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High Performance Plant Selection for Landscape Reclamation in the Subtropic Climate Zone: A Case Study

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Abstract: The unplanned urbanization, industrialization, tourism, construction of barrages and the areas like airports, have exhorted pressures on the natural resources of Turkey. The wrong decisions in the land- use have caused the disruption and destruction of forests, agricultural and other natural areas. In this way, the ecological balance formed for millions of years have been deteriorated. Because of these reasons, the importance of landscape reclamation for Turkey can be understood. Plants are the most effective materials for landscape reclamation practices. But they must be chosen and used correctly. Several researches including vegetation studies on the field and road side slope stabilization with plants helped to list herbaceous perennials, shrubs and trees for reclamation purposes for the Mediterranean and Aegean Regions with their peculiarities such as ecological needs, size/shape and sensibility to environmental factors.

Key words: Landscape reclamation, Mediterranean and Aegean Regions in Turkey, sub tropic zone, shrubs and trees, herbaceous perennials, plant selection

INTRODUCTION

Soil erosion increased throughout the 20th century. About 85% of land degradation in the world is associated with soil erosion[1]. When vegetation cover is low and the soil is loosened, soil erosion increases and its fertility decreases. This phonemon leeds to the degradation of the ecosystem through destruction of the soil structure[2]. Building highways, dams and open pit mine works cause drastic changes in environment. By using live plant material for landscape reclamation, ecosystem can be restorated in an ecologically correct manner[3].

Especially in rural areas, using of plant, stone, concrete, soil and metal is called landscape reclamation[4]. For the reclamation and revegetation of slopes and highway embankments both local and exotic hardy herbaceous and woody species were selected for the creation of semi-natural, multi-layered plant communities. These are established as mixtures of fast-growing and soil protecting low cover pioneer plants together with slower growing, but taller and more persistent, soil ameliorating shrubs and trees in a condensed successional process by vegetation engineering, hydro-seeding and afforestation methods[5].

Reclamation is often thought of in terms of re-vegetation and this is not unreasonable. Planned re-vegetation of a mine soil controls erosion, puts the soil back into useful production and creates an aesthetically pleasing terrain[6]. Restoring self-sustaining tropical forest ecosystems on surface mined sites is a formidable challenge that requires the integration of proven reclamation techniques and reforestation strategies appropriate to specific site conditions, including landscape biodiversity patterns. Restorationists working in most tropical settings are usually hampered by lack of basic information on the wide variety of native tree species that characterize the pre-disturbance forests, as well as insufficient understanding of the ecology of disturbance and natural recovery to design effective restoration programs[7]. Planting of perennial crops cause less severe erosion and it limits soil loss, especially in the tropical areas. The introduction of a hay crop into a perennial crop reduces erosion, improves soil fertility and helps maintain populations of predator. The proposal to produce perennial grains has been faced by several agroecologists that expect reduced input like tillage and chemical fertilizers. However, at the moment, perennial grains are too low in productivity and much research effort is needed to improve these candidates[8].

When planning the re-vegetation of land the first priority is to a select the eventual land use as this can affect the restoration strategy. Otherwise the restoration

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of derelict areas may offer a variety of potential land uses, ranging from agricultural and amenity use to land suitable for housing and industry[9].

Total area of Turkey is 78 million ha, which have been divided to agricultural areas (36%), forest and maquis (30%) and pasture land (8%). In the country whose topographic structure is varied and which is distributed between the sea level and 5165 m height, the mean height is about 1250 m. The 22.1% of the soils have slope between 0.6% and the rest have a slope more than 6%. Yearly rainfalls are between 250 and 2500[10].

The sub tropic climate zone in Turkey comprehenses some part of the Aegean Regions' coast and the overall of the Mediterranean Regions (Subtropical zone of Turkey). The temperature is this region is between 14-18°C. The summers are arid and the winters are rainy. The Mediterranean regions of Turkey are more rainy and consequently more damp according to the other Mediterranean Regions. The humidity is high especially in summers. In the areas where these forests are damaged, evergreen maquis can be seen. Among the species that form the maquis vegetation are mostly *Quercus coccifera, Arbutus andrachne, Arbutus unedo, Ceratonia siliqua, Calycotome villosa, Laurus nobilis, Myrtus communis, Olea* sp., *Pistacia terebinthus, Pistacia lentiscus, Phillyrea latifolia, Cercis siliquastrum, Nerium oleander, Vitex agnus-cactus* etc. At the areas where the maquis is damaged there are *Sarcopoterum spinosum, Poterium spinosum, Cistus salvifolius, Jasminum fruticans, Erica arborea, Erica manipliflora, Erica verticallata* that have a height of 30 cm. Although maquis is the primary vegetation in the Mediterranean Regions other than Turkey, it is a seconder shrub-group developed as a result of the damaged forest in Turkey[11]. Mediterranean and Aegean Regions, in spite of their limiting factor as dry hot long summers, have rich natural vegetation for landscape reclamation and ecosystem restoration.

Turkey is one of the important gene centers of the world with particular reference to plant genetic resources[12]. During the period of hundred years of industrialization on the parallel lines, the world threatened population density, diversified polluted species, forest fires, expansion of agricultural lands, dryness of wet- land and unawareness and excessive use of resources have subsequently decreased the important species of flora and fauna that consequently disrupted the ecological balance[13]. This degradation is especially seen in the coastal line of the subtropic zone of Turkey. For example, in a research made in the west coasts of Turkey; the coastal zone between Küçükkuyu and Edremit has special valve from the viewpoint of biodiversity due to the variety of plant assemblages demonstrated. Anthropogenic factors play an important role in the degradation of natural vegetation (i.e. land use practicses have changed in the Edremit area)[14]. Mediterranean upland ecosystems in Israel were threatenend by the combined impact of traditional and neotechnological landscape degradation, caused by exponentional population growth, urbanization and industrialization. In order to reconcile the need of sustaining and improving the open Mediterranean landscape with socio-economical advancement, comprehensive landscape masterplans are urgently required. Within such masterplans, drought resistant plants should play an important role in the ecological rehabilitation, stabilization and beautification of denuded and man-made habitats[5].

MATERIALS AND METHODS

The study area is located along the Aegean-Mediterranean coast of Turkey (between 35°-40° North and 26°-38° East) from 0 to 3.700 m in altitude. The climate is characterised by mild rainy winter and hot dry summers. The mean annual temperature ranges between 1 (high mountains) to 19°C (coastal areas). The annual rainfall mainly ranges between 400 and 1200 mm, concentrated in the winter months. The vegetation is characterised by typical Mediterranean formations such as the maquis, garrigue and coniferous forests. The maquis and *Pinus brutia* forests dominate the coastal part. The garrigue formation occupies the stony and arid areas where the maquis and *Pinus brutia* forests have been destroyed. High and inland areas are covered by coniferous forests with *Pinus nigra, Cedrus libani* and *Abies cilicica*. This territory includes zones affected by heavy human pressure (overgrazing, over cultivation, deforestation, forest fires and tourism) and abandoned lands[15]

The research method is formed of different stages. In the first stage, the areas in the subtropical climate zone of Turkey and the disruptions formed in the natural landscape are tried to be determined by scanning the indigenous and foreign literature. Besides the observations made on the field it was benefited from the studies of Altan[16], Davis [17], Ekim [18], Korkut [19] and Yilmaz[20,21] especially in the determination of the plants that are found naturally in the subtropic climate zone of Turkey. In the second stage, the role and importance of plant material for landscape reclamation has been emphasized. In the last stage, a plant use matrix has been developed to be used in the landscape reclamation studies in the Aegean and Mediterranean Regions that form the subtropical zone of Turkey. Thus, it is aimed to

ensure the consideration of the aesthetic and functional properties of the woody and herbaceous plants that may be used in decreasing the problems at the landscape reclamation studies in the region.

RESULTS

The role and importance of plant material for landscape reclamation: It is impossible to deny the importance of using plant material for their multipurpose uses. In many situations the naturalness of vegetation will be important not just because natural wild species are likely to survive better, but because of wild life considerations. Exotic species are often introduced into an area for good reasons, but they can give problems and sometimes get out of hand and disrupt the natural balance of species[22]. Landscape design for reclamation projects, especially the bioengineering branch require fast growing, easy to cultivate and resistant plant forms such as: *Populus* sp., *Salix* sp., *Betula* sp., *Alnus rubra*, *Alnus rhombifolia*, *Sorbus americana*, *Quercus rubra*, *Robinia pseudoacacia* and diverse bushes, grasses and forb types[23].

The functions of plants for landscape reclamation are[21,24];

- They protect the surface of the soil by absorbing the energy of raindrops.
- They decrease the flow of water and air thus decrease the soil erosion by covering the soil surface up to a certain height.
- They decrease the extremes of the soil by covering the surface.
- They decrease evaporation thus decrease the sensitising of soil against erosion by shading the soil.
- They increase the organic contents of the soil that helps the water arresting capacity of the soil and decrease the efficiency of the factors causing erosion, by the remnants of the plant.
- Significant improvements can be gained to establish ecological balance by planting.
- The plants are strengthened by time on the contrary to the other reclamation materials.
- They both add pleasant visual values and mask the unpleasant views, odours, noises.
- Using plant is more economic in long-term application.
- Create positive psychological effects on human being, which have innumerable benefits.

There are some environments to which plants of one species or another have not become adapted, though as a general rule the more extreme the environment, the fewer the species those are available. Also, in harsh environments, growth rates and over all productivity is very low[22].

Re-vegetation techniques: When re-vegetating the problematic and naked areas in many ways, in the selection of the plant material; ecological factors, the amount and the price of the plants, equipment of application, availability and quality of workers, etc. are taken into account[21,25].

- Seeding methods are; broadcast seeding, hydro seeding, spot seeding, dry mulch seeding, seeding trees and shrubs. But the most efficient methods is hydro seeding by using water, adhesive, fertiliser, mulch, chemical stabiliser with the mixture of woody and herbaceous plant seeds[21,25].
- Cutting and division of the re-vegetation methods. Division of woody and herbaceous plants is a successful application in suitable environments for they have roots to establish the physiological (water) balance and get a grasp on slopes. On the other hand in the slopes with sufficient soil moisture cuttings of woody plants especially *Salix* sp., *Cotoneaster dammeri*, *Tamarix* sp. can be used both as a living material, which strengthen and spread by time and also as a constructional soil stabilizer. There are many methods created with this material such as woven fences, brush mattresses, branch mats, fascine mats wattle fences, cordon construction, brush wattles, slope fascines, hedge layer, brush layer, hedge brush layer, placing of cuttings in to wall joints, crib wall construction with branch layering, live crib walls, live concrete walls, vegetated gabions, live slope gratings, vegetated palisade and pole construction etc.[3,21,25].

In addition to these, planting bare rooted plants during the dormancy period, laying turves and the plants grown in any container type, are the most used planting methods.

The correct selection of the plant material application in the correct season, preparing the soil and combining the contraction of methods increases the success. Especially in the Mediterranean and Aegean regions the conservation of the soil water is the key factor. Moisture conservation chemicals, mulching and late fall plantations ensure more successful results.

Plant selection criteria: The plants used on damaged areas have some peculiar characteristics. The factors for plant selection can be summarized as;

- All the ecological and micro ecological structure of the study area must be known (soil, hydrology, climate, topography etc.) and the most suitable plants for these very special environments should be selected.
- Deep, wide and strong rooted, densely branched and effectively leaved soil covering plants can be used.
- Easily obtainable and easily propagated plants must be selected.
- Plant should be resistant to pest, disease and frost, smoke and dust.
- Plant should have a regeneration ability.

DISCUSSION

Some plants for landscape reclamation in the Mediterranean and Aegean Regions of Turkey: In the Mediterranean-type areas the potential for the use of plant material for soil stabilization is therefore relatively good if the minor constrains to plant growth resulting from seasonal water shortage can be overcome. However, the dry summer period has another effect of increasing the risk of fire, which is regarded as a natural component of the Mediterranean-type ecosystem. This can pose a potential threat to the engineering applications of the vegetation and because it tends to occur during the dry summer months, its effects are longer lasting and persist for several years before the full regeneration of the vegetation cover takes place[22].

For the selection of the plant material of the Mediterranean and Aegean regions for landscape reclamation purposes, the ecological circumstances that change locally and frequently must taken into consideration. Even north and south facades of the same hill require different material and methods.

For different cases, all properties such as the geographical situation, geological structure, geomorphology, hydrogeology, soil, climate and vegetation must be studied and analysed separately. The plant material can be selected with the given plant use matrix (Table 1).

Table 1: The plant use matrix for landscape reclamation in the Mediterranean and Aegean Regions of Turkey[8,21,26,27]

	Name of plants									
Trees	Evergreen	Faster growing	Drought hardy	Growing on wet soil	Sun-hot hardy	Shadow hardy	Growing on steep slopes	Lives on seaside	Tolerant to fire	Growing on poor soils
Acacia cyanophylla	•	•	•		•		•	•		•
Ailanthus altissima		•	•				•		•	•
Cercis siliquastrum				•						•
Ceratonia siliqua	•		•		•		•	•		
Eleagnus angustifolia			•		•		•	•		•
Gleditschia triacanthos			•		•					•
Parkinsonia aquelata			•		•					•
Robinia pseudoacacia		•	•		•					•
Schinus molle	•	•	•		•				•	
Shrubs										
Calicotome villosa	•		•	•			•		•	
Cistus creticus	•		•	•			•	•		
Cistus salvifolius	•		•	•			•	•		
Cotoneaster dammeri		•			•		•			•
Cytisus scoparius			•	•						•
Ephedra campilopoda	•		•				•			•
Genista acanthociado			•	•	•		•			•
Jasminium fruticans		•	•	•			•		•	
Lavandula stoechas	•		•	•			•		•	•
Lonicera xylosteum					•			•		
Lycium halimifolium	•				•			•		
Origanum smyrneum			•	•			•			
Pistacia lentiscus	•		•	•			•			•
Phyllirea latifolia			•							•
Pyracantha coccinea		•								
Salix purpurea		•			•	•	•			
Salix repens				•		•		•		
Salix viminalis					•	•	•			•
Spartium junceum	•		•	•			•			•
Sarcopoterium spinosum			•	•						•
Tamarix sp.			•	•			•	•		
Ulex europaeus				•	•			•	•	
Herbaceous perennials										
Coronilla varia	•	•		•	•		•		•	•
Lotus corniculatum		•		•			•			•
Melilotus alba	•	•					•			•
Onobrychis sativa	•	•	•	•			•			•
Salvia triloba	•	•	•	•			•			•
Thymus serpyllus			•	•			•	•		
Trifolium repens	•	•			•		•			•

• Represent that the related species has the specific feature

Some of natural plants can be widely utilized in landscape planning studies for urban and rural areas in Turkey. However, it is necessary to carry out trials under field conditions to determine the adaptation and regeneration abilities and also propagation methods of natural plants.

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