# GEOTROPISM IN VETIVER

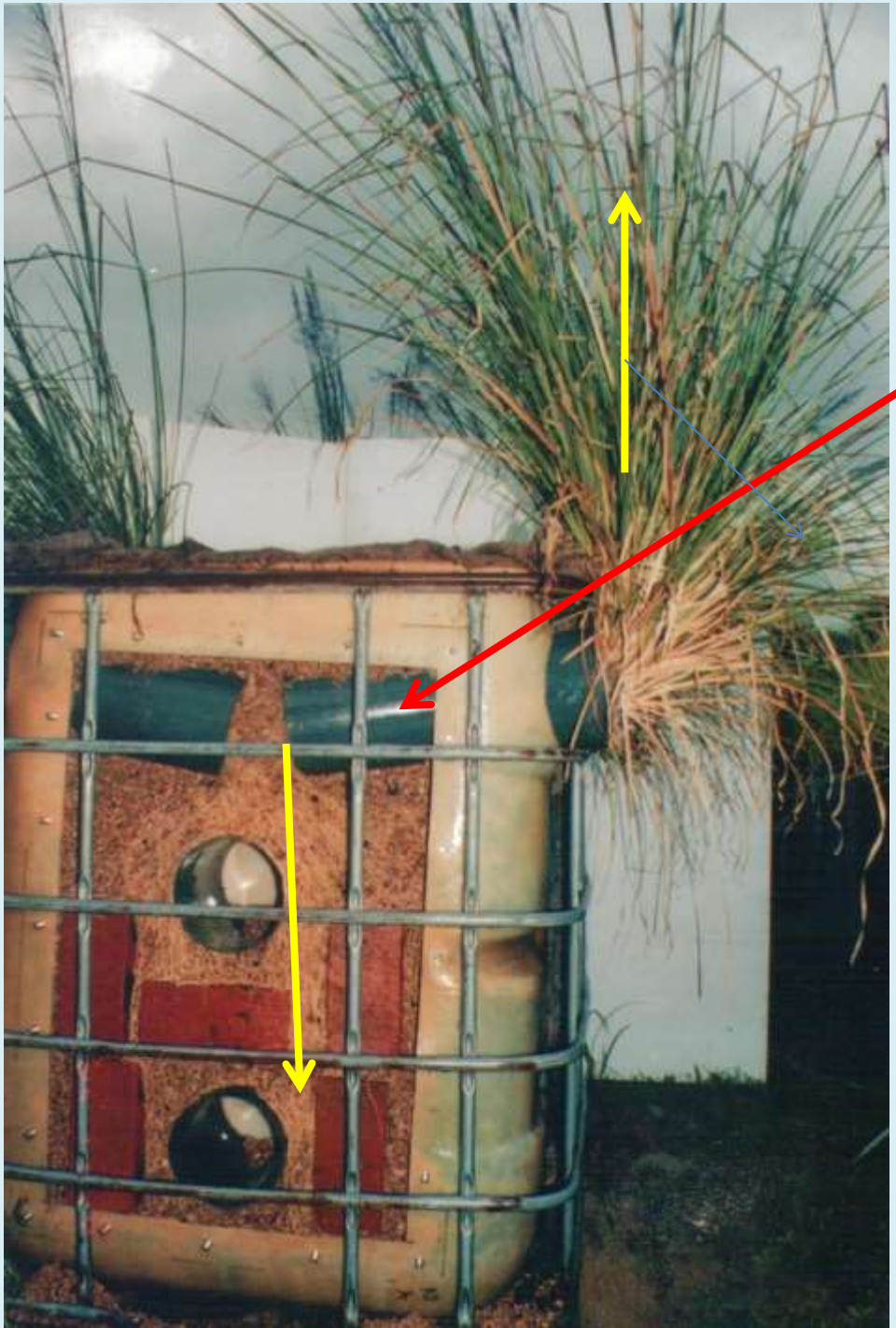
*Paul Truong*

*TVNI Technical Director*

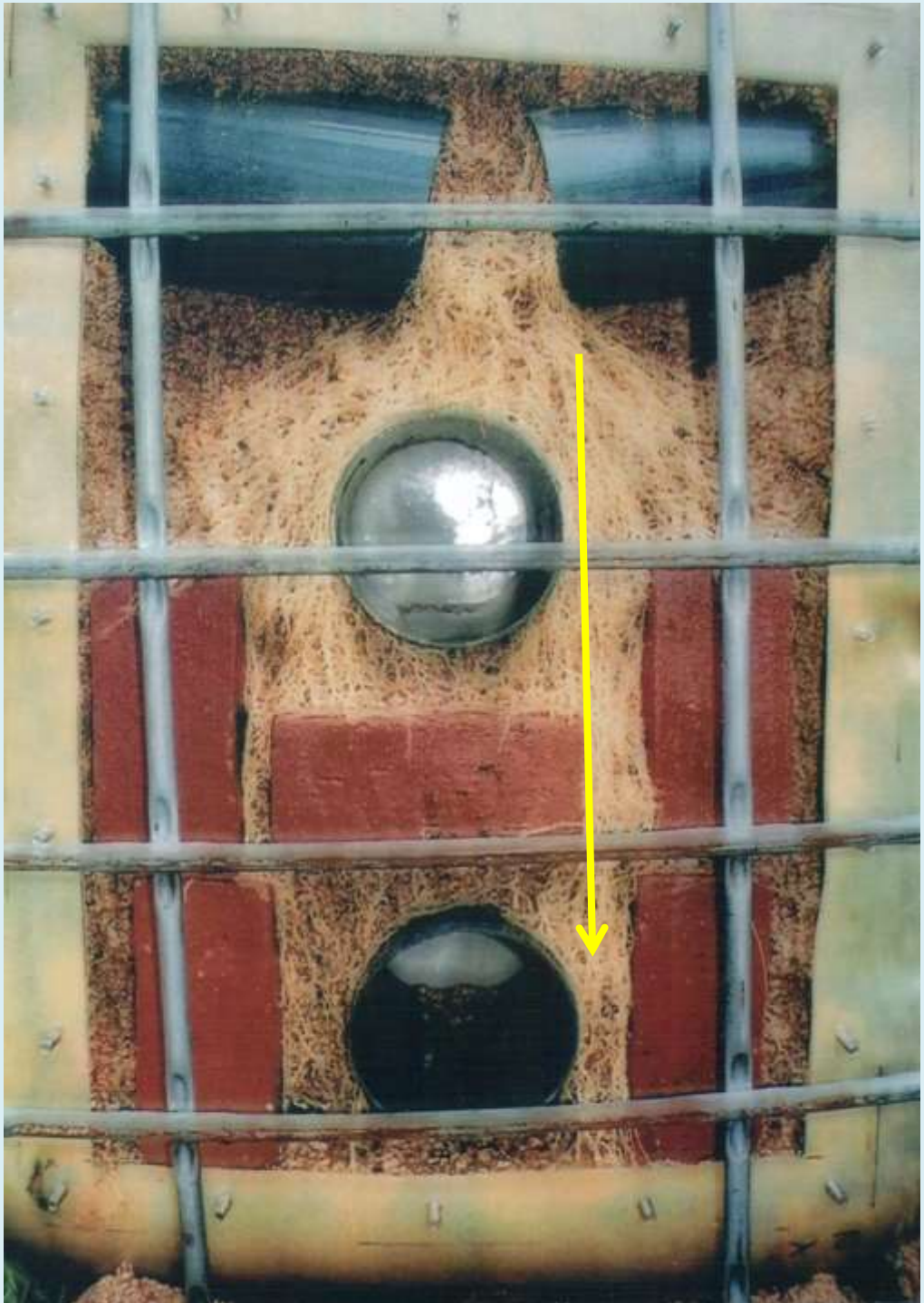
*Geotropism (also known as Gravitropism) is a growth movement by plants in response to gravity . Charles Darwin was one of the first to scientifically document that:*

- **Plant roots have Positive Geotropism: roots always grow down**
- **Plant shoots have Negative Geotropism: shoots always grow up**

**Dr. P K Yoon of Malaysia clearly demonstrated this mechanism in the following photographs**



**Vetiver was planted almost horizontally through this tube. While the roots grow down and the shoots grow upwards**



**The roots grow downwards**

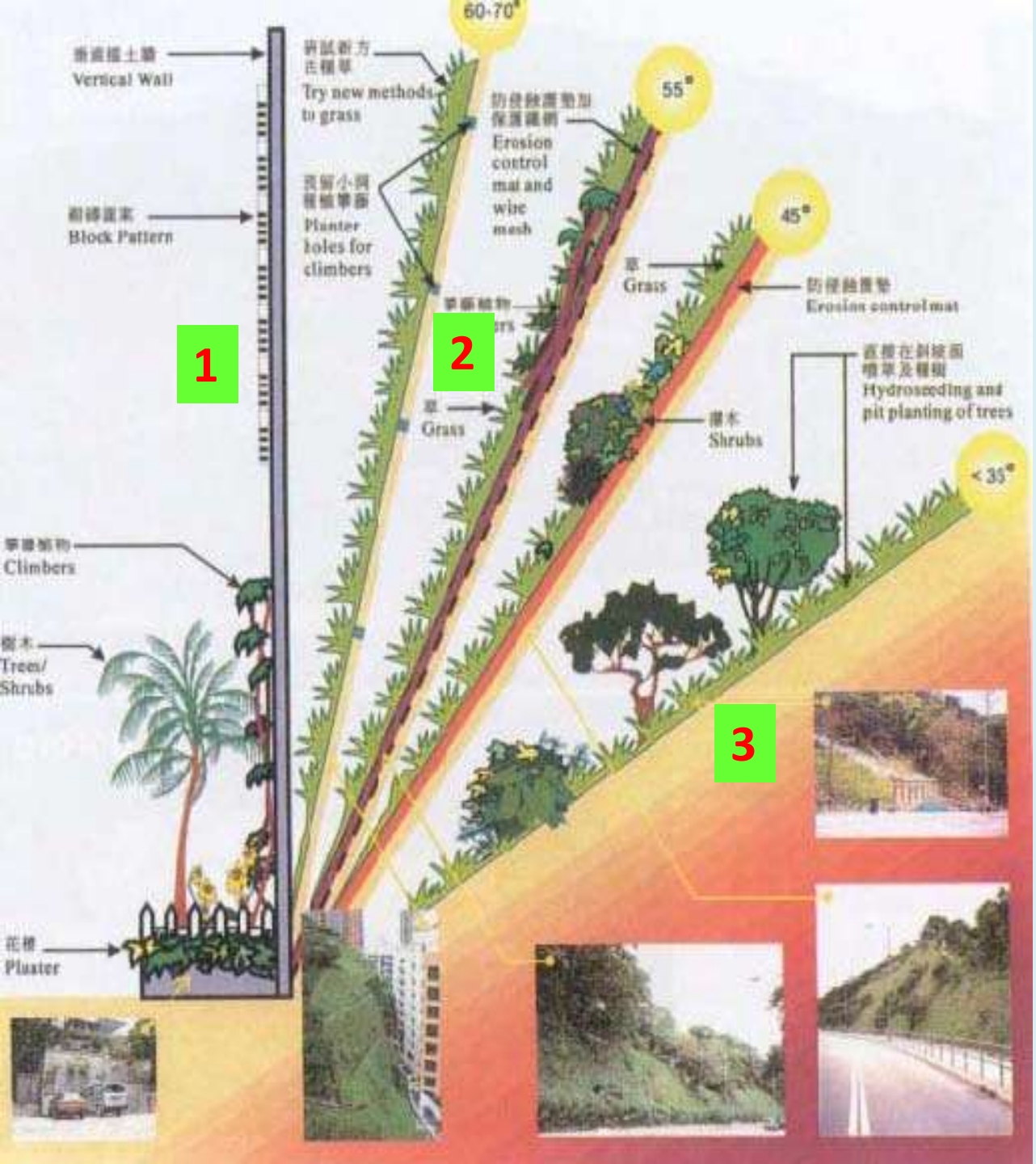

Shoots
Roots

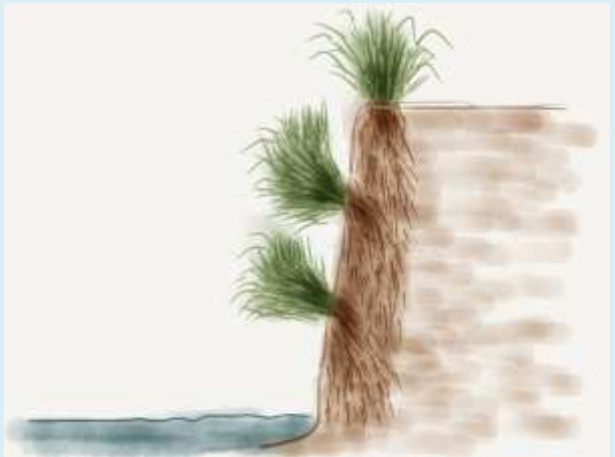

**The combination of Vetiver extensive roots and its positive geotropism effect create a stable protective cover on soil surface below the plant when it is planted on extreme slopes**

**These pots fell on its side in the nursery. Note the roots on the bottom of the pot grew out the hole and downward, those roots that cannot get through the holes forced its way sideward and down**

# Options for slope protection:

1. **Hard structure**
2. **Combination of hard and soft bioengineering including geotextiles**
3. **Bioengineering alone including geotextiles on erodible soil**

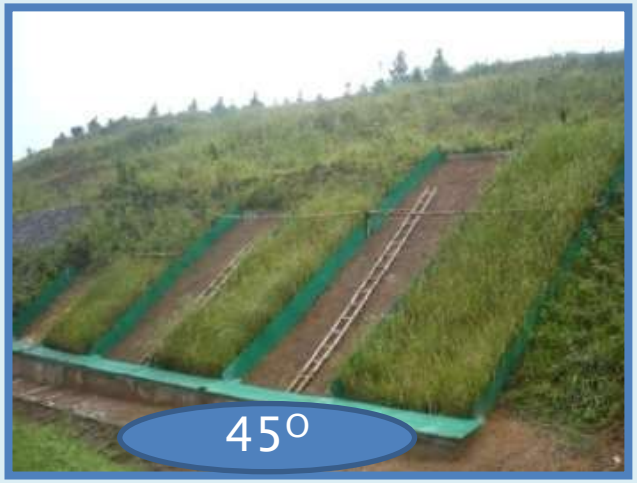


# Small Scale Laboratory Experiments at Indonesian Institute of Road Engineering (IRE)

*Asep Sunandar and Nanny Kusminingrum*

Soil Type: Silty Clay Loam , Stability Index: Unstable, 3 Month Old, West Java



Soil Type: Dusty Clay, Stability Index: Unstable, 3 Month Old, West Java



# Small Scale Laboratory Experiments At Indonesian Institute of Road Engineering (IRE)

*Asep Sunandar and Nanny Kusminingrum*

Soil Type: Clay Loam , Stability Index: Stable, 4 Month Old, Nagreg West Java

Slope 80°,
Age: 4 months
Before trimming

Slope 80°,
Age: 4 months
After trimming

# Indonesian Institute of Road Engineering (IRE)

## Trial comparing 3 Vetiver planting densities, Bahia grass and bare slope at Nagreg West Java


Vetiver
Bahia grass


Vetiver planted at 3 densities

# Very steep, 80° slope on highly erodible red volcanic soil

# CONCLUSION

- **Vetiver system can be used effectively to control surface erosion and shallow failure of road slope**
- **Vetiver system can be used effectively at slope between $30^{o}$ – $60^{o}$**
- **Vetiver system could be applied by road authorities to cope with erosion and shallow failure of road slope**
- **At road slope >$60^{o}$, vetiver technology is not recommended to be applied solely (must combined with geotextiles and/or mechanical methods)**

**Based on the above technical data, vetiver system has been used very effectively in stabilising extreme and highly erodible slopes around the world**

**The following photos show successful applications of VS on extreme slopes:**

- **Without geotextile and No Hard Structure**
- **With geotextiles**
- **With Hard Structures**

# Extreme and Highly Erodible Slope Stabilisation Around the World without Geotextiles

# AUSTRALIA: Brisbane. Queensland (Paul Truong)

## This very steep sandy riverbank, holes were made with special tools


25 5 2001


25 5 2001


25 5 2001


23 4 2002

# BRAZIL: Road Batters (Paula Pereira, Deflor)

# CHINA: Zhejiang Province (Cheng Zhou)

## National Highway 330 on slope area of 10 600m2 to prevent landslides


# COLOMBIA: Road Batters (D. Londono)

# HONGKONG: Road Batters (PK Yoon)



Sin Tin Wai Estate
Feature No. 7SW-D/C1


CED Contract No. GE/2000/04
Landslip Preventive Works for Slopes and Retaining Walls
in Tsuen Wan and Kwai Tsing Districts
Feature No. 7SW-C/C47 at Kwai Shing Circuit
11.5 MONTHS
11 MONTHS
8.5 MONTHS
8 MONTHS
25 JUN 2002

# INDONESIA: East Java (IRE, 2009-2010)

Before

1 month

2.5 months

4 months

Slope length: 300m, height: 14 m,

Regular trimmings after 4 month

# INDONESIA: Bali (David Booth)

Steep land before planting Vetiver

Planting vetiver using long ladders

Vetiver growth after 1 month

4 months after planting

# INDONESIA: Bali (David Booth)

# INDIA: Assam, Doria Bridge approach (Shanta Bhattacharyya )

# MADAGASCAR: Lavaka (Yoann Coppin)




With Vetiver and without..

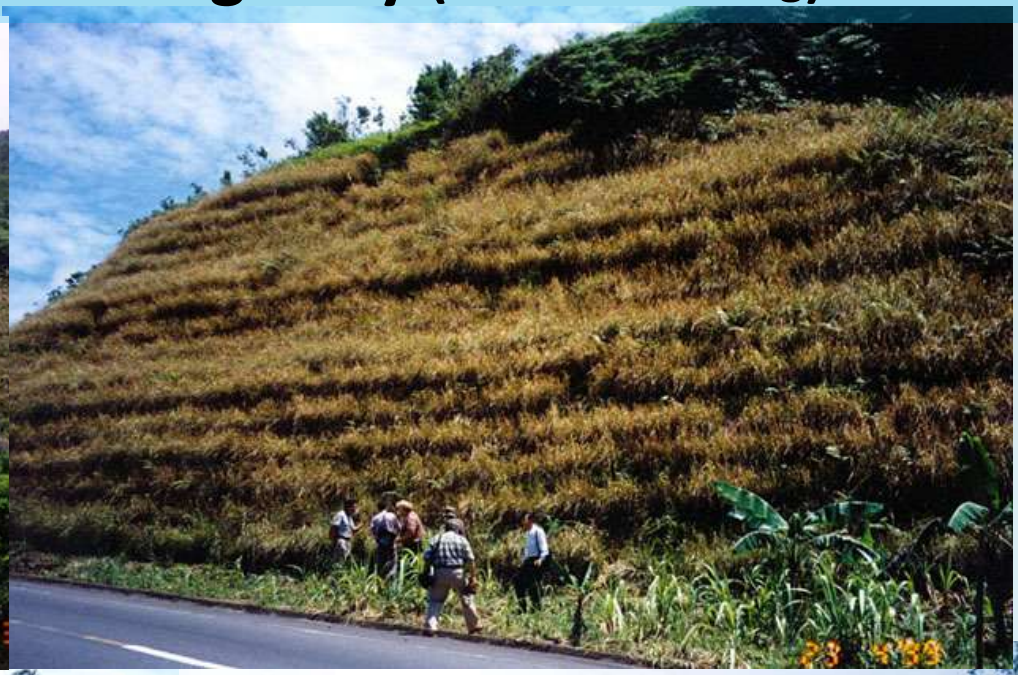
# MADAGASCAR: Railway Batters (Yoann Coppin)




27/05/2010


28/05/2010

# PHILIPPINES: Central Luzon Highway (Noah Manarang)



# THAILAND: Central Highlands (Surapol Sanguankaeo)

# USA: Hawaii Island: Ocean cliff face (Jason Fox)

# VENEZUELA: Road Batters (Rafael Luque)

# VENEZUELA: Landslide (Rafael Luque)

# VIETNAM: Ho Chi Minh Highway– Central Vietnam (Paul Truong)

# Ho Chi Minh Highway – Central Vietnam

# Ho Chi Minh Highway
# Central Vietnam

# VIETNAM: Danang– Central Vietnam (Man Tran)

# Extreme and Highly Erodible Slope Stabilisation Around the World with Geofabrics

# AUSTRALIA: Brisbane, Australia (Paul Truong)


**Highly erodible sandy soil with gradient up to 50o at some sections**


11 05 2013

# BRAZIL: Road Batters (Paula Pereira, Deflor)

# GUATEMALA: Batters on 72 degree slope using 3D geofabrics (Leonel Castro)

**Batters on 72 degree slope with geofabrics (Leonel Castro)**

**May 2012**

**June 2012**

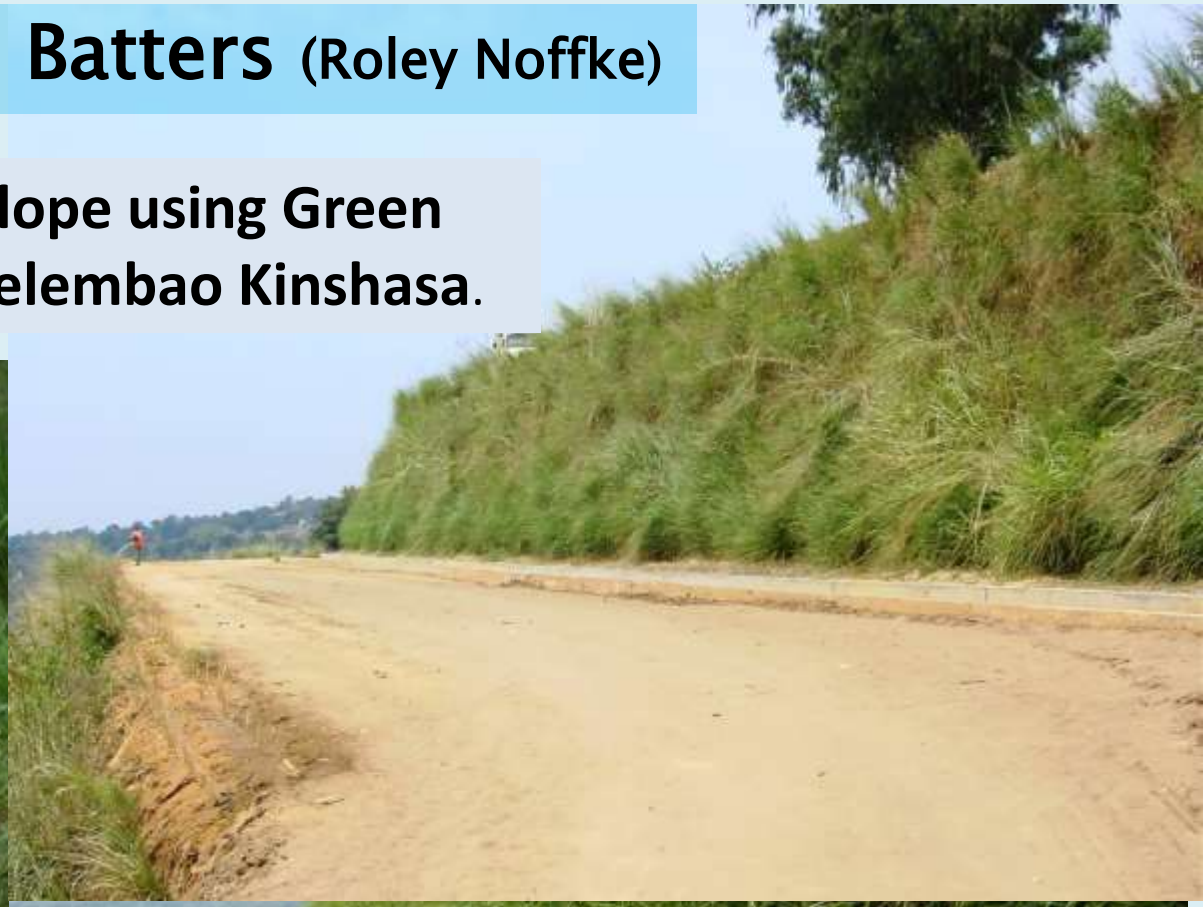
# Very steep Batters with geofabrics (Leonel Castro)

# GUINEA (West Africa): Road Batters (Roley Noffke)

**Still stable after 8 years**

# DCR CONGO: Road Batters (Roley Noffke)

**On 60°-70° vertical slope using Green TerraMesh walls at Selembao Kinshasa.**



# Extreme and Highly Erodible Slope Stabilisation Around the World with Sandbags and Ecomortar

# BRAZZAVILLE CONGO (Alain Ndona)

**West Africa**
**Urban ravine rehabilitation**

## Sand Bags

**Bags can be filled with sand, soil and fertilizer or a mixture of sand and soil where local soil is poor or rocky.**

# BRAZZAVILLE CONGO (Alain Ndona)

**Vetiver is planted into the bags with soil and fertilizers**

# BRAZZAVILLE CONGO (Alain Ndona)

**Excellent Vetiver growth and ravine stabilized**

# COLOMBIA: Road Batters (Jorge Londonio)

## Eco Mortar

**Is a weak shotcrete,(a mixture of cement, soil and fiber). Eco Mortar was developed and used extensive in Colombia by MECETA .**

# COLOMBIA:
## Road Batters (Jorge Londonio)

## COLOMBIA:
## Landslide
(Jorge Londonio)

**Completely cover the whole slope with vetiver plants**

# COLOMBIA:
## Landslide (Jorge Londonio)

**COLOMBIA:**
**Landslide** (Jorge Londonio)

# COLOMBIA

**Excellent establishment due to erosion control, moisture and fertilizer retention of Ecomortar**

# Extreme and Highly Erodible Slope Stabilisation Around the World with Soilnails and Geogrids

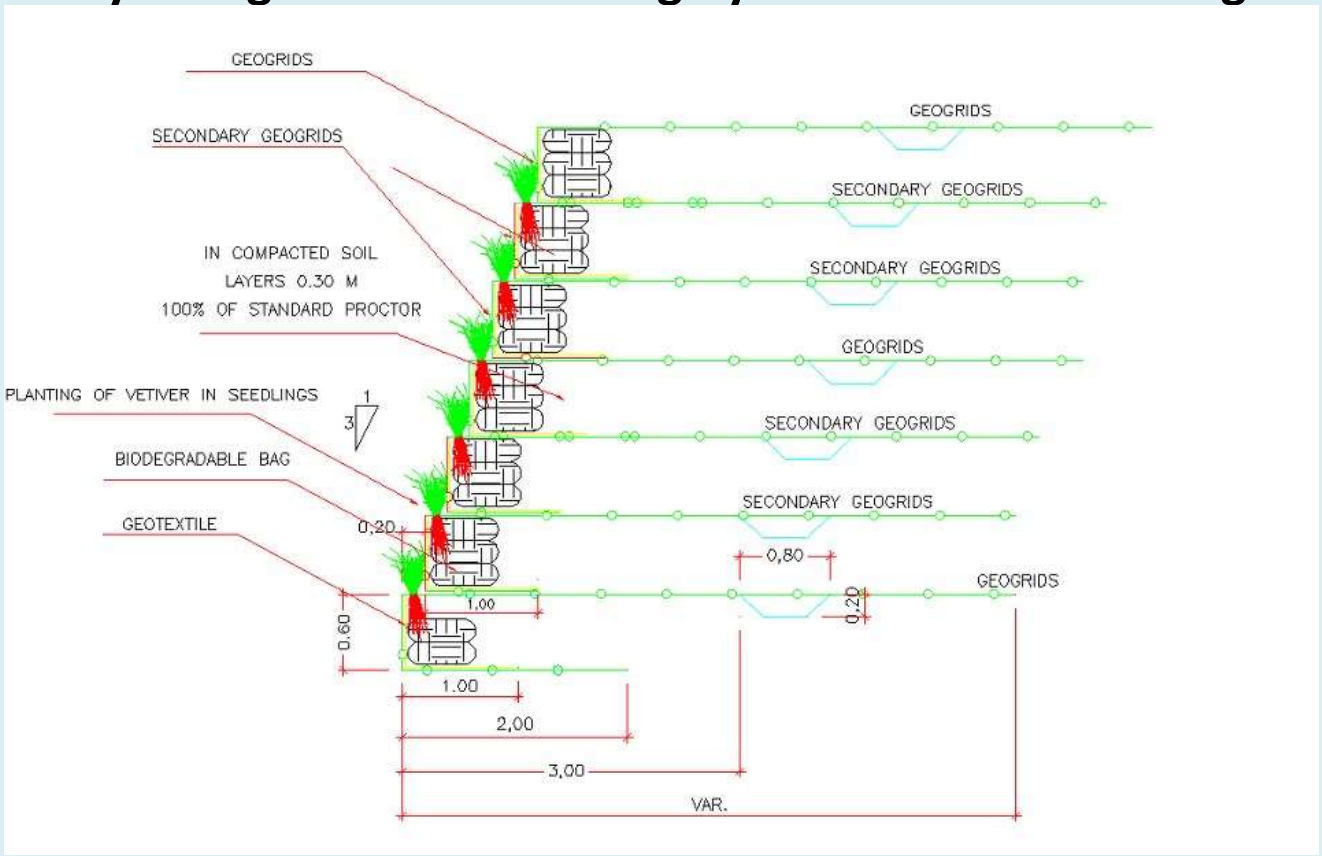
# COLOMBIA: Soil Nails (Daniel Londono)

# VIETNAM: Danang (Man Tran)

# BRAZIL: Santana do Parnaíbal Sao Paulo (Fernando Andrade)

**This is the work performed on in an environmental protected area with approximately 1100 m² of front and 25 meters tall.**

**The technique consists the formation of containment systems using geogrids, soil and Vetiver. The roots of vetiver play a fundamental role for the success of the wall, because its depth and its generous amount of root aggregated to the soil. This very deep roots' system, and rapid growth also makes vetiver very drought tolerant and highly suitable for stabilizing the wall.**

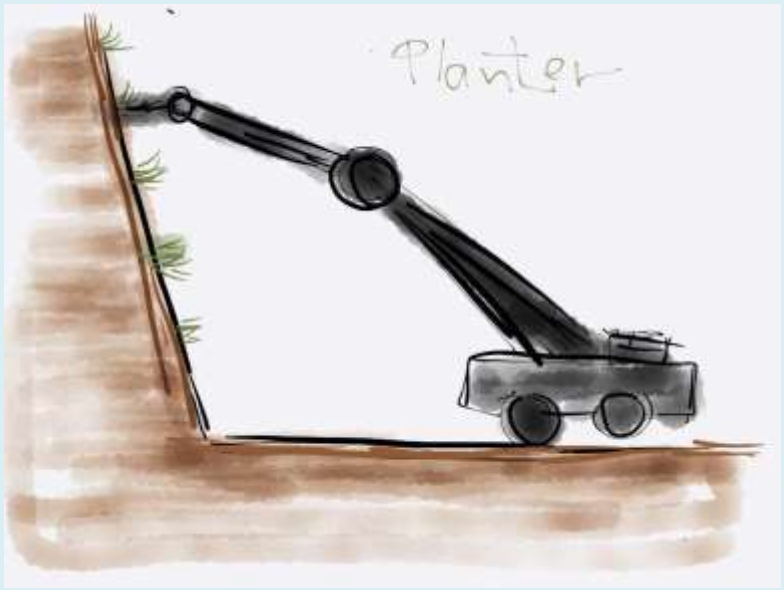


**Two years later**

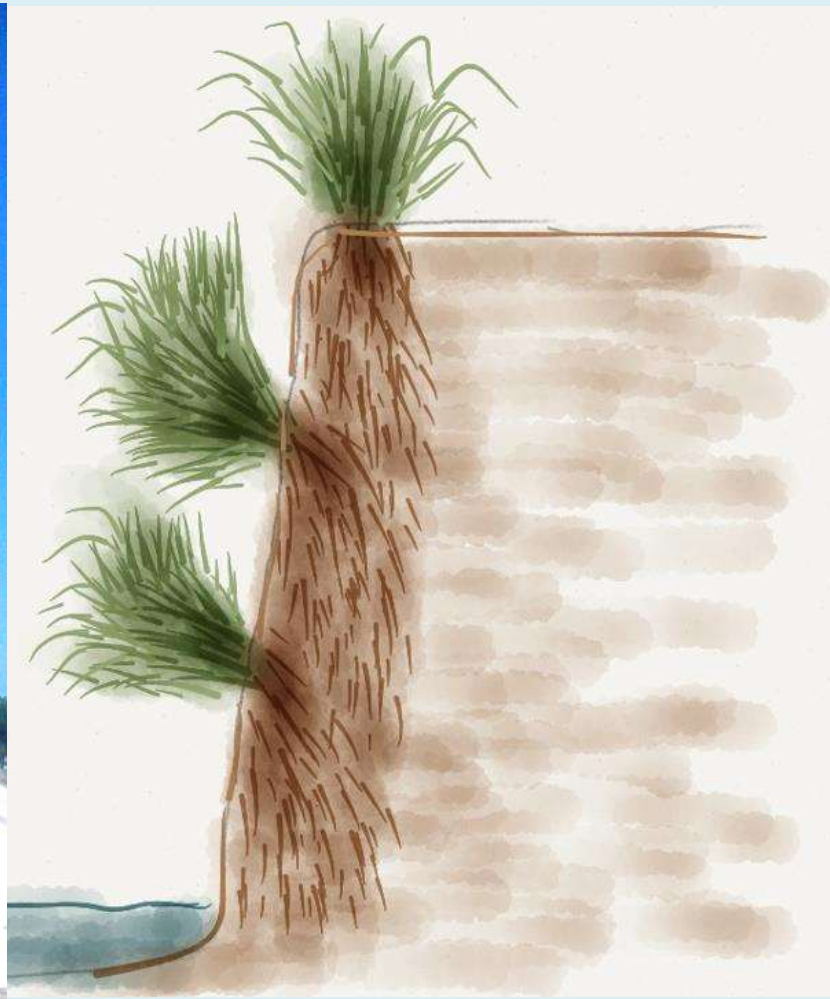
# Some Instruments used for the Planting of Vetiver on these Extreme slopes

# AUSTRALIA: Hole Puncher (Paul Truong)

**This "puncher" is mounted on a backhoe to make holes for vetiver planting on the steep wall**



# GUINEA (West Africa): Ladder, portable drill and strong hands (Roley Noffke)



# INCREDIBLE
# GO FOR IT!