

**Vetiver System for Erosion and Sediment Control,  
and Stabilisation of Steep Slopes**  
**(With special references to the Ho Chi Minh Highway,  
Vietnam)**



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# Special Characteristics of Vetiver Grass Suitable for Slope Stabilization

**Tall Erect and stiff stems, forming a thick hedge when planted in row**

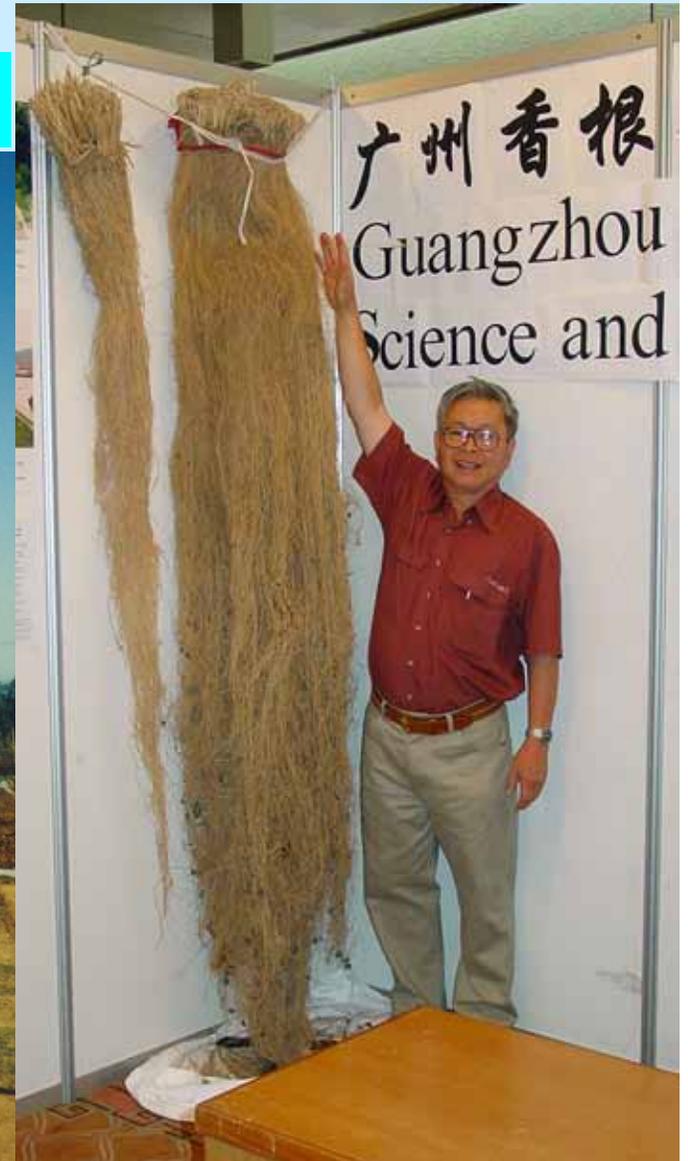
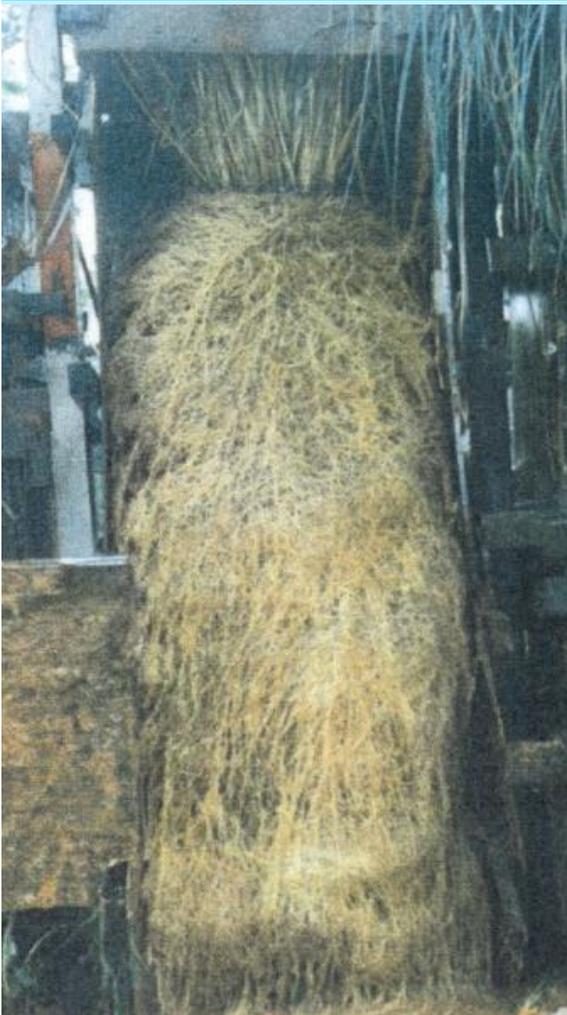


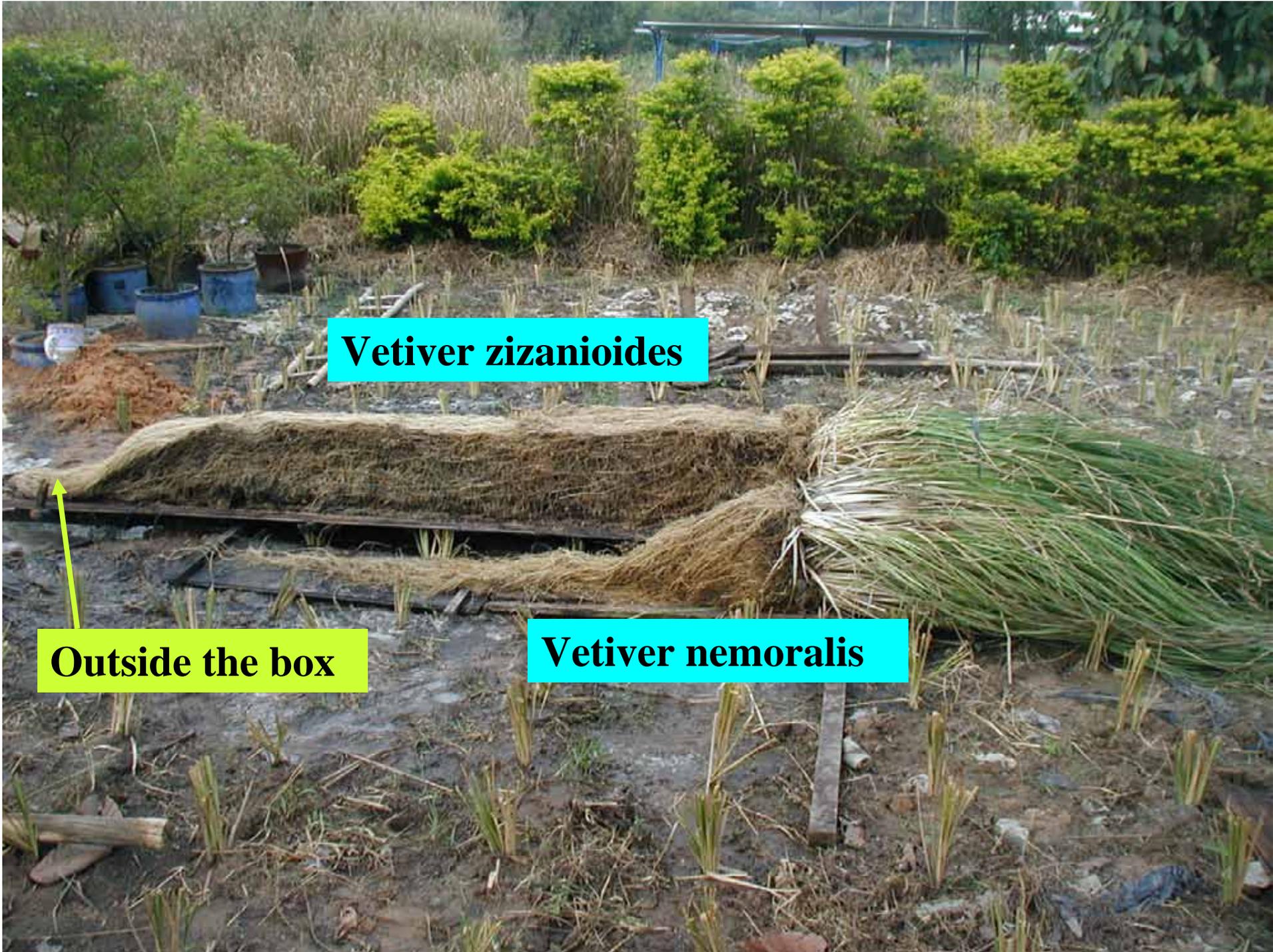
## **Deep, extensive and penetrating root system**

- **Although classified as a grass, for land stabilization purposes, Vetiver plants behave more like fast growing trees or shrubs. Per unit area Vetiver roots are stronger than tree roots.**
- **Extremely deep and massive finely structured root system, capable of reaching down to 2 to 3m in the first year. Many experiments show Vetiver grass can reach 3.6m in the first 12 months on fill slope**
- **This extensive and thick root system binds the soil and at the same time makes it very difficult to be dislodged and extremely tolerant to drought.**
- **Vetiver roots can penetrate compacted soil profile such as hardpan and blocky clay pan common in tropical soils, providing a good anchor for fill and topsoil.**

# Deep, extensive and penetrating root system

One year old: 3.3m deep





**Vetiver zizanioides**

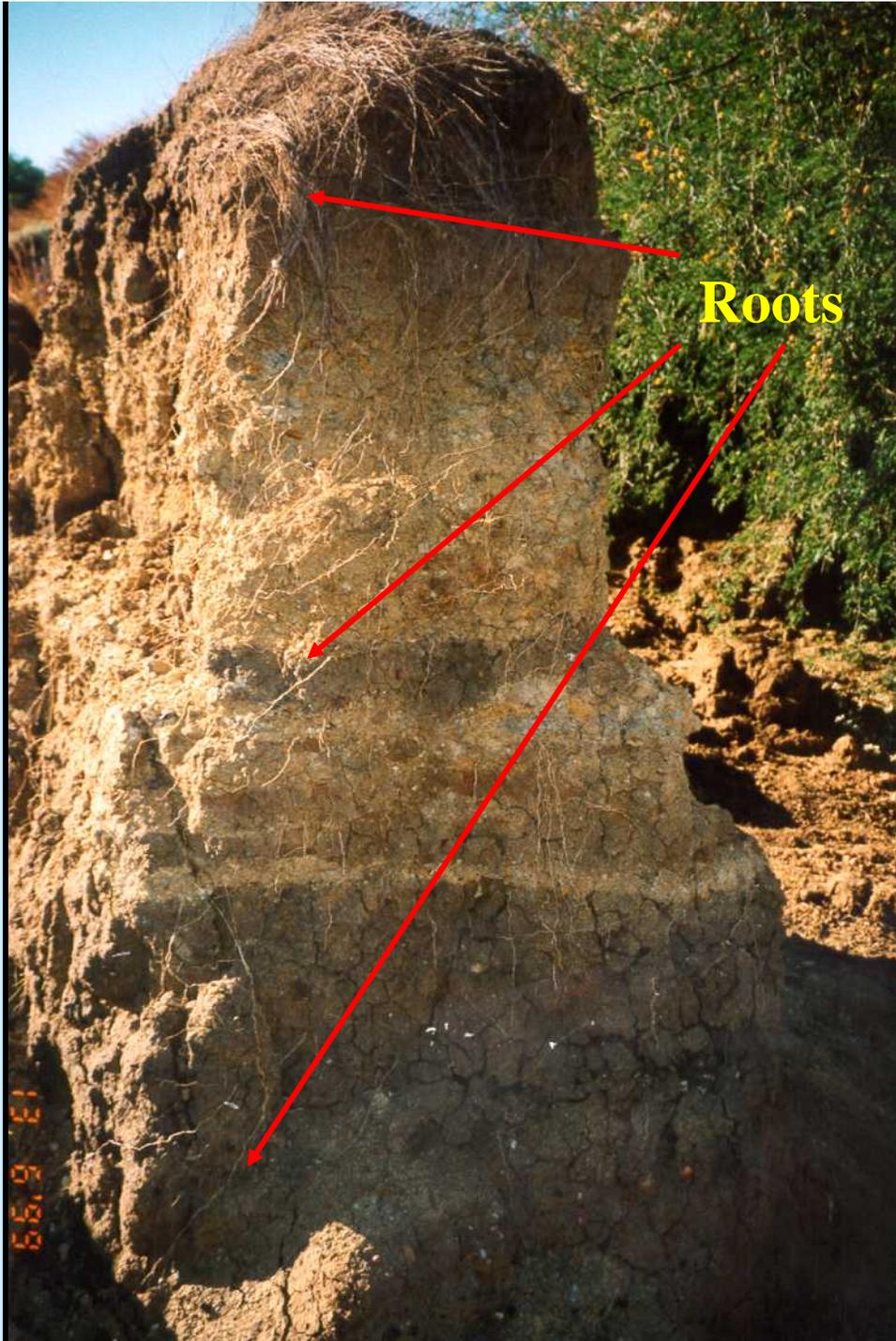
**Outside the box**

**Vetiver nemoralis**

**Strong root reinforcement holding up this wall of soil against water erosion**







**Extensive root  
distribution at  
depth**

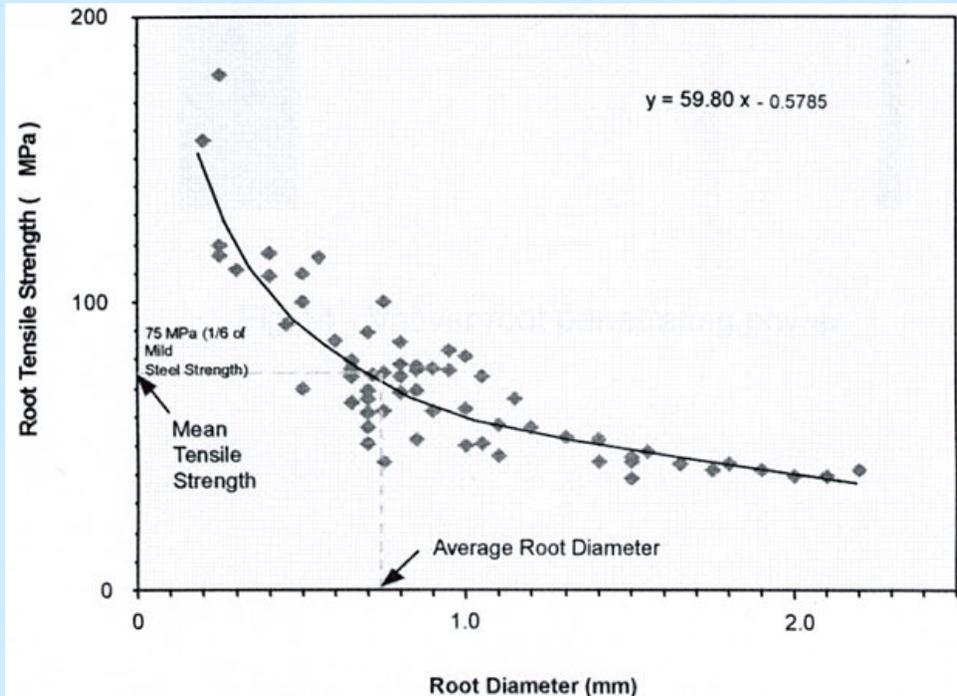


# Mechanical Characteristics

## Tensile strength of vetiver roots

- Tensile strength increases with reduction in root diameter, i.e. stronger fine roots provide higher resistance than larger roots.
- Tensile strength of vetiver roots varies between 40-180 MPa for the range of root diameter between 0.2-2.2 mm.

- Mean design tensile strength is 75 MPa (appr. 1/6 of mild steel) at 0.7-0.8 mm root diameter - the most common size of vetiver roots.
- This indicates vetiver roots are as strong as, even stronger than many hardwood species (Hengchaovanich and Nilaweera, 1996).

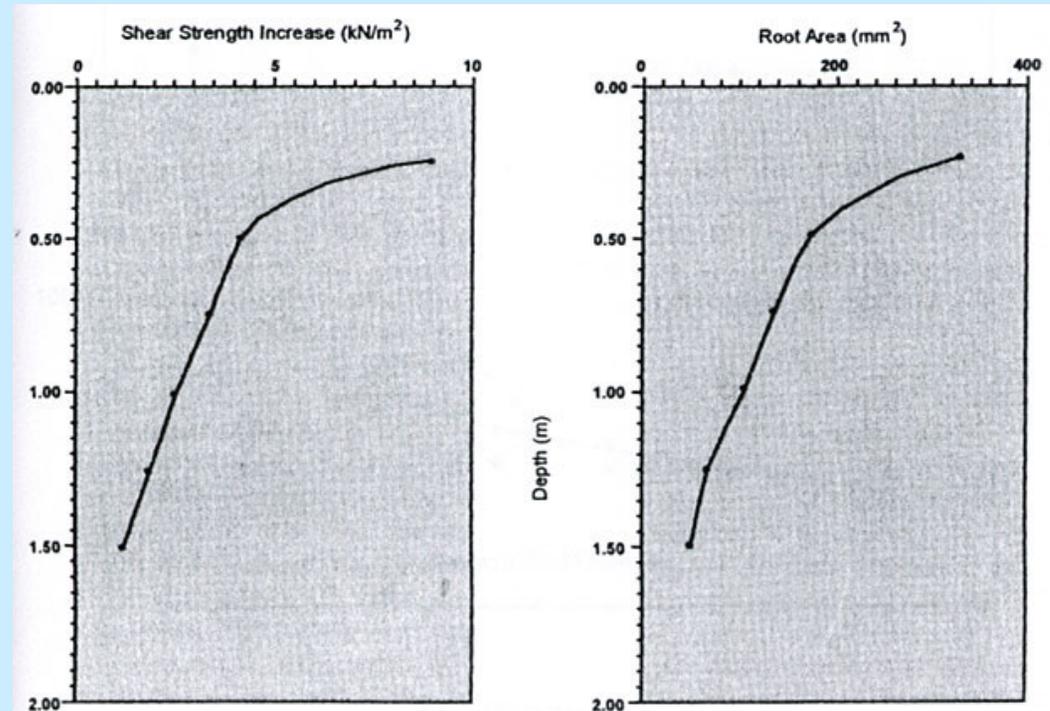


# Mechanical Characteristics

## Shear strength of vetiver roots

- Soil block shear test also showed that root penetration of a two year old Vetiver hedge with 15 cm plant spacing can increase the shear strength of soil in adjacent 50 cm wide strip by 90% at 0.25 m depth. The increase was 39% at 0.50 m depth and gradually reduced to 12.5% at 1.0 m depth.

- Moreover, because of dense and massive root system it offers better shear strength increase per unit fiber concentration (6-10 kPa/kg of root per cubic meter of soil) compared to 3.2-3.7 kPa/kg for tree roots (Hengchaovanich and Nilaweera, 1996).



## Shear test of vetiver roots



## Hydraulic Characteristics

- When planted in rows Vetiver plants will form thick hedges and with their stiff stems can stand up to at least 0.6-0.8m, forming a living barrier which slows and spreads runoff water. If properly laid out, these hedges can act as very effective diversion structures spreading and diverting runoff water to stable areas or proper drains for safe disposal.
- Hydraulic characteristics of Vetiver hedges under deep flows were determined by flume tests at University of Southern Queensland for the design and incorporation of Vetiver hedges into strip cropping layout for flood mitigation. The hedges were successful in reducing flood velocity and limiting soil movement, resulting in very little erosion in fallow strips and a young sorghum crop was completely protected from flood damage (Dalton *et al*, 1996).

# Hydraulic Characteristics

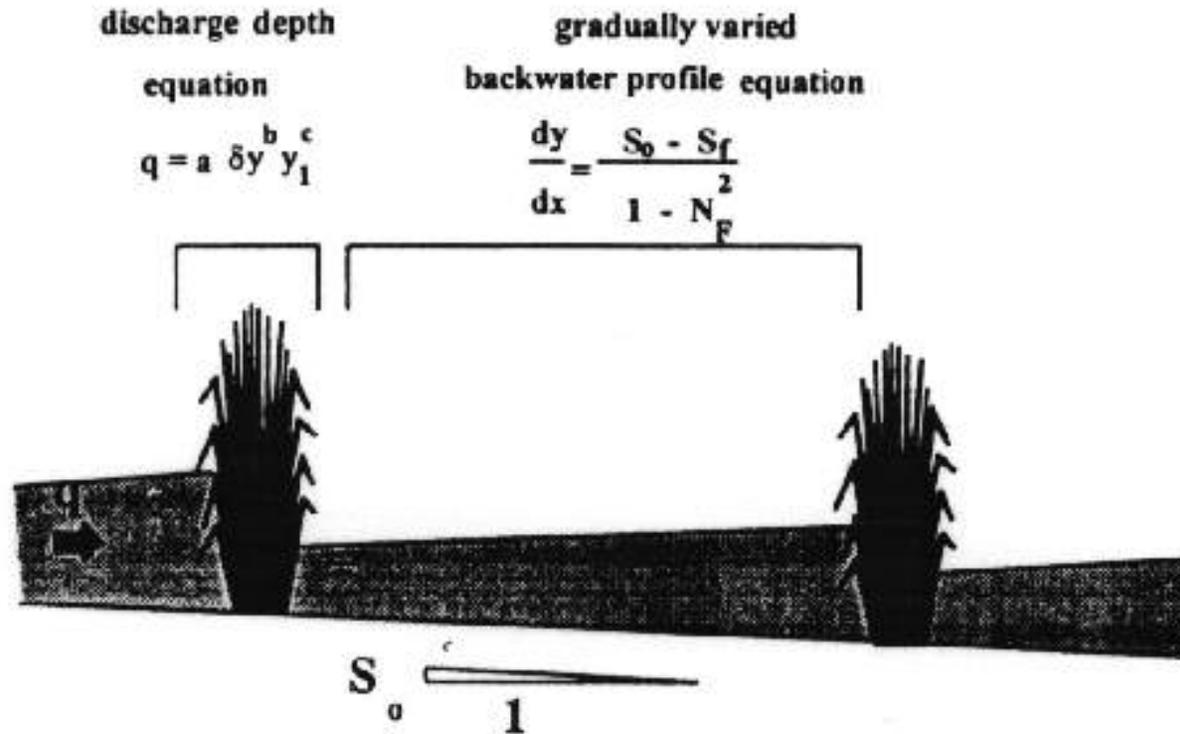


Figure 1: Hydraulic model of flooding through vetiver.

## Hydraulic Model of Flooding through Vetiver Hedges (P Dalton, 1998)

Where:  $q$  = discharge per unit width;  $y$  = depth of flow;  $y_1$  = depth upstream;  
 $S_0$  = land slope;  $S_f$  = energy slope;  $N_F$  = the Froude number of flow.

# Fire tolerance

A very fierce bush fire swept through the area in October 2002

Vetiver row

Sediment trapped by the old row



## Two weeks after fire

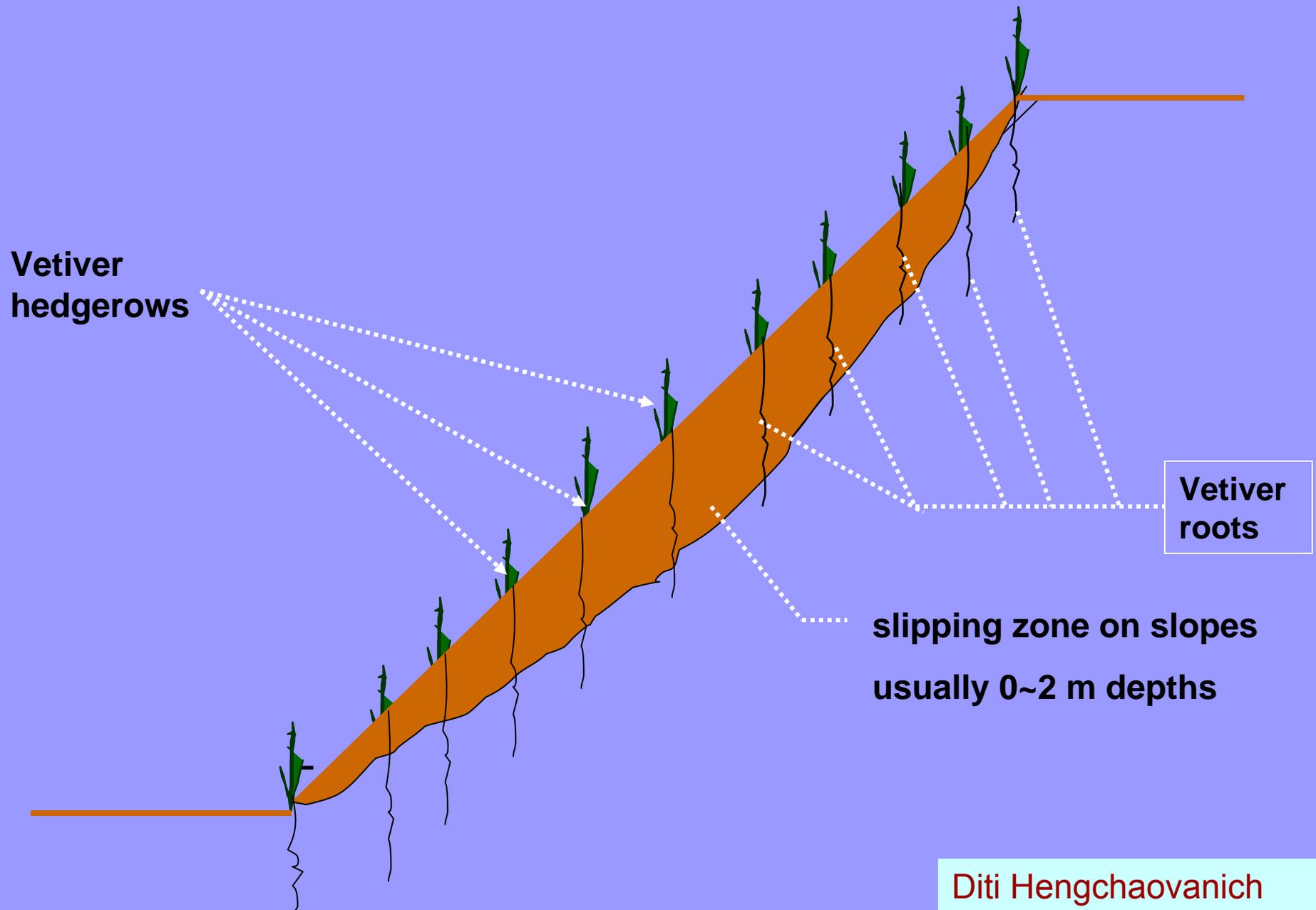


## Five weeks after fire





# Soil stabilisation mechanism by vetiver



## Australian trial on a fill batter



# One and half year after planting



**After 400mm of rain in 10 days**



# After 400mm of rain in 10 days



## Steep batter protected by vetiver hedges



## Eight months after planting



# Close up view of steep batter protected by vetiver hedges







# Bridge abutment stabilisation



Ten weeks after planting



# Cost Summaries

Road Batter Protection	AUD Per linear metre	AUD Per square metre of batter face
Vetiver hedges on Cut Batters	18.40	21.40
Vetiver hedges on Fill Batters	15.50	18.20
<b>Culvert Protection</b>		
Vetiver hedges		18.20
Grouted rock pitching		65.75
	<b>Saving</b>	<b>73%</b>
<b>Road Shoulder Protection</b>		
Vetiver hedges	15.50	
Traditional concrete shoulder dykes	38.00	
	<b>Saving</b>	<b>60%</b>
<b>Table Drain Scour Protection</b>		
Vetiver contour hedges	15.50	
Traditional hard rock check dams	42.00	
	<b>Saving</b>	<b>64%</b>
<b>Miscellaneous Protection Work</b>		
Vetiver hedges generally	15.50	
Steel wire rock mattress		43.00
	<b>Saving</b>	<b>64%</b>

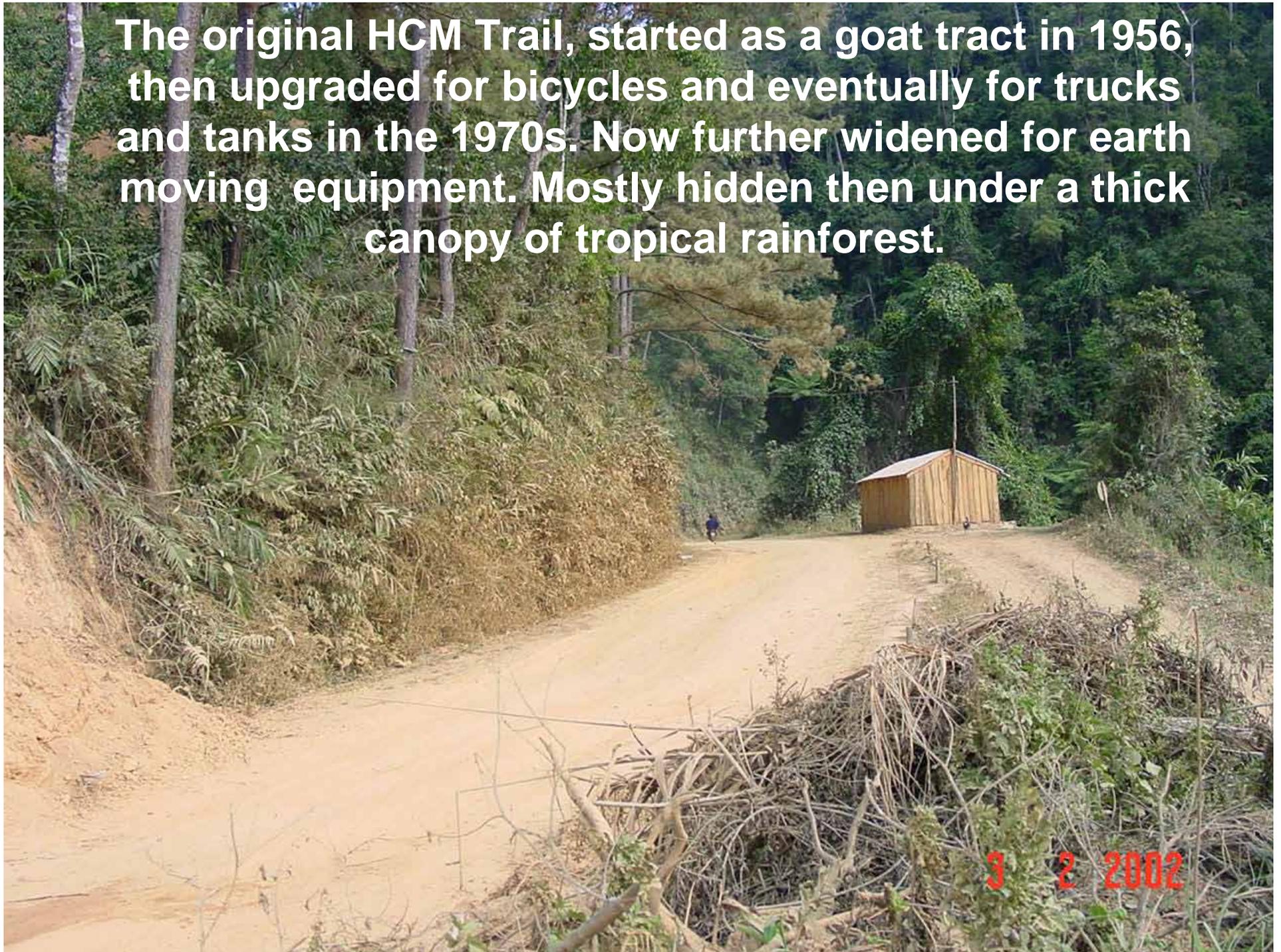
# HO CHI MINH HIGHWAY

## Vietnam

### A Learning Experience

- **Most of this highway follows the old Ho Chi Minh trail, built during the war, through very rugged mountainous tropical rainforest.**
- **It stretches over 3 000km from the cold and frosty mountains on the Chinese border in the north to the swampy acid sulfate soil in the gulf of Thailand in the south.**
- **It was badly designed and haltingly built by army engineers in 2002**
- **Part of it is still unusable due to serious erosion and landslides during the wet season**

**The original HCM Trail, started as a goat tract in 1956, then upgraded for bicycles and eventually for trucks and tanks in the 1970s. Now further widened for earth moving equipment. Mostly hidden then under a thick canopy of tropical rainforest.**

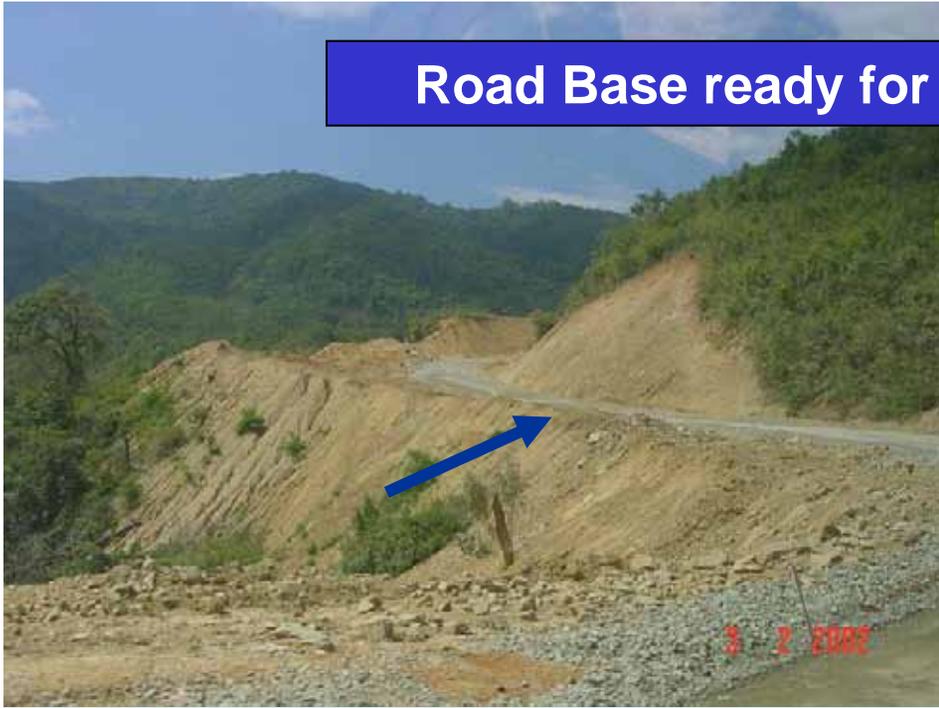


3 2 2002

**Note the scars on the mountain side  
Altogether it is more than 3000km long**



Road Base ready for bitumen paving



Roads





**Road Base ready for bitumen laying**



**Road**



Erosion soon after paving



## Erosion soon after paving



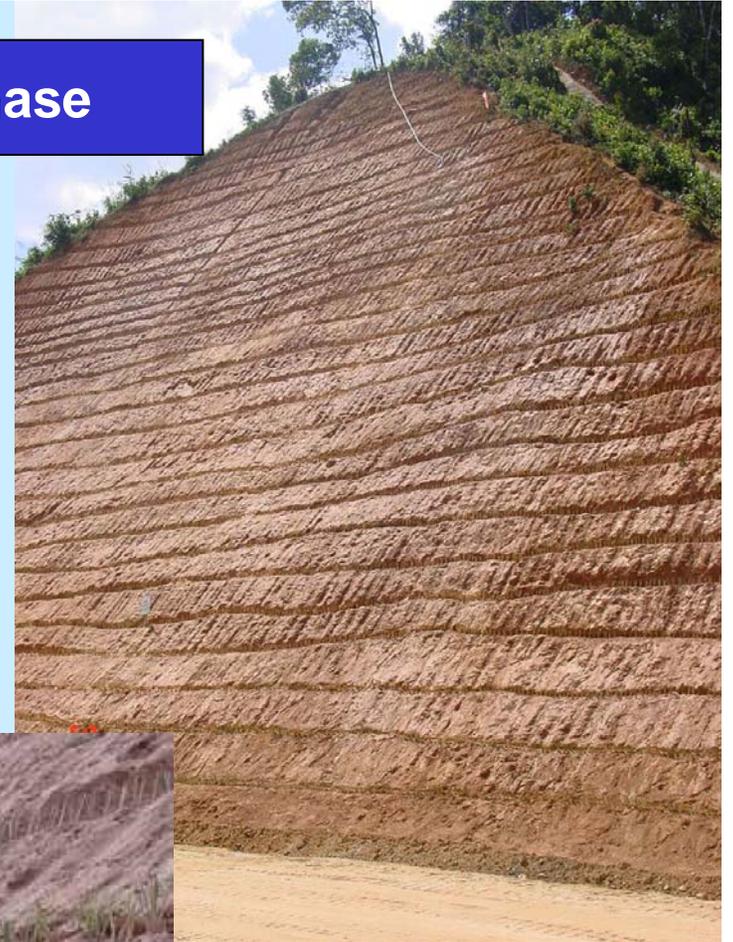
Disaster soon after paving



**Vetiver trial with good results**



## Implementation phase



**On a 1.5H:1V  
gradient, 55m  
high cut slope**

## Implementation phase



Hoping for the best!

ĐỒ HẸN  
KINH DUNG CỤ KỸ THUẬT  
SÁNG TẠO GIẢI QUYẾT BÀI TOÁN

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# Same slope, one year after planting

Although not properly designed, this site remained stable 3 years after planting!



Still have problem at the toe

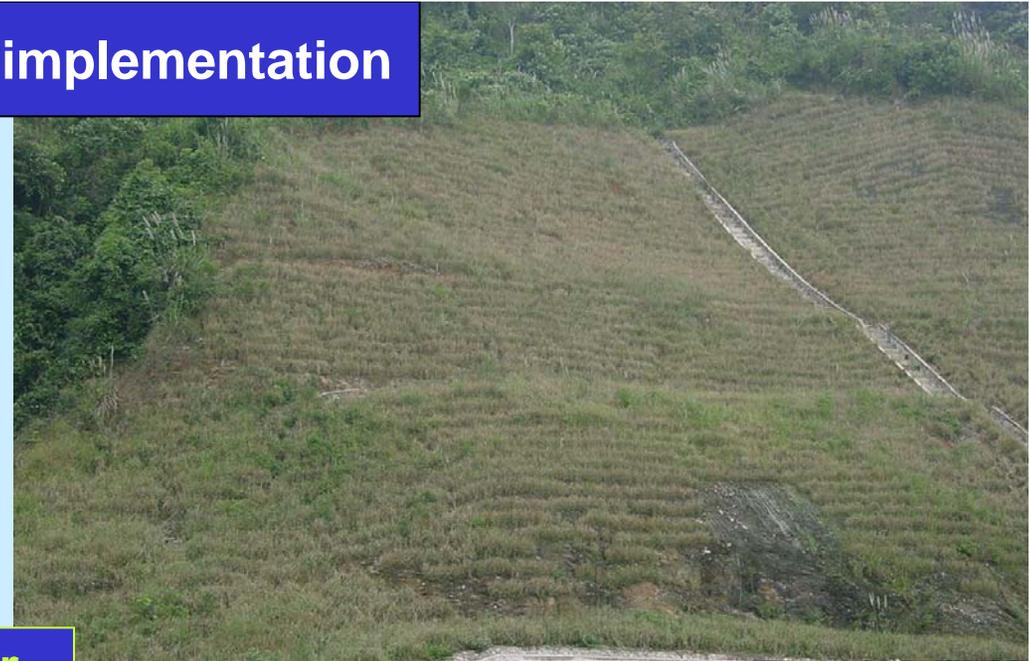
Still has problem



# Three years after implementation



Three years after implementation



Vetiver



Before and After



# Before and After



# Before and After





**With vetiver**

**No vetiver**

**THANK YOU**