

## MOUNTAINS LANDSCAPE IN CENTRAL WEST OF TUNISIA: ESSAY OF EVALUATION OF NATURAL ASPECTS IN BOUCHEBKA'S MOUNTAIN

ISLEM SAADAOU<sup>1</sup>, HAYET ILAHI<sup>2</sup>, CHRISTOPHER R. BRYANT<sup>3</sup> & HICHEM REJEB<sup>4</sup>

<sup>1,2</sup>Doctoral Candidate, Research Unit "Horticulture, Landscape and Environment", ISA, IRESA,  
University of Sousse, Sousse, Tunisia

<sup>3</sup>Full Professor, Department of Geography, Laboratory Sustainable and Dynamic Territorial Development,  
University of Montreal, Montreal, Canada

<sup>4</sup>Full Professor, Research Unit "Horticulture, Landscape and Environment", ISA, IRESA,  
University of Sousse, Sousse, Tunisia

### ABSTRACT

Belonging to the Tunisian dorsal mountains, Bouchebka has a typical landscape of the west-central region of Tunisia. It is distinguished by the importance of the forest area which covers 92 % of the area of the region and the importance of rugged relief. Bouchebka forests part of the great mass of Aleppo pines, located on the plateau between the DjebelChambi and Tébessa mountains cover an area of 19,700 ha. Its mountainous terrain, smoothness and exceptional abundance of sources are the cause of its physical and natural characteristics. The purpose of this research was to reveal the importance of the study area for ecological plans and to help realize its true potential as a multifunctional landscape area. To achieve our goals, analytical research tools based on several interdisciplinary analyses, in particular the cartographic interpretation and delineation of natural and landscape zoning were developed. The obtained results reflect the importance of this territory from the perspective of natural and landscape resources and the necessity of the state intervention and civil society to become engaged for the preservation of this natural heritage.

**KEYWORDS:** Landscape of Mountains, Rugged Landforms, Forests, Landscape Multifunctionality, Mediterranean Region

### INTRODUCTION

The mountain has always been a particular geographic, economic and social entity. Topography, climate, history and cultural heritage involving a specific policy development, management and protection. For millennia, the mountains were also a valuable reservoir of resources such as water, energy, agriculture, forest and biodiversity. Furthermore, mountain areas are characterized by significant impairments which make living conditions more difficult and restricting the exercise of certain economic activities. The fragility of mountain ecosystems, interannual variability associated with a Mediterranean climate, proximity to the Sahara and the presence of a rural mountain population are the key factors in shaping landscapes observed, but also marked by strong natural constraints and anthropogenic generating competition, conflict and risk (Donadiou and Rejeb, 2011). In this regard, our study arises; it is about the study of mountain landscape Bouchebka center west of Tunisia while referring to the various components of the landscape. As a border area, Bouchebka landscape is a natural heritage joint between Tunisia and Algeria, a series of mountains belonging to the

Tunisian dorsal and extending to the mountains of Tébessa Algeria. In general, the landscape refers to a relatively wide range, from a few hectares to a few hundred km<sup>2</sup> (Forman & Godron, 1986). This study aims to identify the main features of the differentiation of mountain territories through a combination of natural and landscape situations.

## MATERIALS AND METHODS

### Study Site

Bouchebka is a part of the sub-region high alfa steppes; this region covers an area of 509,422 ha. It is bordered to the north by the west ridge, on the east by the high agricultural steppe and south by the Atlas Series. The forest of Bouchebka hand of the great mass of Aleppo pines, located on the shelf Between the Djebel Chambi and Tébessa mountains.

It fits Entirely in the Bouchebka's MAP 1/50, 000 (n) LXXXIII) between Lambert coordinates: X = Y = 367-378 and 207-215. It is located in the Governorate of Kasserine, Delegation Feriana its limits, altho sitting on the ground, are the Following: North: Land of Culture and Ain Amara forest All which is separated from the first series of Dernaya by Ain BouDeries track. To the east: crop fields and forestry post Faider Remaïlia Sidi Baïssis. South: Crop fields Henchir El Goussa, the Ennafd El Bagrat up the Henchir Houchet. To the west : cropland between the forest and the Algerian border.

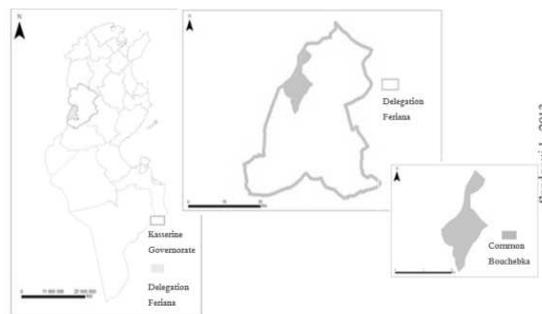


Figure 1: Geographic Location of the Municipality of Bouchebka

### Materials

#### Gis Software: Arc Map 9.3 v

To perform spatial analyzes through our Arc Gis software we use:

- Statistics from the National Meteorological Institute (INM), agricultural statistics from the Ministry of Agriculture (MA)
- Map land use of Kasserine Governorate designed in May 2014 and amended in January 2013.
- The topographic map of Bouchebka: Belonging to the sheet (No. LXXXIII), topographic Bouchebka's map performed on a scale of 1/50, 000 by the superposition of its geographical limit on the topographic base provided.

### Methods

#### Climate Characterization

By its continental location, Bouchebkaarea is known by alternating seasons marked by winters and autumns heavy rains and arid hot dry summers. Thus, this particular climate is characterized by an irregularity that we are going to try to highlight it through the study of some climatic parameters:

Calculation of Emberger's pluviometric quotient: the rainfall of Bouchebka's area was sighted by calculating the Emberger's pluviometric quotient that takes into account rainfall and temperature:

$$Q = 2000 P / M^2 - m^2$$

'M' is the average temperature in Kelvin of the warmest month, and 'm' is the average temperature in Kelvin of the coldest months. P is the average rainfall in millimetres (Benabadaji and Bouazza, 2000).

### **Determination of Rainfall**

#### **The Ombrothermic Diagram**

It allows measuring the importance of monthly precipitation accumulated on a surface of 1m<sup>2</sup>. A comparison with a temperature curve allows you to define with certainty a drought period; Drought is defined as a period when the number of temperatures exceeds twice that of precipitation.

#### **Landscape Analysis of the Study Site: Thematic Maps**

Typically, these items are available as digital files, such as cartographic boundary file and a file of census data. These cards are generally produced using geographic information systems on a PC or charting software for PC. From the land use map, topographic map, the databases of the Ministry of Agriculture (DGF: General Directorate of Forest, Regional Offices had Agricultural Development in Kasserine: CRDA), OTC and MNI some thematic maps were produced using GIS software (ARC Map Version 9.3) on the scale 1/650 000 for maps Kasserine, 1/250 000 for maps delegation of Feriana and 1/100 000 maps of the common Bouchebka. The cards are:

- The distribution map bioclimatic of Kasserine Governorate; made from meteorological data provided by the National Meteorological Institute on a scale of 1/650 000.
- The distribution map of bioclimatic Bouchebka: made by the superposition of the edge of Town on the map of the distribution of bioclimatic Kasserine and using the extension "Analysis Tools / extract / clip" of the "Arc Map" the scale of the map is 1/100000.
- The map of the distribution of forests in the Kasserine Governorate made from the map data of land use and the data of the Directorate General of Forests (DGF) on a scale 1/ 650 000.
- The map of the distribution of Bouchebka forest's: deliberations of the previous map by superimposing the edge of the town and using the extension «Analysis Tools / Extract / clip ", the scale is 1 /100000.
- Location map of forests according to Feriana's bioclimatic area: made by superimposing the location map of mountains and that of the bioclimatic using Arc Map v 9.3 software. On a scale of 1/ 650000.
- Location map of Bouchebka forests according to bioclimatic levels produced from the previous map by the extension "Analysis Tools / Extract / clip" on a scale of 1 /100000.
- Pedologic Map of Kasserine Governorate, made from the soil data on a topographic base of the region on a scale 1/ 650 000.
- Pedologic Map of Bouchebka common: it is a superposition of the geographic boundary of the region with the pedologic map of Kasserine always on the scale of 1/100 000 in the same geographical reference.

- Map of water resources: This is the assembly of different cards such as the map of surface runoff, the map of aquifer systems, maps the location of dams and hill lakes. These cards are based on the data of the Directorate General of Water Resources (DGRE).

The realization of the map of water resources is done in several steps:

- The development Cartographic standards by harmonizing all the cards already developed a unique system of projection with the development of a Digital Terrain Model (DTM).
- The superposition of different maps drawn with the proper choice of colors and symbols for a clearer reading of the parameters included.
- Adequate and meaningful legend.

The same approach is applied to the realization of the map of water resources Bouchebka on a scale of 1/100, 000.

## RESULTS AND DISCUSSIONS

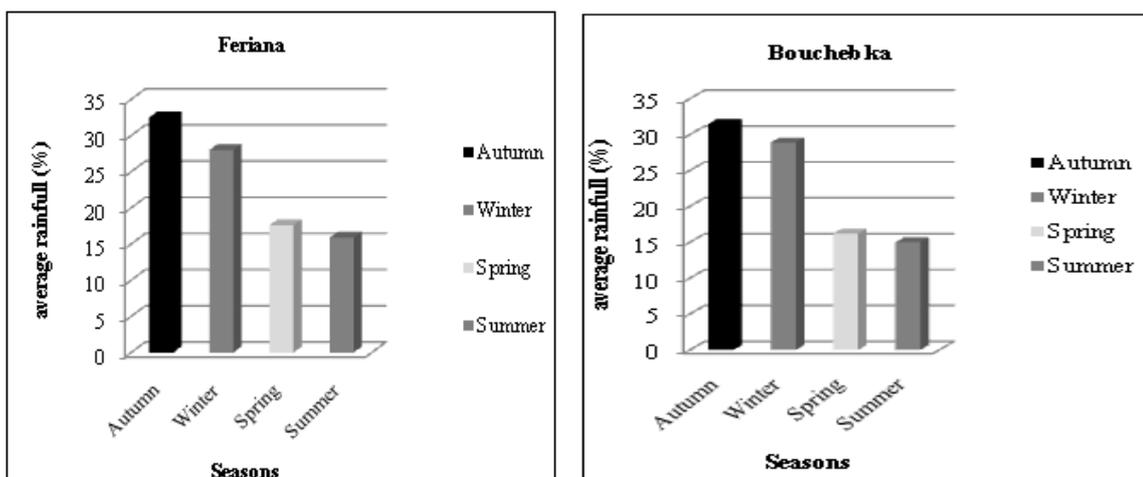
### Description of Bouchebka Landscape

#### Landscape of Bouchebka through Climatology

- **Rainfall**

The annual distribution of rainfall can distinguish two major climatic regions:

- Common Bouchebka: Typical Mediterranean region, where the rainfall is the APHE type (decreasing rainfall in the order fall, spring, winter, summer).
- Delegation Feriana: A continental Mediterranean region trend, where the maximum rainfall tends to move toward the fall summer and minimum in the summer to the winter.



**Figure 2: Rainfall in the Study Area: Average Seasonal Rainfall and its Contribution (in %) in Terms of the Average Annual Rainfall Total**

In 68 % of cases in Feriana, summer was wetter than any of the other seasons. It even happens that summer was the wettest season of the year (as in 2009: 42 % of total annual and 2001 : 38.6 % of total annual etc.), or 41 % of studied years, Bouchebka summer was the wettest season.

Thus, the contribution of summer varies greatly and can be decisive in the yearly total. Maximum rainfall amounts can reach relatively high values: 418.9 mm for 1999, 16% of summer rainfall greater than 100 mm and 44% exceed 50 mm.

The lowest is rather very low, in Bouchebka, 6% of years have been a completely dry; however, the coefficient of irregularity remains strong; coefficients of irregularity, including the coefficient Kg, ratio module of wet year decennial frequency module of the dry year with the same frequency. The coefficient can reach a value of 17, the wet decade exceeds 300 mm, and the ten- dryer is less than 20 mm. Histograms presented in Figure 2 show that the maximum daily summer rains occur most often in June and August.

They can give the annual maximum daily: rain of 8 June 2011 represents Feriana's annual maximum (18.1 mm). It is the same with that of 27 June 2004 (46.1 mm). For Bouchebka station, maximum 48 % are higher than 25 mm and 13 % are higher than 50 mm. Quantities greater than 30 mm rain daily represent from 0.5 to 3 %; those higher than 10 mm, from 20 to 25 % . July is much less rainy, as it is frequently completely dry.

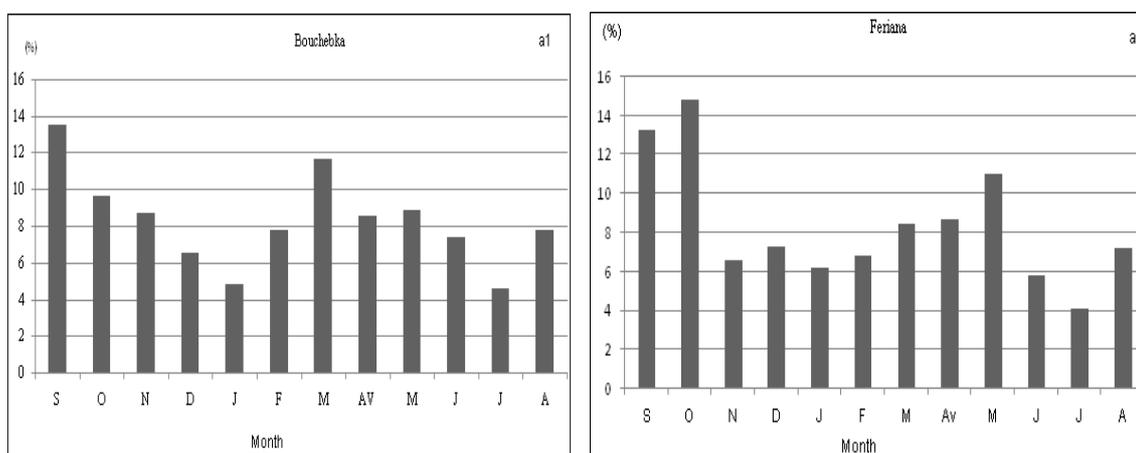


Figure 3: Monthly Rainfall Values and Contribution (%) to Total Annual Rainfall

**Rainfall Quotient and Bioclimate of Emberger**

$$Q = 2000 P / M^2 - m^2 = 44.6$$

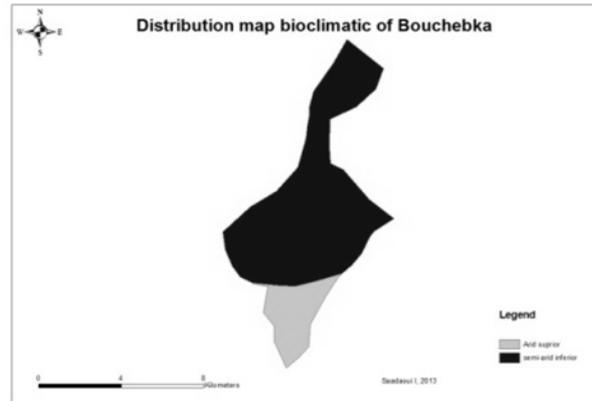
The results allow us to have a value 'Q' between 35 and 70, and since the average annual rainfall is 373.5 mm equal to this empirical index allowed us to define the levels and sub-bioclimate of Bouchebka area whose various characteristics are shown in table 1.

Bouchebka has a rainfall quotient equal to 44.6. That means that the delegation is in a cool semi-arid lower level.

**Table 1: Bioclimatic Characteristics of the Region Bouchebka**

Station	Bioclimatic	Sub-Bioclimate	Variant	Q
Bouchebka	Semi-Arid	Inferior	Cool Winter	44.6

The distribution map of bioclimatic zones shows a transition between arid and semi-arid levels with the dominance of the semi-arid sub-bioclimate level to cool winter.

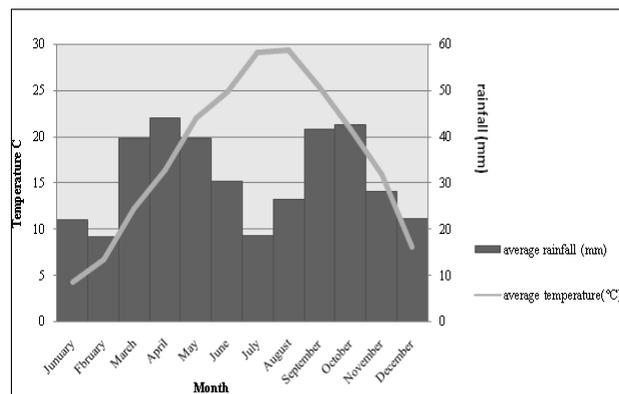


**Figure 4: Distribution Map Bioclimatic to Bouchebka**

### The Ombrothermic Diagram

The Ombrothermic diagram (Figure 5) shows that Bouchebka climate is characterized by hot and dry summers and rainy winters. At the seasonal scale, the wet season runs from October until early May, recording a rainfall of 215 mm / year corresponding to approximately 57.5% of the total annual precipitate. Summer is the second wet season; it contributes to an average of 123.4 mm / year. The driest season is the spring that records only 62.7 mm / yr.

Bouchebka is characterized by an annual average temperature of 19.2 ° C. The summer season from June to August is the hottest with an average of about 26.7 ° C. Winter (December-February) is cold and the average temperature is around 11.1 ° C. At the monthly scale, we note that the cold peaks in January and February when the temperature drops to the minimum values of the order of 7.3 ° C and 1.2 ° C, respectively. From March, the heat begins to rise to meet in July and August respectively with maximum 32.4 ° C and 34 ° C. The temperature range is about 25 ° C, which proves that the seasons are well marked. Average temperatures minimum and maximum were reached July 34 ° C and 1.2 ° C January.



**Figure 5: Ombrothermic Diagram for the Bouchebka Station (1990\_2010)**

### Landscape Bouchebka through Hydrography

#### Water Resources of Bouchebka

Bouchebka covers an area of 5,094.22 km <sup>2</sup>, it is located in North- west of the delegation Feriana to the Algerian border. The database map of the river system and water resources of the delegation Feriana shows that the Municipality has neither Bouchebka ground water nor deep aquifer.

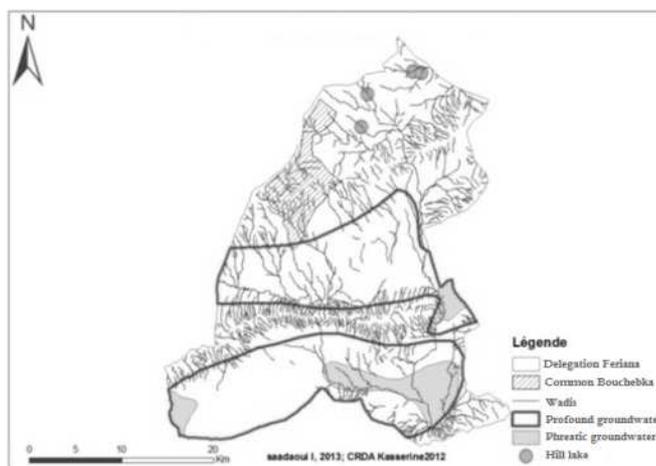


Figure 6: Hydrographic System and Water Resources of the Delegation Feriana

Table 2: Length of Bouchebka Wadis

Wadis	Lengths
Wadis BouChebka	78.657 km
Wadis Chabit Frayna	4.669 km
Wadis Chabit El Khthala	4.556 km
Wadis Tom Smida	3.514 km
Wadis Nfad El Ghmour	2.784 km
Chabit Za`Ra	0.945 km

The table of Bouchebka wadis, illustrated from the data card wadis shows that the most important wadi is the wadi Bouchebka its length exceeds 78 km, it has 82% of the total length of the river system of the study area, the sum of four wadis (Wadi Tom smida, Chabit Frayna wadi, Chabit Khthala wadi and wadi Chabit Za`Ra) existing in the study area has only 18% of the total length of the hydrographic system.

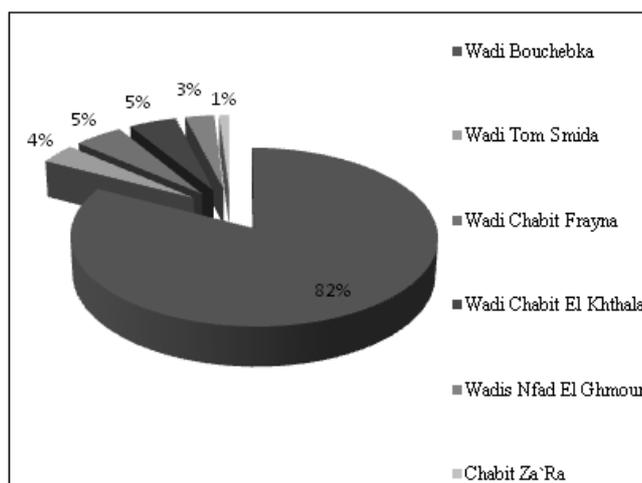
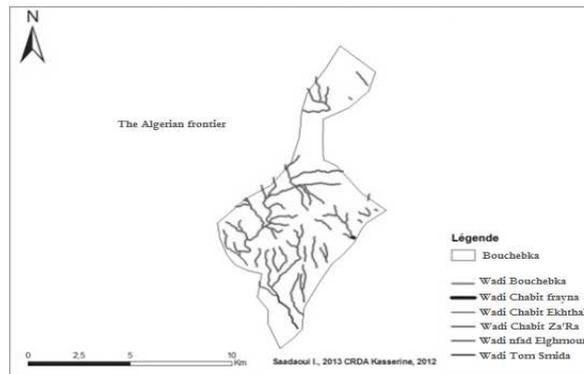


Figure 7: Contribution by Wadis to the Total Length of the River System in the Region of Bouchebka

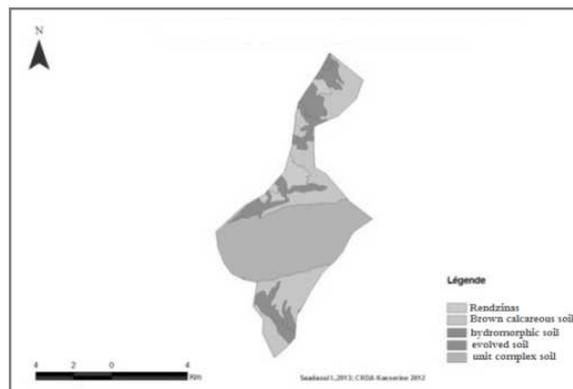
In fact, Bouchebka wadis are all tributaries of the wadis that originate in mountainous belonging to Algeria, a country bordering the west Tunisia.



**Figure 8: Map of Bouchebka Wadis**

### Landscape through Soil Science: Soil Landscape

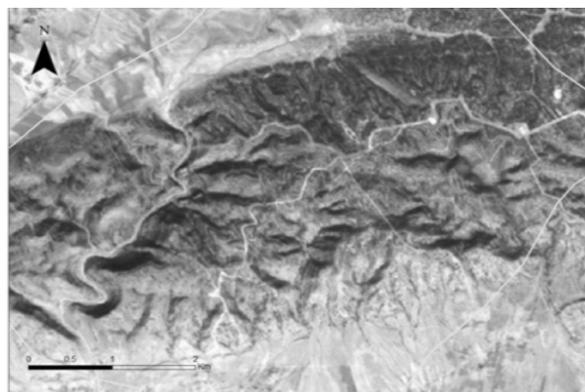
Bouchebka is based on the different facies of the lower Senonian. Predominantly horizontal dips are sometimes inclined to the north. Different source rocks are represented by hard and cracked limestone, calcareous marl, marl and some colluvium. The pedologic map shows that the soils of the study area are a mosaic of brown calcareous soils, rendzinas and developed soils or degraded and complex units of the soil.



**Figure 9: Soil Map of Bouchebka**

### Reliefs

A satellite image of a scale of 1/25, 000 of the study area shows the net distribution of relief in this rugged territory.



**Figure 10: Satellite Image of Bouchebka 1/25 000**

### Landscape through the Vegetation Cover

From the database of the vegetation map we found the following distribution of vegetation cover:

- A natural vegetation (including fallow) with dominance of steppe plants, the most important is the Alfa (covers an area of 1781.04 ha), and forests occupants reliefs at high altitudes.
- An artificial vegetation with agricultural aspect: olive groves, vegetables and cereals, extending over an area of 548.6 ha, of which 398.32 ha and 79.36 ha of cereal cultures olive groves.

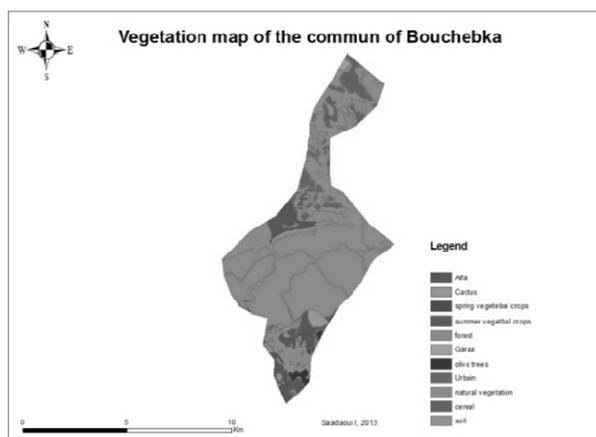


Figure 11: Vegetation Map of Common Bouchebka

## SPATIAL ANALYSIS

### Land Use

The database of the land use of the common Bouchebka map shows the importance of the forest area of the region with 20% of the forest area of the Governorate and 2.15% of the national forest area.

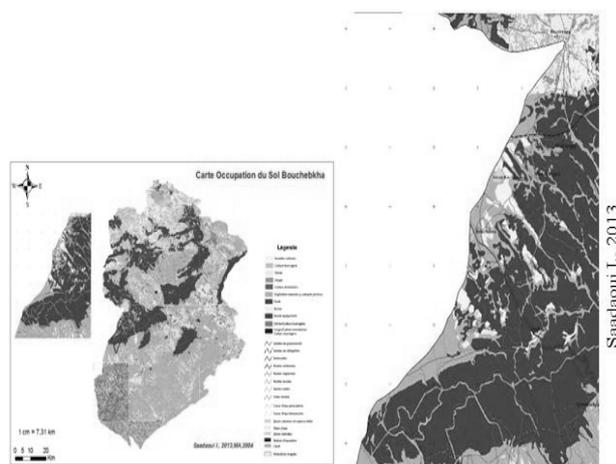
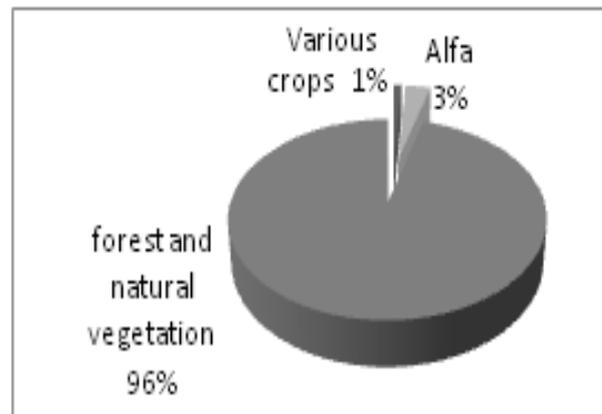


Figure 12: Geo-Referenced Land Use Map of Bouchebka

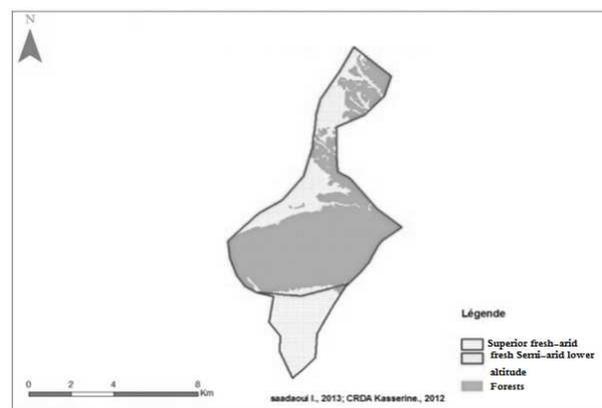
The database of the map also shows that forests and natural vegetation occupy most of the area of the region.



**Figure 13: Distribution of the Area under Vegetation Cover**

### Distribution of Forests According to Bioclimatic Levels

Map of forest distribution shows that the total forest area, 16 991 ha, is located in the semi-arid lower floor, on high altitudes (between 800 and 1280 m); this region is characterized by heavy rainfall and frequent falls annual snow that promotes the distribution.



**Figure 14: Map of Forests Distribution in Bouchebka According to Bioclimatic Zone**

### Phyto- Soil Landscape

Through the superposition of the vegetation map and the soil map to reach the plant-soil landscape map, and referring to the data of the map using data from the Ministry of Agriculture and CRDA Kasserine, it can be seen that :

- The brown calcareous soils evolve under dense canopy, mainly on marl 'calcareous marl' and Torba. They are rarely very deep.
- The rendzinas are found on hard limestone under dense canopy, even in the moor rosemary degraded. They are usually superficial, depth depends on the topography and erosion.
- On very often unsophisticated skeletal soils are located particularly in burned areas where soil and vegetation «remake» on slabs, marl and Torba, we meet the forest vegetation.
- Degraded soils are located on both the slopes discovered that the plates where the rain erosion continually puts the rock itself.

- Alfa is in burned areas and the soil crust.
- The relatively abundant Diss, its presence indicates compacted soils.

Down slope positions some contributed ground under cover in moving towards steppe soils. In the first series of forest Bouchebka, the dominant Complex soil is represented by skeletal soil surface, often unsophisticated slab. On the piedmonts and slopes, both at fresh as hot exhibitions, but under dense canopy exhibitions are the most developed soils and deepest. In the valleys (or ennfad Fai'd) generally agricultural land quality is developed from alluvium.

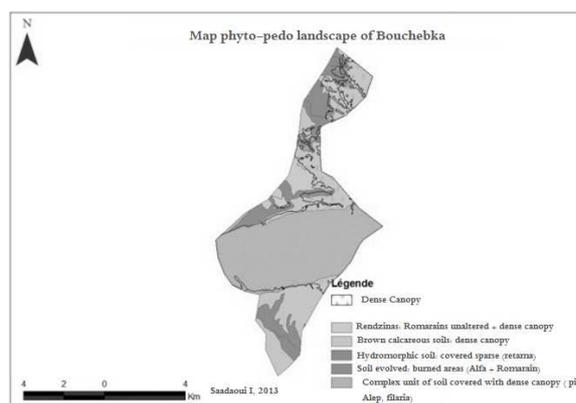


Figure 15: Distribution of Vegetation According to Soil Type in the Area of Bouchebka

## DISCUSSIONS

The study of spatial factors is a field of investigation in the description and the valorisation of natural landscapes of the region, we found that the mountain scenery of Bouchebka is characterized primarily by its significant natural potential, the climate characterized by its irregularity in rainfall which directly affects the land, essentially consisting of a sparse forest cover which occupies 92% of the total area of the region.

This study allows us to distinguish the following main features

- **In Ecological Terms:** Bouchebka Region is a typical Mediterranean area characterized by variability and erratic rainfall and temperatures.
- **Summer Rains are Rainstorms:** It is in the mountainous region of Central Tunisia-continental Upper Steppe they are considerable. The summer season is more or less equivalent (in terms of the amount of precipitation) than winter: two dry seasons.
- **At the Spatial Level:** The region is distinguished by its very fragile because of the difficult weather canopy, the canopy is mainly composed by forests of Aleppo pine and vegetation can be maintained in an environment in semi-arid to arid.

## CONCLUSIONS

The landscape must be both a 'tool' and 'project'. A tool to understand the specifics, strengths, constraints, issues of territory and guide transformations, and a project that is to say, pay attention to the quality and consistency of spatial arrangements implemented as part of a sustainable development policy (Bamba, 2010).

The main idea of our work was to define the natural landscapes in the region of west-central Tunisia in general and those of the common Bouchebka particularly through natural representations which help to define the place. The study of spatial factors that constitute a field of investigation in the description and valuation of natural landscapes of the region we found that the mountain scenery of Bouchebka is characterized by its irregularity in rainfall which affects directly the land, essentially consisting of a sparse forest cover which occupies 92% of the total area of the region.

Existing landscapes express the recent past and space that mark their footprint in the spatial organization of training purposes. The landscape has emerged as a new and valuable tool for diagnosing the status of a territory and as an essential element of a development project or the relevant scale for the assessment of biodiversity turns out to be both the portion of the territory and landscape elements.

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