Keynote Presentation

Vetiver System for the Prevention and Treatment of Contaminated Water and Land

(Special Reference to Domestic and Municipal Wastewater Treatment in Australia)

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EXTENDED ABSTRACT

Application of the Vetiver System (VS) for environmental protection is a new and innovative phytoremedial technology. VS has been used in more than 100 tropical and subtropical countries for treating polluted wastewater from domestic and industrial discharges as well as mine rehabilitation.

Extensive R&D in Australia, China and Thailand over the last 15 years have established vetiver tolerance to elevated and sometimes toxic levels of salinity, acidity, alkalinity, sodicity as well as a whole range of heavy metals and agrochemicals. Latest research also shows its exceptional ability to absorb and to tolerate extreme levels of nutrients, capable of consuming large quantities of water under wet conditions and to produce a massive growth. It is a green and environmentally friendly wastewater treatment technology as well as a natural recycling method. Its end-product has several uses including animal fodder, handicraft and material for organic farming.

Special Characteristics of Vetiver Grass Suitable for Wastewater Treatment and Phytoremediation

- ***Highly tolerant*** to soil high in acidity, alkalinity, salinity, sodicity and magnesium
- ***Highly tolerant to*** Al, Mn, As, Cd, Cr, Ni, Pb, Hg, Se and Zn in the soil
- **Capable of withstanding extremely** high N supply (10 000KgN/ha/year) and P (1000KgN/ha/year)
- **Capable of responding** to very high N supply (6 000KgN/ha/year)
- ***Highly efficient in absorbing*** dissolved nutrients particularly N and P in polluted water.
- ***High level of tolerance*** to herbicides and pesticides such as Diuron or Atrazine herbicides at concentrations up to 2000 mg/L levels.
- ***Vetiver grass is both a xerophyte*** (drought tolerant due to its deep and extensive root system) and a hydrophyte (wetland plant due to its well developed sclerenchyma [air cell] network). Vetiver thrives under hydroponics conditions.

- ***High water use rate*** Under wetland conditions or high water supply Vetiver can use more water than other common wetland plants such as *Typha* spp, (approximately 7.5 times more) and *Phragmites australis* and *Schoenoplectus validus*. Under optimal growing conditions, a hectare of vetiver would potentially use 279KL/ha/day.
- Data on growth and nitrogen content of mature plants indicate that the deep and extensive root system of vetiver could reduce or eliminate deep nitrate leaching of nitrate.

Domestic and Municipal Wastewater Treatment in Australia

- ***Disposal of domestic effluent:***

The first application of the VS for effluent disposal was conducted in Australia in 1995, and subsequent trials demonstrated that planting about 100 vetiver plants in an area less than $50m^2$ have completely dried up the effluent discharge from a toilet block in a park, where other plants such as fast growing tropical grasses and trees, and crops such as sugar cane and banana have failed.

Groundwater monitoring (collected at 2m depth) showed that after passing through 5 rows of vetiver the levels of **total N reduced by 99%** (from 93 to 0.7 mg/L), **total P by 85%** (from 1.3 to 0.2 mg/L), and **faecal coliforms by 95%** (from 500 to 23 organisms/100mL). These levels are well below the following thresholds used by Australian Environmental Authority.

- Total Nitrogen <10 mg/L
- Total Phosphorus <1 mg/L
- *E. coli* <100 organisms/100mL

- ***Disposal of Municipal Wastewater***

Disposal of Municipal Sewage Effluent

Primary treated effluent from a small town in subtropical Australia had the following characteristics:

- Daily output 0.3 ML
- Nitrogen concentration at 13 mg/L
- Phosphorus level of 5.5 mg/L

A two-phase treatment program was adopted:

- *Phase 1*: Preliminary treatment of effluent in the ponds by vetiver pontoons and pond edge planting.
- *Phase 2:* Main treatment by vetiver ephemeral wetlands

Results obtained following full vetiver establishment:

- Total Nitrogen from 30 - 80 mg/l to 4.1 - 5.7 mg/l
- Total Phosphorous from 10 - 20 mg/l to 1.4 - 3.3 mg/l
- 5 Day BOD from 130 - 300 mg/l to 7 to - mg/l
- Dissolved Oxygen from 0 - 2 mg/l to 8.1 - 9.2 mg/l

Disposal of landfill leachate

Disposal of landfill leachate is a major concern to all large cities, as the leachate is often highly contaminated with heavy metals, organic and inorganic pollutants.

- In case of seeping leachate from landfill site, vetiver can be planted *in situ* in the seepage area

- Where leachate is collected in ponds, it can be disposed of by irrigating vetiver planted on the top of the landfill mound and retaining dam wall. Results in Australia and China showed that vetiver growth was not affected by this highly polluted water and grew vigorously that during the dry period, there was not enough leachate to irrigate the vetiver.

Phytoremediation of contaminated land

Due to its extraordinary tolerance to adverse conditions and heavy metal in the growing medium, VS has also been used extensively and successfully for the treatment and rehabilitation of industrial wastes.

Industrial wastes contain very high levels of both organic and inorganic compound have been successfully stabilised and treated in Australia, China, India, Thailand and Vietnam Van.

KEYWORDS: Pollution, contamination, effluent, toxic waste, heavy metals

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A Brief Introduction to the Speaker

Dr. Paul Truong, a Board Director and Asia and Oceania Representative of The Vetiver Network International, and recently Principal Consultant of Veticon Consulting. 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 and Africa.

His pioneering research on vetiver grass tolerance to adverse conditions, heavy metal tolerance and pollution control has established the benchmark for VS applications in wastewater treatment, toxic wastes and mine rehabilitation which he has won several World Bank and the King of Thailand Awards.