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Landscape Degradation and Impact on Cultural Heritage in the Region of Fodele, Greece

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Abstract

It is well known that many areas in Crete Island are threaten by degradation and landscape deterioration due to drought, geology, steep slopes, overgrazing and urbanization. The examined area of Fodele is located 28 km from Herakleion, only 3 km from the Cretan Sea and exhibits aesthetic beauty of significant value due to the specific ecological, historical and cultural conditions. Fodele village is the birthplace of the famous painter Domenikos Theotokopoulos (El Greco), and many tourists visit worth seeing places during the summer. According to the Geological Map, the region consists mainly of schist and limestone, texture of the upper soil horizons is clay or clay loamy, whilst the soil organic matter content is low. In excavations started in 1993, were revealed ruins of buildings and valuable articles of the Minoan era. The old village with a lot of monuments is being threatened by desertification and other geological risks. Overgrazing which was a common practice a few decades ago, had affected the landscape of the area. Moreover, recent public works have reduced soil stabilization in conjunction with absence for maintaining and recovering the protective vegetation (brushwoods, shrubs and thermophylic plants), hence the risk of land deterioration has increased considerably. Management of degradation at local scale requires a multidisciplinary approach involving the collaborative efforts of scientist, public participation and policy makers. According to experience obtained some centuries ago, an effective measure for the protection of the sloping land should be the construction of terraces, supported by dry stonewalls. The following measures and practices against landscape degradation should be suggested: banning of grazing, establishment of protective vegetation that is well adapted to dry climatic conditions and construction of terraces, wherever this is economically feasible. Policies for hilly and mountainous areas, and simplification of existing laws is suggested for an effective environmental protection. Priorities of environmental protection in the area are suggested to be focused on deforestation, rational management of rangeland, and restoration of hydrologic conditions.

Introduction

Hilly or mountainous soils in Crete Island are usually degraded and occur on alluvial or colluvial deposits. The study area of Fodele (Fig. 1) concerns a district where olive trees is the dominant perennial crop and erosion has affected the loss of surface soil horizons resulting in landscape deterioration. The degree of soil degradation varies greatly and landscape has been affected mainly by climatic conditions and human activities. Cardoso (1965) stressed that soils in the Mediterranean region were formed on limestone parent material and that their argillic horizons were developed *in situ* during neogenesis but climatic conditions were different than current conditions. According to data provided by the National

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Meteorogical Service, mean maximum monthly air temperature is 28.7 °C (July), mean minimum is 9.0 °C (January) and annual precipitation is on average 460 mm. The soil moisture regime is *xeric* and water deficit occurs from mid–April to mid–October. Additionally, the Mediterranean climate is characterized by several months of drought, and *xeric* soil moisture regime is defined by the length of summer drought. However, the study area belongs to the *thermo*–Mediterranean bioclimatic zone (UNESCO/FAO, 1963).

Fig. 1. Simplified map of Greece

The objectives of this study was to extend our previous work conducted in the adjacent area of Mallia (Crete Island), in order to provide additional data which may be used in a uniform way for management. Furthermore, to elucidate some of the potential factors that could have led to the deterioration of landscape. Selected properties are explained and attention has been paid to interventions and practices for sustained landscape management.

Materials and Methods

Five representative soil samples were collected from surface and subsurface horizons and mixed thoroughly. The selected samples were taken from eroded surfaces, air–dried, ground and sieved (<2 mm). Particle size distribution was determined by the Bouyoucos hydrometer method (Gee and Bauder, 1986) and pH values were measured in a 1:1 soil–H_2O suspension (McLean, F. 1982). A modified wet digestion Walkley and Black method (Nelson and Sommers, 1982) was used for the organic matter determination. The exchangeable K^+ and

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Na^+ were determined (Thomas, 1982) using a flame photometer, and both Ca^{++} and Mg^{++} were measured with an atomic absorption spectrophotometer (Varian Techtron 400AA–Plus). Available phosphorous was extracted from acid soils by using the modified Bray method (Kuo, S.. 1996). The plant-available iron (Fe), manganese (Mn), zinc (Zn), and copper (Cu), were extracted with 0.005 M DTPA (Lindsay, W.; Norvell, W. 1978), whilst the azomethine-hydrogen method (Keren, 1996) was used for the soil available boron (B).

Results and Discussion

The examined soils are located on backslopes and exhibit high risk of erosion especially during the winter rainy period. Most of surface horizons are acidic as a result of the removal of $CaCO_3$ due to leaching and have been classified as *Alfisols* (Soil Taxonomy, 1999). They consist of well–developed argillic (Bt) horizons which are exposed on the surface, as a consequence of erosion. Olive trees, rainfed grain crops, and vineyards are the common land utilization types on slopping terrains.
The soil pH of samples ranged from 5.9 to 6.1 and the soil organic matter content varied 13.7 and 10.8 g kg $^{-1}$ (Table 1) as it is common for the most Greek arable soils (Yassoglou, 1995).
In these soils the clay content is high and ranges between 55 and 62 %. Concerning the exchangeable cations, Ca^{++} is the most abundant and the content of Na^+ seems to be very low. Although Greek soils contain sufficient amounts of potassium, it seems that the studied soils constitute an exception. The available phosphorus content was very low and ranged between 2.0 and 3.0 mg kg $^{-1}$. The level of Fe, Mn, Cu and Zn extracted with DTPA, is presented in Table 2. It can be concluded that the status of B was at normal level for most of the main crops. Available micronutrients Fe, Mn, Cu and Zn were generally found below the sufficiency levels to sustain crop production (Mengel and Kirkby, 1979; Martens and Lindsay, 1990) and decreased with depth. It can be argued that low content of soil organic matter, exchangeable potassium (K^+), phosphorus (P) and certain micronutrients, are among limiting factors for high yield.

Table 1. Basic soil properties from a representative samples from Fodele

samples	pH 1:1	$CaCO_3$ %	Sand	Silt	Clay	Org.M. g/kg	Exchang. cations cmol/kg				P Bray mg/kg
							K^+	Na^+	Ca^{++}	Mg^{++}	
surface	5.9	0.0	30	8	62	13.7	0.31	0.19	7.54	0.80	3.0
subsurface	6.1	0.0	38	10	52	10.8	0.29	0.18	9.12	0.75	2.0

Table 2. Content of micronutrients in the examined soils

samples	B	Fe	Mn	Cu	Zn
		g/kg			
surface	0.64	4.3	5.72	0.36	1.10
subsurface	0.41	3.5	4.30	0.34	0.84

The differences in concentration and distribution of the available micronutrients may be attributed to parent material heredity, microrelief and human activities such as tillage and urbanization. Liming of the acidic arable soils should be suggested for increasing of trace elements availability. The influence of micro–climatic conditions, human activities and the organic carbon content have affected soil properties and characteristics. Minimum tillage, and construction of terraces supported by dry stonewalls wherever is economically feasible, are

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essential practices to control erosion. Introduction of proper irrigation schemes for water saving, and protection from grazing are essential for sustainable management, whilst the preservation of soil organic matter may enhance soil fertility.

Higher susceptibility to erosion was observed in the steeper slopes and the risk became higher due to urbanization. Erosion and geological risks have affected cultural heritage and the natural landscape of the old village of Fodele. The environmental degradation due to high seasonal tourist activity in the wider area of Fodele, is mainly identified in the excessive number of roads leading to coastal zones, irrational water consumption during the dry periods, high production of wastes, etc. Various alterations, including placement or excavation of substantial material, should be prohibited. In general, landscape architects are expected to be involved in historic preservation and land reclamation. A programme for the sustainable development should be implemented by local authorities, aiming at the balanced integration of tourism activity in the natural environment according to its carrying capacity.

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