geological time very rainy. One manifestation of this was that the water dug into its surface a number of river valleys, many of which are still present today, where they are famous as the dry valleys (Ali Hamid Said, 1995, p176)such as Wadi Al-Arab and Wadi Al-abyad, whose estuaries meet in Chott Melrhir.

Second: Dams and its annexes:

1- Concept of dams:

The designation of dams comes from their frequent use in the movement between the two banks between which the dam was built. These are installations formed in the form of dams on the branches of the natural sewage system between the foothills and the plains, to control runoff water, store the water and soil drifting with it beyond the dams in order to create planting and set up plantations. (Mohamed Hassan, 2004, p264-265)Dams vary in size, structure, and composition, depending on where they are located concerning the mainstream or one of its branches, as well as on the related canals and the amount of flood water they collect.

2- Components and functions of dams (jessour):

According to the *Kisma wa Oussoul Al-Aradayn* Book, the dam consists of an earthy fence equipped with a canal to drain excess water and a Feddan; representing the area used for farming behind the earthy fence (Wazdou, 1999, p205-206) (image 02). Dams were being built not only for the reservation of water, but also for the protection of certain areas, both from the flood that sweeps away their banks and the fear of flooding.

The water system's effectiveness is demonstrated by its monitoring of water, ground land feeding, and soil enrichment with flood-borne silt. The latter works to perform a key function of returning running floods to facilitate their exploitation and subsequent utilization, integrating its function with the adjustment and preparation of canals. It is one of the safest ways of securing crops in the steppe zones and desert frontiers. So we consider it as the link of the agricultural system to capture the flow of water and the silt sediments it carries in the slopes (Malawi Mahmoud, 1983, p117) toward the bottom of the basin, to then be stored behind the dam to benefit from it in agriculture and planting (Wazdou, 1999, p223) (Image 03).

Through our survey and provisions in some sources, we highlight the deployment of large-sized dams establishment, which may exceed 10 m in height and the width of its top is about 03 m, ranging from 80 to 100 m in length (Arbia Hilali, 2011, p4). Through our field observations and aerial photography concerning small dams, we have found these dams spread widely, especially in the canyon gorges such as the Wadi Al-Arab Gorge and Wadi Al-abyad, due to the favorable terrain conditions as a point of contact between mountains and streamlined plains to facilitate the steering of their waters. The diversity of these dams is varied by the techniques and materials used in their construction. (Shaniti Mohamed El Bashir, p107-108)We can see these kinds of installations in Wadi Al-Arab from Qal'at Al-Torab (the dust castle) to Badis and through Khenguet (Alquier. (J), 1941, p36). Gsell pointed out that there was a dam that existed between the banks of the Arab Valley at the high level of the village of Khenguet, but it disappeared and its most prominent features collapsed, where it was connected to ancient irrigation channels (Gsell (S), 1997, p56)Birbent asserts that this dam is approximately 04 km from the village. It was built after the Roman period to compensate for the water loss after the Romanian canal broke down. It is also believed that the dam's role was to supply the town (Birbent. (J), 1964,p184) because these dams were built in the form of small fences with longitudinal positions that corresponded to the topography of the region. Their role is to feed spring water, which is used to water small agricultural areas. In addition, these dams are also constructed on the basis of the potential flow of new spring water in other parts, as well as their role in feeding basins associated with water channels for watering below these dams. (Despois.j, 1949, p203) (African ditch, 1949, p191)These dams or dams are varied according to the function intended as follows:

A. Conservation dams: (Tabia)

This barrier is also called Tabia (Image 04) according to the region. Its size and characteristics are:

- ✓ Half- deviant crossing.
- ✓ Dimensions: Overall, a few dozen meters away. Its length is 1-4 meters and its width is 2-5 meters. (Al Ghamdi Mohammed, p19).
- ✓ Location selection: It is desirable to be perpendicular when water flows, thus being parallel to subsistence lines in most cases. Dams of this kind, many of them fit in small basins (Figure 01). The construction process depends on two types:
- Generally, the ground barrier is supported by stones (Figure 02).
- The lower part of the stone wall is rarely reinforced and supported by a soil barrier as a backdrop for exposure to flood erosion, especially in the event of flooding.

B. Simple dams with the task of preserving some water for later use and not for so long.

C. Dams to prevent the soil from water erosion to preserve agricultural land, usually built on the side or center of the valley and cross to the other side.
D. Large stone side walls built along the valley. Its significance stems from the fact that it prevents soil erosion and the collapse of large stones from the mountain's surface into the valley stream, allowing the water to be calmed and directed if it is free of stones.
E. Guiding walls, which are the basis of the entire water system, as they face water and, hence, guide them to certain areas. Guidance is usually to a water slope that may represent a large water conservation tank or to agricultural land where valley water is divided equally on small farms. (Al-Shalmani, 1997, p168-169).
F. Obstructive walls and their mission is to calm the extreme fast water, especially in canyons whose course is wide and vast, where the water reaches the site to be exploited very quietly. The importance of these valleys and walls in general lies in two main objectives:

✓ Gather the largest amount of water and place it under the control system.
✓ It ensured the best way to control the water without the occurrence of heavy torrents that might descend into the canyons with the resulting damage. (Ali Hamid Said, 1995, p180-181).

So the importance of these dams or dams is great because of its positive technical effects, which we can summarize in the following:

- Reduce runoff and water erosion.
- Promote aquatic infiltration to the subsoil.
- Works on the accumulation of alluvial soil.
- Feeds and increases groundwater quantities. (Baradez (j), p191)

In order to be of great benefit to these waterworks, the ancients have taken into account many conditions of establishment and utilization to achieve the purpose of these installations, including providing the initial material for the establishment, which is local materials such as clay, hard stones, gypsum, and milk mixed with hay, as well as tidy stone (Ben Karba Saleh Yusuf, 2011, p454-468). As we have observed, these dams are built with soil and can be reinforced by roots, trunks of the palm trees, and trees. However, the better ones were built with stone because they can resist floods. It was also recommended by Farsati Abu al-Abbas in his book Al-Kisma, the Origins of the Two Earths: “They build it, that is, the dams, with stones if it was built before, and they add Zarb[†] to it (Mohamed Hassan, 2009, p177) (Book of Historical Geography, p265) if they want to.” (Abu al-Abbas Farsati, 1997, p250-306)He values its reconstruction with the same construction material as before and is desirable to be covered with tree branches and Zarb as a material that supports the dam’s cohesion so as not to be exposed to erosion and corrosion. People are thus accustomed to leaving a narrow crack in the dam, which is one of the dam’s components, through which excessive water passes. Farsati claims that if the stones pass through the incision, they must repair it so that the stones do not harm others.(Abu al-Abbas Farsati, 1997, p306) Moreover, among the risks to which the dam is also exposed after drift and fracture when floods run, we find other damage affecting the dam’s consistency, such as rodents and reptiles that negatively affect the effectiveness of dams. Forstay adds “people had in their dams a rat hole or a spiny-tailed lizard hole.” One of the conditions for farmers is not to let the dam fill up and overflow its water because it will, with obsolescence, weaken the dam and thus erode and break it.

In order to determine the conditions for the completion of these dams within the local environment, we have decided to allocate a table indicating these conditions (Table 01):

[†]Zarb: It means plant and it may be thorny placed on these dams for farmers to not pass. Some sources have reported that a scholar denounced a man walking with his horse off the road, demolishing people’s dams

Soil and stone quality	Climate/Rains	Terrain	Agriculture Type
- At the basin level, the soil may be shallow and lush - Soils and stones of valleys	- The amount of rain falling between: 100 to 250 mm	-Regression: medium and severe.	- Rainfed crops. Planting olive trees, fig, palm

Table (01): Conditions for the Creation of dams(jisser) (scheme adapted from R. Morez)

The effort of those who set up these dams appears to be significant under normal conditions and harsh potential associated with the improvement of agricultural seasons (Arbia Hilali., 2011, p 2)and security conditions, which are factors that stabilize and attract the population to pursue farming, after grazing and trading.

Equipment	Labour	Costs
- Construction equipment: shovel, Pickaxe ... - Means of moving stones, dust, and timber.	- Building one dam a day requires an estimated workforce of 120 men.	Providing construction price. Providing fare. Providing the price of food.

Table (02): scheme adapted from R. Morez, The Cahiers of Agroecology.

Through some procedural studies that calculated costs and tools to create only one dam, (The Japanes Resources Society, 2001, p520) it seems that it would have entailed providing possibilities that one person might not be able to provide. The issue of engagement and partnership was therefore very important in such cases.

(Table 02) shows approximately the quality of these capabilities and construction resources.

3- Exploitation of dams for agriculture and implants:

Valley floods usually lead to a sufficient accumulation of silt and water (Mohammed bin Hamed al-Ghamdi, p 24). The area of these arable accumulations is estimated at 0.2 hectares to 20-40 hectares from the catchment area. It is therefore recommended to combine two types of agricultural crops.

A. Fruit trees to produce fruits and encourage water infiltration, dam stability, and provision of shade (such as olive trees, figs, palms, and grapes) (Image 05).

Annual crops confined to the rows of tree orchards (such as barley, wheat, beans, lentils, peas, melons, and onions[‡]).

B. Maintenance activity: The writer of the Kisma book, though indirectly in many water provisions, refers to the subject of maintenance in which these constructions last for a longer period because these constructions will not have the desired effectiveness if farmers do not start each year and after the harvesting season to maintain and refurbish water establishments. This will only be by:

- ✓ Repairing the walls of dams and dams and their affected sides due to water flow by creating a terrace of stones and gravel known as the pillow or chest that is within the parts of the dams and also as a belt that extends the width of the valley to face

[‡] As a model of this kind, I recall here what Allah (God) said in the story of the owners of the two heavens in Al-Kahf Surah, verse 32: "And cite for them the parable of two men: To one of them, We granted two vineyards, and We surrounded them with date-palms, and We placed between them crops." Undoubtedly, it must have been dams located near palm trees that separated these two heavens.

water pressure and relieve the burden of what beyond it of soil. (Ben Wazdou, 1999, P 223).

- ✓ Sealing leaks caused by runoff, rodent burrows, and desert foxes.
- ✓ Gradually raising the dam thresholds at silt deposition rate.
- ✓ Maintaining crops grown each year by plowing land before rainfall to facilitate water infiltration. (Laetitia (S),).

C. The advantages and disadvantages of the exploitation of dams: Although these dams have some disadvantages, raising the value of their establishment gives many positives to the agricultural community, as evidenced by the continued operation of this system for generations until the present day.

Third: Engineering and construction requirements for uncover drains (drainage ditch):

Drains' concept and system: It is the natural point at which water is diverted from the canyon to the land associated with it. Essentially, drains are water formulation with a transformative function to control liquid flow. It can be regarded as the standard irrigation unit of less than five farmers per day, distributed according to known pints. (Look at Ben Wazdou, 1999, p196).

1- Groundwater divide: It is the lowest unit that divides water among the beneficiary group and is usually jointly built with stones, bricks, plaster, and lime and also needs the participation of those involved in its maintenance due to the strength of the water flow. when establishing and preparing the drains, the farmers take into account the flow of water, especially what relates to the reduction of runoff or flow speed, as well as the control and reduction of the dust washed with water in the area below the drain, in addition to not causing harm to others, whether by reducing or increasing the flow, which can cause drift or backfill. Therefore, all works that divide the flow into sub-streams or reduce liquid quantities in the main stream, whether water or soil, fall within the function of the drain. However, the increase in flow speed or in water-borne solids is completely contrary to the function of the drain. Thus, in accordance with these provisions, drilling or alteration of drainage platforms may be permitted only on the basis of agreement on the resulting reduction of valley water or submersion of adjacent land. This can be summarized to understand many hydraulic concepts as we have collected and explained the disadvantages and advantages of using drains in (Table 3).

Disadvantages	Advantages
Techniques	
- Very stressful and continuous maintenance. - Requiring a lot of manpower	- Well controlled by peasants and by local techniques. - Requires artwork and special equipment.
Economic and environmental	
- Reduced grassland area - Reduce runoff and make little use of water for those at the mouth. - Climate change has exacerbated drought, making the use of this technique more random.	- Increase agricultural yield. - Diversification in agricultural production. - Improving farmers' material income. - Reduce the soil erosion process and work to renew soil. - Mitigates runoff and recharges aquifers with water.

Table (03): Advantages and disadvantages of dam exploitation (adapted from S. Laetitia)

The function of drains is as follows:

- Transformative function from watercourse to exploitation location.

- Control function and reduce the speed of runoff in the valley.

- Control and mitigation of dust with water in the area underneath the drain, not causing harm to others, whether by reducing or increasing the flow they were receiving and the possible drift or backfill. Thus, the increase in flow speed or in water-borne solids is completely inconsistent with the drain's function. (Wazdou, 1999, p 196-197).

-The water drainage rate is not more than one-fifth of one drain.

- The characteristics of structural drains can be changed and the allocated value of one-fifth should not be exceeded. Each participant can create what he wants from drains as agreed and just as they are equal in benefit, they are equal in harm, too. The establishment of drains as defined by the author of the Kisma book, Sheikh Abu al-Abbas Farsati, is subject to a number of conditions that we note in table (04), namely:

Hydraulic Concept	What is in the book	Engineering use
The drain is a natural field that transfers water from the valley to the land with ownership.	Let them use it (the valley), and they make for it drains... and the drain works only on the valley's land or a land that the owner has authorized to work in, or land of an unknown owner.	The drain is set up to control liquid or solid flow (such as soil), and also controls the division of surface water. Drains can be established only in a land with certain characteristics.
Natural area for the division of the drain's water.	Make their shares on the valley side or on two sides.	The drain can be set up on one bank or the two banks of the valley.
Changing the drain's characteristics.	If he wants to make that drain two or three, he has that.	To change the drain's functional characteristics, it can be divided into multiple drains (two and three).
Re-establishment of the drain in case of drift with torrent.	He may not lift it out of his first place if the torrent goes to the drain... Some of them say: If the land is his, let him lift it where he wants if it doesn't harm his neighbors.	The re-establishment is related to what the bank may cause if it is relocated, including a change in the level of its water or the damage it carries to the land of others.
Procedures for utilizing the drain's water	They should not use more than one-fifth of the valley, whether one man or two men or the public.	The value of utilizing one drain's water is one-fifth of the current water and all beneficiaries are equal in order. All of this takes into account one-fifth of the drain's starting point.

Table (04): Hydraulic Concepts in the drains' field.

- It is created only for those who own land or land belonging to another person, but after taking permission from the owner, or land that her owner is unknown.

- The water of drains should not be lifted from their first location, except in the case of consent.

- No drain should be established if its location is unknown due to damage because of the torrent.

- It is forbidden for any person to expand his drain from above or below the groundwater divide if the expansion relates to it, as well as to drill as such.

2- Establishment of drainage channel:

Usually to set up water drainage channels or as we defined them by drains, we must establish in the first phase dams. The process of establishing dams is based on the proper selection of their locations in order to perform their best function, such as flood and current protection and flow restraint, thereby reducing water erosion. A part of this dam is allocated to establishing the drain, which can be divided into two types:

A. **Side vent:** This label refers to the part of the dam that allows water to flow through a dedicated channel, where the water takes a curved shape to break the energy and strong flow at this stage, and can be square or round (Maldonado Basilio Papon, 2008) (figure 03-04). We don't know the exact length of this vent's aperture, but it can be estimated at about a meter or two and a half and its height can be about a meter and a half. (Mallouly Idrissi Abd al-Rahman, 1997, p 222) It is recommended that this part be stone-built at the level of the threshold in support of the dam. The threshold of these dams is usually located in the upper third of the dam. It is at one or both sides of the dam according to the intensity of the water force. This is one of the most traditional and common types among farmers.

B. **Central vent (drain):** The drain is usually in the form of a canal in the middle of the dam (Image 06). This system is equipped with specifications to perform the function of discharging water in the best way where:

- Both sides of the drain must be reinforced with hard and solid stones during the construction.
- Other sides in the downstream part must also be formed by stones to break water energy. This method is much less common than establishing the vent because it is complex and expensive, and less suitable for climate changes, especially during periods of flooding and drought (Bonvallo (J), 1986, p163-171) (Figure 03-05). On the ground, we found drains in the south of Aures always in a low-lying area adjacent to the road or located at the farm border. These drains are usually placed in one major drain. The latter collects the drained water from all the farms adjacent to it, so that each irrigation canal ends with a drainage canal in a deflated area. Furthermore, drainage canals relate to the level of the water when determining its depth. The water level remains about 10-50 cm lower than the soil surface. The bottom of the canal must allow the discharge of the lowest point in the irrigated area by selecting the drain's appropriate inclination as it achieves a free flow towards the final estuary. During the drilling of the drain, the width of the canal at the bottom shall not be less than 30 cm, according to the method of drilling. Concerning the depth of the canal, it reaches about (1-1.5 m) depending on the type of soil. The objective of this drainage is to reduce the level of groundwater, and wash saline-soil areas, in addition to protecting crops from suffocation. Drainage is divided into horizontal-double drainage, which may be exposed or closed by pipes that drag water to the final downstream. (Figure 06).

Fourth: The system of dividing and distributing water based on the number of drains:

The distribution system of water spread in the oases of South Aures, which recognizes the landowner's right to own water originating from his land, is one of the most famous water systems established by Saleh Bey after his famous visit in 1776. As we have said earlier, the value of land in the region is determined by its abundance of water, without which there is no value. Water is the origin of land ownership, as opposed to the hill where water is considered an element of land only because it depends mainly on rain. According to the people, given the scarcity of rain, the land needs irrigation and the necessary artificial watering, which cannot be exploited without it. So, they made water a property closely

connected to the land and had to divide water. The most circulating method in alternate division is to divide by the number of palms or drains, which depend on giving the total water flowing at regular times to each user within a specified period. Ville noted that the people of the region used springs alternately to water grain and palm plantations (Ville. (M) ,1865, p250) Time is measured by conventional means, namely the height of a particular human being, a pole, or the time it takes to unload a bowl of cylindrical copper placed on a known measurement and in which there is a narrow hole in its base. The bowl is filled with water until it is depleted or left empty until it is filled through the hole (Aslan Abd al-Wahab Mohammed, 2000, p55)that is known as Taghyira or Kharouba. (Capot-Rey. (R), 1953, p347-348) This bowl is a time term intended for a certain period of time that is the period when the bowl is full or empty. (Aslan Abd al-Wahab Mohammed, 2000, p55)The people of the area have also used a tool known as "Machkouda", made of copper that looks a bit like a soldier's helmet with a tube penetrating from the center, approximately 15 centimeters long. Within the sides of this bowl, there are grades to calculate the duration. The bowel is placed inside a large basin filled with water. If this bowel is filled with water leaking from the tube, it sinks inside the basin and hence calculating a full hour of watering time. The peasant then holds a knot in a green fern so that he can calculate the number of hours allocated to watering. This tool is commonly used at night and in cloudy times. If the sky is clear and the sun is bright, the person's own shadow will be used at different times. (Yakoub Abd el Ali, 2012,p 24)We witnessed this in one oasis of Aures oases, such as Jumourah, where Saleh, the Bey of Constantine, had divided the watguer of her springs before 1830 with a precise division system. One-third of the water was separated by a water distributor and the other two-thirds were divided into three equal divisions, each going to a specific runnel (Sakya). Concerning the main water source, the turn consisted of sixteen shifts, i.e. eight days. This means that each of the four clans living in the oasis receives three shifts with regard to the distribution, that is, to use the distributors and runnels for one day and a half as they wish within the group. The division is made between the group's families in view of the area of land under cultivation or the number of palm trees. A statistician, also called a water bailiff, counts and replenishes the value of each water quota. (Jabali Mahal Al-Ain, 1986, p85) Moreover, the spring's water is stored in a tank and it is called in some villages Al-Majin, which grows or gets smaller depending on the volume of water it receives at night and then opens in daylight to water. It is noted that Spring Water is divided into shares owned from ages such as lands owned and exploited through sale, purchase, and borrowing or rent. People own water rations according to their financial ability. Who has a lot of lands is supposed to have a lot of water, and if the landowner doesn't have any source of water, he has to rent or buy. Some villagers have been termed the share of water by the name Al-Asr because it is the time of division among the people. This share is divided into parts: half, quarter, and one-eighth. The alternation of these quotas varies from one week to two weeks to more than 20 days, depending on the possession. In this regard, Al-Hasan Al-Wazan reports on how water is divided and distributed in one of Zab's western oases (Lichana), saying "Due to its lack of water, each peasant brings water to his field one or two hours per day depending on his land vastness... These peasants have water hours to fill it and when it is empty, their allotted watering time is over and the water beneficiary is not entitled to keep it at that time." (Al-Wazan, 1983, p139) (Yusuf A.-H. A., 2001, p102)[§]

[§] Perhaps the simplest of clocks used to calculate watering time came in the form of a cone-shaped jar that narrows towards the base and has a side hole near the base. Whenever the water comes down from the hole, the water level in the jar gives a measure of the passage of time. The subsequent development was the water clock with an internal flow. This watch consists of a top pot with a fixed water aperture and a surplus water port. The aperture empties the water into a cylindrical-shaped bowel and since the top water surface of the bowel remains constant, the water in the lower bowel rises steadily.

Conclusion:

We believe that in these sediment and mountain areas, it is necessary to manage existing water resources efficiently, strengthen water reserves, or in other words preserve the existing and search for the missing. Such measures require good planning, strategy-building, and policy-making; the ultimate goal of which is to transform water-deficient areas into water-sufficient areas. This can be achieved through developing and applying appropriate strategies, including resorting to our written heritage to inspire proven water techniques such as dams, drains, and groundwater divide, linked to interactive, corrective, and proactive measures, in addition to adapting to few amounts of water and reducing water waste in all its forms. Scientific research, technological innovation, and the implementation of plans and policies can help achieve this goal. What is important is that it can be implemented directly by a peasant or a simple local farmer but with the help of a competent and experienced technical framework. Current shortcomings in the water system can easily be addressed, so the dam routes must therefore be better strengthened with regard to prevailing flows, especially in mountains and remote areas with difficult natural and climatic characteristics where lean grains grow scattered among valleys. This poses a very serious threat to the nutritional and water needs of the population because if traditional techniques continue to be abandoned, rainwater that is not directed from the steep slopes will destroy agricultural land and cause significant damage not only to agricultural output but even to lives as we see it today.

Annex of figure:

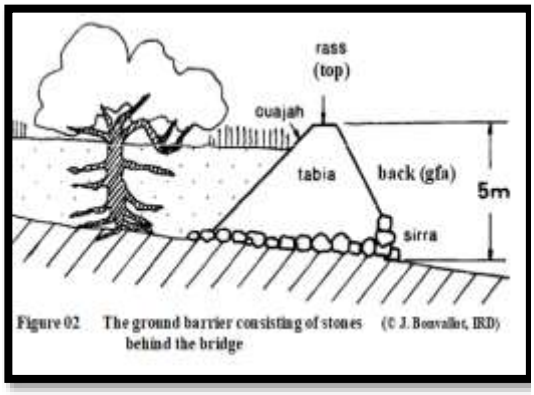

Figure 02 The ground barrier consisting of stones behind the bridge (© J. Bouvallot, IRD)

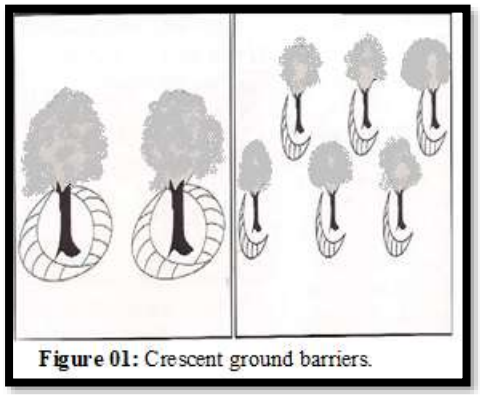
Figure 01: Crescent ground barriers.

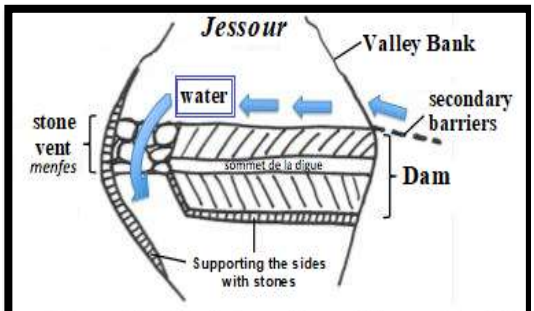

Figure 04: Side drainage through the vent (menfes)

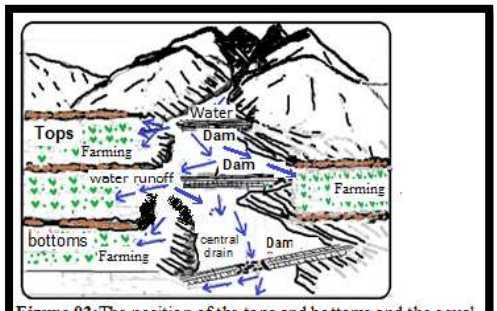

Figure 03: The position of the tops and bottoms and the equal arrangement in the exploitation of water using Dam.

Annex of image:

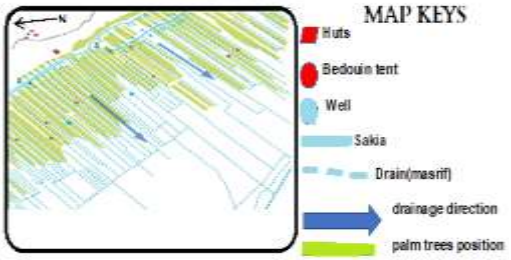

Figure 06: The direction of water drainage towards Chott Melrhir (Algeria)

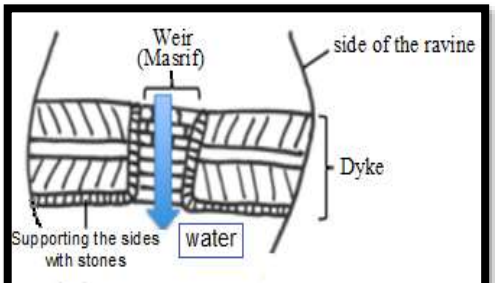

Figure 05: The central dam (adapted from J.Bouvallot, IRD).

Image 02: Activating the dam(jessour) system.

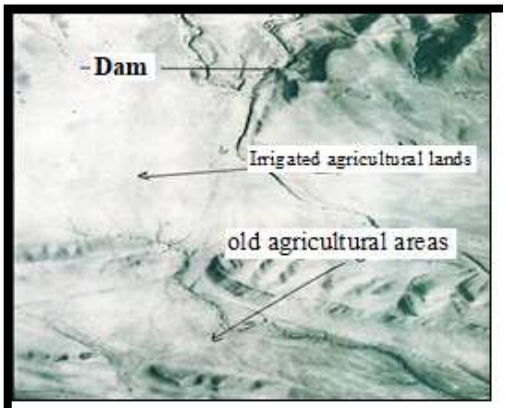

Image 01: Irrigation of agricultural lands in ancient times in the south of Aures(Algeria) based on dams 1945. (Adopted from Baradez).

Image 04: Importance and support of the **(Tabia)** in the protection of orchards.

Image 03: The effectiveness of establishing dams(jisser) to protect tree planting.

Image 06: A vent in the middle of the dam.

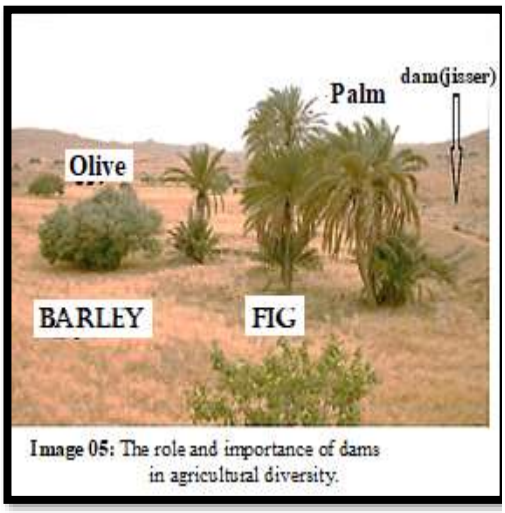

Image 05: The role and importance of dams in agricultural diversity.

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