

# Revitalizing Roadside Landscapes: Ecological and Bioengineering Measures for the Wad Medani-Sennar Slope Connection, Gezira and Sennar States

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## Abstract

It was thus decided to investigate this issue to find a method to protect slope from erosion on this road and to provide new approaches to slope erosion knowledge gap in Sudan. An engineering survey was carried out, followed by geotechnical studies, experimental work and interviews with academic experts regarding native vegetation in the survey area. These include measuring the eroded parts of the road. Studying cross-sections of the road; soil experiments to check the strength, compaction and particle size distribution and a native vegetation survey to check for suitable plants that could be used to control the slope erosion. It was found that an appropriate bio-engineering method to stabilize the slope soil against erosion due to rainfall was to cultivate the grasses *Cynodon Dactylon* and *Vetiver* on the slopes. The Wad Medani-Sennar roadside slope connecting the Gezira and Sennar States is a vital transportation corridor that facilitates the movement of goods and people. However, the slope faces challenges related to erosion, instability, and ecological degradation.

**Keywords:** Ecological degradation; Surface erosion; Gezira Scheme; Geotechnical studies

## Introduction

Recognizing the importance of preserving the natural environment while ensuring safe and efficient transportation, ecological and bioengineering studies have been undertaken to stabilize the slope and mitigate the associated environmental risks [1]. This article explores the significance of these studies and the innovative approaches employed to address the ecological and engineering concerns. The capital cities of the two most important states in Sudan, Gezira, and Sennar are linked by the Wad Medani-Sennar road. Sennar has a large dam for producing electricity and provides electrical power to all Sudanese states. Gezira is an agricultural state and has the largest agricultural scheme in Africa. The Gezira Scheme is found in the area between the two capital cities. The Wad Medani-Sennar road is thus extremely important as it is used to transfer crops from production sites to wholesalers and retailers [2]. The road is also the national carrier between the cities of the south and the north. The use of native vegetation results in lower maintenance costs, conserves natural resources, and increases the biodiversity of the region, resulting in benefits for the local wildlife [3].

## Ecological concerns

Ecology enriches our world and is crucial for human wellbeing and prosperity. It provides new knowledge of the interdependence between people and nature that is vital for food production, maintaining clean air and water, and sustaining biodiversity in a changing climate [4].

The Wad Medani-Sennar roadside slope lies in a region characterized by unique ecological features, including diverse flora and fauna, river systems, and wetlands. Construction and maintenance activities can potentially disrupt this delicate balance, leading to adverse effects such as soil erosion, habitat loss, and increased sedimentation in water bodies. Preserving the ecological integrity of the region is crucial not only for biodiversity conservation but also for maintaining the overall environmental health of the area [5].

## Bioengineering solutions

Bioengineering is a subset of green infrastructure that uses

vegetation to serve an engineering function. The most common uses of bioengineering include soil surface protection against erosion, soil stabilization, and improved drainage functions. Rather than relying solely on conventional engineering methods, bioengineering utilizes living plant materials and natural elements to enhance stability and prevent erosion. Several bioengineering techniques can be employed to stabilize the Wad Medani-Sennar roadside [6].

**Vegetation Cover:** Planting suitable native vegetation on the slope helps bind the soil together, reducing erosion risks. Deep-rooted plants and grasses are particularly effective in stabilizing slopes, as their roots penetrate deep into the soil, preventing landslides and surface erosion [7].

**Terracing:** Constructing terraces involves creating horizontal steps along the slope, reducing the slope's steepness and minimizing erosion [8]. Terraces can be reinforced with vegetation to provide additional stability and erosion control.

**Gabion walls:** Gabions are wire mesh containers filled with rocks or stones. Constructing gabion walls along the slope provides structural support, controls erosion, and promotes natural drainage. These walls are often integrated with vegetation to enhance stability and aesthetic appeal.

**Geotextiles:** Geotextiles are permeable fabrics placed on the slope to reinforce the soil and prevent erosion. They stabilize the slope while allowing water to drain through, reducing surface runoff.

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**Riparian buffer zones:** Establishing riparian buffer zones along water bodies near the slope helps filter sediment and pollutants, preventing their entry into the water system. Native vegetation within these buffer zones aids in erosion control and provides habitats for aquatic life.

### Ecological and bioengineering studies

**Enhanced slope stability:** The use of bioengineering techniques improves slope stability, reducing the risk of landslides, erosion, and soil loss. This ensures the long-term safety and sustainability of the Wad Medani-Sennar roadside slope.

**Ecological preservation:** Native vegetation and ecological systems are conserved and protected through the implementation of bioengineering methods. This helps maintain biodiversity, restore habitats, and protect natural resources [9].

**Reduced environmental impact:** Bioengineering techniques minimize the use of non-renewable materials and chemicals, reducing the ecological footprint of slope stabilization activities. These approaches prioritize sustainable practices and align with environmental conservation goals.

**Aesthetic appeal:** Integrating vegetation and natural elements into the slope stabilization process enhances the visual appeal of the roadside area. This creates an attractive and harmonious environment for road users and surrounding communities [10].

### Conclusion

Although not all plants were considered, the study has proven through vegetation surveying, geotechnical studies, and chemical soil data that there were suitable plants and grasses available around the research area that could be used to stabilize the slopes. Vegetation also has many benefits, including the improvement of the landscape surrounding the highway, and helps to reduce the impact of high-intensity rainfall.

Used in large open areas, vegetation can thus reduce soil erosion due to rainfall intensity and improve the meteorological situation in Gezira. The ecological and bioengineering studies conducted for stabilizing the study recommends applying Eco protection techniques to protect the highways from slope failure due to erosion resulting from the intense rain showers in autumn, and this reduces the number traffic accident victims because of highway failure at this time of year.

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