ENVIRONMENTAL RESTORATION AND IMPROVEMENT IN THE MEDITERRANEAN LANDSCAPES OF GREECE: SUSTAINABLE USE OF PLANT SPECIES-A REVIEW

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Abstract- Greece is a part of the Mediterranean zone that has contributed to a great biological diversity and shelters a vast array of ecosystems and landscapes with a high endemism rate in plant species. This study provides a review of the ecological use of plant species for environmental restoration and improvement of the Mediterranean landscapes in Greece. A noteworthy fact is that Greek - Mediterranean flora offers a great variety of species, from which we can choose the most suitable for possible interventions, favoring sustainable management and development. Using plant species for habitat restoration can contribute to long-term protection and enhancement of our natural and cultural heritage as well as landscape protection, management and planning. Furthermore, using native plants can increase ecosystem resilience to climate change and combat the proliferation of invasive alien plants. Nowadays, the restoration of an ecosystem is not just an act or a project, but rather something mandatory in the context of sustainable management and development. The study of the literature review for environmental use of plant species for environmental restoration in the Mediterranean region will be continued in the next years.

Keywords- Ecosystem, degradation, biological diversity, flora, sustainability.

I. INTRODUCTION

1.1 Spatial data of abiotic environment in Greece

Greece, with a population of 10.500.000, spans 132.000 km^2, is a part of the Mediterranean zone, the Palaearctic bio-geographic region and is located in the southern part of the Balkan Peninsula (Map 1). It is a region characterized by diverse climate (29 climatic zones according to the Thornwaite climate classification), something that is attributed to its geographical position, the diversity of its ground morphology and the presence of sea water. Nonetheless, at the majority of its extent, this area's climate can be considered Mediterranean, inhabiting mild, wet winters and warm, dry summers (Karras, 1973, Ministry of Environment, Energy and Climate Change, 2014).

It is a country with 2/3 of its territory covered by mountains of medium height (approximately1500 m) while it also showcases a great variety of geomorphological formations (large number of caves and other underground structures), rock formations (Prealps , Alpine and post alpine) and all categories of soils formed under Mediterranean climatic conditions (entisols, inceptisols, alfisols, vertisols).

The combination of all these factors mentioned above have contributed to a great biological diversity, while many ecosystems have been characterized as protected due to the high number of endemic and rare species of fauna and flora (The habitats Directive 92/43 / EEC and the NATURA 2000 network, 1998, Ministry of Environment, Energy and Climate Change, 2014).

II. THE PRESENT STATE OF FLORA BIODIVERSITY IN GREECE

Greece shelters a vast array of ecosystems and landscapes with a high endemism rate in plant species. Greece's flora is comprised of 5752 species and 1893 subspecies of angiosperm plants that represent the 6600 taxa that belong to 1072 genus and 185 different families. Greece is also a hotspot of biodiversity in the Mediterranean, harboring 1278 endemic species (22.2% of total species number). The greatest rate of endemism is found in the southern areas of the country (Strid, 1997; Strid and Tan, 2002; Tan and Iatrou, 2001; Georgiou and Delipetrou, 2010; Dimopoulos, et al. 2013).

Regarding endemic plants in Greece, 253 species (18% of the total number of indigenous species) are considered endangered and are subject to one of the following categories: IUCN vulnerable, threatened or severely threatened. During the past 15 years there have been two Red List books published with a case study built on Greece. The total number of species that have been studied in these books is approximately 460, a number that adheres to only 8% of the country's flora (Phitos, et al. 1995; 2009).

III. ECOSYSTEM DEGRADATION AND RESTORATION

Ecosystem disturbance is defined as a shift in the structure and synthesis of a biocoenosis through the modification of the environment and the change in resource availability (Drake et al., 1989). For

example, ecosystems in which mining is present are considered severely degraded. Severely degraded ecosystems are those in which flora and fauna have been eliminated while topsoil has been removed (Brofas, 2011).

Restoration of degraded ecosystems usually includes storing and relocating topsoil, sowing, fertilizing and covering degraded areas with trees and shrubs (Fox et al., 1996). The desired goal of this restoration is usually the return of the ecosystem to its previous state regarding biodiversity, structure and ecosystem function. However the amount of time and effort required for ecosystem restoration might be significant. A common and realistic means of evaluation of the restoration process is comparison to undisturbed ecosystems which possess the desired ecological features (Aronson et al., 1995). These areas of reference must be neighboring to the degraded ecosystems we are trying to restore since structure, function and other environmental parameters are more likely to be similar in these ecosystems. Ecological restoration is a relatively new field in environmental science which studies all the functions and processes that bring a degraded ecosystem to its proper, previous form. As a result, it is a multidisciplinary field that encompasses knowledge from applied ecology, botany and landscape architecture. Ecological restoration was originally expressed as a term in 1935 but it was defined during the late 80's (Jordan et al., 1987).

Today various definitions are applied to ecological restoration (NRC, 1992; Jackson et al., 1995; SWS, 2000) but they all have a common component: reversing the disturbance cause by human interaction. According to the Society for Ecological Restoration (SER, 2002) and IUCN (1986), ecological restoration is defined as the process during which a degraded ecosystem's health is restored. This definition is a very wide one, indicating that restoration is not a theoretical notion but something applicable which involves social and environmental factors. The soil and vegetation of an area support a number of plants and microbial communities while biotic and abiotic interact, putting together what we know as an ecosystem. This ecosystem is affected by, mainly, environmental conditions such as climate. Furthermore, an ecosystem has two main characteristics: its structure and its function. These two factors can me examined in order to evaluate the extent of the degradation of an ecosystem after human interaction or natural disasters. Prior to ecosystem degradation, its functions and structure are variables that are bound to high values, while after degradation one or both of these values decline to zero. If a degraded ecosystem is neglected and not subject to restoration there is a high probability that it will restore itself at some point (Bradshaw, 2002). To conclude, this is how disturbance, restoration and ecological replacement are linked. This theory is depicted at the diagram below (Fig. 1).

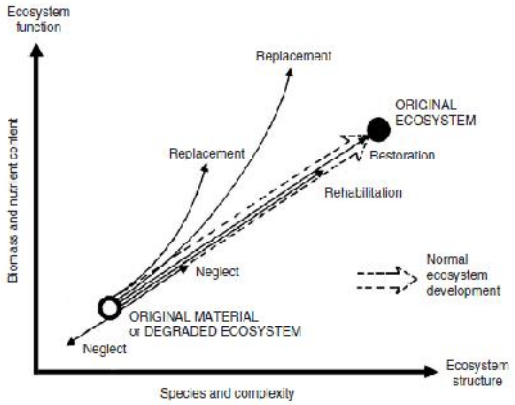


Figure 1. The structure and operation are two characteristics that play a very important role in the decline and resurgence of an ecosystem. When degraded ecosystem, both features are reduced (Bradshaw, 1984).

IV. VEGETATION FUNCTIONALITY AND SELECTION OF APPROPRIATE SPECIES

The presence of vegetation serves many purposes in various areas. These purposes include: soil protection from surface erosion, surface or installation concealment, soil stability and improvement, noise reduction, providing food and shelter for fauna, and improved aesthetic landscape characteristics (Gray and Sotir, 1996).

Regarding the selection of appropriate species for establishing vegetation, a basic priority in the matter is utilizing indigenous plants that are compatible with the natural plant community that is already present in the area that is to be restored. Particularly, must be preferred prodromal plant species that will form the basis for the development of plant community (Chatzistathis and Ispikoudis, 1995; Valiantza et al. 2006).

Species that can be selected (in order of priority) are the following: 1) Prodromal indigenous species, 2) Prodromal species that are differentiated from the already present vegetation and possess the ability to adapt to unfavorable soil parameters 3) Non prodromal species that belong to the vegetation that is already present, 4) Non prodromal species that can adapt to unfavorable soil parameters. Indigenous plant species are defined as those that come to or are established in an area or an ecosystem without direct or indirect human intervention. 5) Adaptability to non favorable conditions, 6) Morphology. The most suitable candidates among plant species that ensure protection from surface erosion are shrub species. 7) The specie's ability to reproduce. Species that are easily bred via sporulation should be preferable. 8) The specie's root morphology. Species that can quickly develop a strong root system are favored. 9) Flammability of the species. 10) The ability of the species to revegetate after circumstances such as a wildfire. 11) The duration of foliage. Evergreen species are preferable. 12) Species that produce a small amount of biomass per area measured are

preferable as there is a smaller chance of wildfire and less growth requirements. 13) The specie's aesthetic value. During species selection, it must be take into account that in adjacent areas to disturbed soils, many species coexist as fixed plant communities as the result of the interplay of biotic and abiotic factors over time. This interaction is complex and a simple indexing or even utilization of the very same species, using the same cover rates, may not be efficient or possible in large-scale restoration (Table 1) (Coppin and Richards, 1990; Alifragis, 2002; Valiantza et al., 2006).

Table 1. Indicative catalog of trees, shrubs and herbs proposed to restore vegetation in disturbed areas (Case Study in Ancient Olympia in Greece) (Lyrintzis et al., 2011).

Trees	Shrubs	Aromatic plants
Quercus ithaburensis Decaisne ssp	Pistacia lentiscus L.	Rosmarinus officinalis
Quercus pubescens Willd.	Fraxinus omus L.	Santolina rosmarinifolia
Quercus ilex L.	Nerium oleander L.	Lavandula angustifolia Mill.
Quercus coccifera L.	Vitex agnus-castus L.	Artemisia arborescens L.
Pinus pinea L.	Arbutus unedo L.	Thymus sibthorpii Bentham
Populus alba L.	Arbutus andrachne L.	Origanum majorana L.
Populus alba L.	Arbutus andrachne L.	Origanum majorana L.
Cupressus sempervires L.	Acer sempervires L.	Mentha piperita L.
Laurus nobilis L.	Viburnum tinus L.	Satureja thymbra L.
Olea europaea L. ssp oleaster	Sparteum junceum L.	
Cercis siliquastrum L.	Rhamnus alaternus L.	
Tilio tomentosa Moench.	Cotinus coggygria Scop.	
Pistachia terebinthus L.	Phlomis fruticosa L.	
	Phillyrea latifolia L.	

CONCLUSIONS

The restoration of an ecosystem is not just an act or a project, but rather something mandatory in the context of sustainable management and development. Ecosystem restoration aims to improve not only the aesthetics of a landscape but also to reverse all degradation factors (therapeutic intervention) and to accelerate the recovery speed of an ecosystem while also increasing its biological value.

Our investigation shows that vegetation resettlement methods in disturbed soil, mainly by seeding or planting seedlings of local native flora, are the most economical and at the same time eco-friendly methods. A noteworthy fact is that Greek - Mediterranean flora offers a great variety of species, from which we can choose the most suitable for possible interventions, favoring sustainable management and development.

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