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SECTION 8. Architecture and construction.

A CHECK LIST OF MEDITERRANEAN PLANTS TO CONTROL EROSION IN TURKEY

Abstract*: Soil loss by erosion has been defined as a global problem since the vegetative dispersal diminished in recent years. The erosion is severe in European countries where vulnerability of the agricultural fields has been alarming. Turkey has been experiencing a serious land degradation issue due to erosion with approximately soil loss of 500 × 10^6 t y^{-1} and 83.21% of agricultural lands are estimated to be under risk. Also, there is a gap in the literature about how to select the plant species for erosion control and management in Turkey. Therefore, the aim of this study was to create a check list of some erosion control plants which can be planted in Mediterranean region of Turkey. Providing a check list for increasing the density of vegetation against soil erosion can help land owners and managers to maintain the farmlands and forest cover and pioneer decision-making plans. By this way, prospective researches may benefit from the erosion control plant species and easement of their selection process.*

Key words*: Erosion control in Turkey, erosion prevention, soil degradation, soil loss.*

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1. Introduction

Vegetation is one of the most important components of the soil. It is essential that the topsoil coverage is a precaution against the erosion. Soil erosion can be defined as "*the process by which wind, water, ice, and gravity wear away the land's surface*" [1]. According to [2] the substantive topsoil transformation happens during the flow of water, declining the soil quality, lack of nutrients in the subsoil, and decreases permeability that induces developing run-off and therefore speeding soil erosion.

One of the best ways to decrease erosion is to maintain and improve vegetative cover of the soil. Most of the researchers around the world have been investigating new ways and methods to increase the amount of vegetation by afforestation and land management activities. The fact that the population of the world has been substantially going up fast, many woody lands and green areas have been invaded by human activities. Thus, people have been negatively affecting the nature by deforestation activities, degradation of the soil, and causing to the increase of erosion [3].

Soil loss by erosion has been defined as a global problem since the vegetative dispersal diminished in recent years. For instance, [4] have researched that in Italy, the annual soil loss rate can reach 100-150 t/ha per year. The erosion is severe in European countries where vulnerability of the agricultural fields has been alarming. Forest harvesting, especially, has been implemented before regrowth of young trees causes an increase of sediment yield from a forest catchment. In the later of 20th century, some catchment experiments were done by professional environmentalists to investigate the impact of rising vegetation on decreasing soil erosion [5].

Erosion has been causing a serious land degradation issue in Turkey with approximately soil loss of 500 × 10^6 t y^{-1} and 83.21% of agricultural lands are estimated to be under risk of water erosion [6]. Also, there is a gap in the literature about how to select the plant species for erosion control and management in Turkey. Therefore, the aim of this study was to create a check list of some erosion control plants which can be planted in Turkey.

2. Material and Methods

2.1 Study Area

Turkey is located as a bridge between Europe and Asia continents. The population of Turkey was 74.4 million in 2011 based on Address-Based Population Recording System. The country's surface area, including lakes is estimated 783,562 km^2 of which 755,688 km^2 are in Southwest Asia and 23,764 km^2 in Europe. It is connected and surrounded by three seas; the Aegean Sea on the west, the Black Sea on the north, the Mediterranean Sea on the south. The Sea of Marmara is also compassed within the north-west side of the country. Turkey has a high topography, and there have been 3 levels of vegetation recorded along with the forest belts as broad-leaved deciduous, coniferous, and alpine grass. The country has a forest cover of 22 million ha which is equal to 27% of total land cover. The climate consists of three different types as Black Sea climate, Mediterranean climate, and continental climate due to country's geographical location and topographic features [7].

3. Results and Discussion

The majority of soil erosion occurs due to the transportation of the topsoil by active gullies, concentrated water flow, rills, and soil pipes [2]. In contrast to these erosion types, the vegetative cover with deep root plants holds the biomass and also has highly beneficial soil particles which aggregate topsoil. More importantly, an intensive root disperse enhances the soil strength and these high dense rooted-plants in topsoil lead to create hedgerows preventing productive topsoil particles from running off (Figure 1) [8]. Dense root network and high vegetative cover on soil surface can be also observed in grassed waterways which provide substantial soil cohesion, limits surface wash, and prevents channel incision (Figure 2) ([9]; [1]).

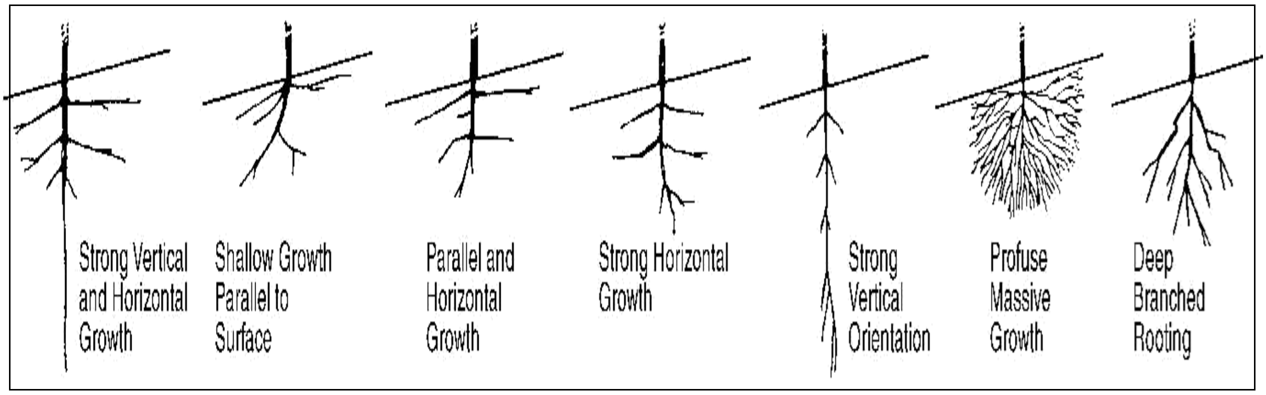

Figure 1. Types of root growth and development [1].

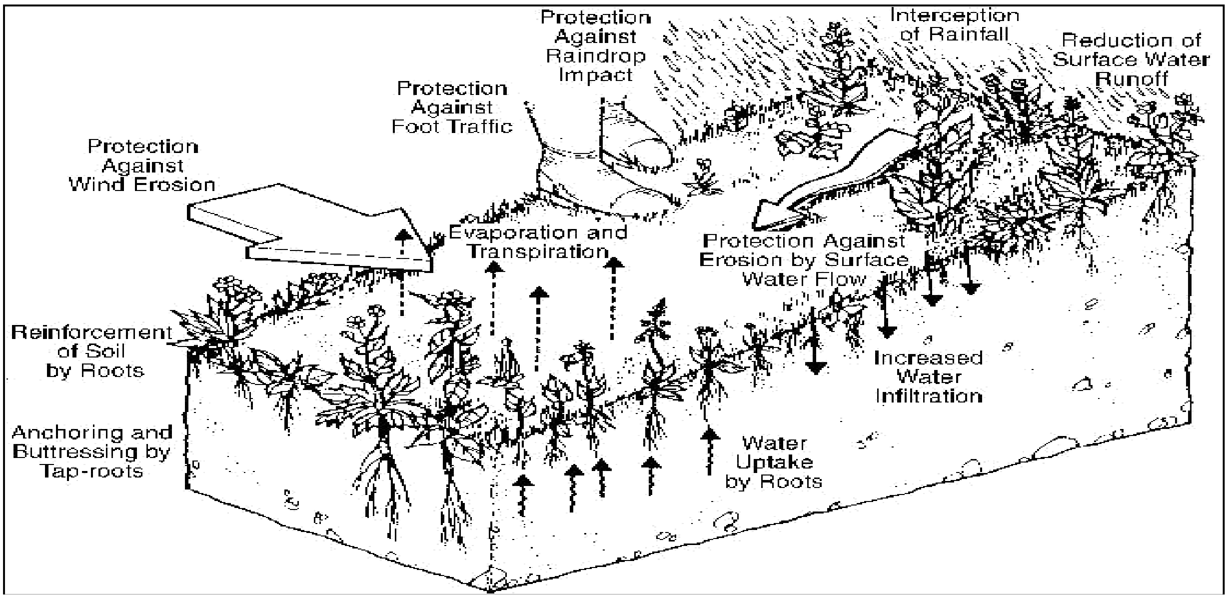

Figure 2. The influence of vegetation on soil erosion [1].

The probability of erosion is very low if the range of vegetation on a land is >30%. Especially on channels, vegetation type has a significant effect on sediment flows and soil loss. The sediment flow causes to the physical, chemical, and biological hazardous results in North America 16 billion dollars each year and studies have not sufficiently emphasized the economic hazard of the stream channel degradation [10].

Furthermore, one major factor leading soil erosion is human-effects such as deforestation, traditional tillage instead of applying conservational methods, accelerating numbers of construction activities. Unconscious agricultural methods particularly play an important role on accelerating soil erosion amount. Human activities may induce soil erosion zones to reveal and one of the best examples of this can be defined as farming. Once indigenous vegetative cover is altered by non-native species, the type of soil, its productive minerals, and biomass considerably reduce due to replacement. Therefore, any alteration on vegetative cover might result with soil loss and less sediment flow [11].

2.2 Selection of plant species

The type of species in a vegetative cover is very important to restrain the degradation effect of soil erosion. The aggregate stability, infiltration rate, soil erodiblity factors are directly influenced by the plant selection and plant disperse. A group of plant species can respond the erosion more effective than a single type of woody or herbaceous plants existing in the soil. Mixture species are more efficient to fill the gaps in the soil with adapting the environmental alterations and overcoming the difficulties. While placing different types of plant species in vegetation, mixtures should be relevant to plant reactions, their competitive behavior, erosion resistance, and statements of success in the soil ([2]; [1]). Based on the information listed above, some Mediterranean plant species which can be used to control soil erosion in Turkey are listed in Table 1.

Table 1. List of plants and the potential of their root system to increase the erosion resistance of topsoils[12]

Name of the Plants	Vegetation Type	RSD (0-10 cm topsoil)	Erosion Reducing Potential
Avenula bromoides	Grass	$0.3.10^{-12}$	Very high
Juncus acutus	Reed	$2.72.10^{-8}$	Very high
Lygeum spartum	Grass	$2.41.10^{-7}$	Very high
Helictotrichon filifolium	Grass	$1.61.10^{-6}$	Very high
Plantago albicans	Herb	1.10^{-5}	Very high
Brachypodium retusum	Grass	8.10^{-4}	Very high
Anthyllis cytisoides	Shrub	$2.29.10^{-3}$	Very high
Piptatherum miliaceum	Grass	0.01	Very high
Tamarix canariensis	Tree	0.01	Very high
Stipa tenacissima	Grass	0.03	High
Retama sphaerocarpa	Shrub	0.03	High
Salsola genistoides	Shrub	0.03	High
Artemisia barrelieri	Shrub	0.07	High
Dorycnium pentaphyllum	Shrub	0.11	Medium
Rosmarinus officinalis	Shrub	0.15	Medium
Atriplex halimus	Shrub	0.18	Medium
Nerium oleander	Shrub	0.19	Medium
Dittrichia viscosa	Shrub	0.19	Medium
Fumana thymifolia	Shrub	0.25	Low
Thymus zygis	Shrub	0.32	Low
Teucrium capitatum	Shrub	0.32	Low
Limonium supinum	Herb	0.37	Low
Ononis tridentata	Shrub	0.45	Low
Thymelaea hirsuta	Shrub	0.50	Very low
Phragmites australis	Reed	0.60	Very low
Bromus rubens	Grass	0.71	Very low

* RSD = relative soil detachment rate for the 0.10 m thick topsoil below the plant crown (0 = very high erosion resistance, 1 = very low erosion resistance), 0 < RSD < 0.01 = very high erosion-reducing potential, 0.01 < RSD < 0.10 = high erosion-reducing potential, 0.10 < RSD < 0.25 = medium erosion-reducing potential, 0.25 < RSD < 0.50 = low erosion-reducing potential, RSD > 0.50 = very low erosion-reducing potential.

While observing the soil loss in a field, it is essential to benefit from the Revised Universal Soil Loss Equation (RUSLE) program. Also, evaluating a sediment yield and susceptible areas, soil loss equation is very significant. In addition, cover crops and the climate are one of the main influencing factors of soil loss and degradation. For example, the Yellow River Basin has been investigated by many scientists to figure out and predict the reason of soil degradation. The selection of a land cover is associated with the prediction of precipitation rates and temperature alterations in a sediment yield. Thus, to decide which plant species to implement in sediment field impacts the amount of soil loss and erosion [13].

2.3 Managing the vegetative cover

Soil erosion and its effectiveness have been increased since local farmers have been applying the conventional methods while cropping. This situation induces to severe soil loss and disturbance with negative economic impacts. As technology has evolved and improved, scientists are providing new contemporary tillage and protection methods to sustain the productive crop lands, forests, and soil nutrients [14].

The developing technology has some substantial negative impacts on maintaining the vegetative cover due to lack of investigations. Poor reforestation methods are declining the number of trees which hold the topsoil and implement high endurance against soil erosion. Also, low ground cover might decrease the friction rate of soil particles, thus, it causes to soil degradation in sparse vegetative dispersal fields. In addition, agricultural fields have the majority of the soil erosion issue the fact that the maintain cover is tilled by conventional methods rather than conservational tillage system [2].

One of the other effects that associate with controlling vegetative cover is human disturbance [7]. The plant coverage preventing soil degradation is explicitly damaged by people. For Instance, Wang et al. (2008) defined human disturbance on forest as *'Ecological Stress'*, and the Ecological Stress is classified into Mortality and Vitality Stresses. The Mortality factors such as wildfire and contaminating the soil might be reduced in case of early detection of deforestation. However, the Vitality Factors could be diminished by realizing before the vegetative cover completely disappears [15].

Deforestation which is caused by logging is another reason of human destroys. Many young forests are cut down to benefit from the woods and the productive soil is used to settle on. The conventional logging and Reduced Impact Logging (RIL) led to wide field scale downstream and on-site soil loss. The off-site loss can also raise the amount of soil loss by increasing pollutants, sedimentation, and turbidity. In addition to that, the on-site loss causes to intensify the chemical and physical fertility in the soil. The majority of the tropical areas are inconveniently harvested by local forest managers; therefore, controlling the management systems after the feedback loop during initial planning and applications of forest operations plays an important role to reduce human alterations to the vegetation [16].

Furthermore, agricultural management practices significantly amplify the yield of production during the maintenance of vegetative cover. For many years, farmers have been practicing conventional farming methods to expect good harvest. However, today, sustainable controlling methods of agricultural harvesting came into prominence due to soil degradation and erosion. These agricultural technologies can be also embraced by local farmers to improve the income and productivity of farming sector [17].

The protection of biomass in the soil is the other main reason of controlling the vegetation. In Mediterranean environments, the topsoil biomass might be damaged due to wildfire or overgrazing, ultimately, the cover crops which significantly decrease concentrated flow erosion with dense roots may disappear [14]. For example, Baets et al. (2007) measured the Root density, root length density, and root diameters of 26 Mediterranean indigenous plant species to estimate the erosion reducing rankings by corresponding with soil erosion rates. As a result of their study, they found that by increasing the number of plants with high density roots and also managing their plantation, the hazard of concentrated flow erosion and its risk substantially diminished in Mediterranean local fields.

The topography of the land with vegetative cover is one of the most significant environmental effects that alter the implementation of cover crops and controlling the soil erosion. Indeed, steep slopes which have arid or semi-arid soils and sparse vegetation are at the highest soil erodibility risk. To afforest these fields which are inconvenient for farming, contemporary methods have been applied in order to revitalization. Vegetables are one of the most common green cover to stabilize these high steep slopes. An increasing demand on vegetable production has revealed in Southern Asia, however, mountainous environment restricts the maintenance of vegetation. The farmlands built on slopes bigger than 30^0 result with serious soil erosion which declines the eutrophication of waterways, soil fertility, and crop fruitfulness. Thus, lack of vegetative cover management practices damage to environment, public health, and the economy ([17]; [18]).

In recent decades, changing the agricultural plants into indigenous vegetative cover have induced to replacement of topsoil, as a result, the top soil mass movements and sedimentation have significantly increased. In fact, this environmental cover conducts the scattering and dispersing the erosion power. Ultimately, replacing the plants for various aspects can also result with detrimental circumstances in nature [19].

3. Conclusion

The management activities including conservational tillage, afforestation, and convenient land preference for establishments have a significant impact on controlling the erosion. Since the popularity of conventional management systems have diminished, the new technological methods have been used by local farmers, forest managers, and householders. These techniques are demonstrated by experts from various fields to decline the soil degradation and soil erosion rates. However, there is a lack of knowledge in Turkey regarding conservational tillage and afforestation techniques, and therefore, a check list of erosion control plant species can be used for these management practices.

Agricultural management systems which consist of sustaining the productive soil nutrients may also decrease due to lack of farm fields. This decline leads to a substantial alteration of vegetative cover. Without tillage and management practices, the soil changes into a non-agricultural land with excessive moisture and less nutrients. In contrast, by conservational tillage systems, rotations, contour farming, grassed waterways and many controlling methods, the farmlands might be transformed into more productive and healthy soils. For instance, application of cover crop systems considerably protects the topsoil from scouring, rain intensity, chemical fertilizers, and topsoil erosion risks. Besides it is a healthy and natural method to proceed on farmlands.

Furthermore, the afforestation practices significantly minimize the soil disturbance and soil erosion in steep slopes and lands which are prone to degradation. The vegetative cover and diversification of the plant species increase, the enhancement of soil heterogeneity developed, thus the organic matter amount in the soil rises [2]. The precautions related to prohibiting the logging activities also help young forest sustain in the future. Old trees which are planted in mountainous lands buffer the surface runoff, sedimentation, and topsoil movement. Simultaneously, it induces to keep the water resources clean and decrease the turbidity in the water. As a result, the vegetative cover protects the productive soil, inhibits the land sliding on steep slopes, controls the rain drop energy, and conserves the fauna on the land.

To increase the benefits of vegetation against soil erosion, people might be educated to preserve and save their environment. In addition, new technological methods can be implemented on critical areas to manage the vegetative cover and sustain the green environment in the future. By this way, soil erosion may be taken under control and soil loss and degradation could be restrained. Instead of building the farmlands on the plains, construction works are established on productive and valuable lands. In order to stabilize the base of a building, the soil is considered to be strong enough to weight the construction. If farmlands are used for construction works, then soil erosion is inevitable because of disturbing the soil and vegetation.

Most of the researchers around the world have been investigating new ways and methods to increase the amount of vegetation by afforestation and land management activities. The fact that the population of the world has been substantially increasing, many woody lands and green areas have been invaded by human activities. Providing a check list for increasing the density of vegetation against soil erosion can help land owners and managers to maintain the farmlands and forest cover and pioneer decision-making plans. By this way, prospective researches may benefit from the erosion control plant species and easement of their selection process.

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