ASSESSING THE HEALTH OF THE CHETTABA FOREST (ALGERIA)

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ABSTRACT

The establishment and interpretation of diameter and height structures are essential for forest management decisions. This study aims to describe the diameter structure and spatial distribution of *Pinus halpensis* populations in the Chettaba state forest (Constantine, Algeria). The knowledge of these parameters is an essential step for their sustainable management. The diameter at 1.30 m from the ground and the total height of *P. halpensis* individuals were measured on 6 plots along an altitudinal gradient. The height structure shows that trees in the height classes between 5 and 10m have a very high density, indicating low natural regeneration. The total structure indicates that smaller trees are more abundant than larger trees ($17.5<d\leq27.5$cm). These results contribute to the improvement of knowledge on current condition indicators of natural *Pinus halpensis* stands that can be used as a basis in the management of Chettaba forest.

Keywords: Pinus halpensis, floristic diversity, spatial distribution, regeneration

INTRODUCTION

The concern for the conservation of biodiversity, taking into account the needs and aspirations of local populations, has become real since the Earth Summit in 1992. This has led to an urgent need to understand the direct and indirect effects of human activities on biodiversity, which are the subject of numerous scientific debates. Despite this collective awareness, the erosion of biodiversity continues [1]. [2] and is a threat to humanity. The overall Algerian biodiversity counts about 16000 species of which only 1% of this total is used in the economy. The richness of the national biodiversity is a reflection of the ecosystem diversity. The mountainous massifs of Algeria conceal an important biological diversity.

In order to better understand the degradation of ecosystems, which is both natural and anthropogenic, the study of vegetation seems very appropriate. Indeed, the flora and vegetation of a region are the result of a long process of natural selection under the action of climate, edaphic and topographical conditions, without forgetting anthropic activities [3], [4], [5].

A precise knowledge of the existing forest resources, as well as their evolution should focus on the floristic composition, on the structure and on the regeneration of valuable species, hence the need to carry out a forest inventory which is the subject of this work.

The objective of this work is to obtain information on the characteristics of woody resources (height, diameter, basal area...) and the quantitative relationships between them. This will help to take care of this forest formation considering all the ecosystems that are connected to it and studying different alternatives of development and conservation of all the forest species that are in the Chettaba forest, which would contribute to the protection of the latter.

MATERIAL AND METHODS

The situation of the forest of Chettaba

The state forest of Chettaba belongs to the watershed Kebir Rhumel, it is located southwest of Constantine, south of Ibn Ziad, north of Ain Smara and east of Oued Athmania. The study area is located on the topographic map of Constantine Scale 1/200.000 sheet N 17 and more or less located between the coordinates 36°18', 36°21' north latitude and 6°26', 6°30' east longitude (Figure 1).
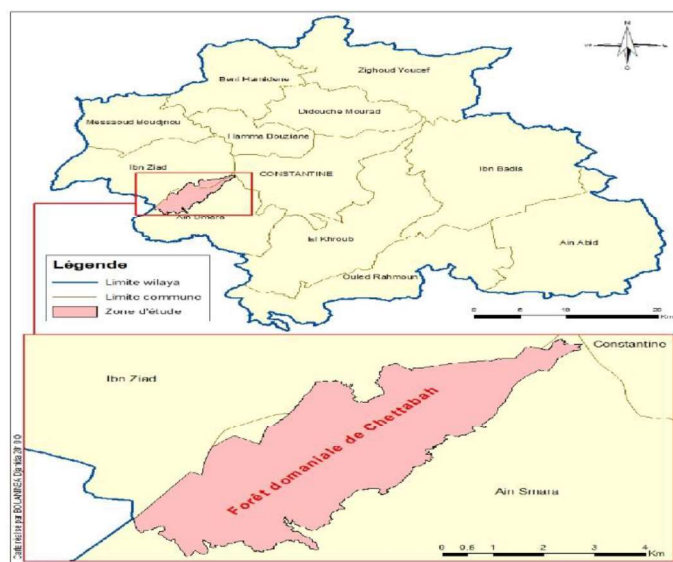

Fig. 1. *The geographical location of the Chettaba forest.*

Dendrometric parameters

In order to characterize the diametrical distribution of Aleppo pine stands present in this forest and the vertical structure, 6 sampling plots were randomly established. These plots were rectangular, with an area of 400 m² (20 m x 20 m) within which all individuals were counted. For each of these trees, the circumference at 1.30 m (C) and the total height (H) were measured.

The data obtained were entered into the Excel spreadsheet, which allowed us to determine the ecological characteristics and the structure of the natural population of *Pinus halepensis*.

The formulas of the parameters studied at the level of each plot are shown in Table 1 and which are:

- The density (A) or number of individuals per hectare.

- Basal area (G in m²/ha) is the sum of the cross-sectional area at 130 cm above the ground of all *P. halepensis* individuals.

A multitude of indices are developed and those used in this paper are the Shannon, Pielou and Simpson indices [6].

Table 1. *Measures of diversity.*

Index	Measuring diversity
Specific richness: $RS = \sum_{i=1}^{K} Si$	Horizontal
Shannon Index: $H = \sum_{i=1}^{K} Pi \ x \ lnPi$	Horizontal
Simpson's Index: $D = 1 - \sum_{i}^{s} Pi^2$	Horizontal
Hill Index: $Hill = (1/D)/e^H$	Horizontal
Pielou Index: $E = \frac{H}{lnS}$	Spatial Distribution

RESULTS AND DISCUSSION

The average density of woody plants in Chettaba forest is 492±368 individuals/ha with an average basal area of 30.18±5.04m²/ha and an average volume of 75.68±5.04m3/ha (Table 2). For all plots, the average diameter ranged from 25.65 to 34.12 cm; these stands show more developed characteristics at the perch stage (low and high). The maximum diameter observed was 48.47 cm.

Table 2. *Characteristics of the plots studied.*

Plots	N/ha	D (cm)	G (m²/ha)	H (m)
P1	250	30.61	18.92	9.03
P2	600	25.65	32.50	9.29
P3	645	26.42	35.50	10.02
P4	350	28.18	23.03	8.35
P5	467	34.12	35.50	11.45
P6	645	27.89	35.65	10.42

The distribution of individuals by diameter class was fitted to a polynomial function (Figure 2). This figure shows a high proportion of individuals with dbh between 17.5 and 27.5 cm. This actually reflects the heterogeneity of dry forests with respect to woody diameters. However, it was observed that there are dry forests with many small-diameter individuals and dry forests with very few small-diameter individuals. The vertical distribution is given by the distribution of the number of stems in all plots per hectare for each height class, and provides information on the vertical stratification of the stand [7]. A large proportion of trees are between 10 and 15 m tall (low perch); this class has a large number of individuals (Figure 3).
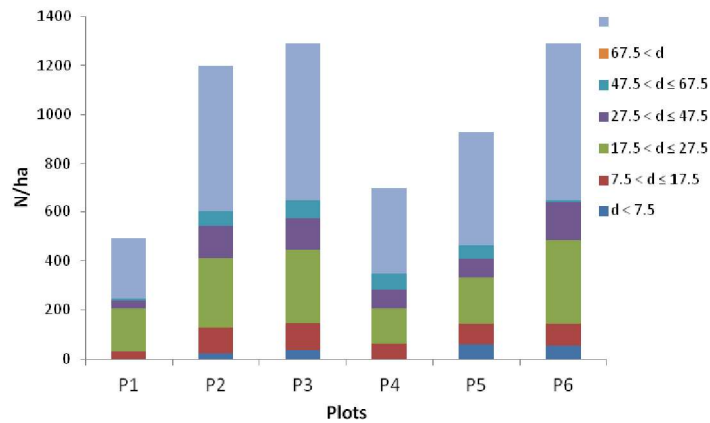

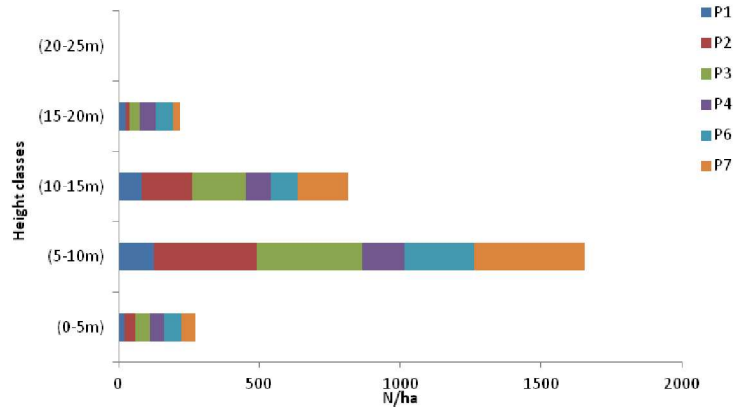***Fig. 2****. Distribution of the number of stems according to the diameter classes.*

Fig. 3*. Distribution of the number of stems per hectare by height classes.*

The values of the Shannon and Simpson indices are not very significant and indicate a low floristic diversity (Table 3). The Shannon index is often accompanied by Pielou's equitability index. The equitability index measures the distribution of individuals within species, independently of species richness. Its value varies from 0 (dominance of one of the species) to 1 (equidistribution of individuals within the species). These two indices remain dependent on the size of the samples and on the type of habitat. It is therefore difficult to use them as a descriptor of the state of an environment unless threshold values for each type of habitat and for a given sampled area are determined beforehand, as proposed by [8]. The Hill Index ranges from 0.84 to 0.99. The closer the Hill Index approaches 1, the lower the diversity. In order to facilitate interpretation, it is then possible to use the 1-Hill index, where maximum diversity will be represented by the value 1, and minimum diversity by the value 0. The Hill index seems to be the most relevant insofar as it integrates the other two indices and thus allows comparisons of different stands. However, it may be useful to use all three indices together in order to extract a maximum of information and to better understand the community structure.

Table 3. *Diversity indices.*

Plots	RS	D	H	E
P1	1.09	1.29	0.84	0.40
P2	0.36	0.59	0.88	0.67
P3	0.67	0.50	0.99	0.50
P4	1.09	1.41	0.84	0.30
P5	0.33	0.58	0.88	0.72
P6	0.44	0.61	0.86	0.61

CONCLUSION

The structural study and the floristic composition of the forest allowed to know the diversity of the plant groups of this ecosystem. The forest of Chettaba functions today as an isolated ecosystem undergoing pressures at its periphery and justifies the need to conserve this ecosystem. The evaluation of the specific diversity by the index of Shannon index and equitability shows a certain relationship with the disturbance of the environment. In spite of a relatively average density of woody plants, the woody flora of the forest massif presents species with a strong socioeconomic use that is a priority for revalorization. These assets militate in favor of strengthening the strategies of development and sustainable management of the forest massif.

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