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TOPOGRAPHIC CHARACTERIZATION AND VEGETATION DISTRIBUTION IN THE ACHACH FOREST: IMPLICATIONS FOR ECOLOGICAL ZONING AND SUSTAINABLE MANAGEMENT

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Abstract

This study presents a topographic and ecological characterization of the ACHACH Forest, focusing on elevation, slope, and aspect, and their influence on vegetation distribution. The forest exhibits an altitudinal range between 200 m and 800 m, corresponding to the thermo-Mediterranean bioclimatic zone. Analysis of slope classes reveals that nearly 80% of the terrain has low to moderate inclines (<20%), indicative of a relatively gentle landscape. Aspect distribution shows a predominance of north-facing slopes (22%), followed by northwest (15%) and west (13%), affecting microclimate and vegetation types. The spatial distribution of dominant species, including Tetraclinis articulata (Thuya), Pinus halepensis (Aleppo pine), Quercus rotundifolia (Holm oak), Quercus suber (Cork oak), and Eucalyptus spp., is strongly correlated with topographic variables. This research provides insights into local ecological dynamics and lays the foundation for ecological zoning and sustainable forest management.

Keywords: Topography, Vegetation Distribution, Forest Ecology, Ecological Zoning, Sustainable Management, Slope, Aspect, Elevation, Tetraclinis Articulata.

1. INTRODUCTION

Topographic factors such as elevation, slope, and aspect are primary drivers of vegetation distribution in Mediterranean forest ecosystems, influencing microclimate, soil moisture, and solar radiation (Kumar et al., 2020; McCune & Keon, 2002).

Understanding these relationships is crucial for ecological studies, conservation, and sustainable forest management (FAO, 2020; Quézel & Médail, 2003).

The ACHACH Forest, located in a semi-arid Mediterranean region, exhibits significant topographic heterogeneity, ranging from 200 m to 800 m in elevation.

Dominated by Tetraclinis articulata (Thuya), the forest also hosts Pinus halepensis, Quercus rotundifolia, Quercus suber, and reforested Eucalyptus species.

Previous studies in North African forests have highlighted the importance of topography for species distribution and ecological zoning (Benabid, 2000; Blondel et al., 2010).

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The Present Study Aims To:

- Characterize the topographic structure of the ACHACH Forest;
- Analyze correlations between topography and vegetation distribution;
- Provide baseline data for ecological zoning and sustainable forest management strategies.

2. MATERIALS AND METHODS

2.1 Study Area

The ACHACH Forest covers approximately 13,419 hectares, with elevations between 200 and 800 m.

The climate is classified as thermo-Mediterranean, with annual precipitation of 350–500 mm and mean annual temperature of 18°C (Benabid, 2000).

2.2 Topographic Data Collection

Digital Elevation Models (DEM) were obtained from GLOVIS and processed using ArcGIS 10.8. Slope and aspect were computed, and classes were determined as follows: slope <10%, 10–20%, 20–30%, >30%; aspects grouped as N, NE, E, SE, S, SW, W, NW.

2.3 Vegetation Survey

Fifty sample plots (20 × 20 m) were established across the forest. Species composition, abundance, and dominance were recorded.

Plant species studied included Tetraclinis articulata, Pinus halepensis, Quercus rotundifolia, Quercus suber, and Eucalyptus spp. Phytosociological analysis followed Braun-Blanquet (1964).

2.4 Data Analysis

Correlation analysis between topographic variables and species distribution was performed using ArcGIS and R software (R Core Team, 2023). Maps were produced to visualize spatial patterns of vegetation in relation to slope, aspect, and elevation.

3. RESULTS

3.1 Elevation

The forest ranges from 200 m to 800 m. The thermo-Mediterranean zone favors drought-resistant species such as Thuya and Aleppo pine (Benabid, 2000; Quézel & Médail, 2003).

3.2 Slope

Slope distribution: <10% (30%), 10–20% (50%), 20–30% (15%), >30% (<10%). Gentle to moderate slopes dominate, supporting soil stability and plant establishment (Poesen et al., 2003).

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3.3 Aspect

North-facing slopes dominate (22%), followed by NW (15%) and W (13%). South and SE aspects represent 10–11% each. Aspect influences solar radiation, soil moisture, and species-specific microhabitats (McCune & Keon, 2002).

3.4 Vegetation–Topography Correlation

- **Tetraclinis articulata**: dominates gentle, dry slopes (S, SW, W).
- **Pinus halepensis**: prefers sunny, well-drained slopes.
- **Quercus rotundifolia**: southern and southwestern slopes.
- **Quercus suber**: eastern and southeastern slopes, moderate humidity.
- **Eucalyptus spp.**: eastern slopes, benefiting from morning sun and slightly higher moisture.

4. DISCUSSION

Topographic parameters strongly determine vegetation patterns. Elevation defines bioclimatic conditions; slope affects soil retention and water availability; aspect influences solar radiation and microclimate (Kumar et al., 2020; Poesen et al., 2003). The observed species distribution aligns with prior studies in North African and Mediterranean forests (Benabid, 2000; Blondel et al., 2010).

The spatial analysis provides crucial insights for ecological zoning and forest management, suggesting that native species restoration should consider topographic preferences to enhance survival and ecosystem resilience (Lamb et al., 2005).

5. CONCLUSION

This study demonstrates a clear correlation between topography and vegetation distribution in the ACHACH Forest. Data from this study can guide ecological zoning, conservation planning, and sustainable forest management, particularly in semi-arid Mediterranean ecosystems.

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