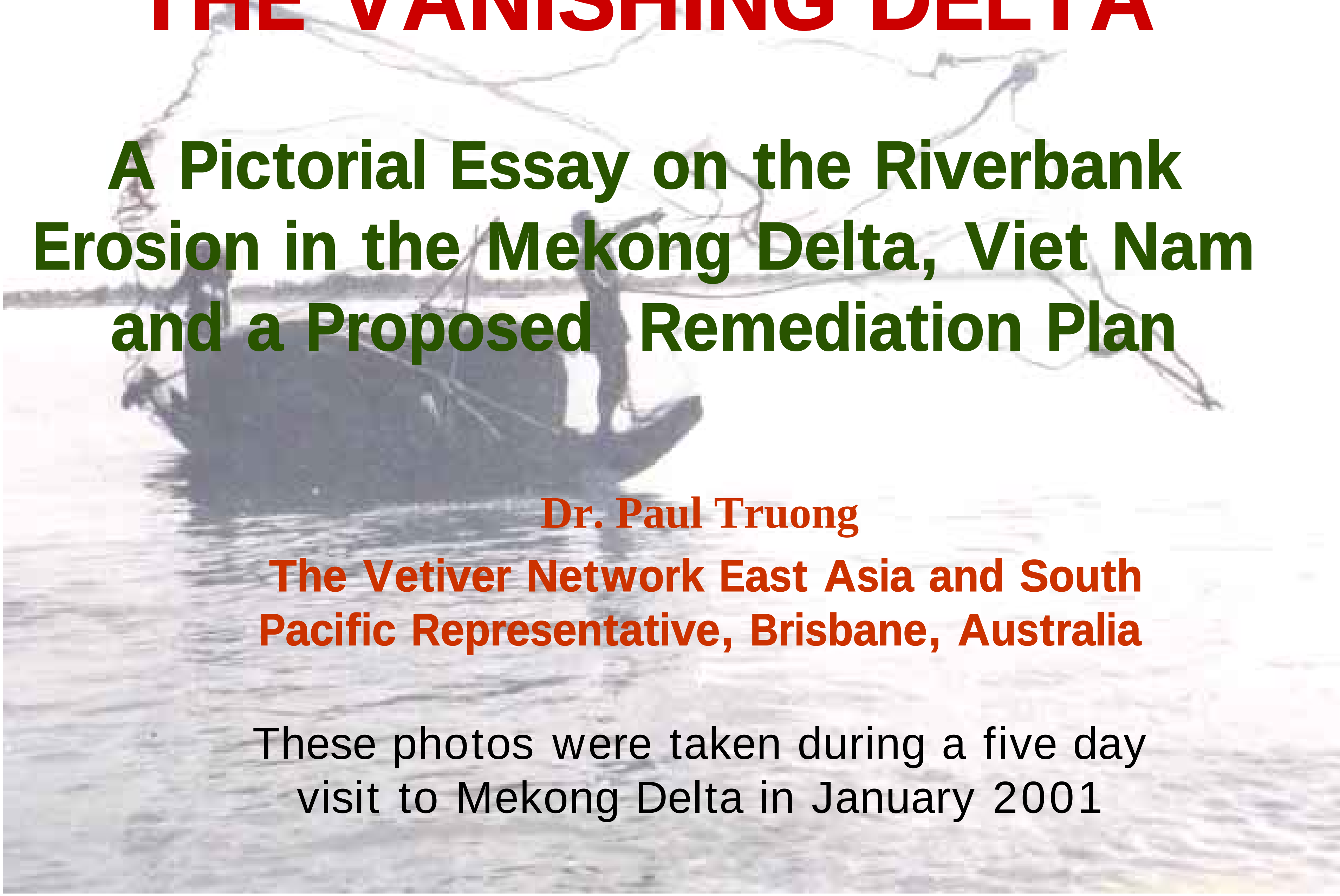
THE VANISHING DELTA

A Pictorial Essay on the Riverbank Erosion in the Mekong Delta, Viet Nam and a Proposed Remediation Plan



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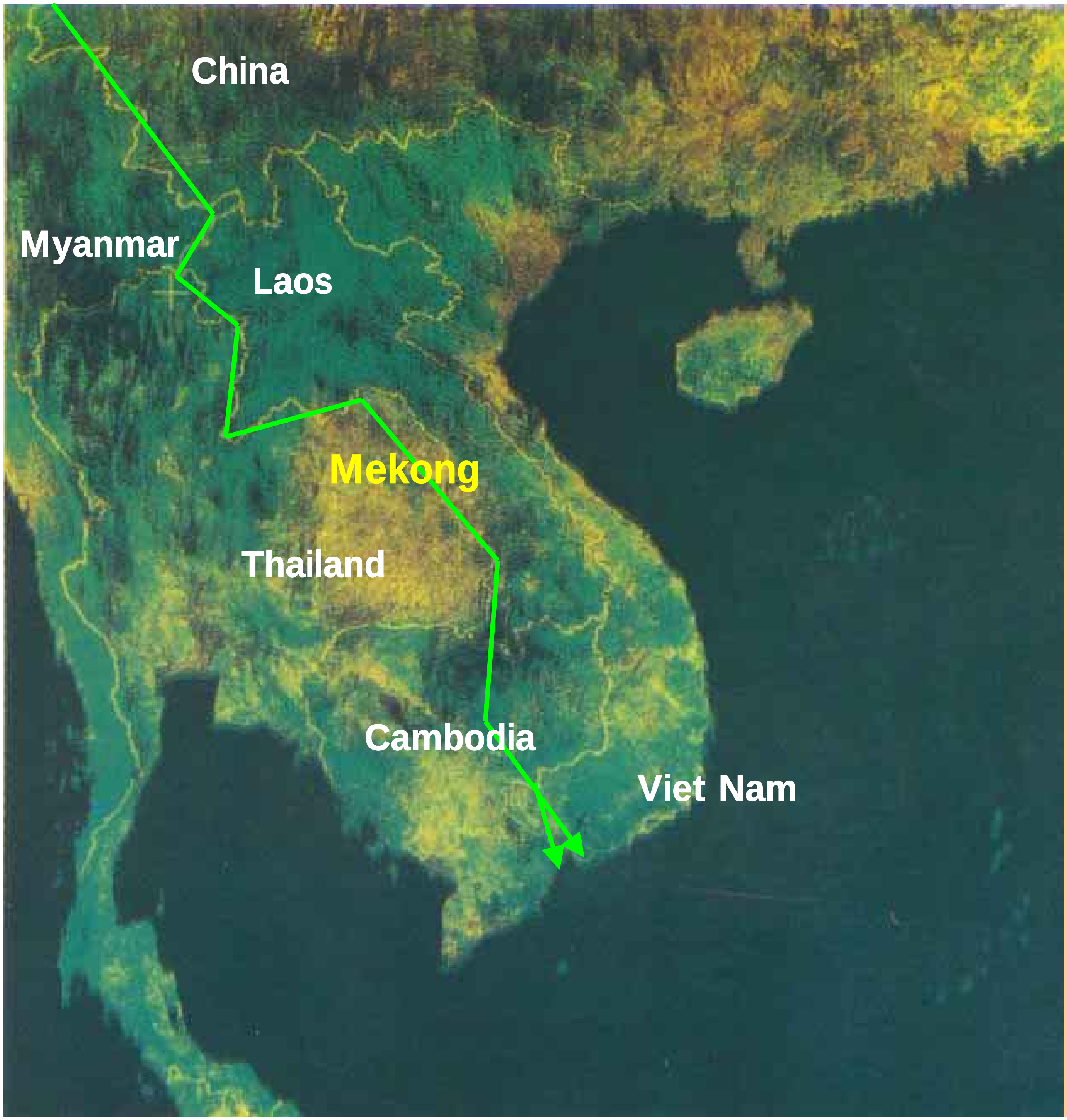
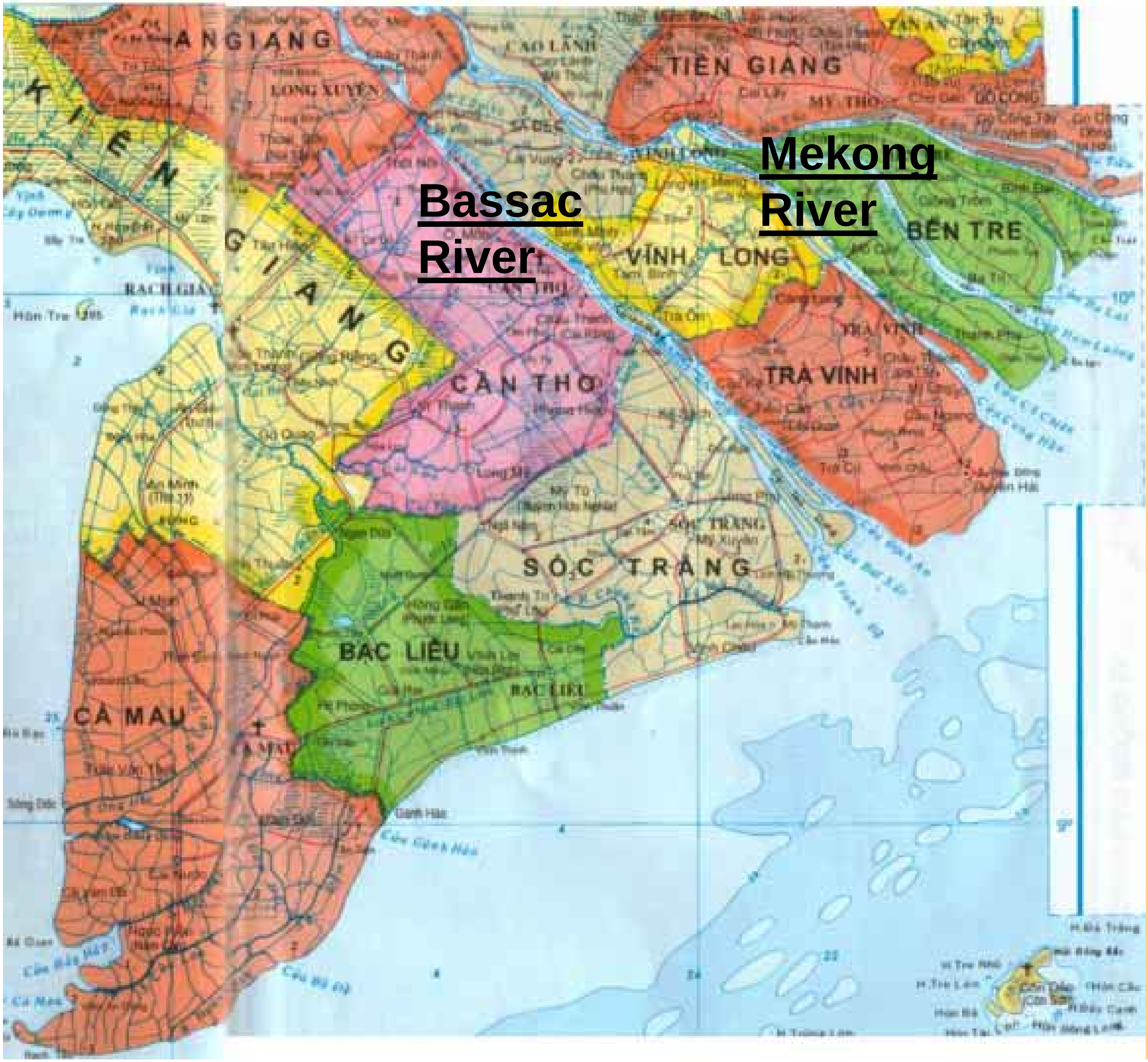
These photos were taken during a five day visit to Mekong Delta in January 2001

THE MEKONG RIVER

- The Mekong river, Cuu Long in Vietnamese, meaning 'Nine Dragons, which name indicates its size and power over the lands and peoples along its 4 350km long course and a catchment of over 810 600km^2.
- Originated in Tibet, it flows through six countries and emptying to the South China sea
- Over millennia the sediment load of its water has created a massive delta providing the most important agricultural and fishery resources for Vietnam.
- The Mekong delta is a "Meander Plains", changing its course once it has silted up its present 'bed'.
- Static engineering solutions have been tried and failed in many countries, including the U.S.
- A new and more flexible approach is needed and worth considering.



The course of the Mekong river through China, Myanmar, Laos,Thailand, Cambodia and finally Vietnam



The Mekong Delta and its main rivers: the Mekong in the north and the Bassac in the south

In many places the Bassac are wider than 1 000m across, with very strong current during the rain season

Due to its large size, strong wind can whip up large waves at times

Cantho City is located on the mouth of Cantho river, one of the major tributaries of the Bassac

THE MAIN TRANSPORT CORRIDOR

- The fragile alluvial soils of the Mekong Delta, combined with high water tables and a myriad of streams and rivers, mean that road infrastructure is expensive to build and maintain.
- The road system in the delta is scarce and poor, therefore the network of rivers and canals has always been the main thoroughfares in the delta, providing the main means of transportation for its people and their produces
- Over centuries, in addition to the myriad of rivers and streams, numerous canals were also built to improve irrigation, drainage and transportation for the local people

Traffic on the Mekong

- The Mekong river and its southern branch, the Bassac are the main transport corridors of the delta.
- While the Mekong provides international shipping access to Cambodia and transport to Ho Chi Minh City.
- The Bassac is the main “super highway” transporting all agricultural and fishery produces between cities and to Cantho for export

Medium size barge

Medium size boat

Traffic on the Tributaries and Canals

People in the delta spend much of their daily life on the waterways, relying on their boats for both business and pleasure. The following slides show the typical activity on a few smaller rivers in the southern delta.

A typical riverside market

Typical activity near a commercial centre

A family run about

A medium size boat, equivalent to an utility or pickup truck

A semi trailer size boat

RIVER BANK STABILITY IN THE PAST

- Historically erosion on the banks of the Mekong river has been an on going process caused by the siltation of its channels resulting in changes in river hydrology and occasional floods.

- On the other hand erosion of the banks of both large and smaller tributaries and canals rarely occurred in the delta. Although these watercourses were used then, as they are used now, as the main transport corridor, the sampans and smaller boats of the past were mostly manually powered

These small crafts produce practical no waves to damage the banks.

PRESENT RIVERBANK EROSION

- Due to economic development in recent years, almost all boats traveling on the rivers and canals are now motorised.
- These boats produce waves which pound the banks day and night causing massive erosion.
- The soft alluvial soils range from silt to loam and are extremely erodible when wet.
- The problem of erosion has been intensified in recent years with the introduction of more powerful (old car and truck) V6 and V8 engines,
- Boats fitted with these engines produce huge waves.
- The severity of the problem is worse in remote areas as they need faster means of transport to markets and towns.
- For example in the southern end of the delta, the Ca Mau province, erosion is far worse than in Cantho City, the capital of the Mekong Delta.

The Erosion on the Banks of the Mekong

- Erosion on the banks of the Mekong and Bassac rivers occurred in the past due to changes in river hydrology, floods and wave action.
- However the erosion rate has been exacerbated enormously in recent years by the increase in boat traffic.
- The problem will certainly be worsened in the future with the coming of not only higher traffic volume but also from bigger boats and barges.

Recent erosion washed away a large chunk of land, what is left will be gone soon.

At least 20m of land was lost in the last 2 years according to the local farmer

This raw surface is a common sight along the river

This freshly eroded surface at high tide was not caused by a recent erosive event, indicating that erosion occurred continuously

The Erosion on the Banks of Rivers and Canals

Active erosion threatens the stability,damages or destroys properties, infrastructures and productive farm land along the banks of both rivers and canals in the delta.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According to local residents, the red line indicates the position of the bank 3 years ago, at least 6m of land was lost.

This canal bank was rebuilt with freshly dredged soil

This canal bank was recently rebuilt after severe erosion

Property destruction

Infrastructure destabilization

A wooden bridge abutment was washed away

Productive farm land collapsed into the river

This orchard becomes a “hydroponics” garden

CASE STUDY

The following photos illustrate the seriousness of the problem:

The water supply of Cantho City is in jeopardy as active erosion threatens the stability of the intake structure built on the bank of the Bassac river. Despite continuous effort and several major attempts to stabilise the site, erosion continues. In the past 3 years more than 10m of bank have been eroded.

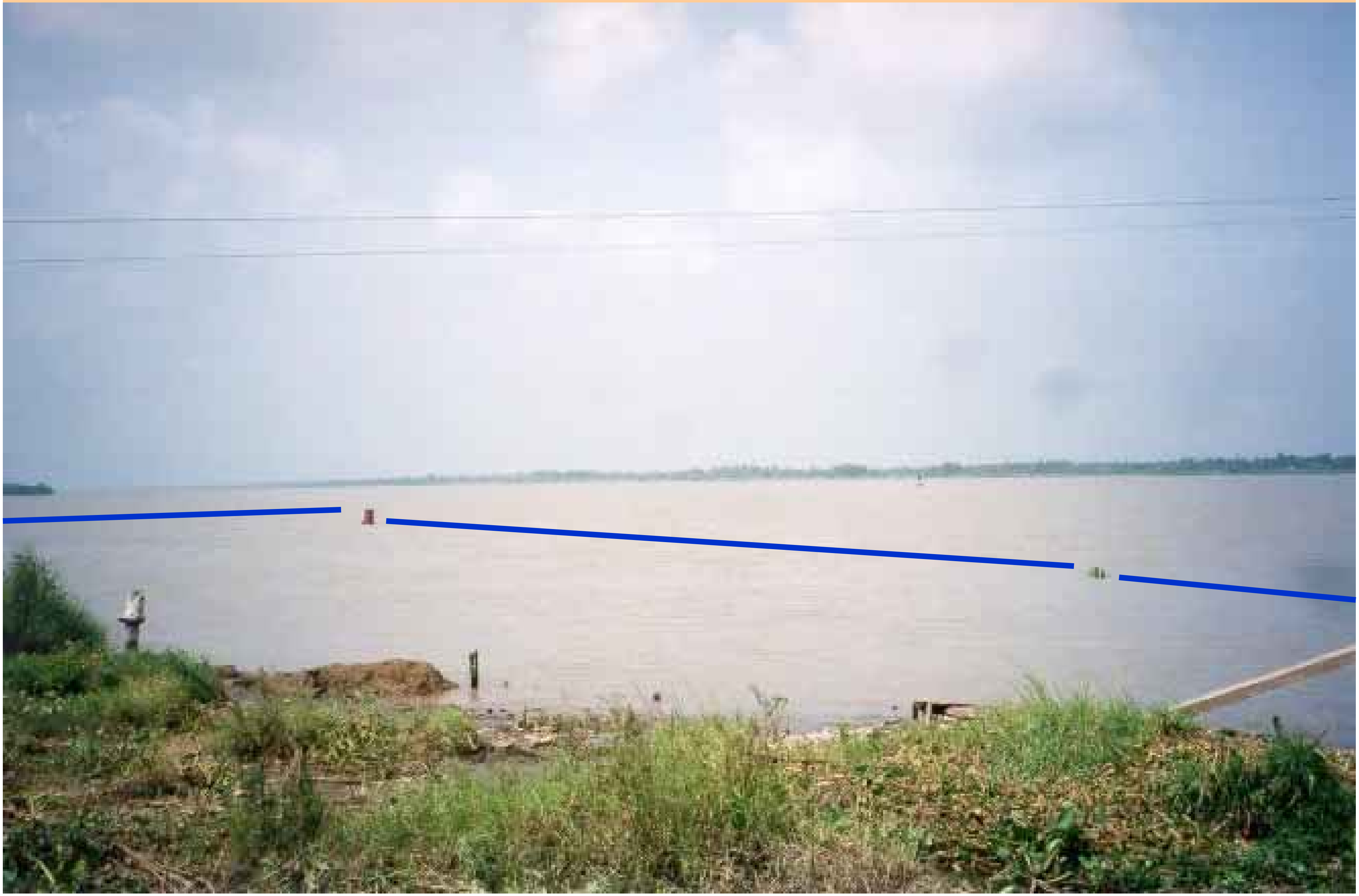
It is predicted that at the current rate of erosion, the intake pipe will collapse in less than two years unless very costly measures are taken by the authority.

Active erosion occurs on the upstream side of the intake structure of Cantho City water supply on the Bassac bank

As well as on the downstream side of the structure

Native vegetation provides little protection

Blue lines indicate the position of the shore line 3 years ago, two old posts are still visible (upstream side)



Blue line indicates the shore line 3 years ago on the downstream side

THE CAUSE

River bank erosion is resulted from waves created by the powerful motorised boat traveling at high speed on these rivers and canals

These “shrimp tail” motors are very popular as they are simple and cheap to operate

They come in all sizes and shapes

At high speed they create very destructive waves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Grand Prix day on the Cantho river

Double motors

Double troubles

Waves at low tide

Waves at high tide

LOCAL MEASURES

River front land owners have resorted to all available means to stop the erosion. Some methods are low cost and temporary others are long term and very expensive measures.

However their successes vary but on the whole they are ineffective as the following photos show.

Vegetative Methods

Water hyacinth and a local water plants *(Phragmites vallatoria* L.) are commonly used to combat the erosion.

Water hyacinth is a floating weed which can choke up rivers and canals.

Phragmites vallatoria L is a perennial grass up to 3m high, with erect, stout and hollow stem of about 1-1.5cm in diameter. The stems are not flexible and break easily under pressure. It has a relatively shallow root system of about 0.5m depth.

Water hyacinth is kept in place by a bamboo barrier to stop waves from reaching the shore

Water hyacinth is retained by Phragmites

Phragmites vallatoria L

Native grasses and Eucalyptus trees

Ineffectiveness of Vegetative Methods

Due to various reasons, the vegetative means of bank stabilisation used locally are not effective or at best provides only temporary relief.

Erosion continues behind the water hyacinth barrier

Trees are not much help either

Native grass is equally ineffective

This Phragmites barrier look very impressive from the front

But erosion continues to happen behind its “back” as waves from unprotected section upstream got behind it

Constructed or Engineering Methods

Various constructed barriers are also widely used, they are expensive to build but their effectiveness depends on the costly maintenance

Phragmites and timber fence

Bamboo and wood structure

Solid timber barrier

Sandbags

Concrete wall

Rock Rip Rap

Rip Rap and timber fence

Sandbags and timber fence

Gabion rock basket

And ultimately, a steel wall, normally used for wharf construction is needed to protect this factory

Failure of Constructed or Engineering methods

Inherently, most of these structures are not stable as they are built on the ***soft and highly erodible alluvial foundation***

Erosion behind sand bags

Collapse of wooden barrier due to lack of maintenance and eroded foundation

Collapse of concrete wall due to lack of maintenance and eroded foundation

Combination of vegetative and engineering methods

This combination seems to provide the best solution to the erosion problem, but they are very expensive to install and not suitable and practical for most situations.

The foundation of this riverside restaurant is weakened so the owner went a lot of expenses trying to stop the erosion.

A highly elaborate defense set up


Transplanted mature
mangrove

VETIVER SYSTEM: A PRACTICAL SOLUTION

- The Vetiver System (VS) is a new Bioengineering technology based on the use of vetiver grass (*Vetiveria zizanioides* L.) in various applications
- VS has been developed in the last 10 years through extensive research, development and applications.
- VS has been used successfully to stabilise highly erodible riverbanks in Australia, Asia and Africa.
- This technology is an effective, practical and low cost method of riverbank stabilisation for low lying, tropical and alluvial lands such as the Mekong Delta.

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Vetiver System for the Mekong Delta

The Vetiver System is particularly suited for the Mekong delta because:

- It is simple, low cost, low-tech, labour intensive and low maintenance
- The Vetiver System can be applied to all rivers and canals from fresh to brackish water zones and acid sulfate soils of the delta
- For the Mekong river itself, as the river moves its course, the low cost and fast growing VS moves with it.
- For the less erodible tributaries and canals the VS will provide a long term erosion control measure.

Special Characteristics of Vetiver Grass

The following characteristics make vetiver grass highly effective for river bank stabilisation in the delta:

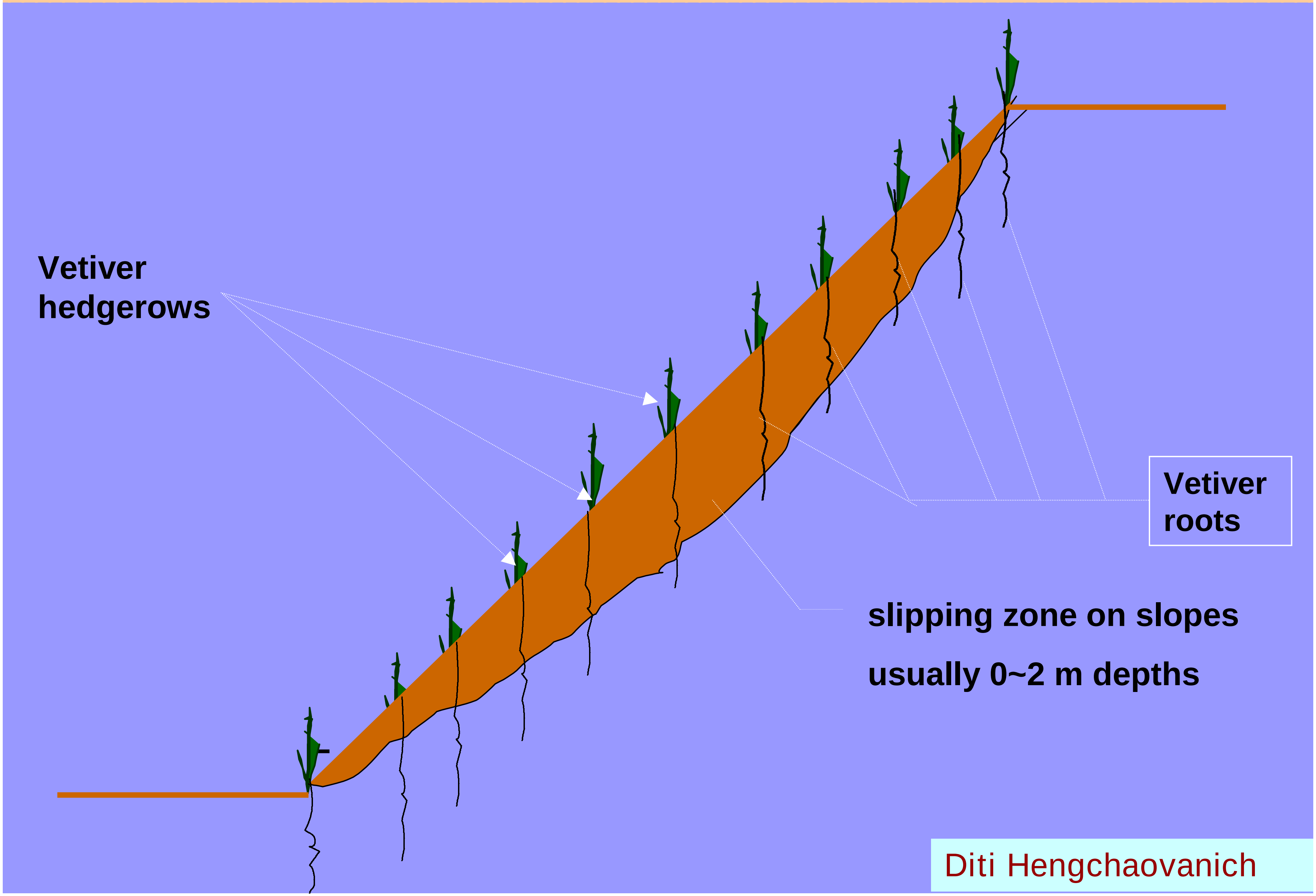
- A deep, penetrating and extensive root system that binds the soil, and reinforces the soil structure which requires extraordinary force to dislodge.
- Erect and stiff stems forming a dense hedge which are very effective in retarding water flow, reducing the erosive power of the strong current and dissipating the waves energy.
- The top portion of the vetiver plant is flexible and bends over under strong flow. The bent tops act as an energy dissipater
- Vetiver is tolerant to saline and acid sulfate soils.
- Vetiver survives under prolonged and complete submergence and it resumes growth after emerging from the water. Under partial submergence conditions, vetiver can remain indefinitely, as it was originally a wetland species.

Deep and Penetrating roots:

One year old plant with 3.3m deep root system

Vetiver roots have the tensile strength of 75 Mpa, equivalent to1/6 strength of mild steel reinforcement.

Soil stabilisation mechanism by vetiver



Diti Hengchaovanich

Strong root reinforcement holding up this wall of soil against water erosion

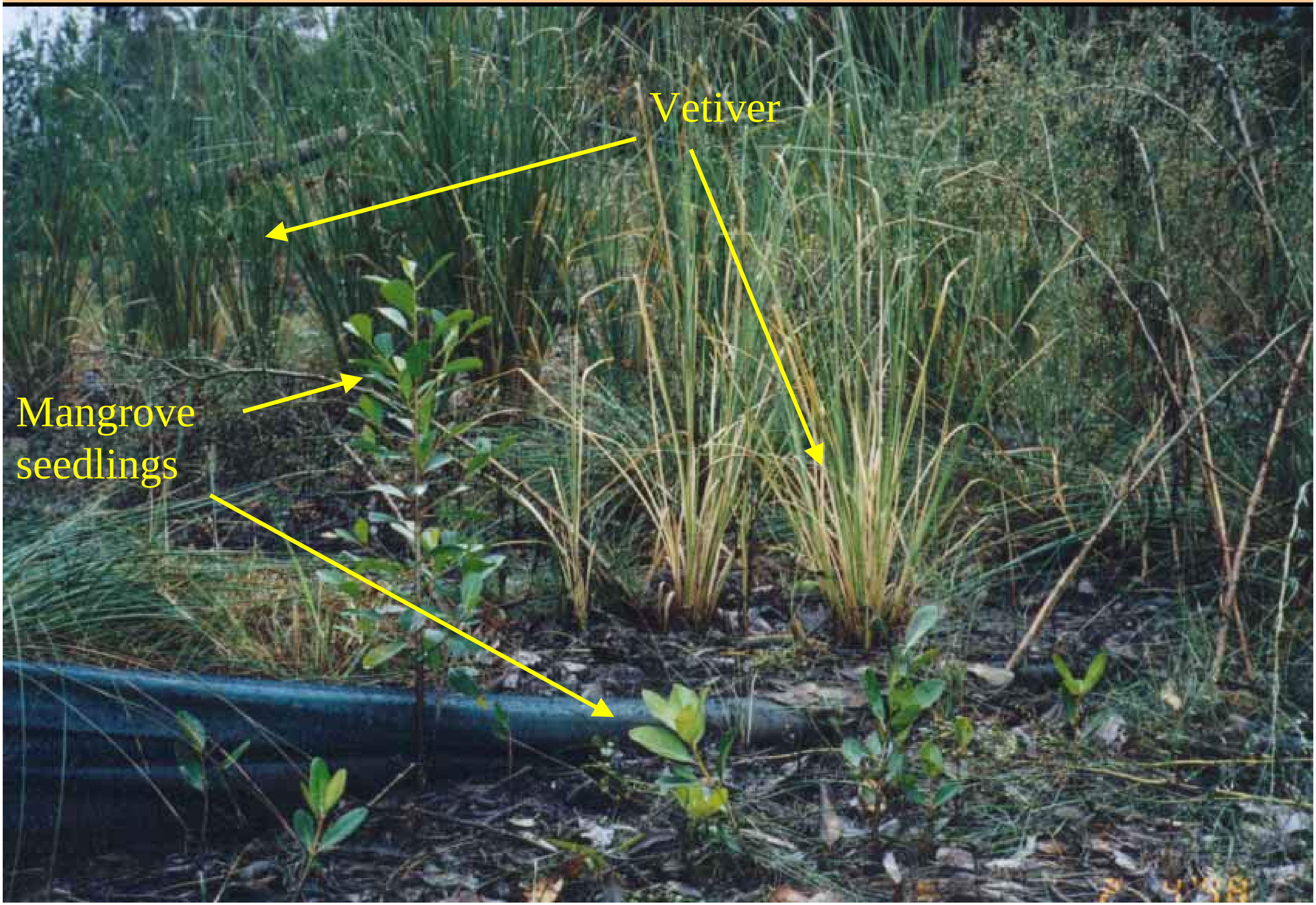
Stiff and Erect Stems: Providing a thick but porous barrier which retards water flow and traps sediment

Strong current flattened the native grass but not vetiver on this waterway

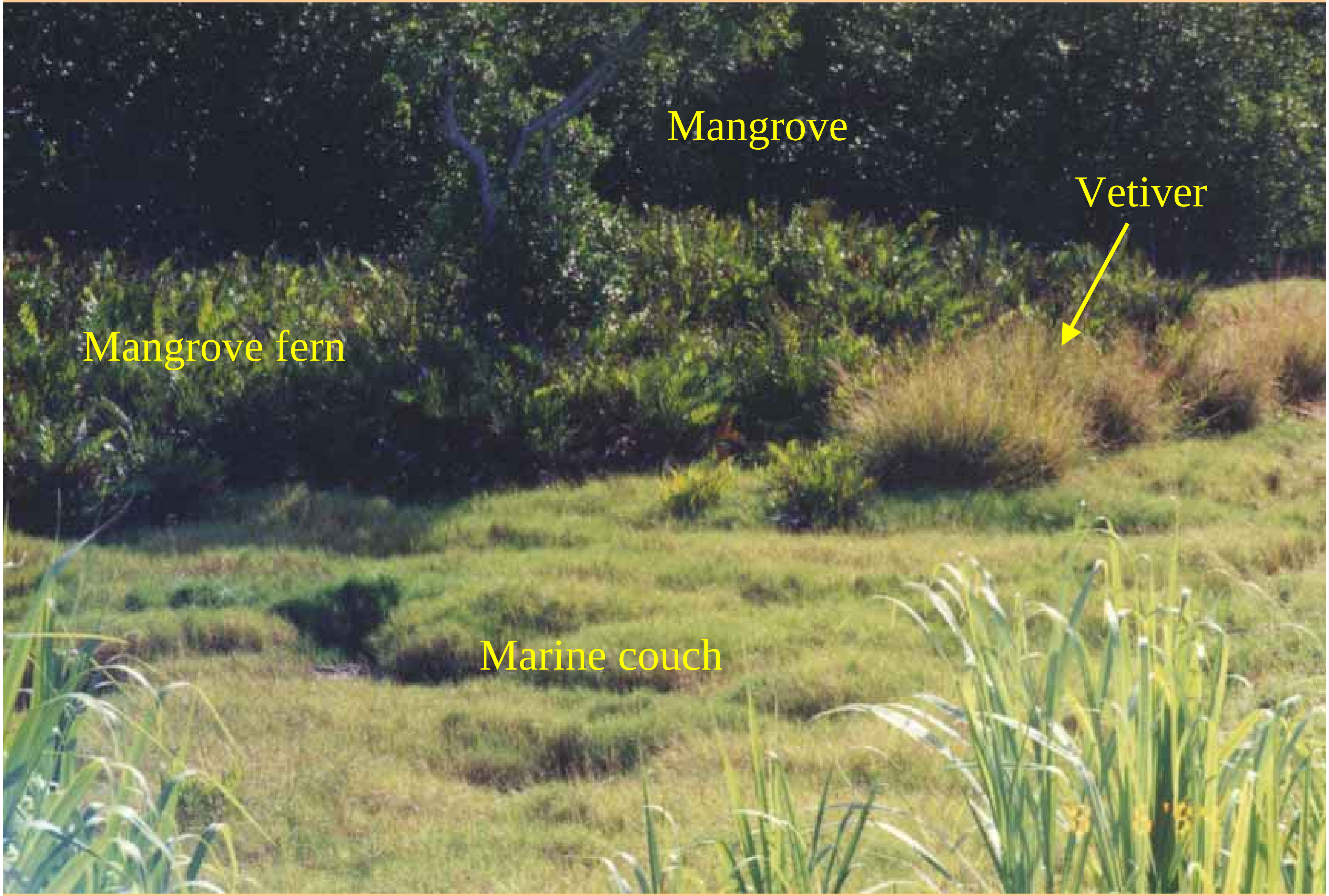
Tolerance to submergence:

Growing vigorously in water

Tolerance to salinity: Growing among mangrove seedlings



In Fiji vetiver growing next to mangrove stands



Tolerance to Acid Sulfate Soils: Vetiver planted to stabilise the banks on this highly erodible acid sulfate soil in coastal Queensland

One year after planting

Principles of the Vetiver Grass System for River Bank Stabilisation

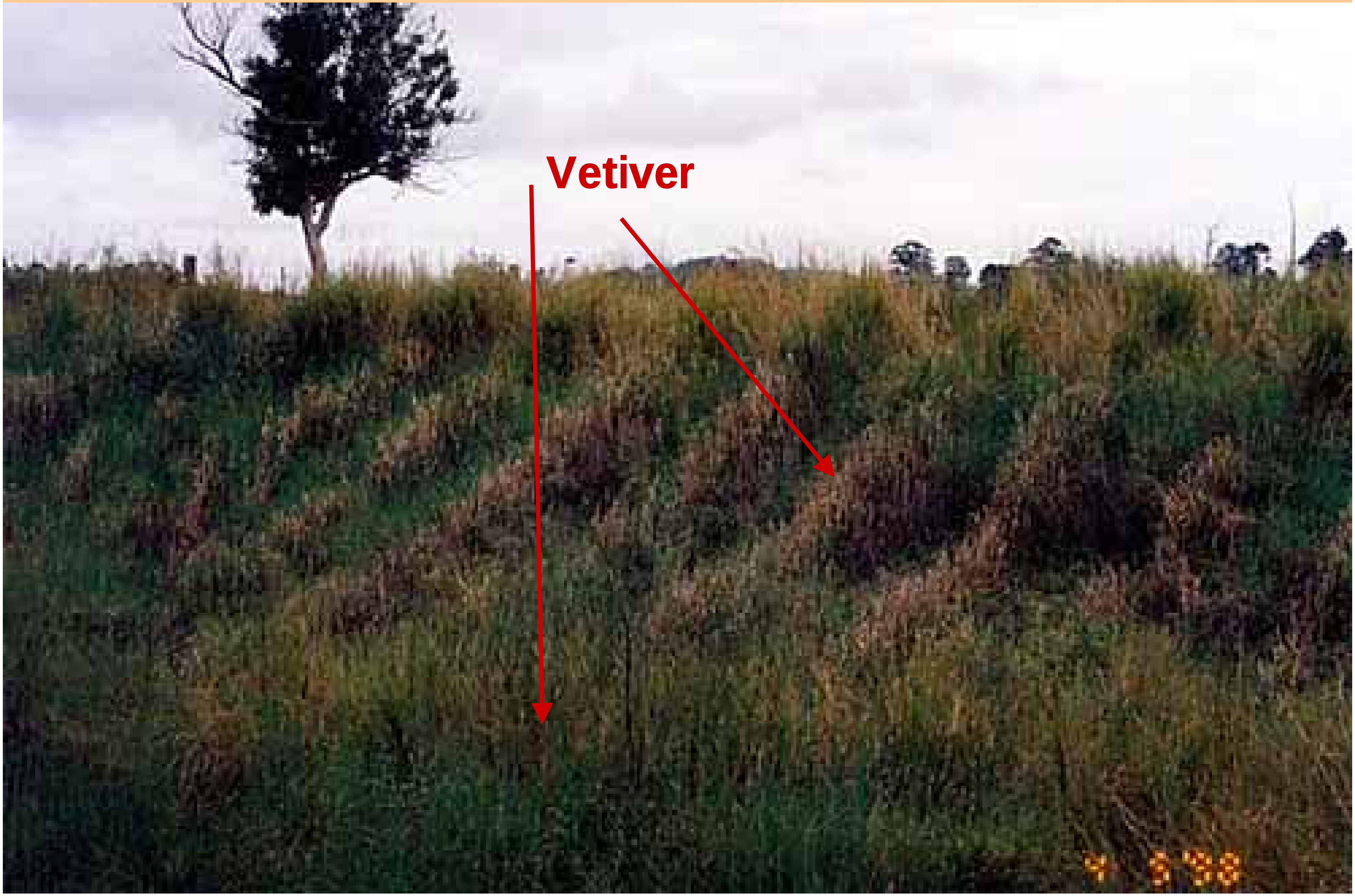
Firstly to stabilise the bank steep gradients, horizontal rows planted on approximate contour lines

Secondly to prevent scouring from the strong flow, planting of cross rows is needed to reduce flow velocity of the strong current..

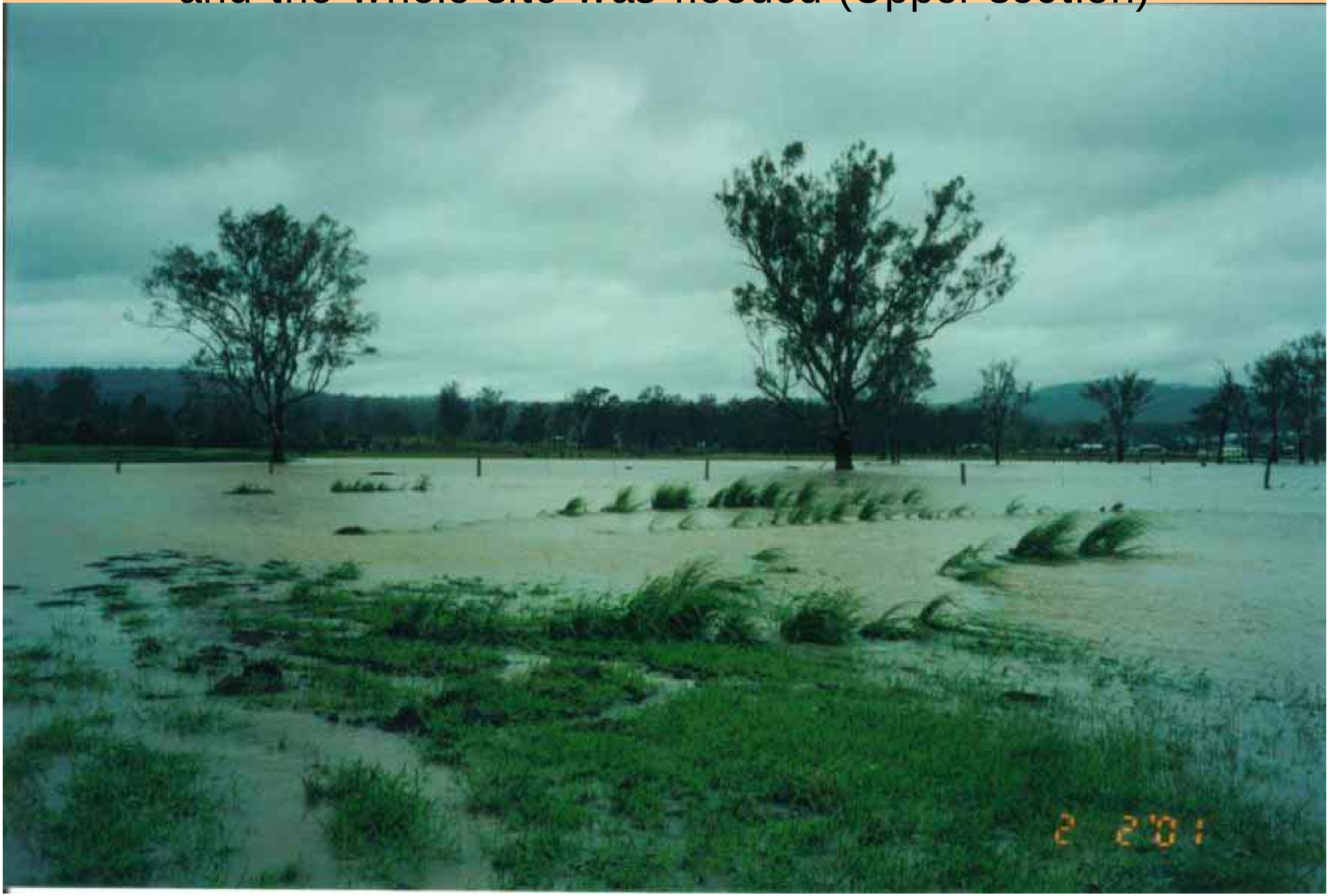
The following photos illustrate these points and some examples of VS application for flood erosion control in Queensland, Australia and other countries

Australia: General view of the planting layout on a river bank in Australia, showing the horizontal rows at 1m Vertical Interval and cross rows at approximately 3m interval

This bank was undamaged by several floods during the last few years

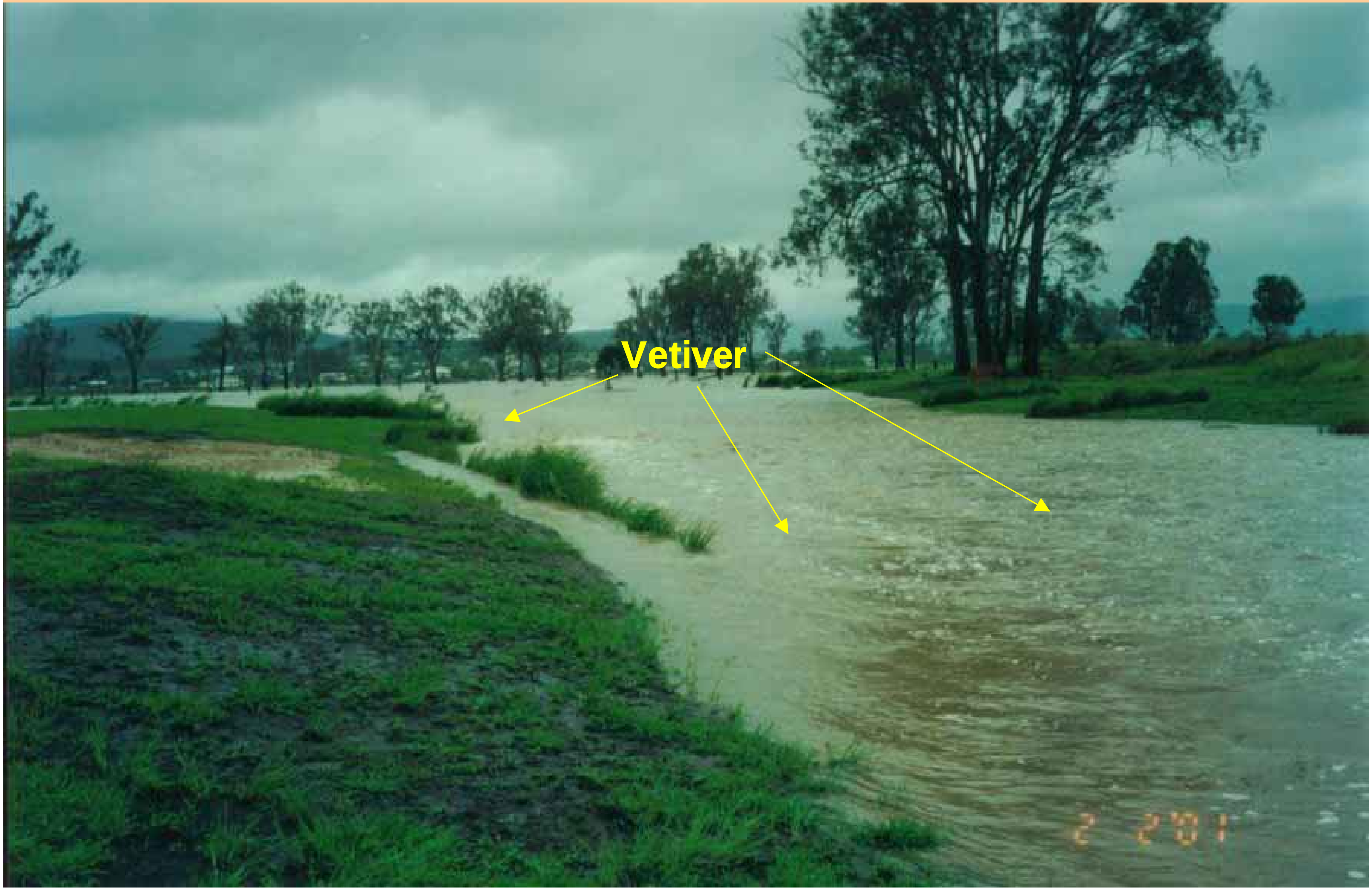


A big storm hit this drainage channel 3 months after planting and the whole site was flooded (Upper section)



Very fast flow flattened and inundated most of the vetiver hedges in this drainage channel

Very fast flow up to 5m/sec in some sections of the channel completely submerged and flattened the hedges



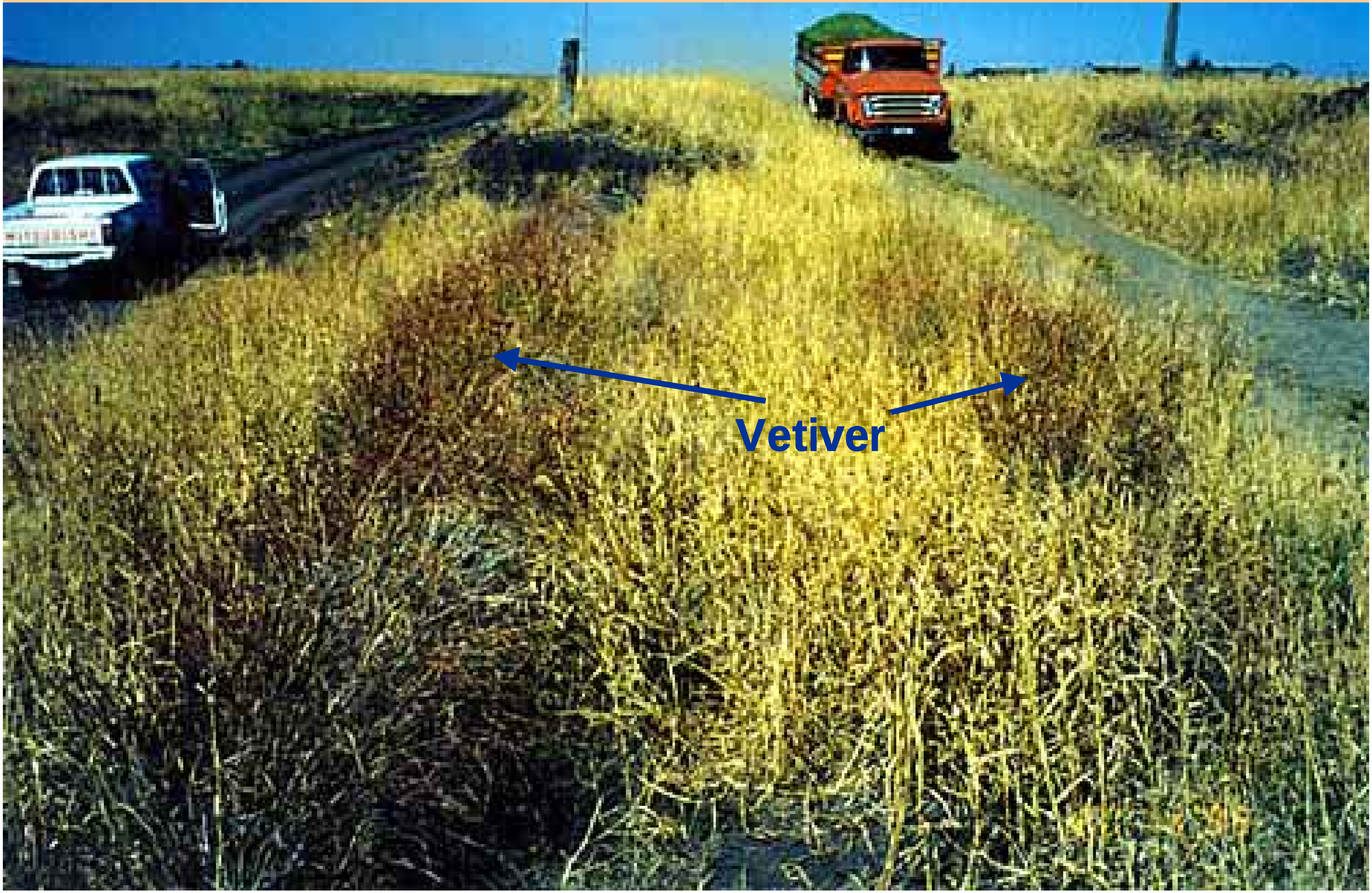

Vetiver hedges

Although only 3 month old, the young hedges provide a very effective protection with only minimal erosion at the head of the channel

Seven weeks after flooding looking up from lower section

Nine weeks after flooding,
looking down towards the channel

Two rows of well established and mature vetiver, planted upstream from the causeway to protect it from flood erosion.



A 3m deep flood swept through this causeway, completely submerged the vetiver rows

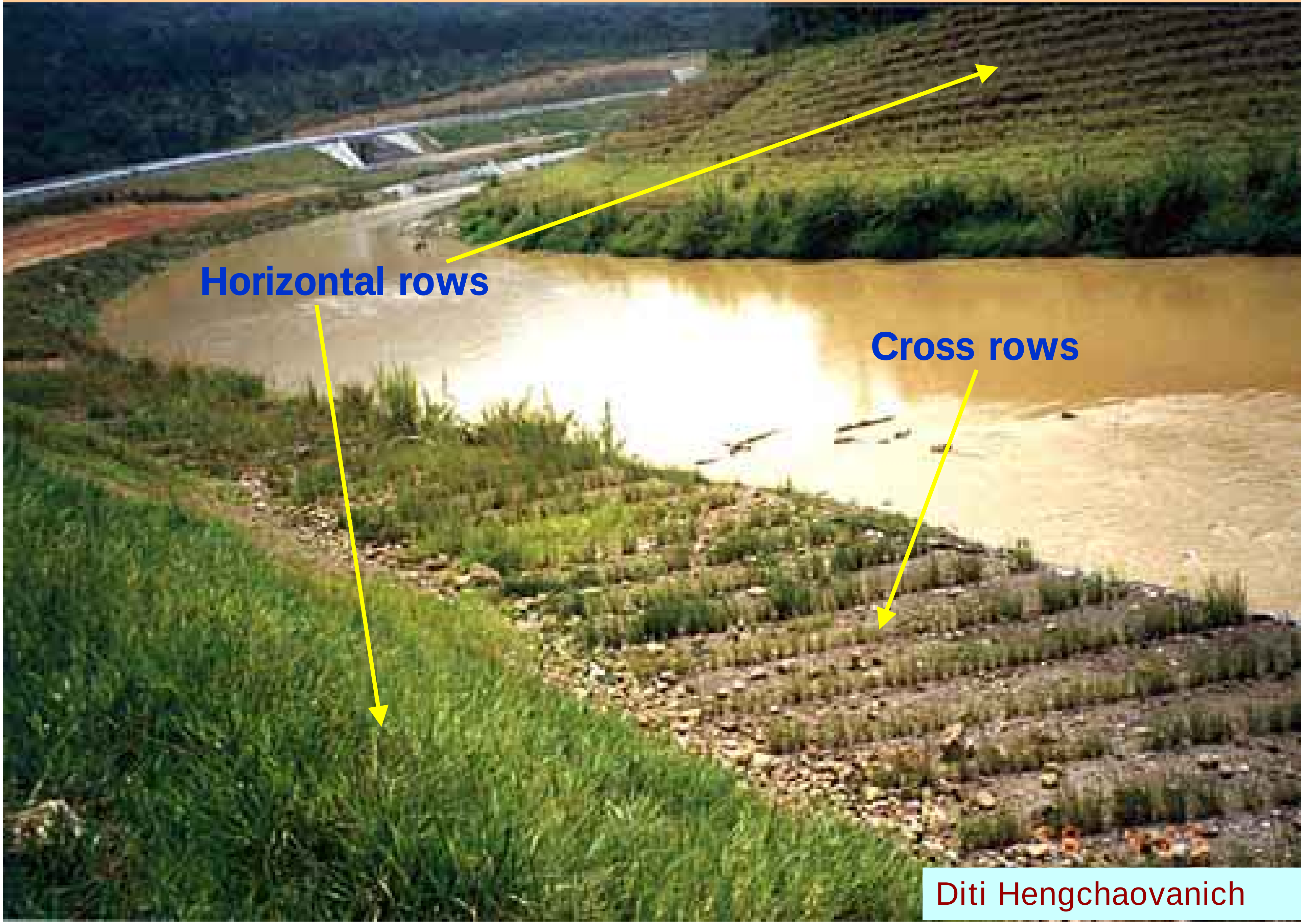
Although badly battered, the vetiver hedges held firm during the flood, preventing the undermining of the concrete causeway

Highly turbulent flood flow across a causeway in northern Australia

After several floods the gabion was extensively damaged, indicating the weakness of rock structure under flood

This causeway was again flooded 8 months after planting with flow up to 3m deep. Despite the young age vetiver plants were sufficient to withstand the high velocity flow and stop the erosion .

Malaysia: Another excellent example and outstanding success



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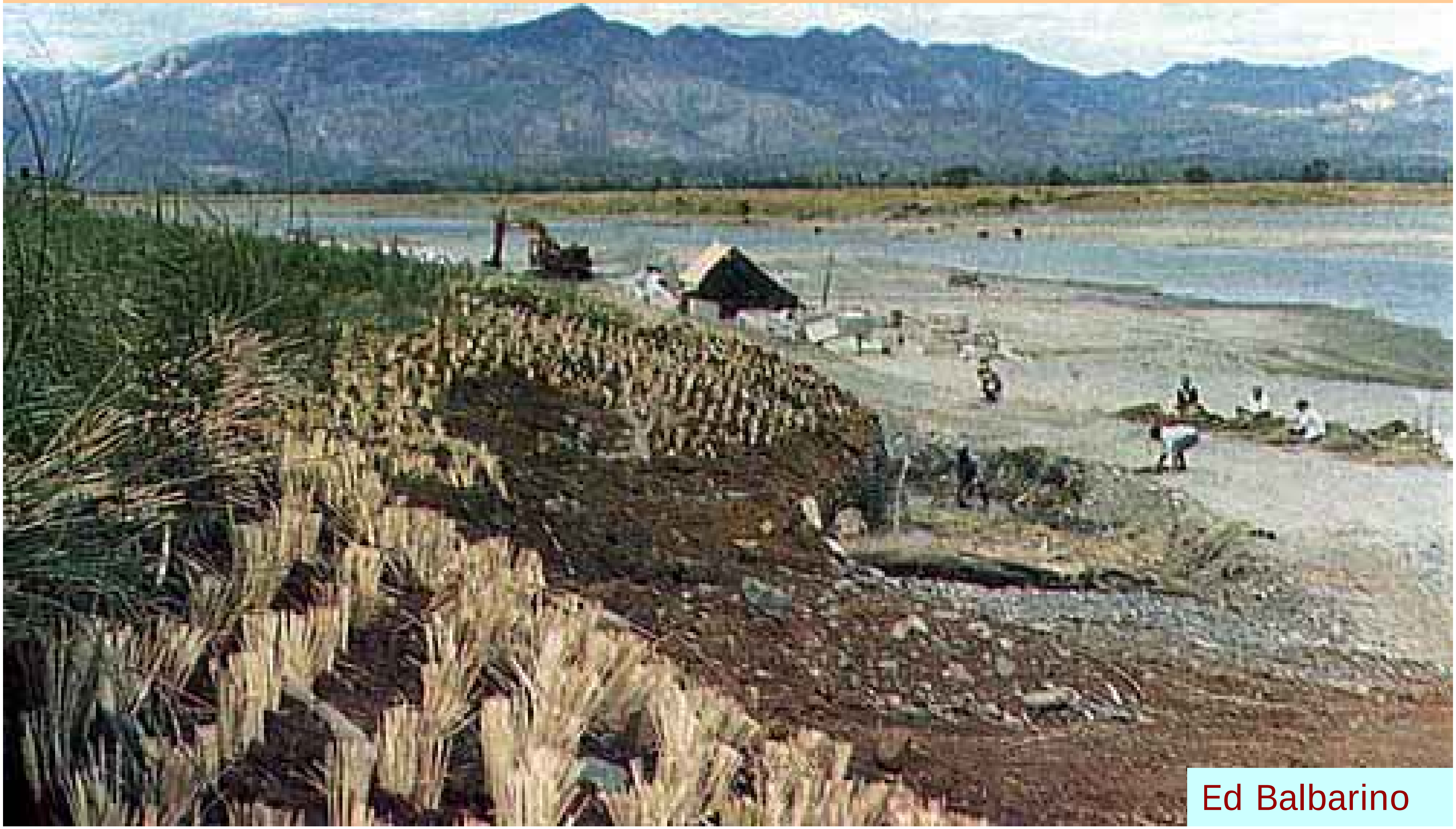
Philippines: Vetiver was planted to protect the bank of Abra River against flood erosion



One year after planting, the bank was successfully stabilised

Ed Balbarino

South Africa: An excellent example of rows layout on a river at a sugar estate near Durban

Zimbabwe: Very effective protection against high velocity flow in a drainage channel

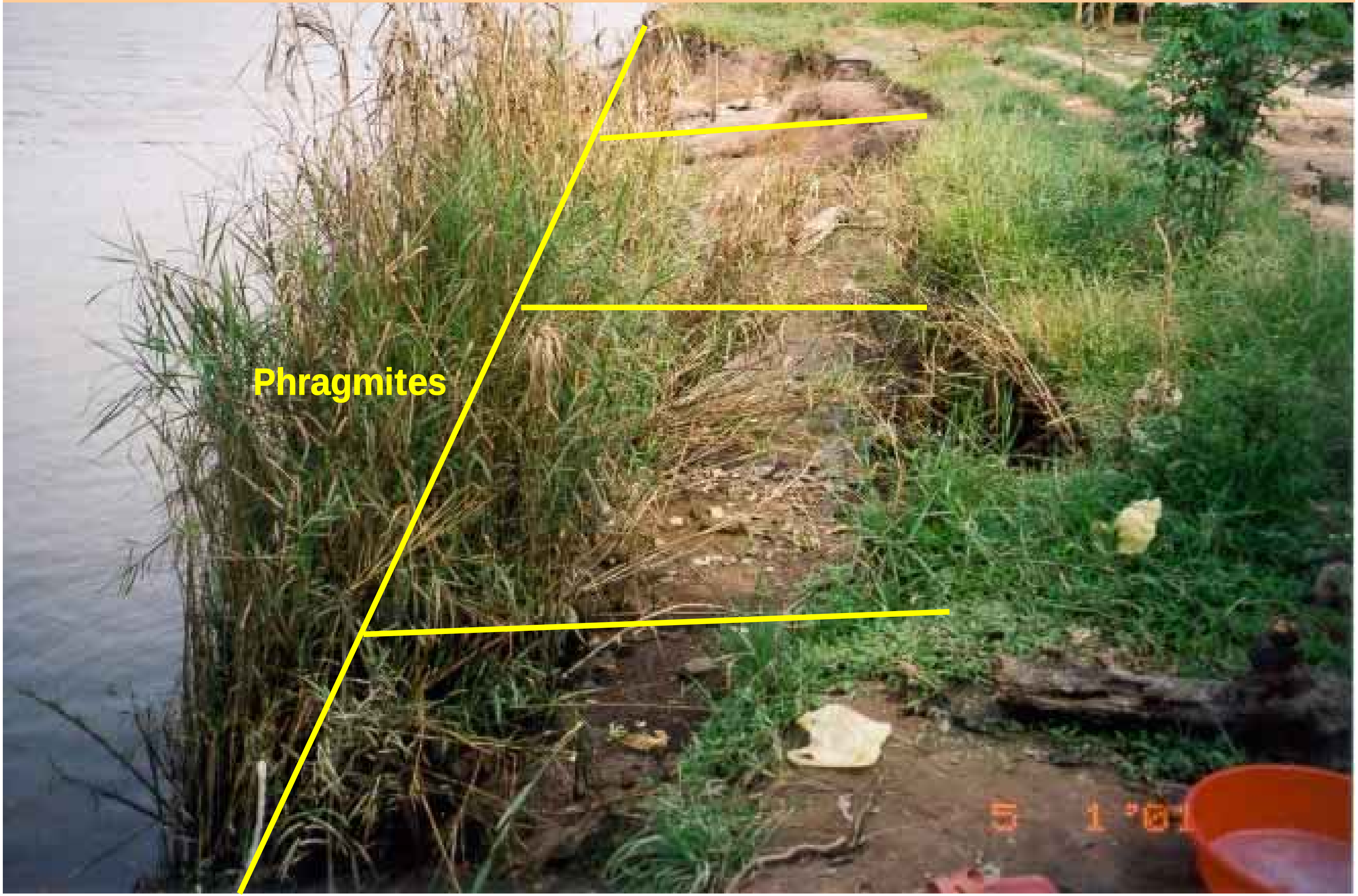
Proposed Applications of the Vetiver System in the Mekong Delta

The followings are diagrammatic illustrations of how the Vetiver System will be applied under various situations to control erosion on the banks of waterways in the Mekong delta.

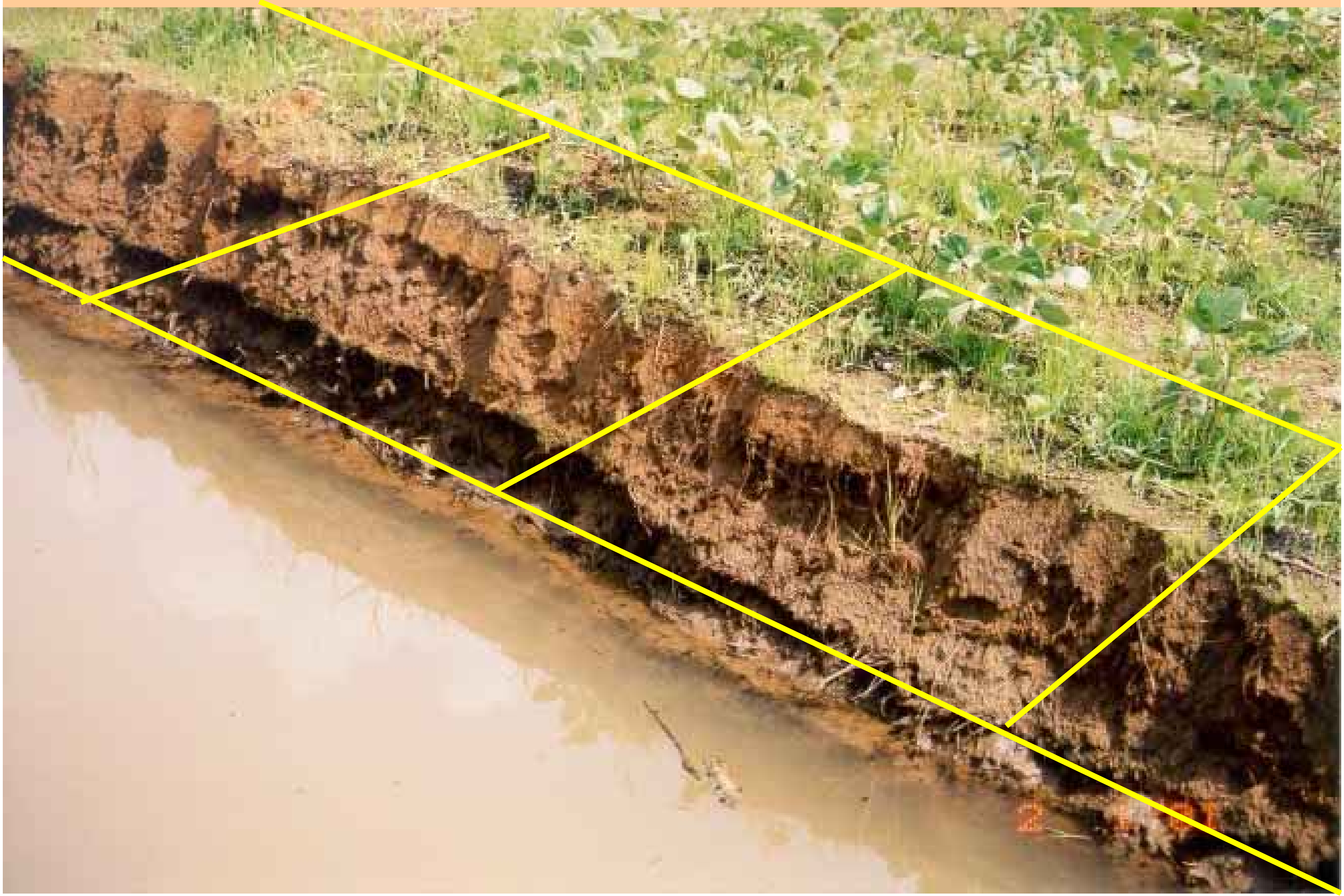
The exact design at each location depends on the site specific characteristics such as tidal variation, salinity, soil structure, slope gradient, slope length, traffic volume etc.

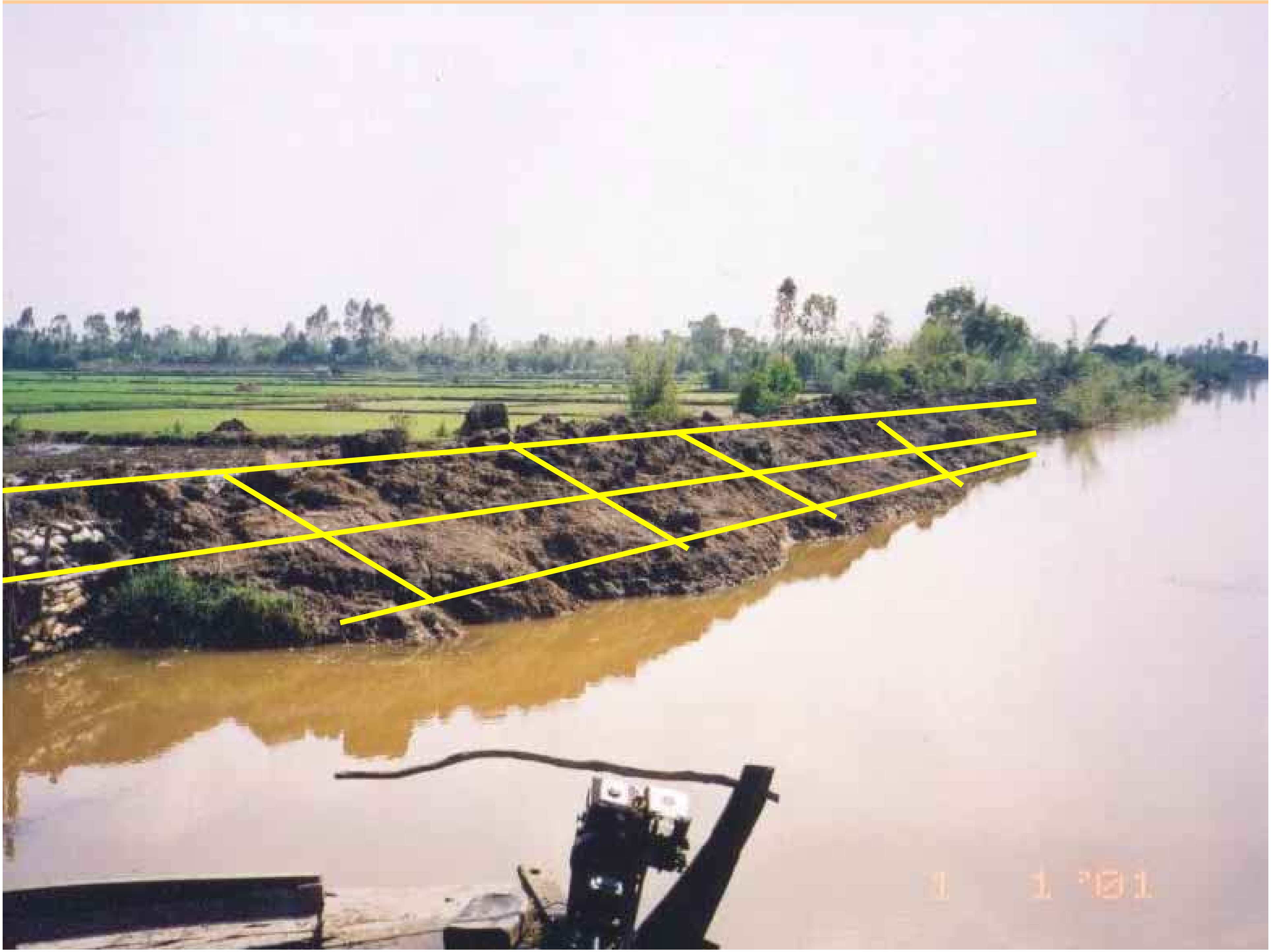
The yellow lines indicate the position of vetiver rows, row position and spacing are indicative only

Replacing Phragmites with vetiver wherever needed



Some earth shaping is needed to reduce slope gradient for vetiver establishment

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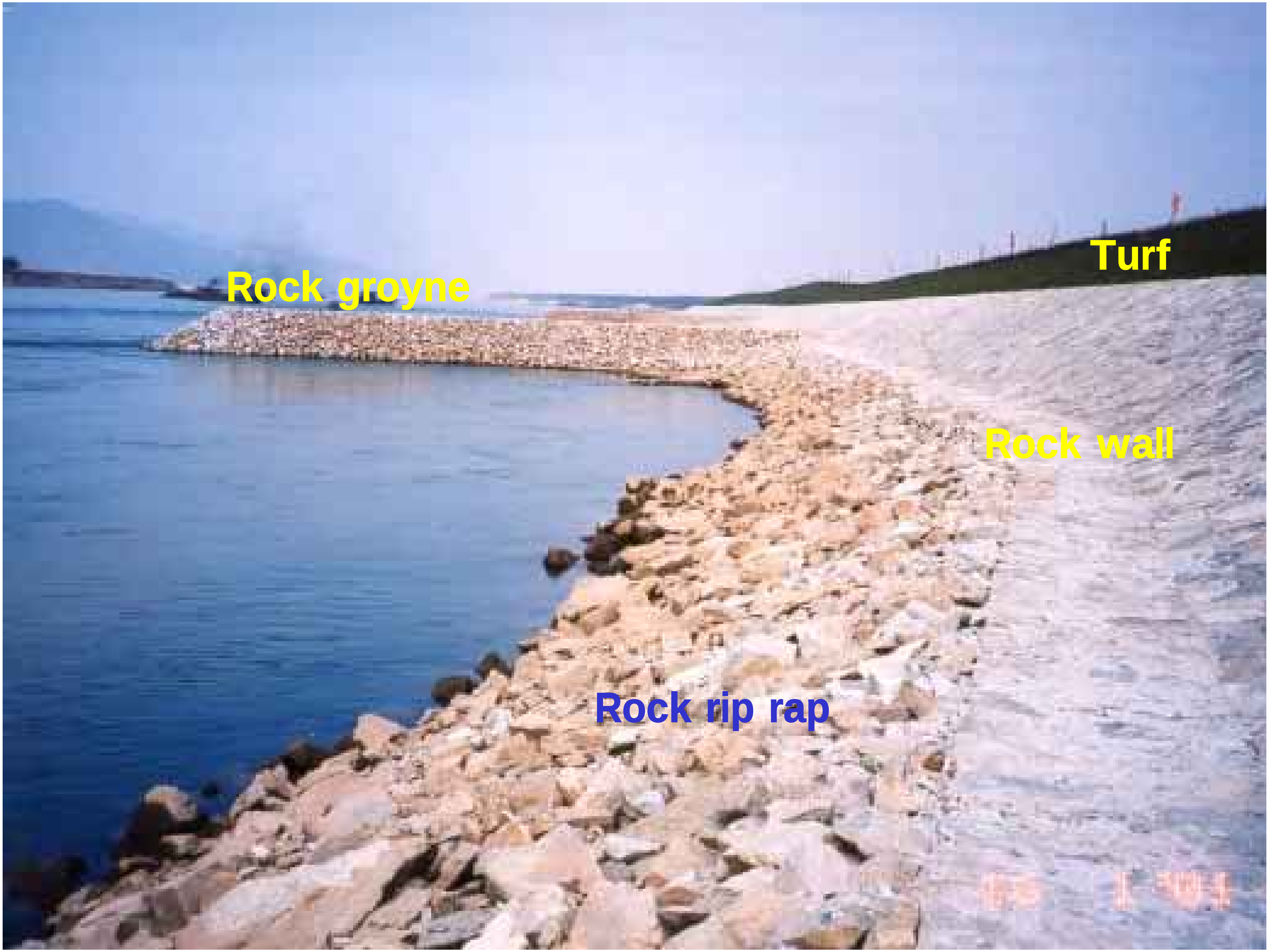
THE VERY COSTLY ALTERNATIVE

- Rock walls, rock baskets or rip rap are traditional methods used for riverbank stabilisation in Asia, particularly in China and Vietnam.
- These methods are high-tech engineering structures, requiring special skill and high maintenance costs
- These methods are much more expensive, may be several thousand times more in the case of the Mekong delta as rock is not available locally and some imported materials are required
- But most importantly they are not effective as they are not stable themselves on the alluvial plains of Asia. The following photos show their ineffectiveness and high costs.

Red River north Vietnam:The bank was first covered by a layer of small rocks then by rock baskets (large size rocks encaged in imported heavy gauge galvanised steel wire)

But this method provided no protection as this bank had been previously covered by similar rock baskets. Remnants of the old rocks which collapsed in the last flood, were still visible in the river.

China: Similarly the Chinese also uses this very costly method to protect the bank of the Pearl river in Guangdong


Rock groyne
Turf
Rock wall
Rock rip rap


GO VETIVER