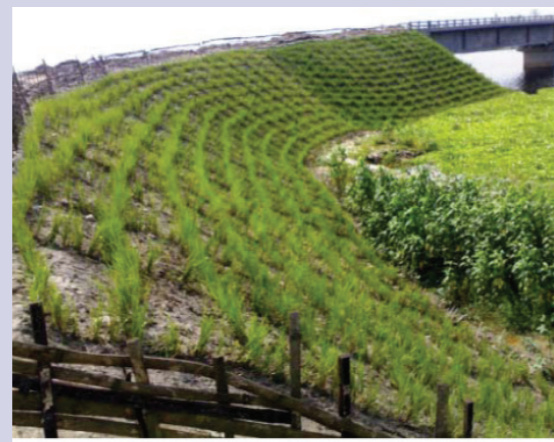


EXTREME SLOPE STABILISATION WITH VETIVER SYSTEM

Paul Truong
TVNI Technical Director



Pacific Rim Vetiver Network

Technical Bulletin No. 2014/1

Extreme Slope Stabilisation Using Vetiver System

By

Paul Truong
TVNI Technical Director

Office of the Royal Development Projects Board
Bangkok, Thailand
February 2014

The Pacific Rim Vetiver Network (PRVN)

Objective: To serve the countries of the Pacific Rim as the center to collect, compile and disseminate information on the use of vetiver in the forms of newsletter, occasional publications, and homepage of the internet.

Member Countries: The following 20 countries, geographical situated in the Pacific Rim, are members of the PRVN: Australia, Brunei, Cambodia, China, Cook Islands, Fiji, Indonesia, Japan, Lao PDR, Malaysia, New Caledonia, New Zealand, Papua New Guinea, Philippines, Samoa, Taiwan, Thailand, Tonga, Vanuatu, and Vietnam.

Scientist Members: Scientists of the member countries of the PRVN who had made prior contact with the RDPB are automatically registered as the PRVN members, which at present amount to about 800. Others who want to join the Network can apply directly to its Secretariat Office. No application form is necessary. Those who are interested to apply just identify themselves with name, current position, place of work, and mailing address, e-mail address, and other information which they deem necessary.

Activities:

Newsletter: An 8-page quarterly English-language newsletter under the name of VET-IVERIM has been issued, starting first number in July 1997. Its circulation is 1,200 copies for each number. It has been sent in bulk to the Country Representatives of the member countries for further distribution to scientists and institutes within the country in order to save postage and other difficulties in international mailing.

Internet Homepage: The PRVN has established its internet homepage which can be seen through: <http://prvn.rdpb.go.th>. Scientists of the member countries, or from other regions for that matter, are invited to submit information on new research and technologies on vetiver, especially those appropriate to the Pacific Rim countries. Information and pictures are most welcome and can be sent to the PRVN Secretariat by mail, fax, or e-mail (see addresses below).

Publications: It has been the intention of the Secretariat to publish technical bulletins and other documents, as and when opportunity arises. A series of technical bulletins (from one to three bulletins per year) have been launched since April 1998. So far, 23 bulletins have been issued.

The Secretariat

PRVN Secretariat Office
Office of the Royal Development Projects Board
2012, Soi 36, Arun Amarin Road, Bang Yi Khan Subdistrict, Bang Phlat District,
Bangkok 10700 Thailand
Tel.: (66-2) 447 8500; Fax: (66-2) 447 8543
Homepage: <http://prvn.rdpb.go.th>

The Office of the Royal Development Projects Board and the Establishment of PRVN

His Majesty King Bhumibol Adulyadej of Thailand has been dedicated to development work ever since the beginning of his reign in 1946. His Majesty has become familiar with the problems and real conditions of the people through constant visits to every region of the country, often accompanied by Her Majesty Queen Sirikit and other members of the Royal Family. It is during these many Royal visits to the rural areas that His Majesty has realized the need to initiate development projects that would directly benefit the people at the grassroots. Thus, the first Royal Development Project was launched in 1952 followed by numerous projects, which currently reach 4,447.

However, the implementation of the Royal Development Projects in the past lacked cohesiveness because each agency carried out the work on its own without coordinating with other concerned agencies. Therefore, in order to serve and implement the Royal initiatives through a consistently integrated system which allows the Royal Development Projects to run efficiently, the Thai government issued a "Regulation of the Office of the Prime Minister" which became effective on 9 September 1981. The Regulation led to the establishment of the Coordinating Committee for Royal Development Projects which later became the Royal Development Projects Board in 1993. The Board has the major task of directing, monitoring and coordinating the operation of government agencies and state enterprises concerning the Royal Development Projects. Moreover, it considers and approves projects, plans and activities as well as expenditures to be used in the operation of the projects. All of these tasks are supported by the Office of the Royal Development Projects Board (ORDPB), the secretariat of the Board.

With agriculture being the backbone occupation in the Thai society, His Majesty the King understood the vital need in preserving natural resources and therefore, initiated the vetiver grass project in Thailand. The project principally aimed to mitigate soil erosion, a distinct aspect of environmental deterioration in Thailand which needs to be managed properly. His Majesty recognized the potential of vetiver grass as a practical and inexpensive yet effective management and conservation tool to address the soil erosion problem. As a result, the Committee on the Development and Promotion of the Utilization of Vetiver (CODPUV) under His Majesty's Initiative was set up under the administration of the ORDPB in 1992 to look after all the Royally-initiated vetiver projects implemented in various parts of the country. The First International Conference on Vetiver (ICV-1) was held on 4 to 8 February 1996 in Chiang Rai, Thailand. ICV-1 was co-organized by the Chaipattana Foundation and the Mae Fah Luang Foundation with the collaboration of the World Bank and the FAO. The main purpose was to commemorate the 50th Anniversary Celebrations of His Majesty the King's Accession to the Throne.

Immediately after ICV-1, a proposal was made by Mr. Richard Grimshaw, who was then the President of the Vetiver Network, to establish the Pacific Rim Vetiver Network (PRVN) in Thailand with the principal objective of serving as the center to collect and disseminate information on the use of vetiver grass in the form of newsletters, occasional publications as well as a homepage on the internet. His Majesty the King agreed with the proposal and commissioned the setting up of the PRVN under the supervision of the CODPUV, to be administered by the ORDPB. The PRVN then became active with the establishment of a working team on 6 May 1997.

Extreme Slope Stabilisation Using Vetiver System

By

Paul Truong

TVNI Technical Director

Office of the Royal Development Projects Board

Bangkok, Thailand

February 2014

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Foreword

One of the immediate activities of the Pacific Rim Vetiver Network (PRVN) is to disseminate information on the Vetiver System (VS), especially those techniques that are adaptive to local conditions of various countries in the Pacific Rim region. In this connection, the PRVN Secretariat is publishing a series of technical bulletins (TBs) that provide useful information about the VS to readers who are active members of the PRVN.

Since 1998, one to three TBs have been published annually. Altogether, 17 TBs have been published. These are:

-1998: (1) "Vetiver Grass Technology for Environmental Protection" by Paul Truong and Dennis Baker; and (2) "Vetiver Grass for Slope Stabilization and Erosion Control" by Diti Hengchaovanich.

- 1999: (1) "Vetiver Handicrafts in Thailand" by the (Thai) Department of Industrial Promotion; (2) "Vetiver Grass Technology for Mine Rehabilitation" by Paul Truong; and (3) "The Use of Vetiver Grass System for Erosion Control and Slope Stabilization Along the Yadana Gas Pipeline Right-of-Way" by the Petroleum Authority of Thailand.

- 2000: (1) "Techniques of Vetiver Propagation with Special Reference to Thailand" by Narong Chomchalow.

- 2001: (1) "The Utilization of Vetiver as Medicinal and Aromatic Plants with Special Reference to Thailand" by Narong Chomchalow; (2) "Vetiver System for Wastewater Treatment" by Paul Truong and Barbara Hart; and (3) "The Development of the Vetiver System in Guangdong, China" by Hanping Xia.

- 2002: (1) "The Role of the Private Sector in Disseminating the Vetiver System with Special Reference to China" by Hanping Xia; and (2) "The Use of Vetiver for Soil Erosion Prevention in Cassava Fields in Thailand" by Somsak Suriyo and Wilawan Vongkasem.

- 2003: (1) "Vetiver Root - Oil and Its Utilization" by U.C. Lavania; and (2) "Vetiver Victorious: The Systematic Use of Vetiver to Save Madagascar's FCE Railway" by Diti Hengchaovanich and Karen Schoonmaker Freudenberg.

- 2004: (1) "Utilization of Vetiver as a Construction Material for Paddy Storage Silo" by Pichai Nimityongskul and Thammanoon Hengsadeeikul

- 2006: (1) "Rehabilitation of Ravine on the Congolese Floodplain" by Alain Ndong, Paul Truong, and Dale Rachmeler.

- 2009: (1) "Vetiver Phytoremediation for Heavy Metal Decontamination" by Nualchavee Roongtanakiat; and (2) "Application and Development of the Vetiver System in China: 20 Year Experience Retrospection" by Liyu Xu.

- 2013: (1) "Application of the Vetiver System for Wastewater Treatment: An Innovative Nutrient Removal Technology for Sewage Water Treatment in Southern Guam" by Mahammad H. Golabi and Manuel Duguies.

The present bulletin is a special issue which is somewhat different from all the others as it is printed in landscape layout instead of portrait, and with 54 pages in full color. It deals with the use of the vetiver system in stabilising extreme and highly erodible slopes without geofabrics and no hard structure, with geofabrics, and with hard structures.

On behalf of the PRVN, we wish to express sincere thanks to the author, Dr. Paul Truong, TVNI Technical Director, for his great contribution. It is hoped that this publication will be of value to vetiver scientists, agricultural extensionists and others who would like to use vetiver grass for stabilising extreme and highly erodible slopes.

Narong Chomchalow
Coordinator, Pacific Rim Vetiver Network

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EXTREME SLOPE STABILISATION USING VETIVER SYSTEM



Paul Truong
TVNI Technical Director
www.vetiver.org

INTRODUCTION

The important role of Vetiver System Technology in Bioengineering has been well established. It has also been observed that vetiver is very effective in stabilising extreme slopes.

This booklet will explain/demonstrate how Geotropism (also known as Gravitropism) plays an important role in this stabilisation process.

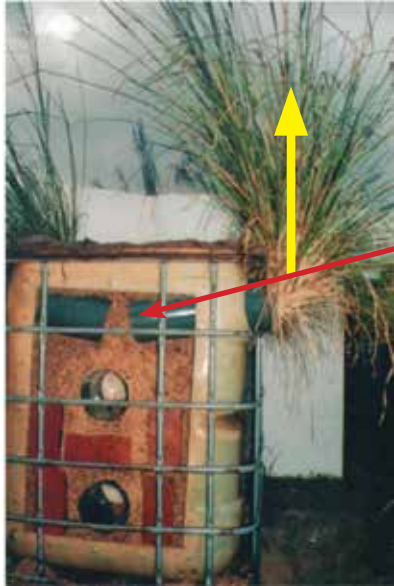
Geotropism is a growth movement by plants in response to gravity. Charles Darwin was one of the first to scientifically document that:

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

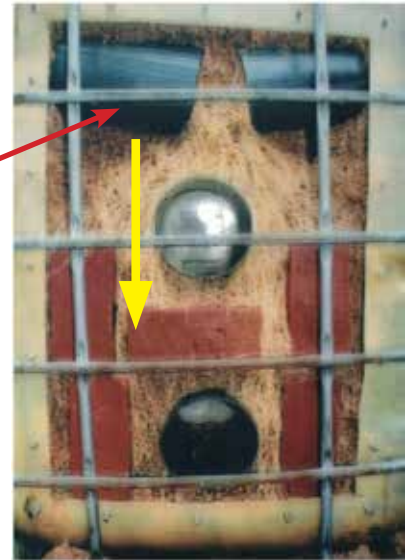
In a series of trials, Dr. P K Yoon of Malaysia, a founding Director of the Vetiver Network International (TVNI), clearly showed geotropism strongly affected vetiver growth and development.

This booklet shows the effectiveness of VST in stabilising extreme slopes when applied correctly.

Vetiver Geotropism Research Conducted by PK. Yoon and P. Truong



Vetiver was planted almost horizontally through these tubes. While the roots grew down, the shoots grew upwards.



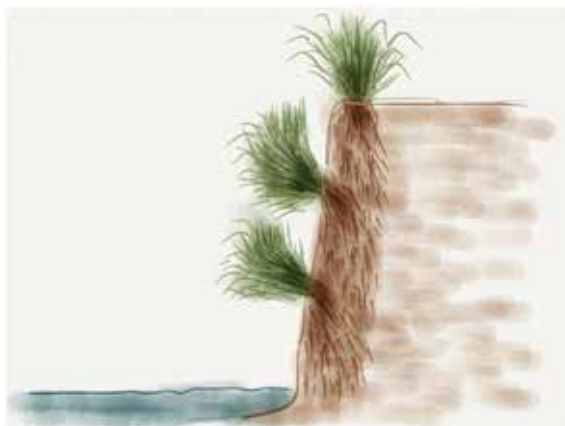
This pot fell on its side in the nursery. Note the roots on the bottom of the pot grew out the drain holes and downward, but those roots that could not get through the holes, forced their way sideward and down.



The combination of vetiver extensive roots and its positive geotropism creates a solid and stable protective cover on soil surface below the plant when it is planted on extreme slopes.



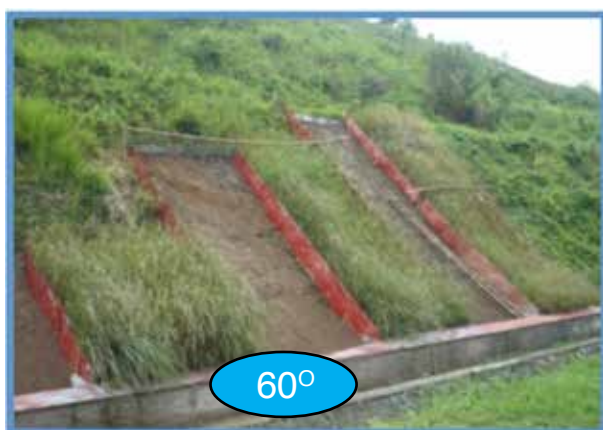
Options for Slope Protection:



1. Hard structures only
2. Combination of hard and soft bioengineering including geofabrics
3. Bioengineering alone including geofabrics on erodible soil

Asep Sunandar and Nanny Kusminingrum Indonesian Institute of Road Engineering (IRE) conducted a series of experiments with slopes ranging from 30° to 80°

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



Indonesian Institute of Road Engineering : Nagreg West Java

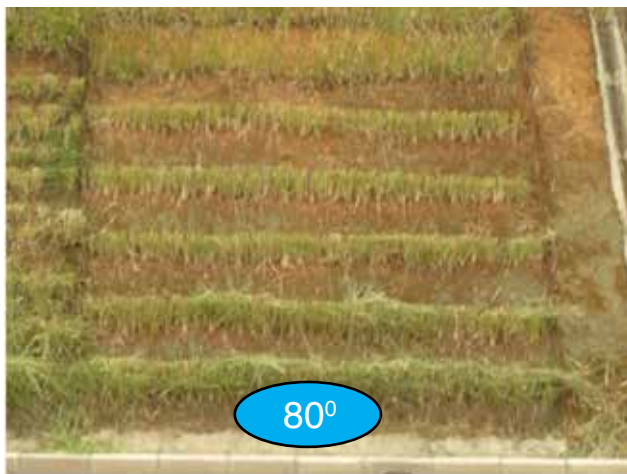
Soil Type : **Clay Loam**

Stability Index: **Stable**

4 Month Old



4 month old, before trimming



4 month old, after trimming

Indonesian Institute of Road Engineering (IRE)
Asep Sunandar and Nanny Kusminingrum



Very steep, 72° 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° – 60°.
- ❑ Vetiver system could be applied by road authorities to cope with erosion and shallow failure of road slope.
- ❑ At road slope >60°, 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 Geofabrics and No Hard Structure
 - With Geofabrics
 - With Hard Structures

Without Geofabrics: AUSTRALIA, Brisbane



This is a very steep sandy riverbank, holes were made with special tools.



Without Geofabrics : BRAZIL Road Batters



Without Geofabrics : CHINA Zhejiang Province

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





Without Geofabrics : COLOMBIA Road Batters



Without Geofabrics : ECUADOR Construction site



Without Geofabrics : HONGKONG Road Batters



Without Geofabrics : INDONESIA East Java

Slope length : 300m
height : 14m,



Before



1 month



2.5 months



4 months



Regular trimmings after 4 months

Without Geofabrics : INDONESIA Bali



Steep land before planting vetiver



Planting vetiver using long ladders



Vetiver growth after 1 month



4 months after planting

Without Geofabrics : INDONESIA Bali



Without Geofabrics : INDIA Assam, Doria Bridge



Without Geofabrics : MADAGASCAR Lavaka



Before and After





Without Geofabrics : MADAGASCAR Railway Batters



MADAGASCAR :
Railway between Tananarive and Tamatave



25,000 vetiver slips planted in August 2013, total 2,500m in length, with a spacing of 0.60m between the rows

Without Geofabrics : PHILIPPINES Central Luzon Highway





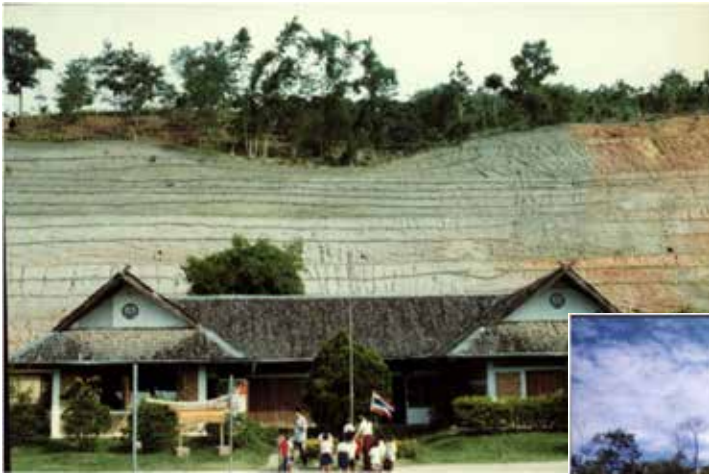
MAIBARARA GEOTHERMAL POWERPLANT
Sto. Tomas Batangas, Philippines

- 10 Vetiver plants per linear meter
- .5 meter distance between rows (10 meters from the top)
- 1.5 meter distance between rows (lower part of slope)
- "ornamental peanut plants" planted in between rows

*EROSION CONTROL AND
REVEGETATION ON CUT SLOPE*



Without Geofabrics : THAILAND Chiang Rai



Landslide : Before and After



Without Geofabrics : USE, Hawaii Island



Without Geofabrics : VENEZUELA Road Batters



Without Geofabrics : VENEZUELA Landslide



Without Geofabrics : VIETNAM Ho Chi Minh Highway



Although badly designed (no benching), it still worked!



Without Geofabrics : VIETNAM Ho Chi Minh Highway



Ho Chi Minh Highway – Central Vietnam



Without Geofabrics : VIETNAM Da Nang



With Geofabrics : AUSTRALIA Brisbane



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



Vetiver planting





6 months after planting

With Geofabrics : BRAZIL Road Batters



With Geofabrics : GUATEMALA: Batters on 72° slope with 3D geofabrics





Very steep Batters with geofabrics



With Geofabrics : GUINEA (West Africa): Road Batters



Still stable after 8 years



With Geofabrics : DCR CONGO Road Batters



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



With Sand Bags: BRAZAVILLE CONGO 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

Vetiver is planted into the bags with soil and fertilizers



BRAZZAVILLE CONGO



Excellent vetiver growth and the ravine stabilized



With Eco Mortar : COLOMBIA Road Batters.



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

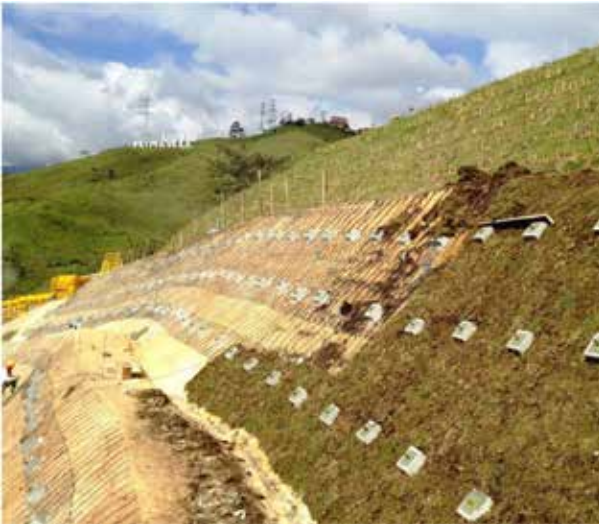
Excellent establishment due to erosion control, moisture and fertilizer retention by Eco Mortar



COLOMBIA : Landslide 60°

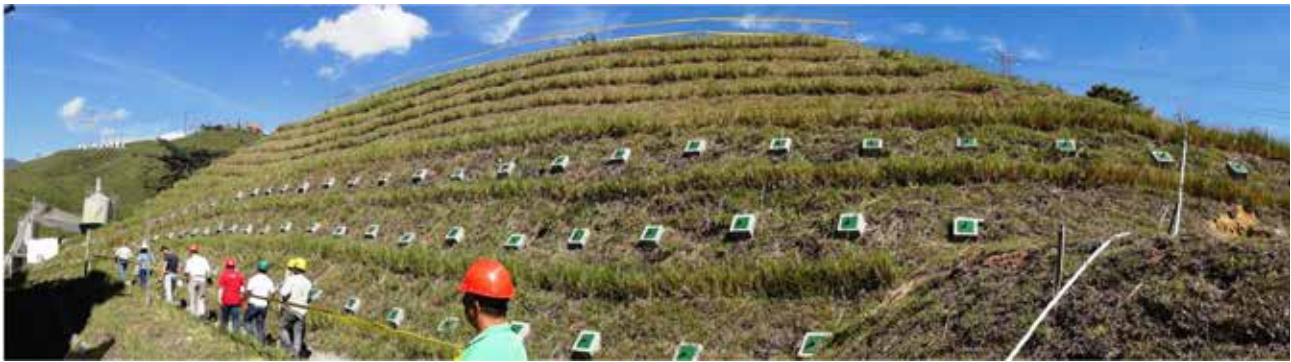


With Soil Nails : COLOMBIA: Medellin





With Soil Nails : COLOMBIA: Medellin



10 months after planting



With Soil Nails : VIETNAM Da Nang

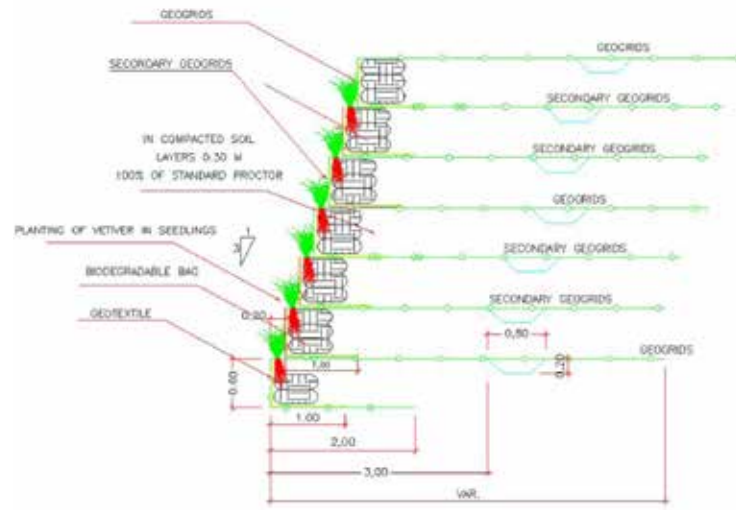


Before and After



Before and After

With Geogrids : BRAZIL Sao Paolo



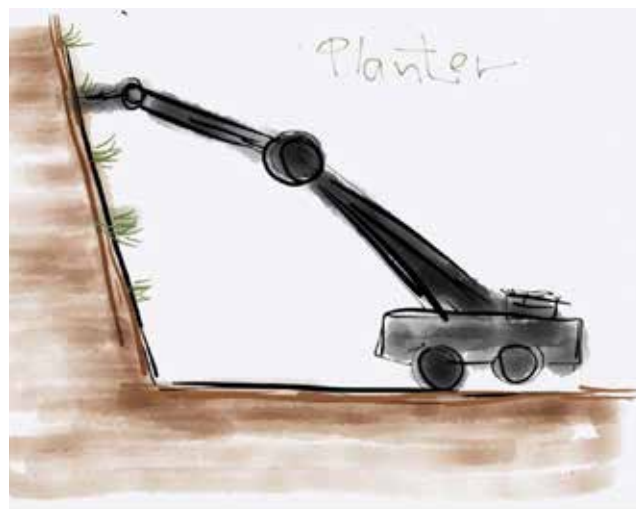


2 years after planting

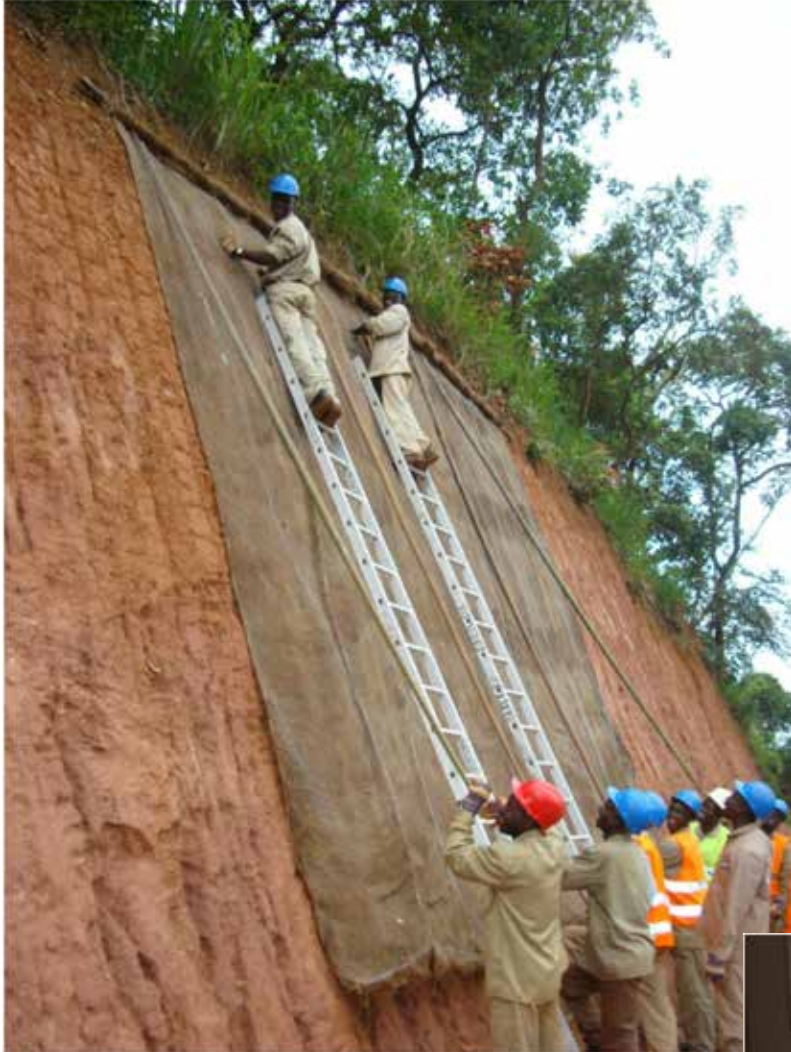


Some instruments used on these extreme slopes

This Australian “Hole puncher” is mounted on a backhoe to make holes for vetiver planting on the steep wall.



Ladder, portable drill and strong hands and courage in GUINEA (West Africa)





**Incredible
GO FOR IT!**

