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# Diagnosis of the state of Jessours in the Matmata mountain chain (South-Eastern of Tunisia) and their landscape integration

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**ABSTRACT:** The arid climate characterizing the South-Eastern part of Tunisia and the alarming water consumption rate that continues to increase are the main environmental problems affecting Matmata mountain chain. To face these challenges, authorities are promoting water and soil conservation techniques that contribute tremendously in a sustainable agriculture. This study presents a technical diagnosis of the current state of Jessours, that are considered as traditional anti-erosion structures and are implemented on the Matmata mountain chain, particularly in the region of Beni Kheddache located North-West of Medenine. In this context, data collection was conducted the spring of 2008 in around 50 Jessours, situated in three ravines (Chaaba Ksar Beni Kheddache 1, Chaaba Ksar Beni Kheddache 2 and Chaaba El Mechref). This diagnosis helps in understanding more clearly the way Jessours system functions, how runoff is collected and in assessing the landscape integration of these structures. This study shows how the majorities of farmers are conscious of the benefits of Jessours and are actively following the appropriate practices of an efficient utilization. However, the collected data indicates that a good number of Jessours lack proper maintenance. In fact, investigations point out that although, 62% of visited Jessours are in a good condition, a worrying percentage of them, around 16%, are in bad condition. Whilst, 22% of visited Jessours are in average condition. Thus, to improve the capacity of rainfall collection of the Jessours system and to ensure a good degree of landscape integration, it is necessary to rehabilitate the neglected Jessours.

**KEYWORDS:** Jessours, arid climate, water collection, Mountains Landscape, Matmata.

## 1 INTRODUCTION

From antiquity, different civilizations that lived in the Mediterranean region kept developing and implementing new methods pertaining to water and soil conservation [1]. For instance, the Phoenician civilization was the first to establish the Meskats and Mgouds practices. Whereas, the Romans were the first to introduce the aqueducts' system and the practice of dams, whilst, the arab civilization encouraged the cultivation of fertile land in a bigger scale through the widespread use of the spate irrigation system [2]. The benefits of these structures lie primarly in regulating floodwater, retaining sediments, recharging aquifers and mitigating the erosion intensity. Hence, improving the overall quality of soil and increasing arable land [3].

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Characterized by its extreme weather conditions, Tunisia is a country where the arid to semi-arid climate is prevalent in approximately two thirds of its total area [4] with an annual rainfall that doesn't exceed the 200 mm in some places [5]. Coupled with the fact that water tables are actually the only renewable natural resource available in the nation, authorities and associations are becoming increasingly conscious of the prominent role of runoff management in a sustainable development [6]. In fact, similar to a great number of countries all over the world, agrarians in Tunisia sought to turn floodwaters into a bless rather than a curse in an endeavor of alleviating water stress and improving agricultural productivity by relying on numerous anti-erosion structures: Starting from the «Majel» or the «Fesguia», which are structures resembling to simple reservoirs and cisterns of water, to the more complex and bigger Water and Soil Conservation systems (WSC), such as «Tabias» and the small dams called «Jessours». However, many climatic, hydrogeological and topographic factors affect the state and efficiency of anti-erosion structures [7]. Thus, the need of ensuring a periodical maintenance of these structures, and in some cases, rehabilitating the sharply deteriorated parts of them [8].

The present work presents an overview of the way Jessours structures operate, a technical diagnosis of their state in three sites of Beni Kheddache region (South-Eastern of Tunisia) and their integration degree in the mountains landscape of the Tunisian arid regions.

## 2 METHODOLOGY

### 2.1 OVERVIEW OF JESSOURS

#### 2.1.1 MODE OF OPERATION OF JESSOURS SYSTEM

The «Jessour» term is of an Arabic origin and presents an anti-erosion system first developed by the ancient Phoenician civilization and then mastered by Romans and Arabs. Basically, the Jessour system consists of building several small dams in a cascade, downstream rivers and ravines [9], in order to trap runoff water and eventually connect it to a series of irrigation perimeters. Farming practices are mainly based on Jessours sytem giving a landscape specific of the region [10, 11]. The Jessour system is a Water and Soil Conservation structure generally adopted in arid regions, such as the Matmata mountain chain. Its primary objectives lie in palliating the intensity of erosion and mobilizing the necessary water for farming purposes and crops cultivation. This area is characterized by a large diversity of spontaneous and cultivated plants can be well adapted to arid climate. Fruit trees (olive, fig, almond, *etc*.), cereals and legumes are the main cultivated plants under rain-fed conditions in this region [10, 11].

#### 2.1.2 COMPONENTS AND OPERATING PRINCIPLE

Figure 1 illustrates an overview from above of the Jessours system and shows a transversal cut of the actual structure. The Jessours are constructed mainly from big quantities of earth taken from the bottom of the valley or watershed and they may be consolidated and reinforced with rocks. The main components of a Jessours system (Figure 1) are the following [12]: The Impluvium «Hammalas» (a), it represents, essentially, the upstream of the watershed and from where water and sediments will be collected; the Terrace «Jesser or Kliss» (b), a space where we will let the vegetation and plants grow and spread to achieve a good degree of landscape integration; the Tabia (c), depending on the runoff intensity, its height may be between two to five meters and finally, the outlet that gives us a higher degree of control and thus enables us to guarantee the security and durability of Jessours by allowing the excess water to exit the system (If it is situated in the center, it is called «Masref» (d) and its downstream part is built in small cascades to decrease the water energy. Whereas, if it is positioned laterally, it is called «Manfess» (e)). Moreover, the direction of the water flow is indicated by the blue arrows.

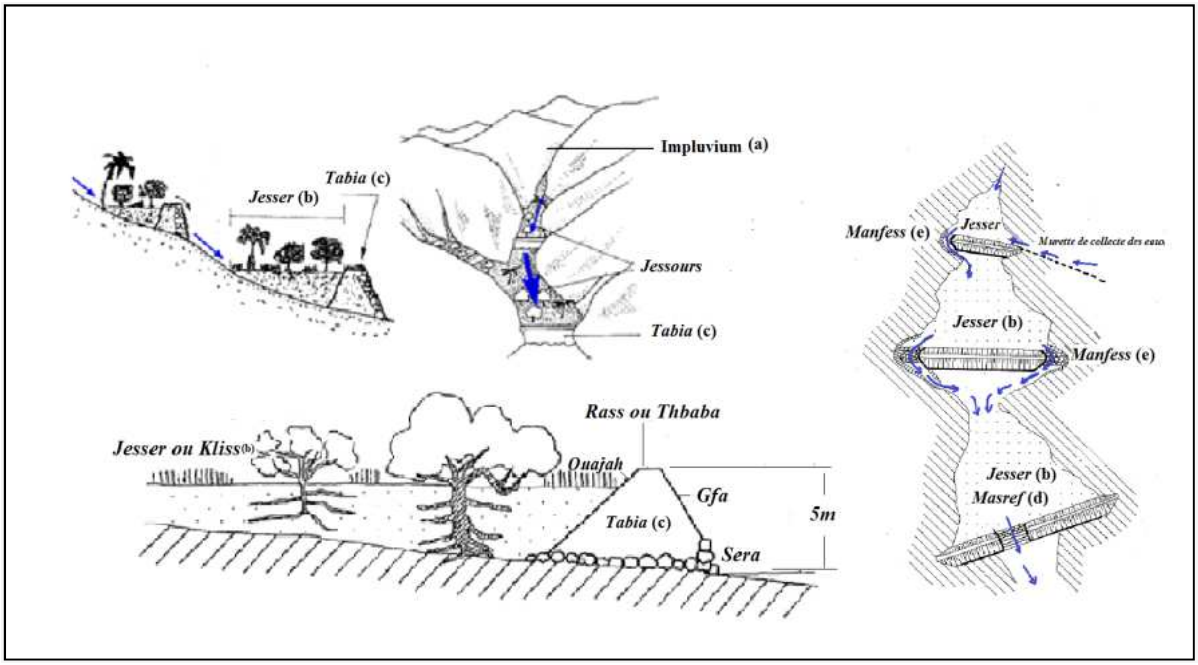


*Fig. 1. Different components of the Jessours system (Adapted)*

## 2.2 METHODOLOGY

The methodology used in this study is essentially based on the analysis of data and collected information throughout the three sites visited in the delegation of Beni Kheddache. Surveys were conducted in around 50 Jessours, during the months of March and April of 2008. Accompanied by a good number of farmers, three ravines were visited (Chaaba Ksar Beni Kheddache 1, Chaaba Ksar Beni Kheddache 2, and Chaaba El Mechref). Different hydraulic parameters were measured and/or simply observed to determine the current state of the investigated structures. A sheet containing a synthesis of these parameters has been prepared.

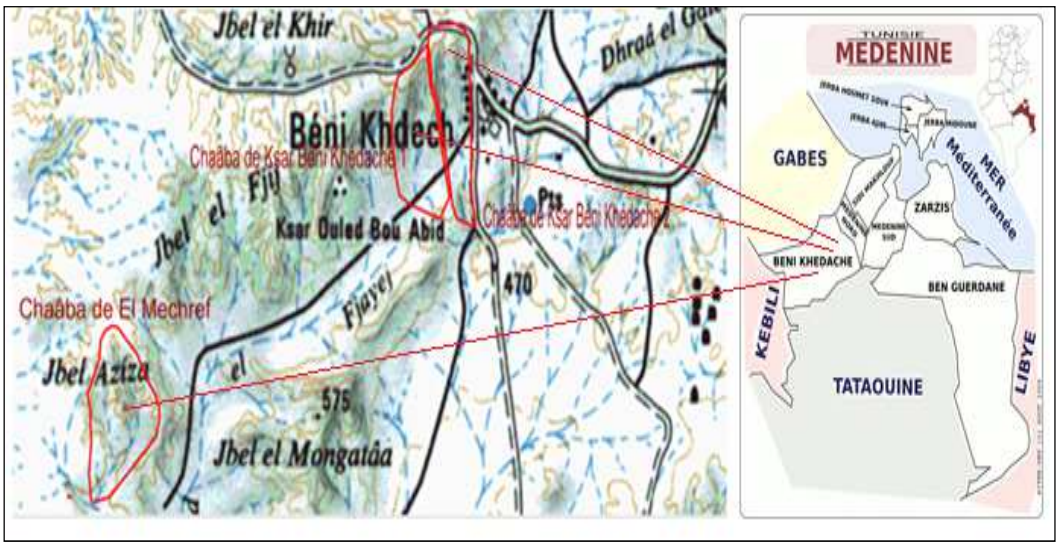


*Fig. 2. Location of the three visited sites (Adapted)*

## 3 RESULTS

### 3.1 SITUATION OF THE CONSIDERED JESSOURS

#### 3.1.1 TABIAS

The three pie charts depict the length, the thickness and the height of Tabias, respectively. As seen in the legends, the length of Tabias vary from less than 30 m to more than 100 m and the thickness of Tabias vary from less than two meters to more than four meters. While, the height of Tabias doesn't surpass the five meters. Most Tabias are characterized by significant lengths and thicknesses. In fact, the length of 33% of Tabias surpasses the 100 m, whilst, the thickness of 74% of them is greater than four meters. On the other hand, the height of nearly half of the investigated Tabias doesn't surpass the two meters. However, 40% of Tabias have a medium height that varies from two to three meters (Fig. 3).

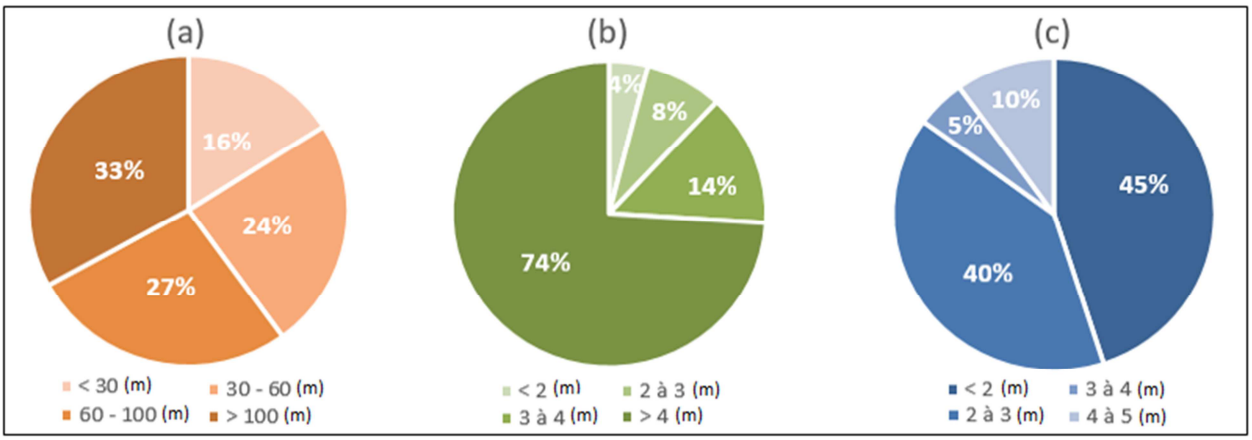


*Fig. 3. Distribution of Tabias according to length (a), thickness (b) and height (c)*

#### 3.1.2 OUTLETS

The pie chart and the bar chart illustrate the distribution of outlets according to their corresponding type (a) and length (b). The majority of Tabias contain a Manfess, with a percentage reaching the 86%. Whilst, the percentage corresponding to Masrefs is less than a sixth of that. On the other hand, the bar chart indicates, that the length of the outlet in more than half the Tabias (about 20), doesn't surpass the two meters, whilst, the number of Tabias with an outlet length of around 2.4, 4.8 and 6.8 are, respectively, around six, four and three. In addition, only about three Tabias contain an outlet with a length that is greater than eight meters (Fig. 4).

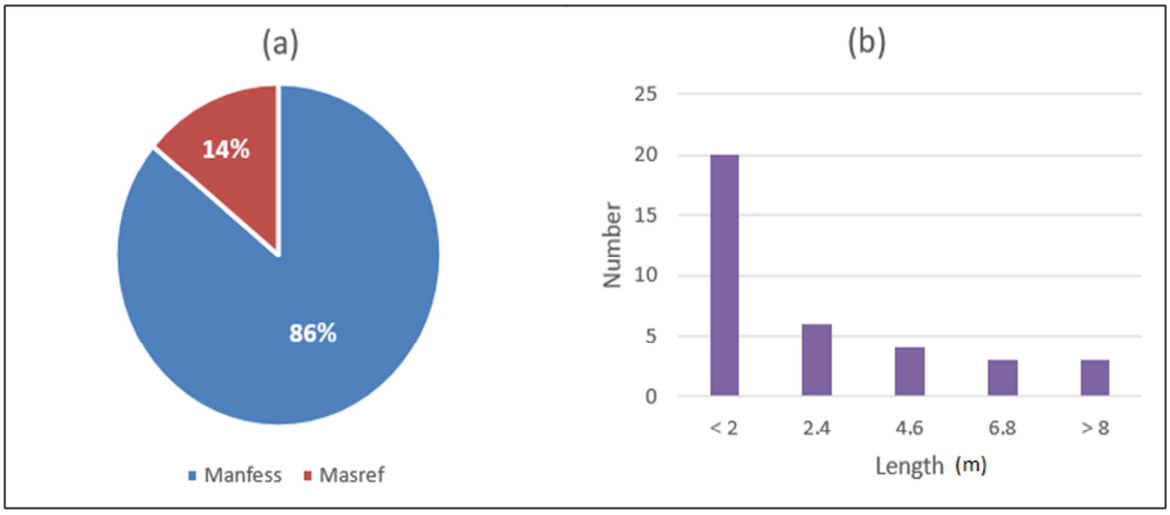


*Fig. 4. Distribution of outlets according to type (a) and length (b)*

### 3.1.3 DAMS

Figure 5 is a pie chart that illustrates the state of visited dams. As shown in the legend, there are four categories describing the state of a dam, starting from «Deteriorated» to «Very good». The pie chart confirms that the majority of dams are well maintained. In fact, almost 60% of dams are in a very good state and approximately a third of that number is in a good state, which is a good indicator. While, 18% of dams are considered to be in a bad state and 2% of them are in a deteriorated state.

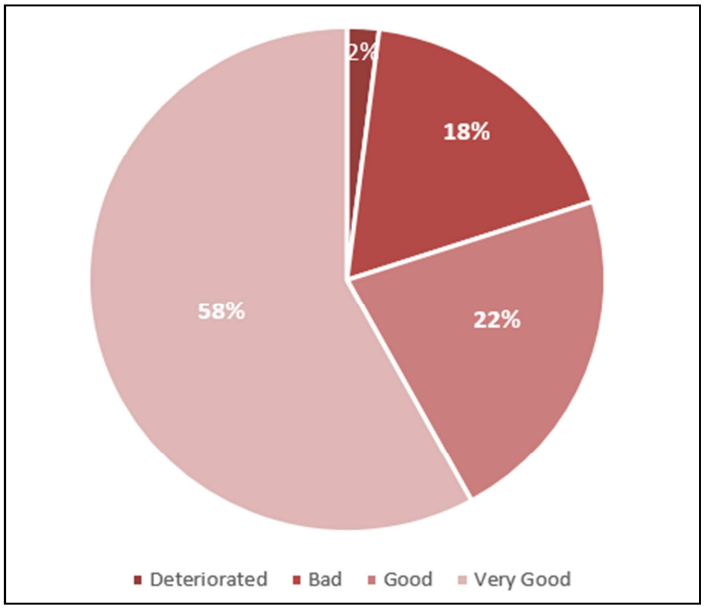


*Fig. 5. State of visited dams*

### 3.1.4 GENERAL CONDITION OF JESSOURS AND FRUIT PLANTATIONS

Approximately 62% of the Jessours are in a good state. While, 16% of the visited Jessours are in an average state. However, 16% of these structures are in a bad state, which is a number that could be seen as worrying (Fig. 6). On the other hand, figure 7 indicates that more than two thirds of the fruit plantations are very well are maintained and 15% of them are maintained well. In addition, figure 7 shows that 10% of these plantations are maintained moderately, whilst, 8% of them are not maintained properly.

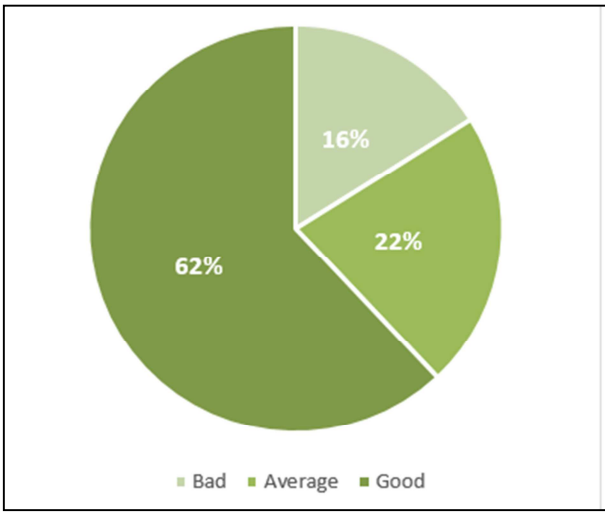


*Fig. 6. General State of Jessours*

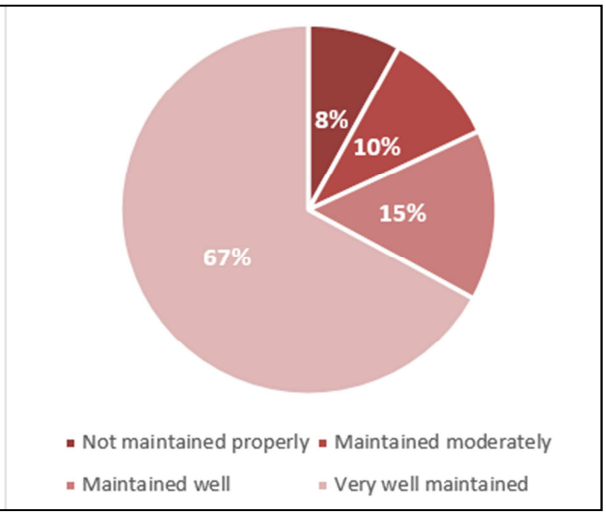


*Fig. 7. General state of fruit plantations*

### 3.2 LANDSCAPE INTEGRATION OF JESSOURS THROUGH PLANTATIONS

Figure 8 shows the integration of Jessours in a mountains landscape. The taken pictures depict, successively from left to right, the Jesser itself, the harmonious succession of Jessours and the insertion of trees in the Matmata mountain chain.

***Fig. 8: Some landscape views of Jessours in mountains areas***

## 4 CONCLUSION

The Jessours system is a typical traditional water and soil conservation structure that plays a huge role in assuring a better management for mountains areas in the South-Eastern part of Tunisia, where the agricultural production is usually limited. In addition, generally speaking, thanks to the beautiful rural landscape produced by the harmonious integration of Jessours in the Matmata mountain chain, the region became a famous touristic attraction. However, in some cases, these anti-erosion structures are in a poor state. In fact, the study shows that approximately, 18% of Jessours are in a bad state, whilst, 2% of them are in a very bad state. To improve the Jessours degree of landscape integration through fruit trees (olive, fig, almond, etc.) and their efficiency in mobilizing water and decreasing the erosion intensity, an immediate rehabilitation program of the neglected Jessours needs to be implemented.

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