



Erosion Control and Plant Maintenance on Highway Slopes: *Vetiver grass*

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Abstract:

Rapid increase of population, developing industry and insensible usage of nature due to urbanization process brought important environmental problems with them. Erosion is the most important of these environmental issues. Eastern Black Sea Region is mountainous, sloping, also having high annual rainfall due to its climate. Soil type of this region is generally high clay soils which lead to high erosion rates. There are many soil conservation methods. Vegetation is without a doubt plays an important role in reducing and preventing soil erosion. Vegetation is essential when it is done correctly and appropriate to environmental conditions. It is sustainable, repeatable and cheap method to prevent erosion and to increase production efficiency. Developing vegetation cover prevents erosion by its roots, stem, leaves and branches. There are many studies on plant species to use in plantations of slope stabilization of highways for erosion control, in Turkey. However, highway maintenance on slope stabilization is not sufficient. *Vetiver grass* is being used in multiple purposes (soil and water conservation, slope stabilization, erosion control, heavy metal absorption, vetiver oil, etc.) throughout the world. One of the most important characteristics of *Vetiver* plant is its strong roots that hold soil together against erosion and on high slope areas. This plant, *Vetiver grass*, is preferred, around the world, for being most effective, efficient and practical erosion control along slopes. In this study, usage of *Vetiver grass* in slope stabilization and erosion control of highways was explained.

Key Terms: Erosion control, *Vetiver grass*, highway slopes

Introduction:

Vetiver grass is a perennial ground covering plant which has high adaption abilities and resistant to negative environmental conditions. *Vetiver grass* has a fast growth pace and has strong mass roots. *Vetiver* is a special plant; has wide range of characteristics, low cost requirements and easy applications. In many studies and applications it is found that *Vetiver* plant effectively prevents erosion. Potential users of *Vetiver grass* use this plant species in stabilization of highway slopes, irrigation and drainage, underground water, mining, and for reducing the pollution. *Vetiver* plants can be used in; reservoirs, dams, gardens, pools that contain fishes, highway slopes, and to prevent landslides at hilltops. Young leaves of *Vetiver grass* are good source of nutrition for animals while old leaves are good for paper pulp, mulch, fuel, fertilizer, roof cover, arts. Roots of this plant are good for aromatic oils, drugs and for pesticide. *Vetiver grass* has a wide range of usage and it can be used in mountain villages to help development of the rural area. Also, *Vetiver grass* can be

economically, socially, and ecologically useful for agricultural ecosystems.

Since 1989, World Bank, *Vetiver* Network and South China Institute of Botany (SCIB) has been experimenting with *Vetiver grass* plants and had success in erosion prevention and repairing of hilltop ecosystems with *Vetiver grass*. In order to expand and spread their success, in 1995, SCIB and GuangDong Provincial Highway and National Highway (National Highway No: 105) agreed on a cooperation of planting *Vetiver grass* on highway slopes to prevent landslides. After 6 months naked highway backfill started to turn into green and there were visible decrease in water and soil loss because of erosion. SCIB and GPHB were happy with their cooperation and continued to work together. Thus, in 1996, both units started to experiment a similar biologic application on First-Ring Highway (one application on unstable part of the road and one application on dangerous part of the road) around Guangzhou. Along the highway two backfilling areas were used. On one site *Vetiver grass* fences were planted and on the other *Mimosa sepium*. There were obvious

differences between two different plant species. After 5-6 months erosion and landslides were ceased at the slopes with Vetiver grass fences but in the same period on the site with *Mimosa sepiparia* showed weak protection over the slopes and there were rainfall damages on the slope, eventually this slope got destroyed (HuiXiu, vd., 1997).

Since 1993 Vetiver System (VS) is being used in mountain road construction and repair projects in North, Northeast and South Thailand. In 1994, Department of Highway created a Standard chart project (SP-204 1994 and SP-206 (Revision) 1999, Highway Slope Protection Plantation) which consists of plantation modeling of slopes and bridge slopes (Sanguankaeo et al., 2003).

There are some studies on usage of Vetiver grass on erosion control and stabilization of highway slopes. Some of these studies are; Cheng vd. (2000), Sanguankaeo vd. (2000), Sanguankaeo vd. (2003), Sanguankaeo vd. (2006), Xia vd. (2006), Sanguankaeo vd. (2011), the Yadana Gas Pipeline Project and The Petroleum Authority of Thailand (2000), Diti (2003). There are several studies in Turkey on erosion control and slope stabilization using ground covering plants. These studies are; Acar (1993), Acar (1997), Emir (2006), Acar ve Var (2001), Acar vd.,(2002), Koçan (2011), Dağistanlioğlu (2007), Azarpour (2011), Seçkin (1986). Vetiver grass isn't well known in Turkey. First project (2002) to use Vetiver plants was a project by Öner Demirel on Çoruh watershed (had the most erosions in Turkey). After this project Demirel and Demirel (2005), Kırıcı et al. (2011), and Cindik (2012) studied Vetiver grass in Turkey.

Highway constructions and repair works of road slopes aren't sufficient due to rapid population growth, industrial developments and urbanization process. In slope plantation, plantation technique and plant species that will be used in the plantation is important. In road constructions (highways, side roads, pedestrian roads, etc.) of Trabzon city, East Black Sea Region, and surrounding areas it is important to choose the right plant species for road slope plantations to prevent soil loss

since this region has steep slopes. Vetiver grass is being used for prevention of erosion in many countries (China, India, Australia, Canada, Brazil, etc.) for a long time. A correct plantation with plants that has strong rooting systems and roots can improve slope stabilization and reduces soil erosion. In this study, usages of Vetiver grass plant, which can help in erosion control applications on road slopes without hurting aesthetics, were explained.

Materials and Methods:

Literature review was made on the subject. Vetiver grass usage in highway slope plantation to prevent erosion, goals and scope of these applications were explained. Functional usage of Vetiver grass with its root and crown growth in highway slope stabilization plantations was investigated with results and conclusions taken from master thesis of Cindik (2012). This study includes subjects as Vetiver grass usage reasons and contributions of Vetiver grass usage in Turkey.

Soil, Erosion and Highway Slopes:

Soil is a nonrenewable natural resource that is essential for humans and all other living organism. It is the home and food source of plants, animals and microorganisms. It is also a filter for rain, storage for underground water, a treasure for mines, and archive of culture and history of nature (Çepel, 2006).

Erosion is the cancer of soil, source of natural disasters, worst enemy of water sources, friend of desertification, doomsayer of flood, a natural disaster that destroys very foundation of life for all living organisms, national treasure thief, an enemy that invades countries silently without having an army or a war (Çepel, 2006).

Soil will keep serving humans in agriculture, industry and in urbanization process. Even though soil is very important there wasn't much attention on soil protection/conservation and erosion control. Turkey's lands and soils are being degraded by erosion. Turkey is one of the countries that suffer from erosion most due to its

topographic characteristics, high altitude and steep slopes.

During highway constructions wrong topography usage damages and destroys upper vegetation on backfill slopes. Grading in backfill sites destroys upper soil vegetation and this causes erosions and landslides.

East Black Sea region is rugged, sloping, has the most rainfall amount in Turkey due to its climate and its soils generally clay heavy so it's more susceptible to landslides. Highway constructions and developing road network road slopes creates visual pollution and with heavy rainfall the surface runoff triggers erosions and landslides. Highways, in continuity that provides transportation circulation, are in interaction with natural and cultural landscape. Noise pollution, visual pollution, air pollution, nature and ecosystem degradation, agriculture and forest area degradation are negative results of highways for landscape. These negative effects prove that highways need plantations.

Plantation of Highway Slopes:

In plantation applications plant species, crown size, color, shape, etc. are important. Since plantation will be made on highway slopes the upper soil and slopes are weak. In highway slope plantations plants that have deep and strong root systems and large crown with high water holding capacity should be used since these plants will reduce erosion and runoff.

Following things are wanted from a ground cover plants that will be used in highway slopes (Cindik and Acar, 2010);

- Being easy to produce and maintain,
- Being Economic,
- Fast growth and good crown development,
- Deep and strong root system development,
- High water holding capacity,
- Being resistant to tough conditions and climate,
- Being resistant to shallow, calcareous, stony ground and to areas susceptible to erosion,
- Having physiological characteristics, leaves, texture, etc. in compliance.

Plantation is an important way for both shallow and mass stabilization. Plantation is being used for ages as a bioengineering tool in erosion control and slope stabilization applications. Plant fences have always been thought as an alternative for soil and water control structures.

Vetiver grass acts like a fast growing tree or shrub species in soil stabilization applications even though it is a ground covering grass. Vetiver grass fences, as can be seen in the results of studies conducted on different countries, are efficient, simple and low cost solution for soil and water control, rehabilitation, and steep slope stabilization (Fig. 1). There are some difficulties of Vetiver grass plantation on road slopes for erosion control and highway slope stabilization because these slopes have little nutrients for the grass compared to agriculture sites.



Figure 1. Esiroğlu Kirankaş location study area (slope 50-65%), Trabzon, 2010.

Vetiver grass Plantation :

Indians has been using Vetiver grass for water and erosion control, agricultural and nonagricultural applications since ancient times. Success of Vetiver grass plantation in slope and surface runoff control, dune stabilization and in erosion control on agriculture areas has been proved, especially, in southern hemisphere. Vetiver grass is suggested for environmental protection, heavy metal absorption, flood control, polluted soil and water rehabilitation, slope stabilization applications. Economic (Vetiver oil, crafts, scent, etc.) and aesthetic value (ornamental plant) of Vetiver grass which is being used as a living system in landscape architecture shouldn't be ignored.

Cindik (2012) had positive results in his master degree thesis where he investigated root and crown development of Vetiver grass in erosion control applications on highway slopes. On a backfill area where is susceptible to erosion Vetiver grass plantation showed positive results with good root and crown development (Fig. 2).

In their studies, Sanguankao et al. (2003), Sanguankao et al. (2006), Xia and Shu (2003), found that Vetiver grass plays an important role in degraded areas and in sustainable development by its characteristics such as size of the ground its crown can cover, growth pace, strong rooting system, high resistance to metals, etc. (Fig. 3).



Figure 2. Esiroğlu Kirankaş location study area (594-610m), Trabzon, 2010.



Figure 3. Vetiver system (VS) that being used on slopes, China (Grimshaw, 2006).

Conclusions:

Vetiver grass, without a doubt, provides ecological benefits for soil and water conservation. Studies showed that Vetiver grass is an ideal bioengineering tool for erosion, environment protection and rehabilitation. Afforestation is most suggested method for erosion prevention applications but this isn't enough alone. Cover ground with plants reduces the kinetic energy of rain drops, reduces surface runoff and win erosion. Vetiver grass can be used to prevent soil losses on highway slopes and to stabilize slopes since its strong roots and large crown development

can reduce soil loss. In order to stabilize slopes on long terms grass and ground covering plants must be used and then this cover should be supported with trees and shrub species. Vetiver grass is frequently being used for erosion and sediment control in Africa, Asia, Middle and South America, South Europe, and Australia to stabilize vertical slopes of highway and railroad.

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