CANAL AND RIVER BANK STABILISATION FOR PROTECTION AGAINST FLASH FLOOD AND SEA WATER INTRUSION IN CENTRAL VIETNAM

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Abstract

Quang Ngai, a coastal province in central Vietnam, is prone to flash flood caused by high annual rainfall, with 70% (2300mm/yr) falling over three months and steep terrain resulting in high velocity water flows. This often leads to flash floods in mountainous areas and large scale flooding in low-lying areas. The high velocity flows and flooding cause severe erosion on dike, canal and river banks built to protect farm land from flooding in the rain season and sea water intrusion in the dry season. Therefore the stability of these measures provides the local community a protection against flash flood and sea water intrusion at the same time.

Both vegetative measures and hard structures such as rock and concrete have been used in the past to protect these banks, but they are ineffective partly due to the local sandy soils used to build them and partly to the strong current. Although vetiver grass has been used very successfully for flood erosion control in the Mekong Delta of southern Vietnam, where flow velocity is relatively slow, it has not been used under very strong current. As a last resort, vetiver grass was tested for its effectiveness in protecting the banks of these rivers and canals.

This paper will discuss the background and results of the two years vetiver trials carried out in conjunction with the Quang Ngai Natural Disaster Mitigation Project.

Keywords: Canal erosion, riverbanks, stabilisation, disaster mitigation

1.0 INTRODUCTION TO THE QUANG NGAI NATURAL DISASTER MITIGATION PROJECT

The Quang Ngai Natural Disaster Mitigation Project (QNNDMP) is located in the Quang Ngai Province in Central Viet Nam (Fig.1). The Natural Disaster Mitigation initiative arose out of the disastrous events of late 1999, when nearly a thousand people died and damages exceeded US$340 million when a typhoon crossed the central coast of Vietnam. The

damage was a result of a combination of 'storm' (waves, higher tides) and flood (Tran *et al*, 2006). Following these events, initiatives by the Governments of Australia and Vietnam resulted in the formulation of a partnership with a focus on an integrated approach to mitigation of the natural disasters (Photos 1, 2&3).

Fig.1: Location map of Quang Ngai province

Photos 1: Flood damages to river and canal banks

Photos 2: Flood damages to irrigation channel and farm dike

Photos 3: Flood damages to asphalted road and farm road


In 2001 Halliburton KBR Pty Ltd were commissioned by the Australian Agency for International Development (AusAID) to prepare a Project Design Document for a project to be based in the central provinces and to act as a demonstration project for the concept of an integrated approach to the mitigation of natural disasters. The QNNDMP is the result of this design and is the first major project to be implemented through the Natural Disaster Mitigation Partnership. The geographic scope of the project is defined as the floodplains of the Tra Khuc and Tra Bong river systems as being representative of typical river systems in central Vietnam. The total investment in the project is approximately AUD15 million shared 80.5% AusAID contribution and 18.5% Government of Viet Nam contribution (Sobey, 2006)

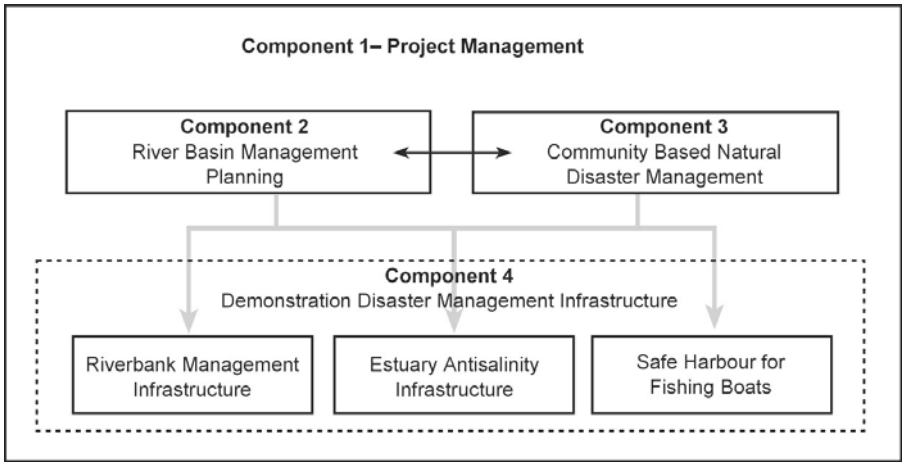
The goal of the QNNDMP is ***to mitigate the impact of natural disasters in the central provinces of Vietnam*** in accordance with the Natural Disaster Mitigation Partnership objectives.

The specific objective of the project is ***to implement appropriate and effective management and infrastructure solutions for the mitigation of disasters and to strengthen community based disaster management*** in the Quang Ngai Province.

The project structure consists of four integrated components as follows:

- Project Management
- River Basin Management Planning
- Community Based Natural Disaster Management
- Demonstration of Disaster Mitigation Infrastructure (including Riverbank Management Infrastructure, and Estuary Anti-salinity Infrastructure and a Safe Harbour for Fishing Boats).

Figure 1 presents the relationship of these components, which can be divided into non-structural (i.e. Components 2 and 3) and structural (Component 4).



The Project has been developed very much in line with the principle of integration, i.e.:

- integration of the mix of desired activities (planning, community development, mitigation works and disaster planning associated with works);
- integration of works that benefit different communities and economics in the coastal floodplains (river works, estuary anti-salinity works and estuary boat refuge);
- integration of programs that address the three prime natural disaster causes (water allocation planning for drought; floodplain management planning and river stabilisation for floods; and salinity control and fishing boat protection for 'storm' (typhoon) conditions).

2.0 APPLICATION OF THE VETIVER SYSTEM IN THE QNNDMP

The Project Design Document and in particular the Environment Assessment recognised that there were opportunities to utilise Vetiver grass technology as an alternative to structural engineering measures for the anti-salinity dyke and riverbank protection work activities of the project. It was recognised however that there was limited experience and knowledge in the use of Vetiver grass in the central provinces of Vietnam. To redress this situation, it was recognised that demonstration trials were needed to verify the suitability of the grass for various uses in the central provinces of Vietnam.

At the time of project commencement vetiver grass was an unproven technology for the proposed uses, so it was expected that there would be a natural reluctance by responsible agencies to promote its use or for communities to adopt it. The protection offered by concrete structures is well understood and for this reason is regarded as the optimal solution. This factor is particularly relevant for natural disaster mitigation projects where fast, but effective solutions are required for the future protection of local communities, particularly in the short term. It was therefore expected that there would be some institutional reluctance to adopt an alternative vetiver based system. Because the use of

vetiver was a relatively unknown procedure in the local area, trials of its use were carried out as part of the overall implementation phase of the QNNDM project.

The main advantages of Vetiver grass over concrete are the ***considerable saving in construction costs and the lower maintenance requirements in the longer term***. It is thus possible to construct significantly longer sections of bank protection for the same cost resulting in a significant increase in the area benefited for a given works budget. In addition, the inevitable involvement of local communities in the propagation, planting and maintenance of the grass following the adoption of Vetiver grass technology may in the future require less demands for major inputs from governmental agencies as the communities adopt a self-help approach using their skills and knowledge of vetiver to carry out their own protection projects.

As noted earlier, there was a need for demonstration trials to be conducted on vetiver in the local area. Initially planting trials were planned on three sections of the existing Binh Chanh estuary dike exposed to differing flood and salinity regimes. The program was expanded to include a section of an irrigation canal in a cutting where exposed slopes were being eroded and a section of an existing riverbank flood protection dike where attempts at establishing suitable ground cover had failed.

3.0 OBJECTIVES AND OUTCOME OF VETIVER TRIALS

The main objectives of these trials were to determine whether vetiver grass can:

- be grown in central provinces of Vietnam
- be established on the harsh conditions of canal and river banks
- can tolerate the saline conditions of the estuarine dikes
- be effective against soil erosion under strong flow and flooded conditions
- be affected by local pest and diseases
- be used for animal fodder
- be maintained cheaply and effectively by local farmers

The trials were conducted at 9 sites:

- 4 anti-salinity dikes at Binh An 1, Binh An 2, My Tan 1 and My Tan 2. Vetiver was planted on mainly coastal sandy loam (Photo 4).
- 1 estuary river bank on Binh Trung dike to control erosion on dike face and toe, caused by rain and flood. Floodwater often came up to 1/2 - 3/4 of dike height which was built with clayey soil (Photos 5&6).
- 3 canal banks on Tho Nam 1 and Tho Nam 2 to control flood erosion canal banks, My Phuoc dike to protect concrete structures (Photo 7).
- 1 river bank at Binh Thoi to control riverbank erosion, built with highly erodible alluvial soil and often overtopped or up to 3/4 embankment by flood water.

Photo 4: Estuary facing dikes built to stop sea water intrusion to farm land

Photo 5: River bank stabilisation against flash flood erosion

Photo 6: Stabilisation of a large river bank against flash flood erosion

Photo 7: Drainage **c**anal bank stabilisation, before and after vetiver planting

Results after 3 years of trials, and the following conclusions were reached (Vo *et al*, 2006):

- Vetiver can be established on a wide variety of soil types from loose sand to compacted laterite fill, including saline sand, poor hill soil, basalt and fluvial silt with various physical characteristics.
- Vetiver thrives in the climatic conditions in the central regions of Vietnam and is tolerant of the dry hot summer season.
- Good tolerance to drought, inundation, saltwater; rehabilitate quickly after drought and flood; fast regrowth after cutting.
- Strong growth, flowers early in the wet season but no seed found so far and low growth in cold season
- No parasite found on Vetiver though minor density of brown spots and stem borer; no habitat of rat and snake found.
- Vetiver is not suitable for all conditions. It was found that the roots did not penetrate sandy soil with saline ground water.
- Local salt tolerant species may be planted at the toe of slopes in saline conditions to provide toe protection allowing vetiver to be planted on the higher slopes for scour protection.
- In reasonable growing conditions vetiver can be established to resist flood flows within three months of planting.
- Even young beds of vetiver encourage silt deposition from flood flows.
- Vetiver should be cut to approximately 100 mm above the ground to encourage fresh growth. Care needs to be taken in the timing of the cutting to ensure adequate regrowth prior to the expected flood season.
- Vetiver can be used as a fodder crop particularly while young.
- Livestock will graze on vetiver if other food supply is limited.
- Other fodder crops may be inter-planted with vetiver to maximise the utilisation of the protected ground.
- Vetiver can protect dike and canal banks against scour and erosion on slope faces well. However, erosion at frequently submerged toes varies with fill materials, salinity levels and water flow velocity.

The following recommendations were made to the QNNDM project:

- Vetiver can be used to protect dike and canal banks against scour and erosion
- Plant Vetiver on one or both sides of embankments;
- Plant Vetiver above the concrete wall of the dikes to protect it from runoff and flood water with high velocity (Photo 8).
- Use local plants/grass to control erosion and scour on the toe above brackish water (Photo 9).
- Use Vetiver in combination with other fodder species such as Guinea grass on large river banks to encourage farmers to look after the hedges (Photo 10).

The outcome of this series of trials resulted in provincial authorities agreeing to a further demonstration where vetiver would be used to provide additional protection at the upstream and downstream ends of the first project construction of conventional rigid riverbank protection.

Photo 8: Vetiver planting above rock wall for protection against runoff and high velocity flow

4.0 INCORPORATION OF VETIVER IN THE DESIGN OF WORKS

From the outset of the project, counterpart agencies were resistant to widespread use of vetiver for riverbank and dike erosion control. While recognising that vetiver was useful in slope stabilisation in roadwork and for bank protection work in the northern and southern river deltas of Vietnam (Le *et al*. 2006), they considered that the flood characteristics of the major rivers in the central provinces were significantly different with higher velocity flows and rapid rise of floods levels. On this basis these agencies firmly believed that experience in the northern and southern deltas was not transferable to the central provinces therefore there was no technical basis for the design of significant hydraulic structures

incorporating vetiver as the principal stabilising factor and erosion protection. Counterpart agencies were prepared to accept the use of vetiver on a trial basis at low risk areas of one of the anti-salinity estuary dykes as this was specifically provided for in the project design document. They were not prepared to consider it for "permanent" structures.

Results from trials through the first flood season clearly demonstrated vetiver could provide protection under severe flood conditions even at only three months after planting. However this did not change the official position of the counterparts. The results of the early trials however encouraged the project to continue to actively promote the incorporation of vetiver protection into the design of the subsequent project funded works. ***The dike and canal demonstrations clearly showed that the use of vetiver was an economic and environmentally friendly treatment that would give an equivalent degree of protection for significantly less capital expenditure***. ***Given that the project has a fixed budget, adoption of vetiver protection for areas where such treatment was appropriate would have allowed a greater area to benefit from the same quantum of external funding.***

Photo 9: Mangrove fern planted on brackish water level to protect the toe of the dike

Photo 10: Planting other fodder species in combination with Vetiver on large river banks

Through a project initiated workshop on vetiver, local agencies gained a greater understanding of the economic, environmental and community benefits of the use of vetiver and subsequently approved further trials on the sections of riverbank upstream and downstream of the My Phuoc revetment that was constructed by the project using typical rock and concrete techniques. These trials proved equally successful in protecting loose bank material and promoting sedimentation from flood flows within three months of planting. Counterpart agencies now accept the suitability of this technique for several situations. Specifically they have recommended ***the use of a vetiver slope protection system for a section of riverbank that could not be protected economically using conventional rock and concrete systems.*** This change in attitude has come about through the impact of the trials and the continued advocacy of project personnel and visiting specialists.

5.0 SUPPORT FOR DEVELOPMENT OF FORMAL DESIGN GUIDELINES

The significance of the absence of specific guidelines for the design of hydraulic works is clearly evident as illustrated by the situation described above. It was also raised by the participants of two project workshops held to promote the use of vetiver as an environmentally sound and economic solution to erosion control problems. These workshops brought together local, regional, national and international agencies to review the trials carried out by the project and to discuss the applicability of vetiver systems for erosion control and other uses.

While the demonstrations described by the presenters at the project workshops were well received and benefits understood, the participants came back to the point that there were no nationally recognised guidelines forming the basis for a project design standard. Without this basis it was considered it would not be possible for constructing agencies to obtain approval or budget for the construction of hydraulic works utilising vetiver for protection. ***It is therefore clear that if the use of vetiver is to be widely accepted, it is essential that a set of technically based guidelines be prepared, accepted and adopted by national regulatory agencies.***

6.0 UPTAKE OF VETIVER BY COMMUNITY GROUPS

Contrary to official reluctance to take up the use of vetiver for protection works, local community groups have quickly grasped the benefits of this system of erosion protection and show great willingness to adopt the system and to use their own funds and resources to develop riverbank protection works.

A particular example of this occurred at An Chau village in the Binh Thoi commune.
At this village the Tra Bong riverbank was vertical and actively eroding and a low level earth filled flood protection dyke on the top of the riverbank was at risk. Through a local

initiative, the commune adopted vetiver as a new approach to address the issue and protect their agricultural land. The commune planned, developed and executed a scheme that included trimming the riverbank to a slope of approximately 1 on 2 and the reconstruction of the dyke with laterite fill. The slopes and crest were then planted with vetiver on a 1m rectangular grid. The space between the vetiver rows was planted with guinea grass that the people could harvest for stock feed. Woven bamboo matting and mini timber stake groynes were used as initial toe protection at the normal river level. Ultimately after the bamboo has decayed, it is expected that the deep rooting characteristics of the vetiver will provide protection to this zone (Photo 11).

This project was entirely community driven with only a minimal contribution from the project to finance some materials and provide technical assistance for the planting and maintenance of the vetiver from the Agricultural Extension Centre. The success of the project clearly demonstrates what can be achieved at a local level using minimal resources and appropriate technology.

In addition to the above scheme that has been successfully implemented, there are many other communities within the project area that have expressed interest in implementing their own schemes. As a result of the interest expressed by the community groups, a workshop was conducted specifically to inform these groups about the potential advantages of using vetiver for small-scale community erosion control initiatives. Following this workshop the community mass organisations such as the Women's Union and the Red Cross have expressed great interest in taking up community vetiver projects. These projects are currently being considered for support through the community based initiatives in the forthcoming project extension.

Photo 11: Local community initiative adopted VS and initiated their own project

7.0 CONCLUSION

The QNNDMP has promoted the utilisation of vetiver as an economic and environmentally friendly methodology for slope protection and erosion control on hydraulic structures. The

project has supported this view through the implementation of demonstration trials funded by the project.

Through these trials and the continued advocacy of national and international specialists, the advantages of using the vetiver system as an economic and environmentally friendly methodology for slope protection and erosion control on hydraulic structures has been recognised by concerned agencies in Quang Ngai.

At the community level there has been strong interest generated and a high degree of willingness to adopt the technology as an economic solution to many community problems.

Limitations to the wider uptake of this technique appear to be the absence of any nationally recognised standard guidelines that a project designer can use as a basis for design.

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A Brief Introduction to the First Author

Mr Vo Thanh Thuy is Vice Director of the Quang Ngai Agricultural Extension Centre, Ministry of Agriculture and Rural Development, Vietnam. Over the last 5 years he has conducted R&D on the application of VS to mitigate flash flood and sea water intrusion in Quang Ngai, a coastal province of Vietnam. As a result of his works VS has been used successfully as a disaster mitigation method in the coastal Vietnam.