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Dr. Paul Truong is a Board Director and Asia and Oceania Representative of The Vetiver Network International (TVNI), and CEO and Principal Consultant of Veticon Consulting. His pioneering research on vetiver grass tolerance to adverse conditions, heavy metal tolerance and pollution control has established the benchmark for Vetiver System applications in toxic wastes and mine rehabilitation, and wastewater treatment, which he has won several World Bank and the King of Thailand Awards. In the last 20 years he has conducted extensive R&D and Application of the Vetiver System in erosion and sediment control, land rehabilitation and environmental protection in tropical and subtropical Australia, Asia, Africa, Mediterranean Europe, Latin America and the USA.

The Long Term Effectiveness of Vetiver System In Highway Batter and Steep Slope Stabilisation

By
Paul Truong

Office of the Royal Development Projects Board

Bangkok, Thailand

February 2015

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 to 16-page quarterly English-language newsletter under the name of VETIVERIM has been issued, starting first number in July 1997. Its circulation is 1,000 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. Starting from No. 63, an e-mail edition has been issued.

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, 21 bulletins have been issued.

The Secretariat

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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 the total of 4200.

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 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.

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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 developing countries in the Pacific Rim. 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, 20 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; (2) "Vetiver Victorious: The Systematic Use of Vetiver to Save Madagascar's FCE Railway" by Diti Hengchaovanich and Karen Schoonmaker Freudenberger; and (3) "Research, Development and Implementation of the Vetiver System for Wastewater Treatment" by Paul Truong and Cameron Smeal.

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

- 2006: (1) "Rehabilitation of Ravine on the Congolese Floodplain" by Alain Ndona, 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 Mohammad H. Golabi and Manuel Duguies.

- 2014: (1) Extreme Slope Stabilisation Using Vetiver System" by Paul Truong and (2) Socio-Economic Benefits of the Vetiver System Technology in Mining Areas in Developing Countries by Paul Truong.

The present publication is TB 2015/1, "The Long Term Effectiveness of Vetiver System in Highway Batter and Steep Slope Stabilisation" by Paul Truong.

On behalf of the PRVN, we wish to express sincere thanks to the author, Dr. Paul Truong, a Board Director and Asia and Oceania Representative of TVNI for his great contribution. It is hoped that this publication will be of value to vetiver scientists and others who would like to know more about the Vetiver System applications in slope stabilization.

Narong Chomchalow
Coordinator, Pacific Rim Vetiver Network

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A PHOTO ESSAY ON THE LONG TERM EFFECTIVENESS OF VETIVER SYSTEM IN HIGHWAY BATTER AND STEEP SLOPE STABILISATION

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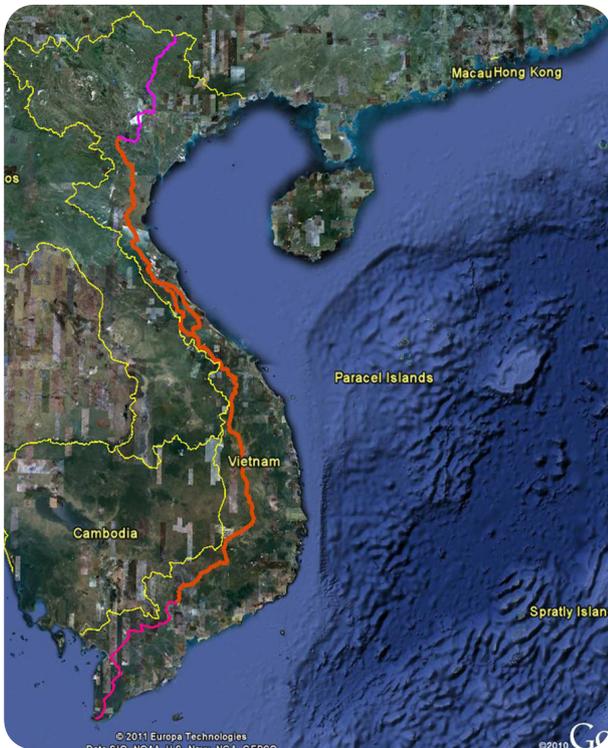
This report comprises of visits to:

1. Ho Chi Minh Highway in February 2014
2. Hong Kong steep slopes and Highway batters in June 2014

HO CHI MINH HIGHWAY VISIT IN FEBRUARY 2014

The aim of this visit was to assess the effectiveness of the Vetiver System in controlling erosion on the **Ho Chi Minh Highway** after 14 years of implementation (2000- 2014). This was conducted as a part of the preparation for field trips for ICV6 in Da Nang in May 2015.

HO CHI MINH HIGHWAY (HCMHW): A Brief Introduction



The main HCMHW connects Cao Bang in the North with Ca Mau Cape in the South, total length 3,200km. It also connects with National Route No.1 by 20 traverses adding another 1,700km.

With the overall length of 4 900km, making the HCMHW the longest infrastructure protected by VST in the world.

Construction schedule:

- Master plan approved by Government in 1997.
- Construction started in 2000
- Designed for 2-8 lanes (40-100m wide) and comprised of 3 main sections:

1- Section 1 (Hanoi-Quang Binh): 500km;

2- Section 2 (Quang Binh-Quang Nam):

2 branches:

- * East HCMHW, 364km and
- * West HCMHW, 514km;

3- Section 3 (Quang Nam-Saigon): 825km

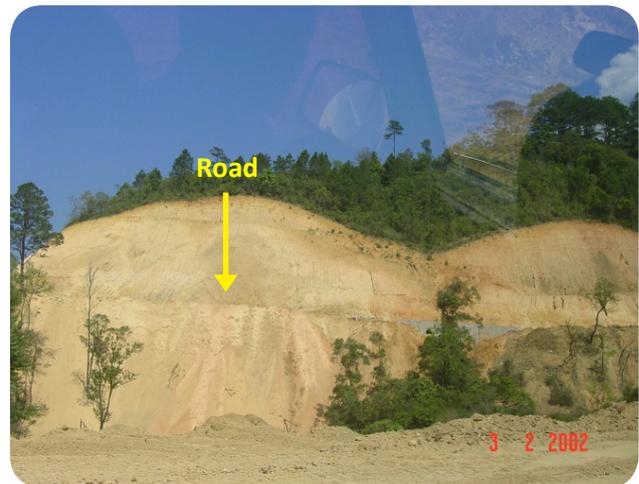
This Report covers a two day trip over a distance of about 1 000km. Starting west from the coastal National Route No.1 at Da Nang to Section 2 (Quang Nam to Quang Binh) on one of the traverse connecting roads (200km) then north to East HCMHW (364km) and to Section 1 (Quang Binh to Hanoi) (500km)

HO CHI MINH HIGHWAY: A Brief History



The original HCM Trail, started as a goat tract in 1956, then upgraded for bicycles and eventually for trucks and tanks in the 70s. Now further widened for earth moving equipment. Mostly hidden then under a thick canopy of tropical rainforest.

HO CHI MINH HIGHWAY: Construction Phase



HO CHI MINH HIGHWAY: Erosion during Construction Phase





HO CHI MINH HIGHWAY: Vetiver System Implementation Phase

Following the obvious failure of the costly conventional measure in controlling the erosion and landslips along the Highway, the Ministry of Transport adopted VS as a preferred erosion control measure on all new sections of the Highway and on eroded slopes of the completed sections.



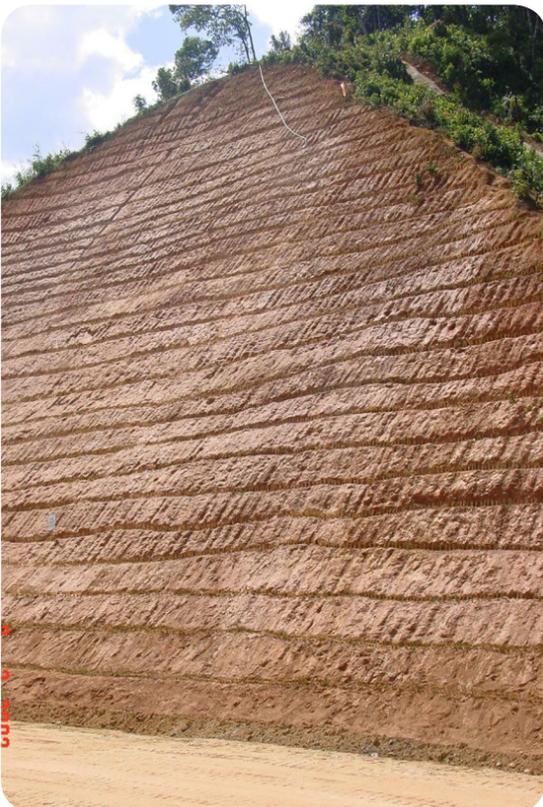
Two to three month old planting on old eroded batters



HO CHI MINH HIGHWAY: Spring Pass Case Study

This mountain pass is called Spring Pass (Deo Lo Xo) because it is so winding and twisting like a metal spring. This pass is at 1060m altitude and 2000mm annual rainfall, with torrential rain in summer and occasional typhoons.

Cut batter (1.5:1) 55m vertical drop and about 100m slope length



Despite badly designed (no benching and internal drainage), this very steep batter was successfully stabilized 3 years after planting and survived several typhoons.



HO CHI MINH HIGHWAY: Fast Forwards, 14 Years Later

Over the distance of about 1 000km of Sections 1 and 2 of the HCMHW, stretching over a wide range of geology, topography, altitude and climate, it was very pleasing to note that the Vetiver System has successfully stabilized this highway in most major sections.



HO CHI MINH HIGHWAY: General view along the Highway in February 2014



HO CHI MINH HIGHWAY: Effects of shading on vetiver growth

It is well-known that Vetiver growth is adversely affected by shading, long term and heavy shading can eliminate it. However Vetiver can persist in very low growth with invading plants when shading is not severe.

In area where local species did not completely cover the whole area, Vetiver persisted and continued to provide protection to vulnerable area



GENERAL OBSERVATION AND SOME CONCLUSIONS

- On the whole there are no serious erosion occurs over the length of about 1000km of Sections 1 and 2 of the HCMHW and Vetiver System has successfully stabilized these sections of the highway
- This survey did not cover Section 3: from Quang Nam to Saigon where some shallow (small slips 1-2m deep) and more serious large (deep-seated slides 5-10m) occurred.
- Occasional eroded batters and small slips occurred, partly due to uncontrolled animal grazing and poor internal drainage
- Vetiver has accomplished its mission as a pioneer plant, providing effective erosion control on very steep and hostile slopes, trapping sediment and runoff water, producing a micro environment to facilitate the establishment of endemic plants
- All these plants re-established naturally by themselves, mostly from endemic seeds from the surrounding areas. Some were blown in from further out.
- In general, the original vetiver was shaded out by the spread of the local plants. It can be found only along the edges of the original planting
- Most importantly, in area where local species did not re-established, vetiver persisted and continue to provide protection
- Based on long term experience in subtropical Australia, local trees will eventually come back to provide a permanent protection

Vetiver planting created favourable condition for local species to come back and faded away due to shading, but it persisted where local species could not come back.

SUMMARY

Construction started in 2000



VS Implementation in 2002



VS Implementation in 2005



VS Implementation in 2011



VS Implementation in 2014



For more details of this report, please refer to
http://www.vetiver.org/VNN_HCMH.pdf

THE ALTERNATIVES

Option 1:

Green and environmentally friendly soft measure, with virtually no maintenance and eventually return to native endemic vegetation as shown in other sites along the Highway

The best trial, where the first sod was planted by the President. It is lucky because it is internally stable, though still having problem at its toe.



Option 2:

Sterile conventional hard structure, equally effective in erosion control but definitely not equally effective in cost of establishment and long term maintenance



HONG KONG VISIT IN JUNE 2014

These projects were carried out by Dr PK Yoon in 1998 and 2001 to stabilise steep slopes and highway batters in Hong Kong

KWAI SHING SITE

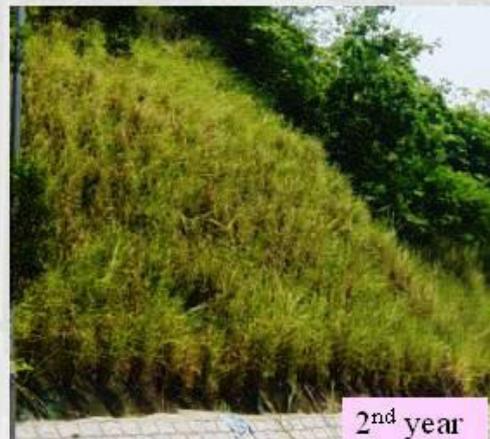
This project was carried out in 1998 to rehabilitate a landslide along a major Highway leading to the City centre

Planting in 1998



Three months after planting





July 2002- 3 years after planting

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



June 2014 – 16 years later





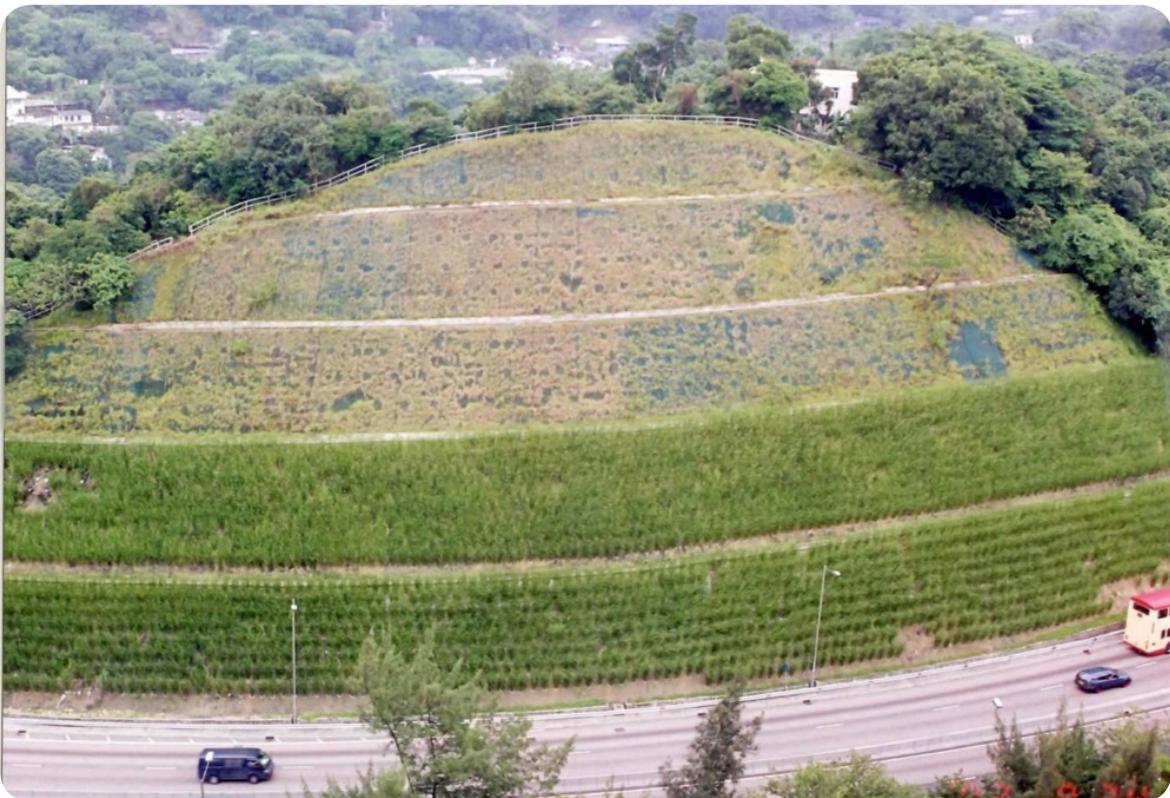
The site is completely stable now, Vetiver has done a perfect pioneering job, stabilised the site and local shrubs and trees are coming back slowly after 16 years..

Vetiver is growing well, with occasional trimming, but growth can be improved with occasional application of fertilisers.

SIN TIN WAI SITE

This project was carried out in 2001 to rehabilitate very steep batter of a major Highway leading to the City centre. Vetiver was only planted on the bottom two terraces to stabilise this batter to promote natural rehabilitation of on upper terraces.

July 2001- Four month after planting



June 2014 – 13 years later





GENERAL OBSERVATION AND SOME CONCLUSIONS

- On the whole these are no erosion occurs on these two sites, the Vetiver System in combination with some hard structures has successfully stabilized the landslide after 16 years, and the very steep sections of the highway after 13 years.
- Vetiver has accomplished its mission as a pioneer plant, providing effective erosion control on very steep and hostile slopes, trapping sediment and runoff water, producing a micro environment to facilitate the establishment of endemic plants
- All these plants re-established naturally by themselves, mostly from endemic seeds from the surrounding areas. Some were blown in from further out.
- Most importantly, in area where local species did not re-established, vetiver persisted and continue to provide protection
- Based on long term experience in subtropical Australia, local trees will eventually come back to provide a permanent protection

Similar to the HCMHW, Vetiver planting created favourable condition for local species to come back and faded away due to shading, but it persisted where local species could not come back.