

**Socio-Economic Benefits of
the Vetiver System Technology
in Mining Areas
in Developing Countries**
By
Paul Truong

Office of the Royal Development Projects Board
Bangkok, Thailand
November 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 to 16-page quarterly English-language newsletter under the name of VETIVERIM has been issued, starting first number in July 1997. Its circulation is 500 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, 20 bulletins have been issued.

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Socio-Economic Benefits of the Vetiver System Technology in Mining Areas in Developing Countries

By

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Bangkok, Thailand

November 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 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. Lavana; (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 Ndonga, 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.

The present publication is TB 2014/2, "Socio-Economic Benefits of the Vetiver System Technology in Mining Areas in Developing Countries" 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 mine rehabilitation.

Narong Chomchalow
Coordinator, Pacific Rim Vetiver Network

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SOCIO - ECONOMIC BENEFITS OF THE VETIVER SYSTEM TECHNOLOGY IN MINING AREAS IN DEVELOPING COUNTRIES



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Veticon Consulting

1. The Vetiver Grass

Morphological Attributes: Stiff and erect stems up to 2m tall and over 2.5m with flower head



Forming a thick hedge when planted in row



Young plant stiff enough to trap large gravel

EXTENSIVE AND DEEP ROOT

China: One year old with 3.3m deep root system

Australia: One year old, 1.3m and root bound

(These roots have a tensile strength equivalent to 1/6 mild steel reinforcement)



CHINA



BRISBANE

Physiological Attributes

- Vetiver grass is both a xerophyte and a hydrophyte and, once established, is not affected by droughts or floods.
- Adaptability to a wide range of soil and climatic conditions,
 - Can be established in sodic, acidic, alkaline and saline soils,
 - Tolerant to drought due to deep and extensive root system,
 - Mature plants are tolerant to extreme heat (50°C) and frost (-14°C).
- Vetiver can withstand burning, slashing and moderate tractor traffic.
- Vetiver is resistant to infestation from most pests, diseases and nematodes.
- Vetiver grass is extremely long-lived and has been observed to persist for over 50 years.

Adaptability Range of Vetiver Grass in Australia and Other Countries

Adverse Soil Conditions	Australia	Other Countries
Acidity	pH 3.3	pH 4.2 (with high level soluble aluminium)
Aluminium level (Al Sat. %)	Between 68% - 87%	80%-87%
Manganese level	> 578 mgkg ⁻¹	
Alkalinity (highly sodic)	pH 9.5	pH 12.5
Salinity (50% yield reduction)	17.5 mScm ⁻¹	
Salinity (survived)	47.5 mScm ⁻¹	
Sodicity	33% (exchange Na)	
Magnesicity	2 400 mgkg ⁻¹ (Mg)	
Heavy Metals		
Arsenic	100 - 250 mgkg ⁻¹	
Cadmium	20 mgkg ⁻¹	
Copper	35 - 50 mgkg ⁻¹	
Chromium	200 - 600 mgkg ⁻¹	
Nickel	50 - 100 mgkg ⁻¹	
Mercury	> 6 mgkg ⁻¹	
Lead	> 1 500 mgkg ⁻¹	
Selenium	> 74 mgkg ⁻¹	
Zinc.	>750 mgkg ⁻¹	

Special Physiological Features

Threshold Levels of Heavy Metals to Vetiver Growth as Compared with Other Species

Heavy Metals	Threshold levels in soil (mgKg ⁻¹)		Threshold levels in plant (mgKg ⁻¹)	
	Vetiver	Other plants	Vetiver	Other plants
Arsenic	100-250	2.0	21-72	1-10
Cadmium	20-60	1.5	45-48	5-20
Copper	50-10	Not available	13-15	15
Chromium	200-600	Not available	5-18	0.02-0.20
Lead	>1 500	Not available	>78	Not available
Mercury	> 6	Not available	>0.12	Not available
Nickel	100	7-10	347	10-30
Selenium	>74	2-14	>11	Not available
Zinc	>750	Not available	880	Not available

2. Vetiver System Technology and Applications

The VST is based on the application of vetiver grass and its unique and extraordinary attributes.

The major applications of VST are:

1. Soils and water conservation in farm land
2. Infrastructure protection by bioengineering
3. Environmental protection by phytoremediation
 - Wastewater treatment: Sewage effluent, landfill leachate and industrial wastewater
 - Mine rehabilitation and industrial contaminated land
4. Poverty alleviation

Globally over 100 countries are using VST for at least one of these applications (www.vetiver.org)

VST Application: Soils and Water Conservation in Farm Land



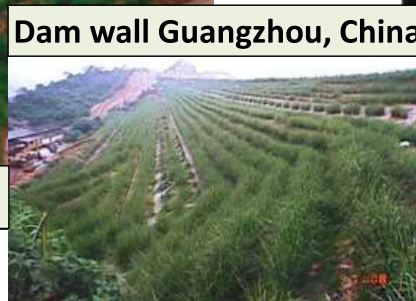
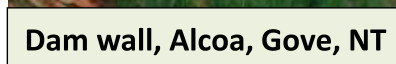
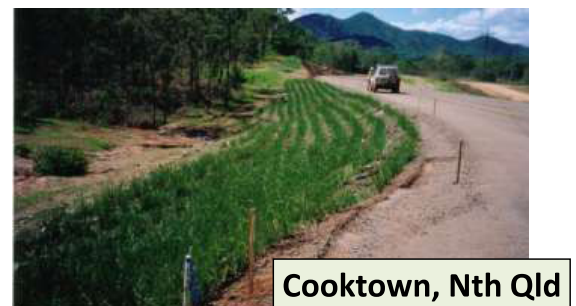
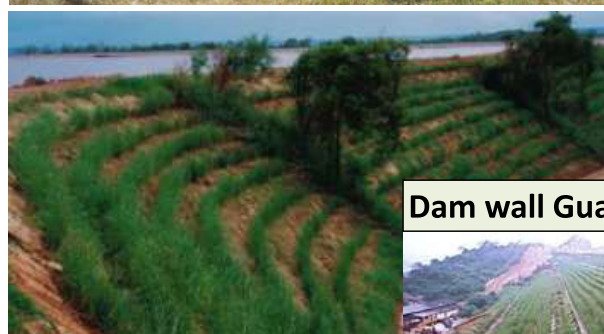
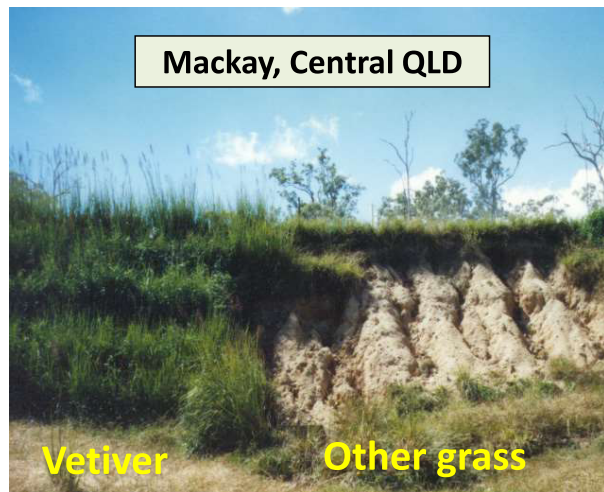
Flood erosion and sedimentation control on the Darling Downs flood plain, Queensland



Soil erosion and sedimentation control on sugar cane field in North Queensland



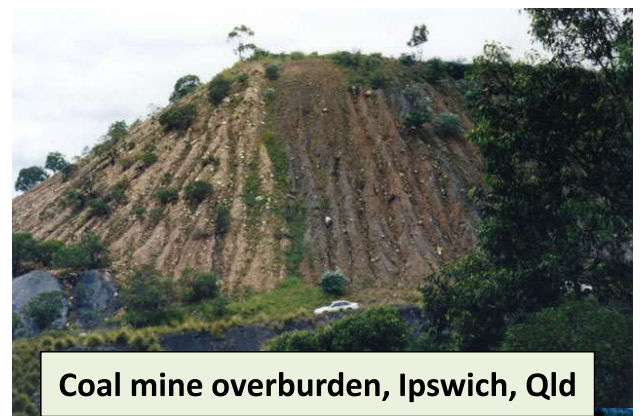
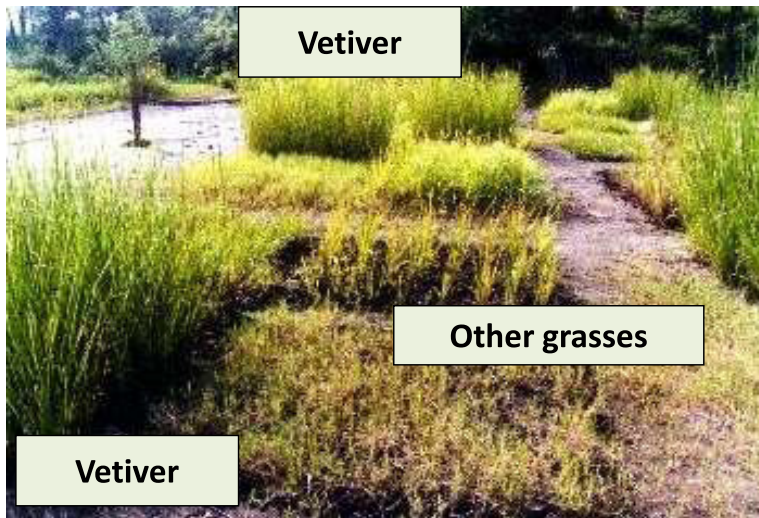
VST Application: Infrastructure Protection by Bioengineering



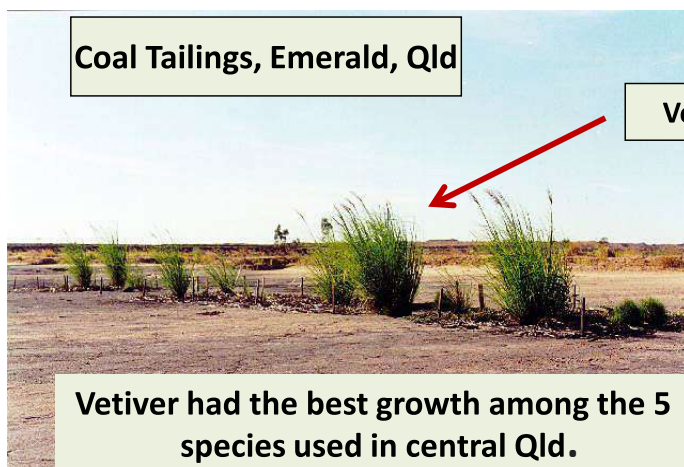
VST Application: Wastewater treatment - Sewage and Leachate



VST Application : Mine Rehabilitation - Overburden



VST Application: Mine Rehabilitation – Tailings



Bermuda grass grows on higher ground which is less caustic.



Good establishment and growth with some lime and fertilisers



Fresh Gold Tailings, Kidston, Qld.

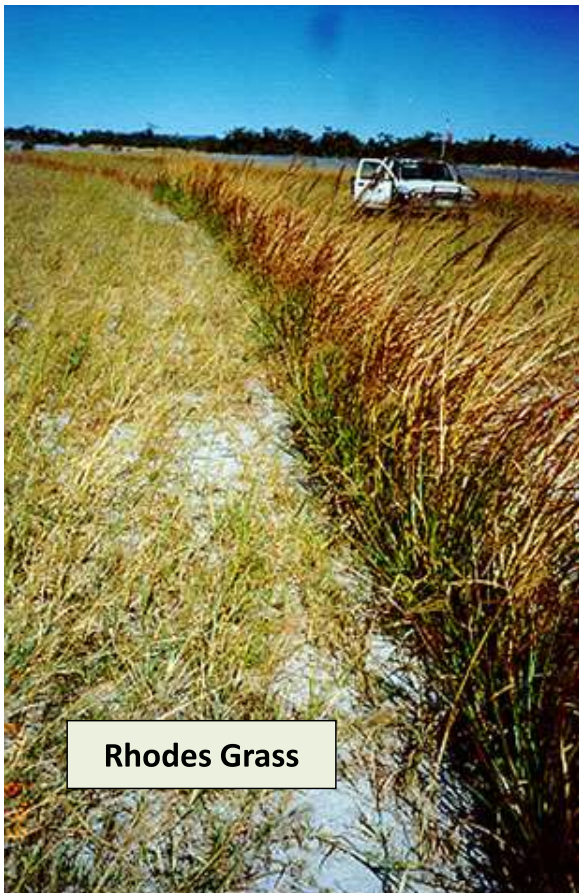


The dust is highly contaminated with heavy metals such as Arsenic, Copper etc.

Millet cover crop to control wind erosion



**The Flexible Vetiver Hedges Provided a LowCost Wind Barrier,
Provided Excellent Protection for Crop Establishment.**



Rhodes Grass



Rhodes Grass



10 years later and grazed by stock

VST Application: Poverty Alleviation



Madagascar



Rural employment
Vietnam



Food crop protection
Indonesia



Venezuela



Handicraft production
Thailand



China

3. Benefits of VST in Mining Areas in Developing Countries



Rural employment: Plant production in Madagascar and Vietnam





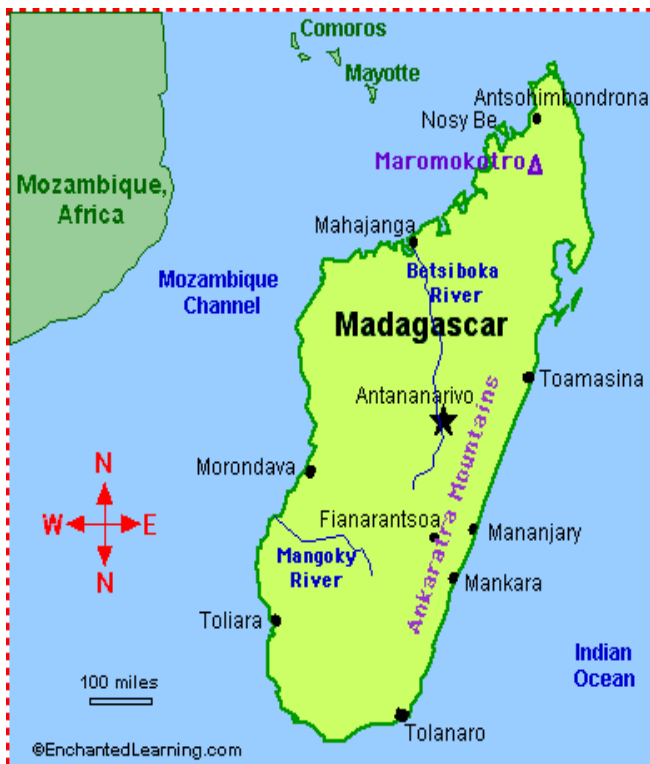
Rural Employment: Handicraft Production in Venezuela



4. Case Studies of Benefits of VST in Africa, Latin America and Asia

1. **MADAGASCAR:** Local employment, professional training and income
2. **VENEZUELA:** Local employment, professional training and income
3. **VIETNAM:** Local employment and income
4. **WEST AFRICA:** Local employment, professional training and income

CASE STUDY 1: Madagascar Demographics



- 4th biggest Island in the world with a population around 20 Million
- 80% of population live below the poverty line.
- Only 54% of population in urban areas & 4% in rural areas have access to potable water.
- Life expectancy is 52 years with 46% literacy.
- Infant Mortality is 89 per 1,000
- Economic isolation for many communities resulted from the collapse of the regional & national road network system with 80% of roads impassable for up to 10 months per year
- Massive environmental degradation (biodiversity)

The Project: Erosion and sediment control of highly erodible sand dunes on service road at Rio Tinto Ilminite mine at Fort Dauphin



The Project

- Started in 2006 with 15 communities and expanded to 32 communities by 2008.
- Involved 133 families over the project period.
- 4,000,000 Vetiver plants were propagated & supplied.
- 40 hectares were stabilised and revegetated with commercial and locally harvested native grass seed species used in mixture.
- Vetiver was inter-planted with native dune vegetation.
- *This community based “Vetiver propagation program” has generated approximately **US\$250,000** collectively to the respective communities within the construction period.*



Nursery establishment training



Family nursery



Project implementation

Nursery Establishment Training



Obtaining Vetiver for home nurseries



Well established nurseries and new houses built from nursery production and employment income

Employment and Technical Training



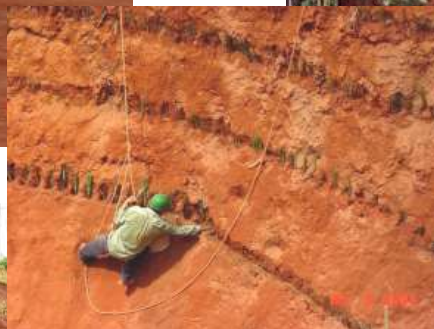
Indigenous people at Fort Dauphin



Project implementation



CASE STUDY 2: VENEZUELA – Poverty Alleviation and Rural Employment The Project: Open Cut Bauxite Mine at Los Pijiguaos





VST for erosion and sedimentation control at Los Pijiguaos Bauxite mine



VENEZUELA: Poverty Alleviation and Rural Employment by Handicraft Production



Introduction



Training



Growing Vetiver



Harvesting

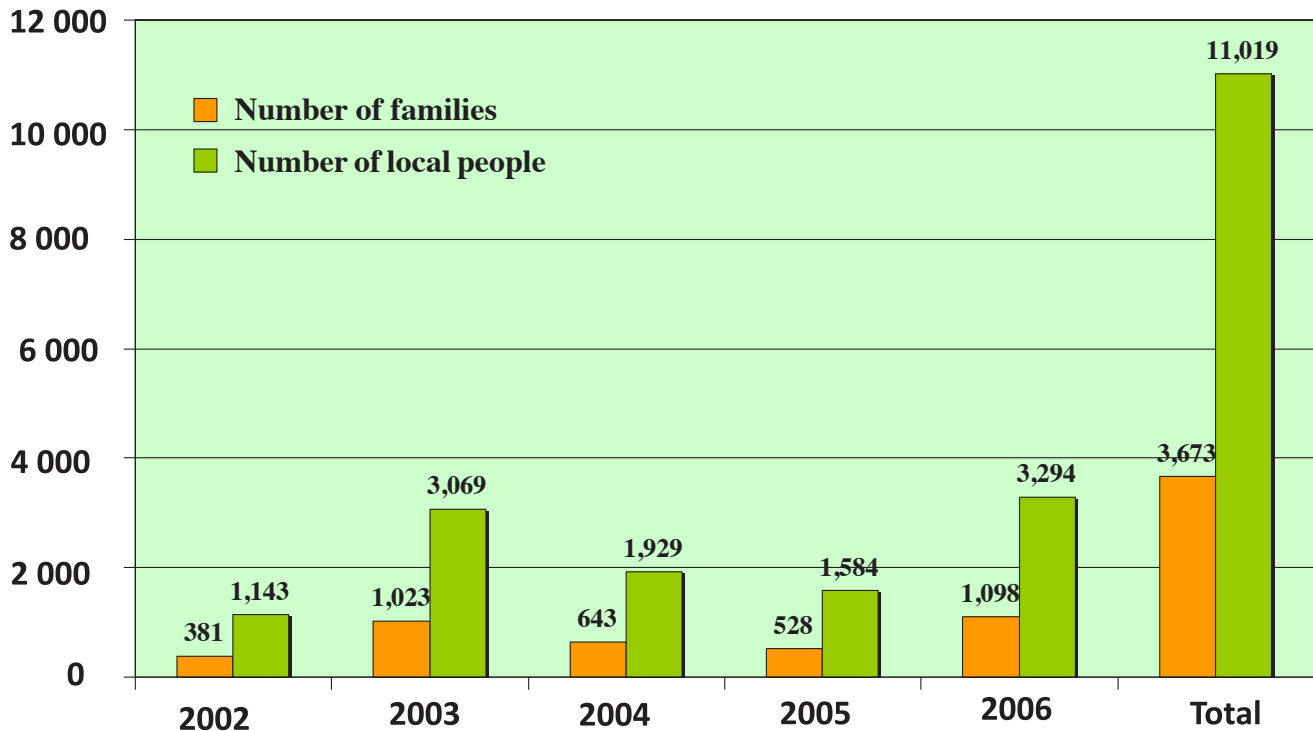


Handicraft Production



Marketing

Number of family and people involved from 2002-2006 (3,673 families and 11,019 local people)



Number of direct and indirect people employed from 2002-2006 (3,673 direct people employed and 367 indirect people employed)



CASE STUDY 3: VIETNAM - Infrastructure Protection

The Project: The Ho Chi Minh Highway



**Before and after VST application on the 3,000-km Highway
from the Chinese border to the gulf of Thailand**



Community nurseries along the Highway



Local employment during implementation phase



CASE STUDY 4: VIETNAM - Infrastructure Protection

The Project: Flood mitigation in the Mekong Delta

Flood water causing severe erosion on dikes



Vetiver planting on outer wall of the dikes



Effectiveness of vetiver planting in protecting dikes from flood erosion



Community Nurseries and Local Employment



CASE STUDY 5: Some Major Mining Projects in Africa

Rio Tinto Bauxite mine at Simandou, Guinea, West Africa





Excessive Erosion Caused by Surface Water Runoff



**Before & After VST Application for Slope Stabilisation –
Reasonable cover attained on slopes PC**



540 ha of tropical jungle situated on the Equator removed in one operation, resulting in a civil and environmental disaster

Phase 1: 20 ha side slopes rehabilitated with VST

GSEZ Nkok, Gabon, West Africa



Work Undertaken

- 30,000m vetiver grass hedge rows
- Bio-Jute – 10,000 m²
- Silt fences - 3,600 m¹
- Sand Bags – 2,500 m¹
- Hydroseeding -200,000 m²

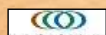
Climatic Conditions

Annual rainfall +
3700mm
2 Rainy seasons –
September to
December & May to
July



Ambatovy Access Road Project, Moramanga, Madagascar

PC: R Noffke



Installing Erosion Control Structures, VST & Hydroseeding



All Vetiver Plants and Labor are Sourced from Local Communities



Malomanye Village On-Site Training in Soil Conservation Techniques



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 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 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 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.

The Author

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.