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

Paul Truong
TVNI Technical Director
Director for Asia and Oceania,
Brisbane, Australia
paultruong@vetiver.org
www.vetiver.org
p.truong@veticon.com.au

All materials in this document remain the property of Veticon Consulting Pty Ltd. Permission must be obtained for their use. Copyright © 2014
INTRODUCTION

1. Vetiver grass

2. Vetiver System Technology (VST) and Applications

3. Benefits of VST in mining areas in developing countries

4. Case studies of benefits of VST in Africa, Asia and Latin America
1- 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)
1- Vetiver grass

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

• Resistant to infestation from most pests, diseases and nematodes.
• Vetiver grass is extremely long-lived, have been observed to persist for over 50 years
## Adaptability Range of Vetiver Grass in Australia and other Countries

<table>
<thead>
<tr>
<th>Adverse Soil Conditions</th>
<th>Australia</th>
<th>Other Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidity</td>
<td>pH 3.3</td>
<td>pH 4.2 (with high level soluble aluminium)</td>
</tr>
<tr>
<td>Aluminium level (Al Sat. %)</td>
<td>Between 68% - 87%</td>
<td>80%-87%</td>
</tr>
<tr>
<td>Manganese level</td>
<td>&gt; 578 mgkg(^{-1})</td>
<td></td>
</tr>
<tr>
<td>Alkalinity (highly sodic)</td>
<td>pH 9.5</td>
<td></td>
</tr>
<tr>
<td>Salinity (50% yield reduction)</td>
<td>17.5 mScm(^{-1})</td>
<td></td>
</tr>
<tr>
<td>Salinity (survived)</td>
<td>47.5 mScm(^{-1})</td>
<td></td>
</tr>
<tr>
<td>Sodicity</td>
<td>33% (exchange Na)</td>
<td></td>
</tr>
<tr>
<td>Magnesicity</td>
<td>2 400 mgkg(^{-1}) (Mg)</td>
<td></td>
</tr>
</tbody>
</table>

### Heavy Metals

<table>
<thead>
<tr>
<th>Metal</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>100 - 250 mgkg(^{-1})</td>
</tr>
<tr>
<td>Cadmium</td>
<td>20 mgkg(^{-1})</td>
</tr>
<tr>
<td>Copper</td>
<td>35 - 50 mgkg(^{-1})</td>
</tr>
<tr>
<td>Chromium</td>
<td>200 - 600 mgkg(^{-1})</td>
</tr>
<tr>
<td>Nickel</td>
<td>50 - 100 mgkg(^{-1})</td>
</tr>
<tr>
<td>Mercury</td>
<td>&gt; 6 mgkg(^{-1})</td>
</tr>
<tr>
<td>Lead</td>
<td>&gt; 1 500 mgkg(^{-1})</td>
</tr>
<tr>
<td>Selenium</td>
<td>&gt; 74 mgkg(^{-1})</td>
</tr>
<tr>
<td>Zinc</td>
<td>&gt; 750 mgkg(^{-1})</td>
</tr>
</tbody>
</table>
### Threshold levels of heavy metals to vetiver growth as compared with other species

<table>
<thead>
<tr>
<th>Heavy Metals</th>
<th>Threshold levels in soil (mgKg⁻¹)</th>
<th>Threshold levels in plant (mgKg⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vetiver</td>
<td>Other plants</td>
</tr>
<tr>
<td>Arsenic</td>
<td>100-250</td>
<td>2.0</td>
</tr>
<tr>
<td>Cadmium</td>
<td>20-60</td>
<td>1.5</td>
</tr>
<tr>
<td>Copper</td>
<td>50-10</td>
<td>Not available</td>
</tr>
<tr>
<td>Chromium</td>
<td>200-600</td>
<td>Not available</td>
</tr>
<tr>
<td>Lead</td>
<td>&gt;1 500</td>
<td>Not available</td>
</tr>
<tr>
<td>Mercury</td>
<td>&gt; 6</td>
<td>Not available</td>
</tr>
<tr>
<td>Nickel</td>
<td>100</td>
<td>7-10</td>
</tr>
<tr>
<td>Selenium</td>
<td>&gt;74</td>
<td>2-14</td>
</tr>
<tr>
<td>Zinc</td>
<td>&gt;750</td>
<td>Not available</td>
</tr>
</tbody>
</table>
2- Vetiver System Technology & 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

Mackay, Central QLD

Road Batters

El Salvador, Central America

Vetiver Other grass

Cooktown, Nth Qld

Dam wall Guangzhou, China

Dam wall, Alcoa, Gove, NT

HCM Hiway, Vietnam
VST Application: Wastewater treatment - Sewage and leachate

Sewage effluent, Ephemeral Wetland, Qld

Teys Abattoir, Beenleigh, Qld

Landfill leachate, Tweeds, NSW

Sewage effluent, Boonah, Qld
VST Application: Mine rehabilitation - Overburden

- Vetiver
- Other grasses
- Coal mine overburden, Ipswich, Qld
- Bentonite mine overburden, Miles, Qld
VST Application: Mine rehabilitation – Tailings

Coal Tailings, Emerald, Qld

Vetiver

Vetiver had the best growth among the 5 species used in central Qld

Redmud, Alcoa, Gove, NT

Bermuda grass grows on higher ground which is less caustic

Old gold Tailings, Kidston, Qld

Good establishment and growth with some lime and fertilisers

<table>
<thead>
<tr>
<th>pH</th>
<th>2.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO4</td>
<td>8500mg/kg</td>
</tr>
<tr>
<td>S</td>
<td>3.75%</td>
</tr>
<tr>
<td>As</td>
<td>970mg/kg</td>
</tr>
<tr>
<td>Ba</td>
<td>710 &quot;</td>
</tr>
<tr>
<td>Cu</td>
<td>230 &quot;</td>
</tr>
<tr>
<td>Pb</td>
<td>290 &quot;</td>
</tr>
<tr>
<td>Sr</td>
<td>350 &quot;</td>
</tr>
<tr>
<td>Zn</td>
<td>560mg/kg</td>
</tr>
</tbody>
</table>
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 low cost wind barrier, provided excellent protection for crop establishment.
VST Application: Poverty alleviation

Rural employment
- Madagascar
- Vietnam
- Indonesia

Handicraft production
- Venezuela
- Thailand
- China
4. 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 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 3,000km 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
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

**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
All vetiver plants and labor are sourced from local communities

Malomanye Village On-Site Training in Soil Conservation Techniques
Thank You