Case Study

Vetiver System for Stream Bank Stabilisation (With special references to the river and canal bank stabilisation in Australia and Vietnam)

Paul Truong[1] Tran Tan Van[2] and Elise Pinners[3]

[1]TVNI Director Responsible for Asia and South Pacific,
Brisbane, Australia. Email: truong@uqconnect.net
[2] Coordinator Vietnam Vetiver Network
Email: van@rigmr.org.vn; trantv@gmail.com
[3] TVNI Associate Director, Nairobi, Kenya
Email: epinners@africaonline.co.ke

EXTENDED ABSTRACT

Stability of Stream and Water Retaining Structure Banks

As in the case of dry land slopes the stability of stream bank is based on the interplay between two types of forces, driving forces and resisting forces. Driving forces promote down slope movement of material, while resisting forces deter movement. When driving forces overcome resisting forces, these banks become unstable.

However, erosion of banks and the instability of water retaining structures are more complicated. Water plays a key role in producing slope failure especially at the toe of the slope; it increases driving forces by:

- Eroding the base of slopes by wave action, which removes the support.
- Loading, that is, filling previously empty pore spaces and fractures, which adds to the total mass subjected to gravitational force.
- Reducing the shear strength of the slope material
- Interacting with surface rock and soil, slowly weakening slope material, and reducing its shear strength. This interaction reduces resisting forces.

Failure occurs when erosion of the bank toe and the channel bed adjacent to the bank have increased the height and angle of the bank to the point that gravitational forces exceed the shear strength of the bank material. Depending on the constraints of its material properties and the geometry of its profile, a bank may fail as the result of any one of several possible mechanisms, including planar, rotational, and cantilever type failures.

Special Characteristics of Vetiver Suitable for Stream Bank Erosion Control

- As a wetland plant, Vetiver withstands prolonged submergence. In Cambodia, Vetiver survived longer than five months under the muddy Mekong River water.
- Given its extraordinary root depth and strength, mature Vetiver is extremely resistant to washouts from high velocity flow. Vetiver planted in northern Australia withstood flow velocity higher than 3.5m/sec in river under flood conditions and, in southern Queensland, up to 5m/sec in a flooded drainage channel.

- Under shallow or low velocity flow, the erect and stiff stems of Vetiver act as a barrier that reduces flow velocity and traps eroded sediment. It can maintain its erect stance in a flow as deep as 0.6-0.8m.
- Vetiver leaves will bend under deep and high velocity flow, providing extra protection to surface soil while reducing flow velocity.
- When planted on water-retaining structures such as dams or dikes, Vetiver hedgerows help reduce the flow velocity, decrease wave run-up. These hedgerows also help reduce retrogressive erosion that often occurs when the water flow or wave retreats after it rises.

Appropriate Designs and Techniques

As in dry land erosion control, appropriate designs and techniques should be adhered to for successful stream banks erosion control. For flood mitigation and coastal, riverbank and dike/embankment protection, the following layout specifications are recommended:

- Maximum bank slope should not exceed 1.5(H):1(V). Recommended bank slope is 2.5:1.
- Vetiver rows should be planted in two directions, one parallel to flow direction (horizontal), for bank stabilisation and the other right angle to the flow to reduce flow velocity
- The first horizontal row should be planted at the crest of the bank and the last row should be planted at the low water mark of the bank.

VS for Flood and Stream Bank Erosion Control in Australia

- ***Flood Erosion Control.*** VS was instrumental in preventing flash flood erosion in a system of open grassed drains in a rural town in Australia. The depth of the water during flood often exceeded 3m and velocity up to 5m/sec during several floods over the last 8 years. In 2008, despite a severe 4 year drought, which cracked open the floor and banks of the drain, vetiver remained healthy and completely protected this drain from a flash flood water more than 3m deep.
- ***Stream Bank Erosion Control.*** The abutment of a new highway bridge was washed out following a flash flood. Following repair, vetiver was planted on this abutment, where it provided effective and low cost protection against some very sever flooding in the last 8 years.

VS for Erosion Control of Stream Bank, Flood Protection Dikes and Coastal Dikes in Vietnam

- ***Flood and River Bank Erosion Control in the Mekong Delta***

The Mekong Delta experiences long periods of inundation (up to five months) during the flood season, with significant difference in water levels, up to 5 m, between dry and flood seasons, and powerful water flow during flood season. Severe erosion on riverbanks, made up of alluvial silt and loam, which are highly erodible when wet, is caused by:

- High velocity flows during the flood season and
- Waves from high power motorized boats travelling on rivers and canals,

A comprehensive Vetiver program was initiated in An Giang, one of many provinces of the Delta, where annual floods reach depths of 6 m. The province has 4932 km canal system requires annual maintenance and repair. A network of dikes, 4600 km long, protects 209,957 ha of prime farmland from flooding. Erosion on these dikes is about 3.75 Mm^3/year and required USD 1.3 M to

repair. The province also includes 181 resettlement clusters, communities built on dredged materials that also require erosion control and protection from flooding.

Depending on the locations and flood depth, Vetiver has been used successfully alone, and together with other vegetation to stabilize these areas. As a result, Vetiver now protects sea and river dike systems as well as riverbanks and canals in the Mekong Delta. Nearly two million polybags of Vetiver, a total of 61 lineal km, were installed to protect the dikes between 2002 and 2005.

- ***Flood and River Bank Erosion Control in central Vietnam***

As a result of deforestation, several annual flash floods occur in coastal central Vietnam. In 2003 as a part of a disaster mitigation project funded by AusAid, VS was the main technology for stabilising canal, river and dike banks in Quang Ngai province to protect farm land from flash flooding in the rain season and sea water intrusion in the dry season. All these structures have been unaffected by several severe flooding events as well as typhoons in the lat 5 years. The project has been so successful that it now being implemented widely in coastal Vietnam

- ***VS application for coastal erosion control in Vietnam***

VS is very effective in protecting sea dikes in Nam Dinh Province in north Vietnam, which were devastated by typhoons in 2005 and Go Cong province in south Vietnam. Vetiver grew vigorously on the embankments in just a few months, despite poor soil and sea water intrusion. It is now protecting the sea dike, preventing surface erosion, and facilitating the establishment of endemic species.

Keywords: flash flood, dikes stabilisation, riverbank, canal bank erosion

References

- Dalton, P. A., Smith, R. J. and Truong, P. N. V. (1996). Vetiver grass hedges for erosion control on a cropped floodplain, hedge hydraulics. Agric. Water Management: 31(1, 2)
- Hengchaovanich, D. and Nilaweera, N. S. (1996). An assessment of strength properties of Vetiver grass roots in relation to slope stabilisation. Proc. First International Vetiver Conf. Thailand
- Jaspers-Focks, D.J and A. Algera (2006). Vetiver Grass for River Bank Protection. Proc. Fourth Vetiver International Conf. Venezuela, October 2006.
- Le Van Du, and Truong, P. (2003). Vetiver System for Erosion Control on Drainage and Irrigation Channels on Severe Acid Sulphate Soil in Southern Vietnam**.** Proc. Third International Vetiver Conf. China, October 2003.
- Prati Amati, Srl (2006). Shear strength model. "PRATI ARMATI Srl" info@pratiarmati.it .
- Truong, P., Tran Tan Van and Pinners,E. (2008). Vetiver System Applications: A Technical Reference Manual (Second Edition). TVNI Publications.

Links to well-illustrated websites:

http://www.Vetiver.org/ICV3-Proceedings/IND_vetoil.pdf
http://picasaweb.google.com/VetiverClients/VetiverSystemsForFloodControl
http://picasaweb.google.com/VetiverClients/VetiverSystemForRiverAndStreamBankErosionContro
http://picasaweb.google.com/VetiverClients/VetiverSystemForDamsReservoirsAndPonds

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.