J-river engineering for Vietnam

Workshop on erosion control in the Mekong Delta
Soc Trang, June 2015

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Onga river, Japan

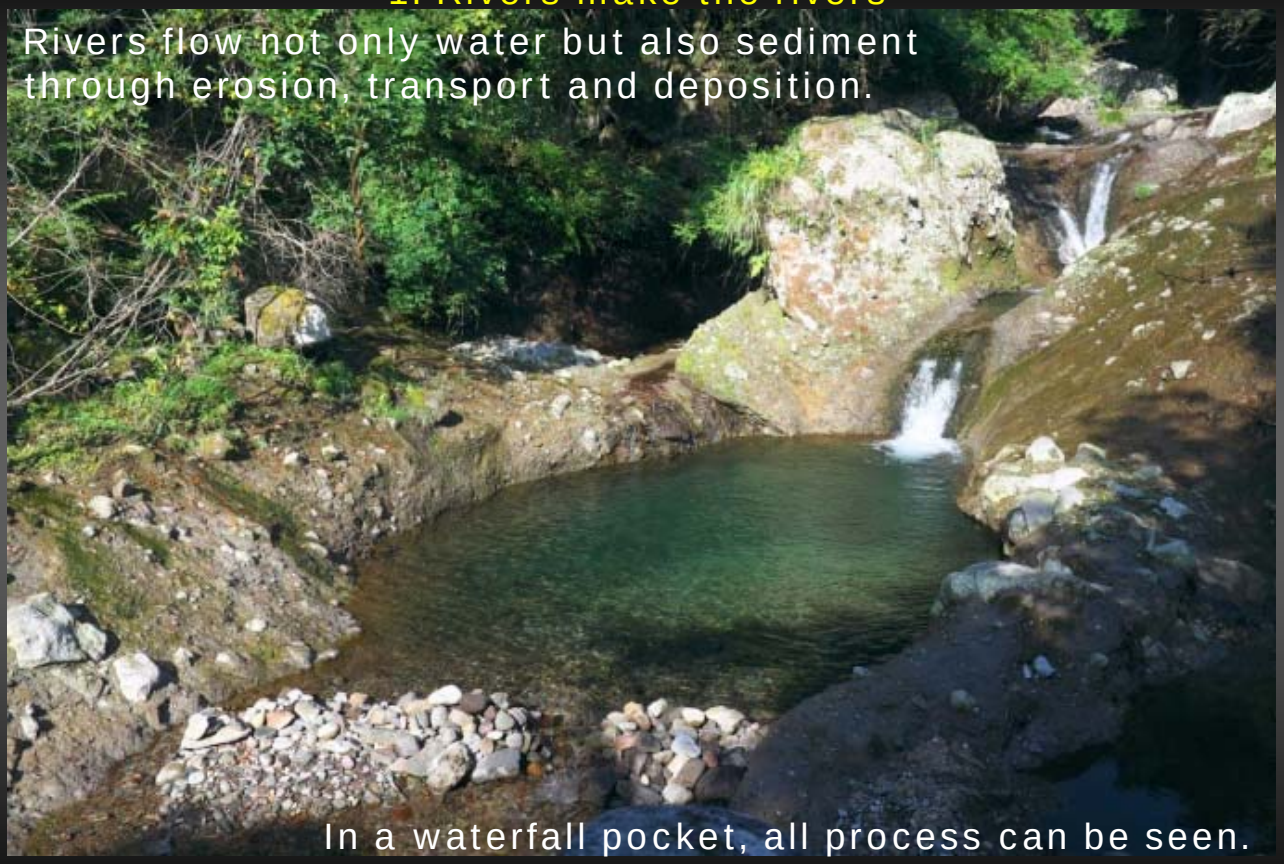
Project for Building Disaster Resilient Society in Vietnam
has an activity for
“small-scale and low-cost riverbank protection works”.

Contents

Niyodo river, Japan

1. Rivers make the rivers

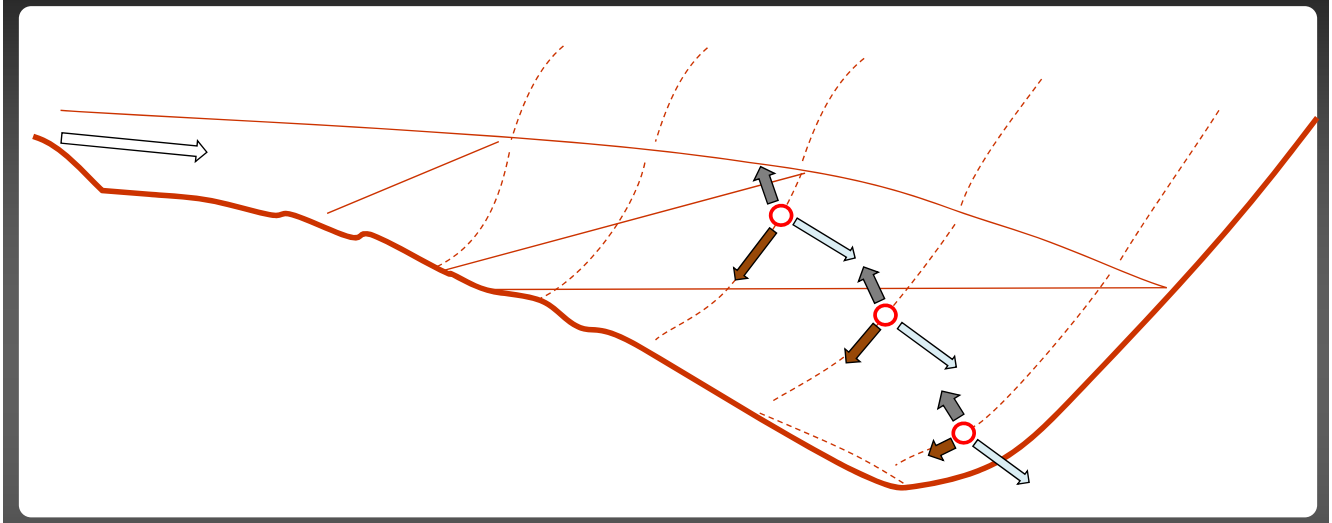
Rivers flow not only water but also sediment through erosion, transport and deposition.



In a waterfall pocket, all process can be seen.

Tsutami river, Japan

Equilibrium on sediment

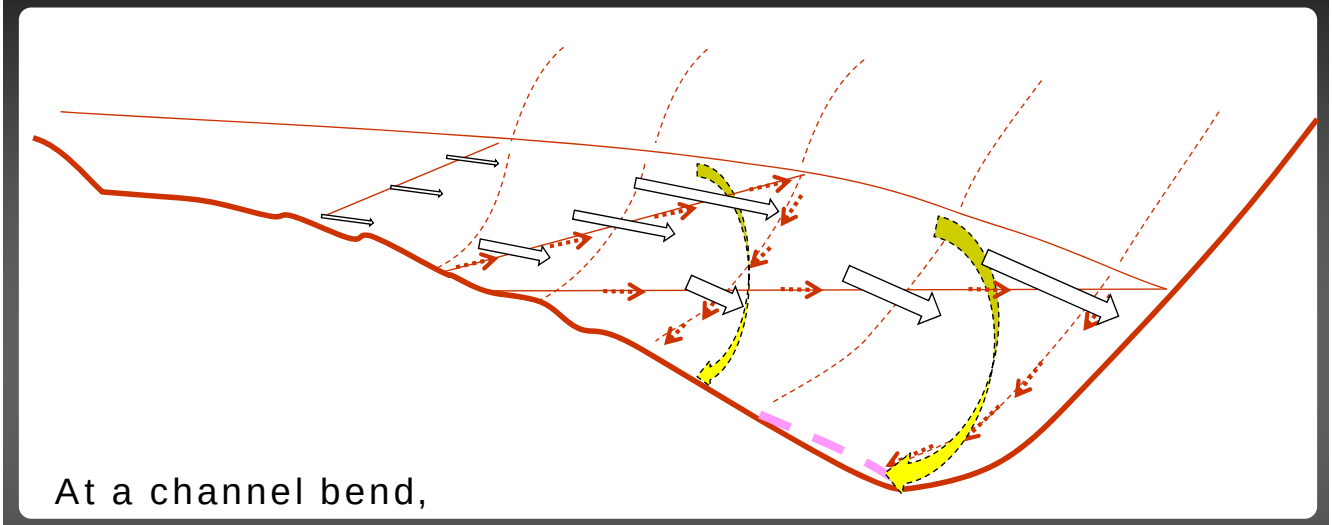


Water flow has tractive force which works on the riverbed.

Sediment resists against it with gravity and friction.

Riverbed morphology shows an equilibrium of the tractive force and the resistive forces.

Spiraling flow

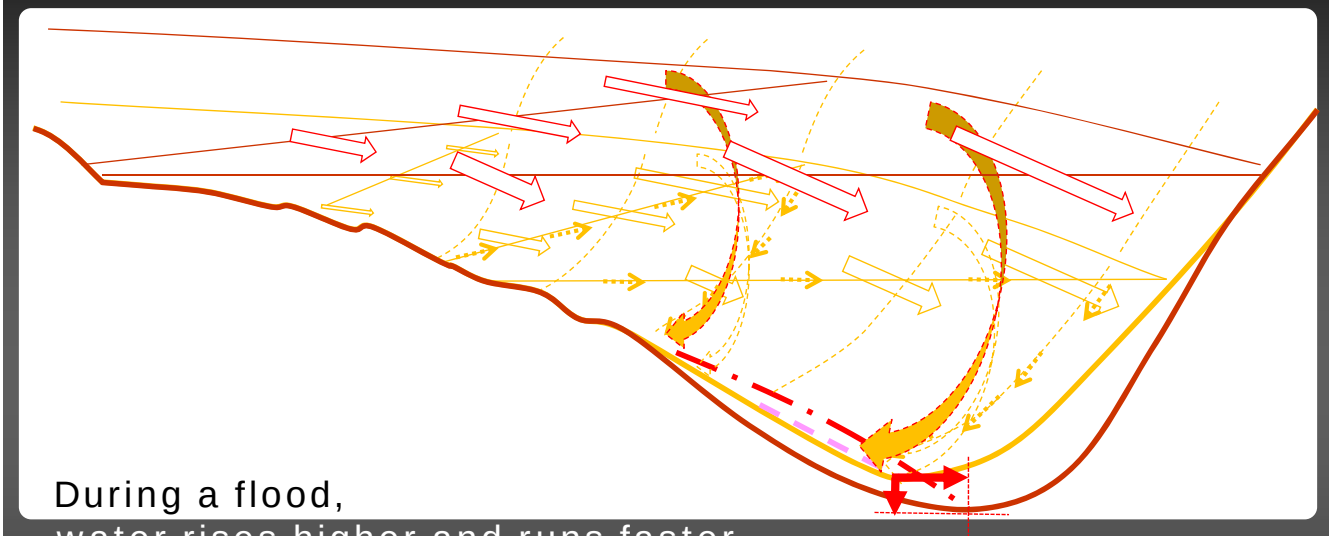


At a channel bend,

fast-moving surface water shift toward the outside due to the centrifugal force, causing counter flow at the bottom.

These secondary flow and longitudinal flow combined to make a spiraling flow, which scours riverbank leaving scour holes and a thalweg in front of the riverbank.

Thalweg shift



During a flood,
water rises higher and runs faster.
The spiraling flow gets larger to make the scour larger.
The thalweg shifts downward and outward.

In the end of the flood,
recession flow deposits sediment into the scour hole.
The thalweg shifts back to upward and inward.

Japanese traditional river engineering is
a trial of using natural process of floods.
This is a basic concept of “rivers make the rivers”.

Monobe river, Japan

Fuji river, Japan

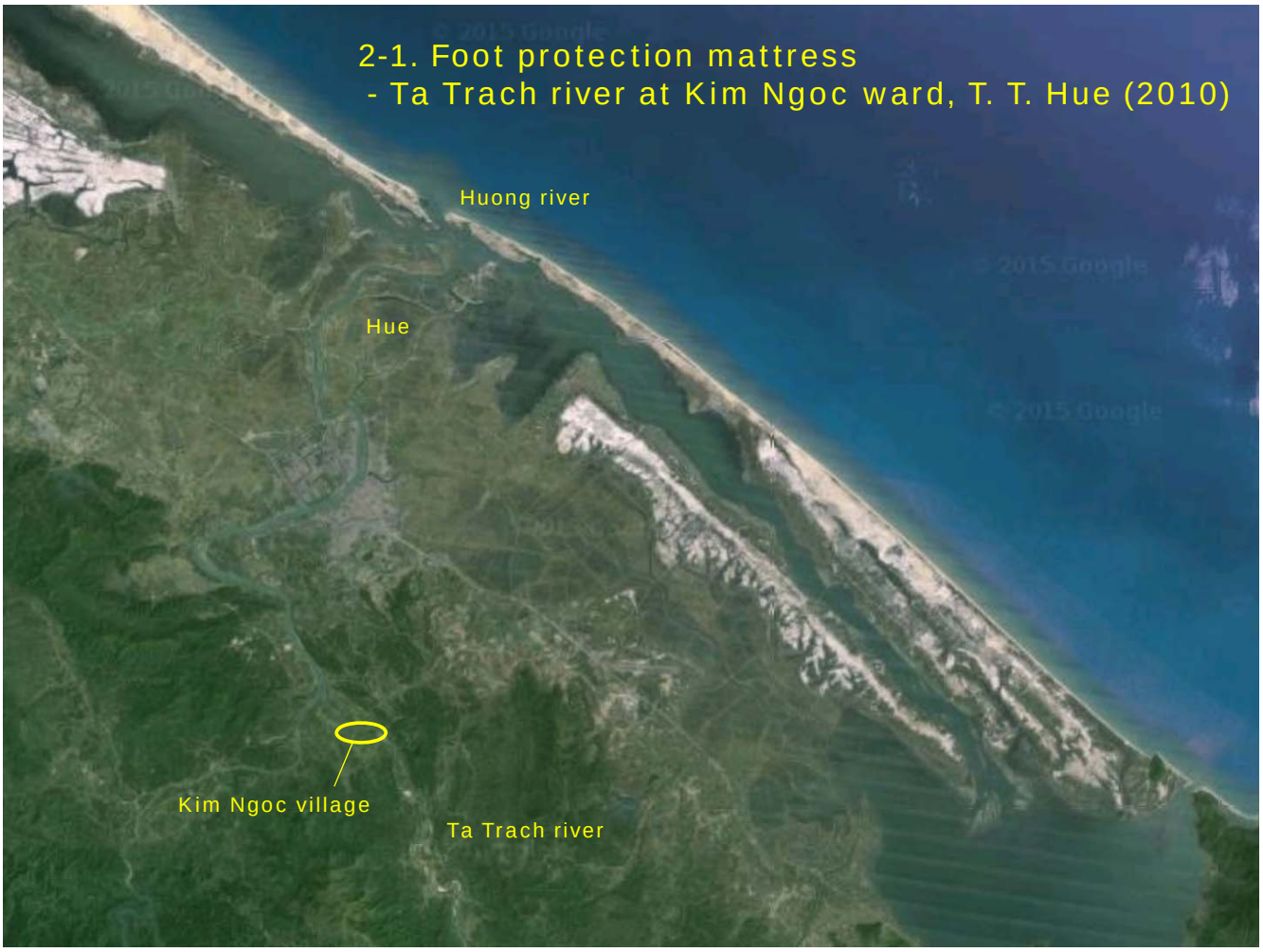
Onga river,Japan

Japanese river engineering standards say that a dyke shall
be protected from river flow by groynes and revetments.
Groynes weaken the flow and revetments cover the dyke.

Kiso river, Japan

Kagami river,Japan

2-1. Foot protection mattress
- Ta Trach river at Kim Ngoc ward, T. T. Hue (2010)



Eroding bank after Flood 2009

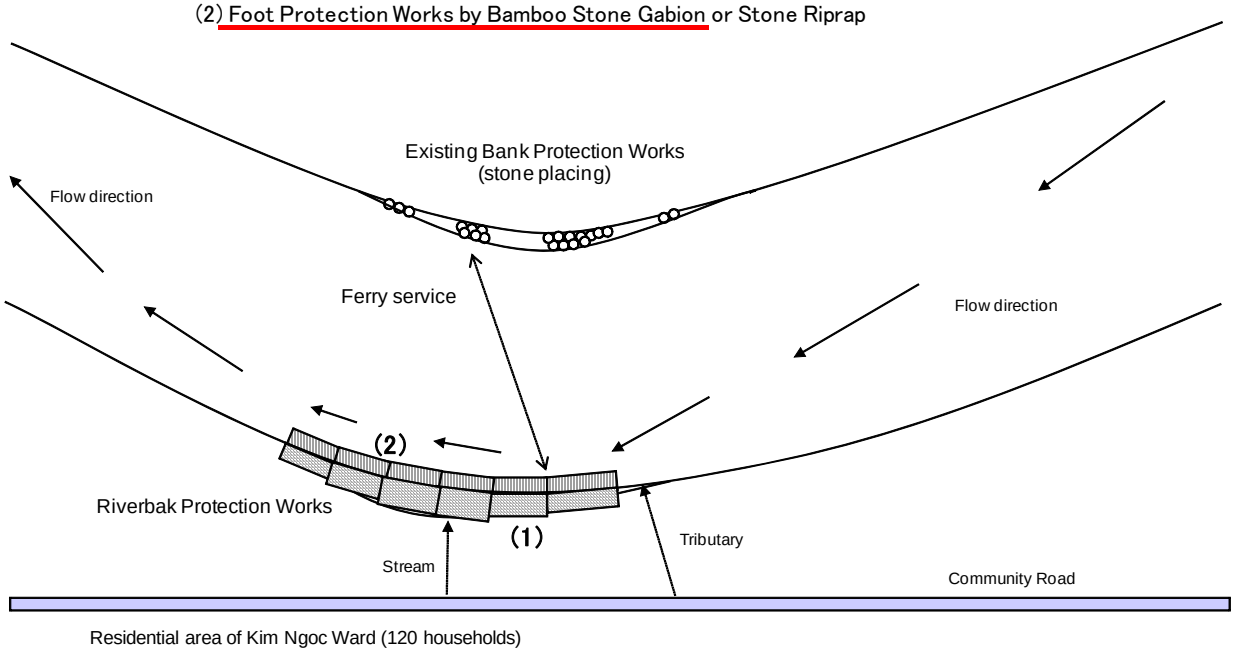
Eroding bank after Flood 2009

To cover the eroding bank, a designed revetment system was installed. The system has slope protection and foundation standardized in Vietnam, and foot protection mattress made of bamboo gabion under the water.

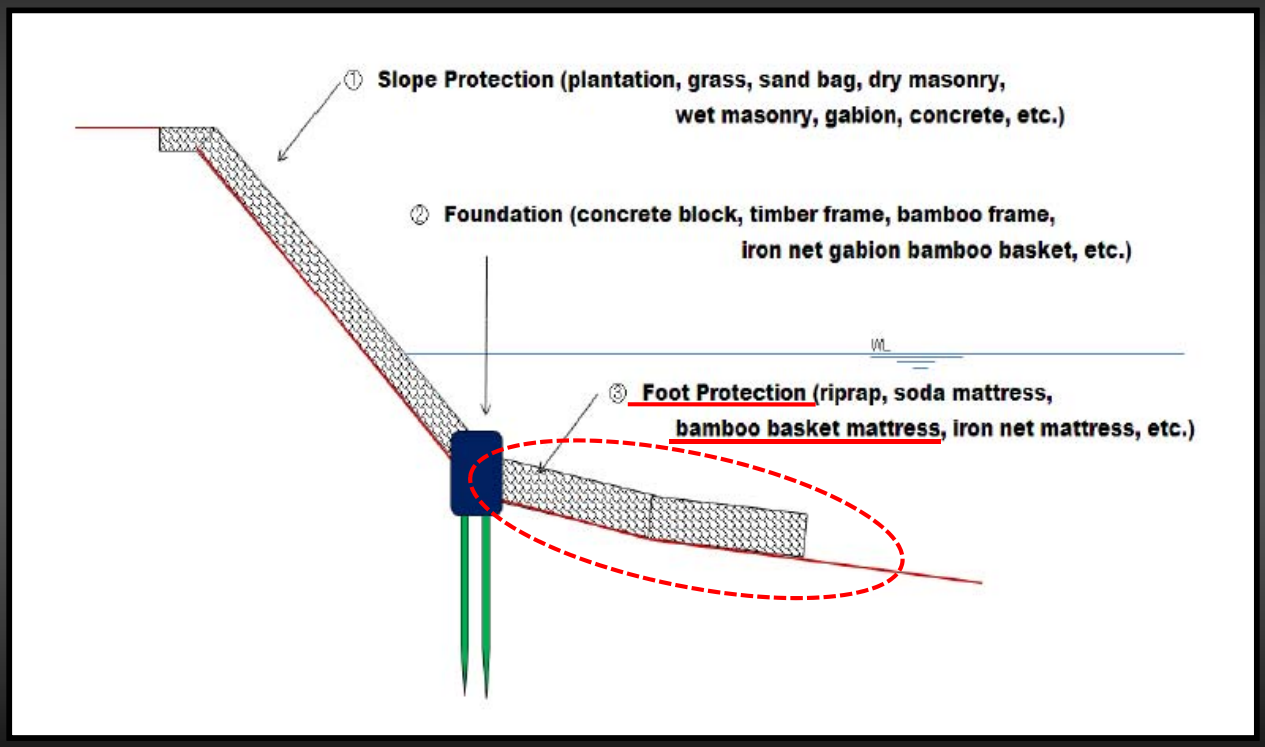
Eroding bank after Flood 2009

(1) Slope Protection Works with Bamboo Stone Box (total length : 250m)

(2) Foot Protection Works by Bamboo Stone Gabion or Stone Riprap



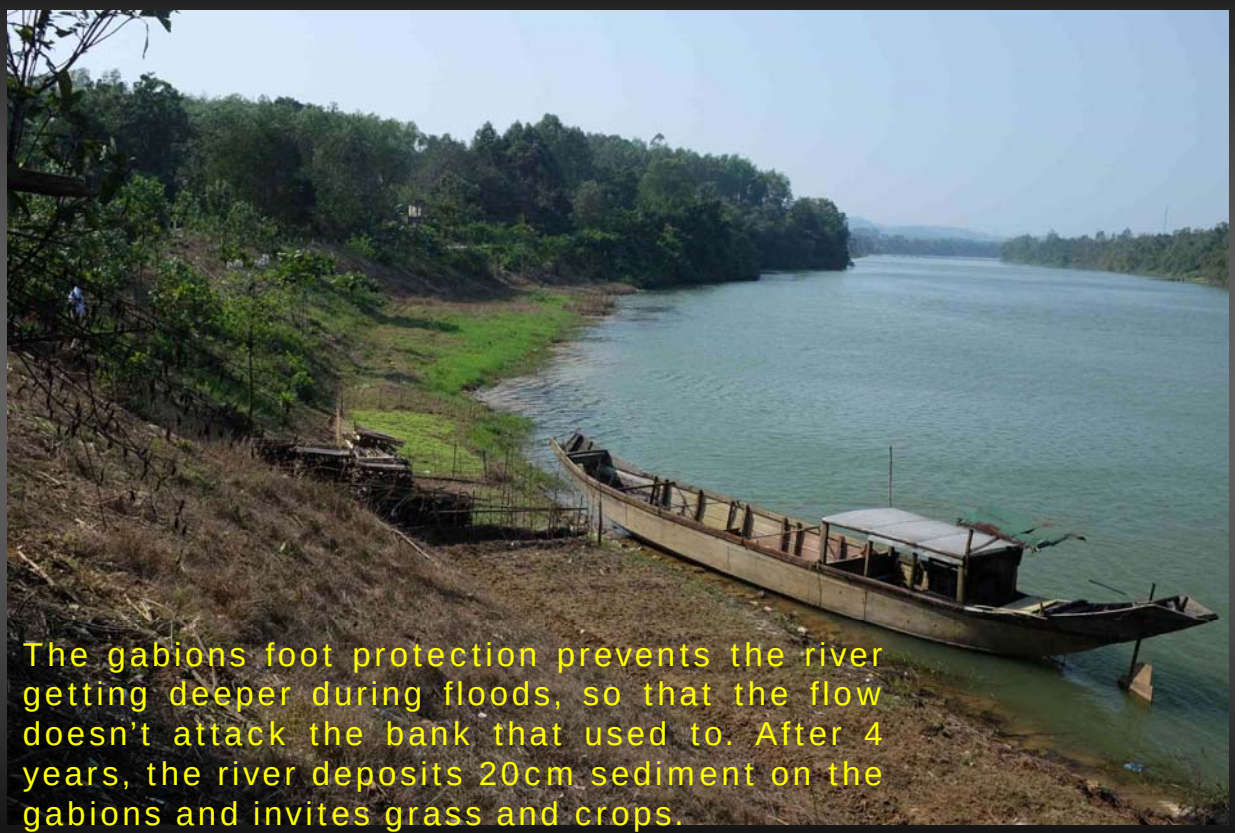
Revetment has a set of structures namely;
(1) slope protection, (2) foundation and (3) foot protection.



Bamboo dragon for foot protection

Bamboo dragon mattress 2 years after construction

Bamboo dragon 4 years after construction



The gabions foot protection prevents the river getting deeper during floods, so that the flow doesn't attack the bank that used to. After 4 years, the river deposits 20cm sediment on the gabions and invites grass and crops.

2-2. Single groyne
- Thu Bon river at Thanh Xuyen ward, Quang Nam (2010)

Eroding bank after Flood 2009

Eroding bank after Flood 2009

To protect an eroding bank, a masonry groyne stands on the crucial point and bamboo basket lay on the riverbank as a guide wall of deflected flow.

Eroding bank after Flood 2009

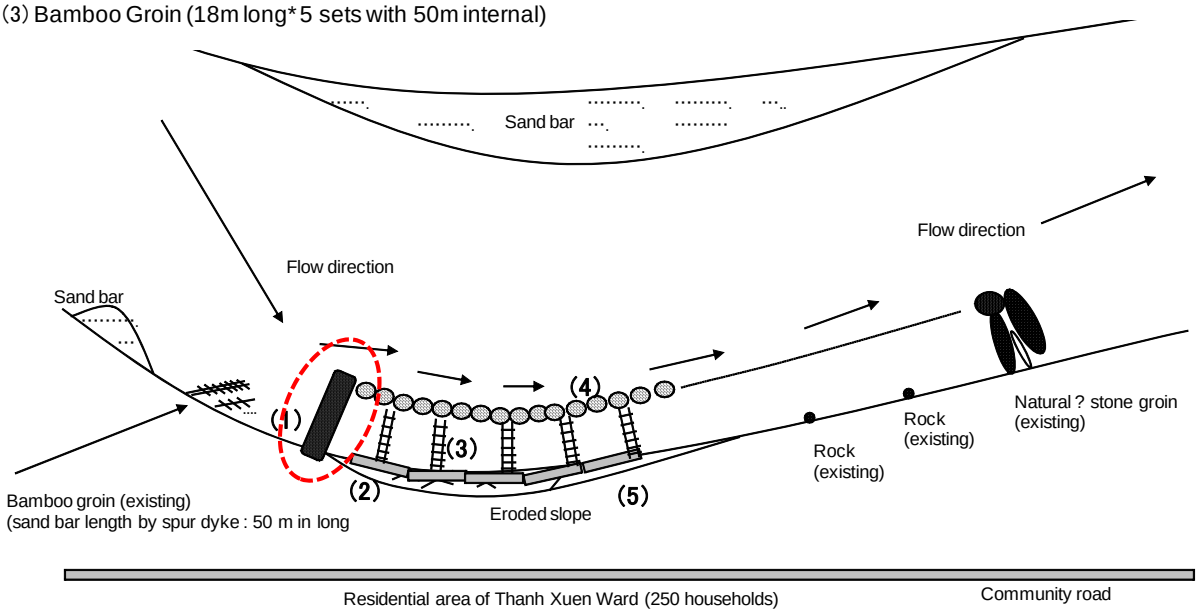
(1) Stone Groin (total length : 20m)

(2) Bamboo Stone Box(1m wide*1m long* 1m deep)

(3) Bamboo Groin (18m long* 5 sets with 50m internal)

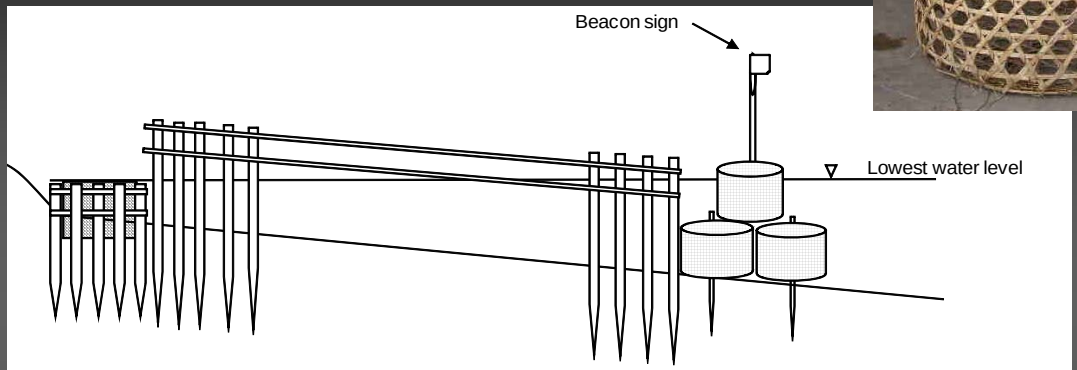
(4) Bamboo Stone Gabion (1.5 m diameter * 1m high)

(5) Slope Protection (leveling and sodding, site works mainly by community people)

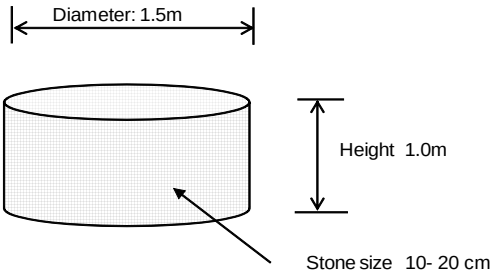


Masonry groyne completed

Bamboo fence/basket as foot protection



Bamboo Stone Gabion



Prefablication of bamboo gabion net :
It is simple net. Can be purchased at market.
However, this gabion net can be prefablicated by community people.
(strongly desired in view of livelihood improvement)

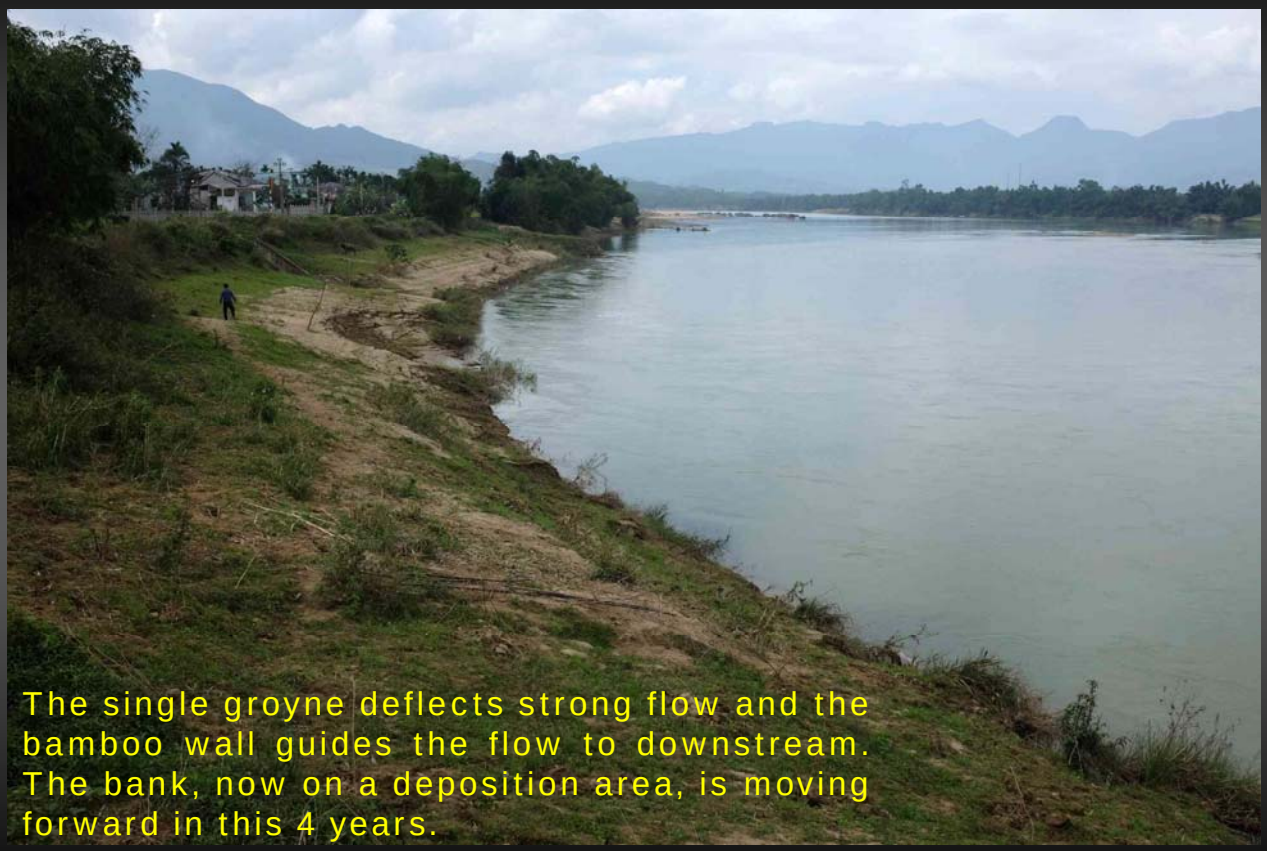
Points to be reconsidered

Bamboo gabion in the first layer in the above Figure :

Gabion net : can be replaced by wire net
Stone to be filled in the net: can be replaced by gravel (not only sand) Material of bag ? ? ?

Masonry groyne 4 years after construction

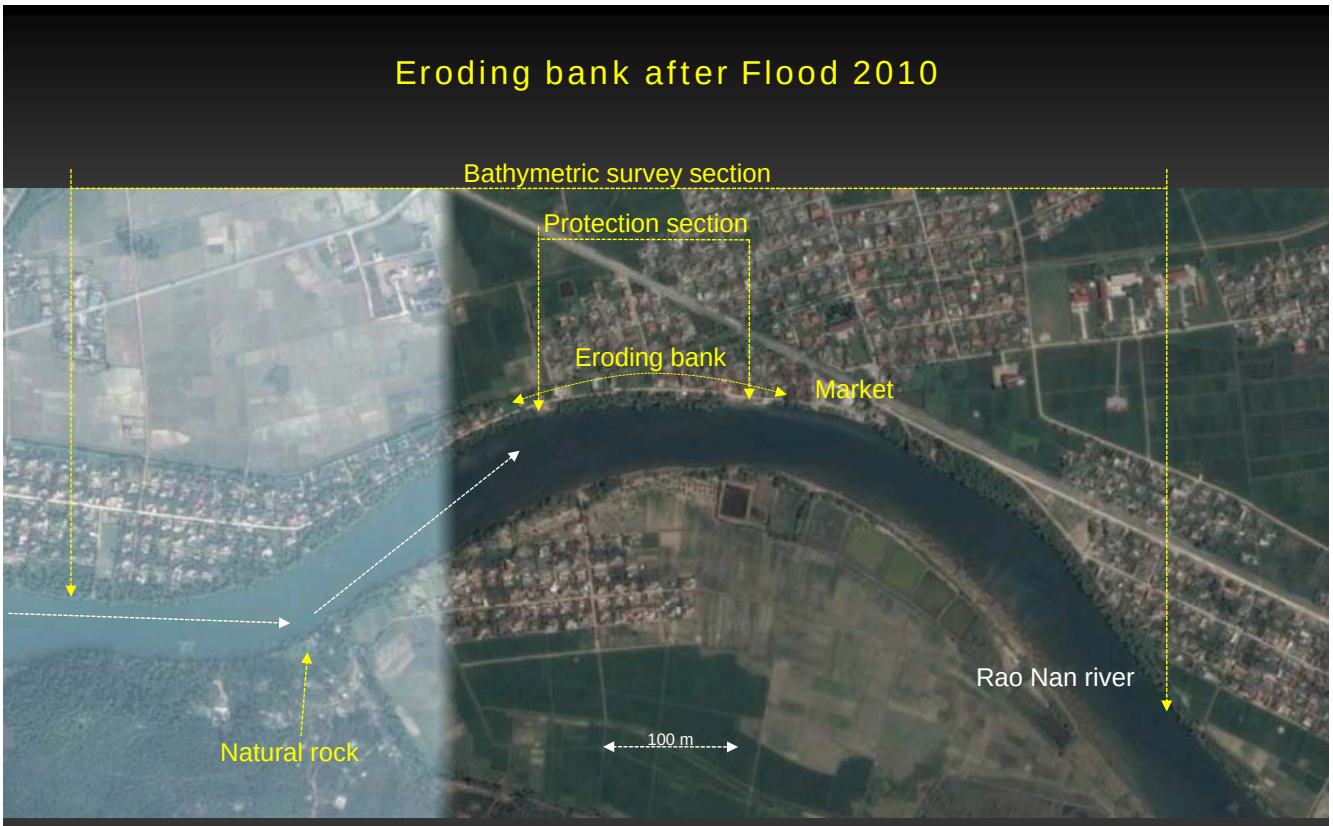
Sand deposition after 4 years



The single groyne deflects strong flow and the bamboo wall guides the flow to downstream. The bank, now on a deposition area, is moving forward in this 4 years.

2-3. Foot protection groynes
- Ran Nan river at Quang Son commune, Quang Binh (2014)

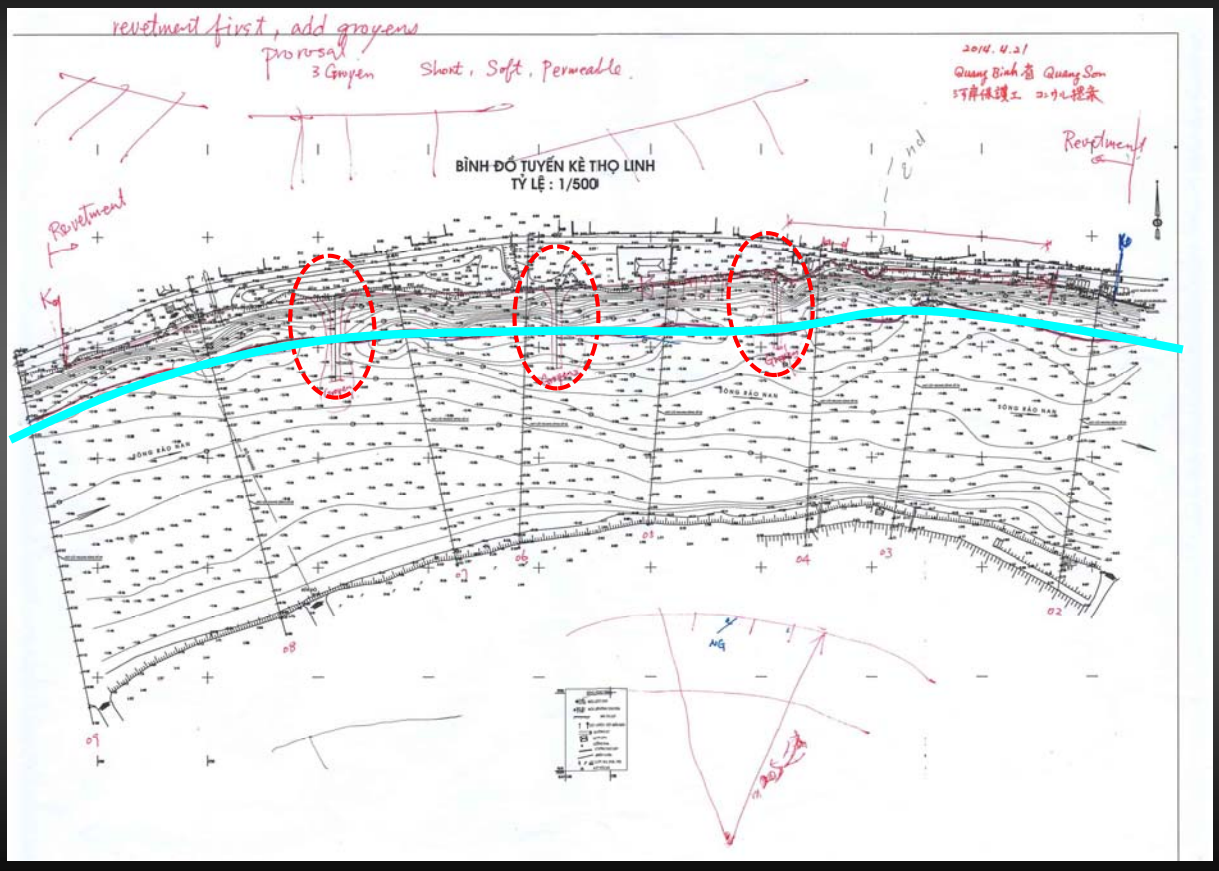
Eroding bank after Flood 2010



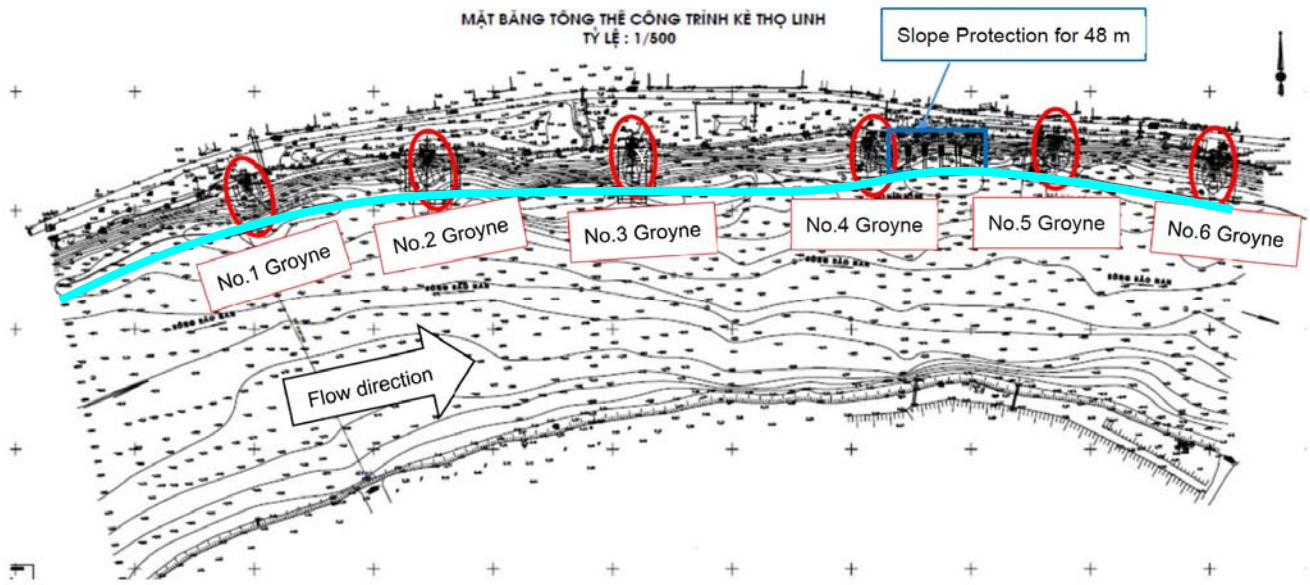
Eroding bank after Flood 2010

Flood flowed on both banks of a meandering channel leaving some scour holes near a market.
This village sits on a low-lying area and river water flowed over roads and paddy field in the flood 2010.

Proposed designed by a consultant



Revised design for non-negative impact and cost-cutting



Bathymetric survey was conducted before designing to select a grave section for cost-cutting. 6 small groynes were laid out on the eroding bank.

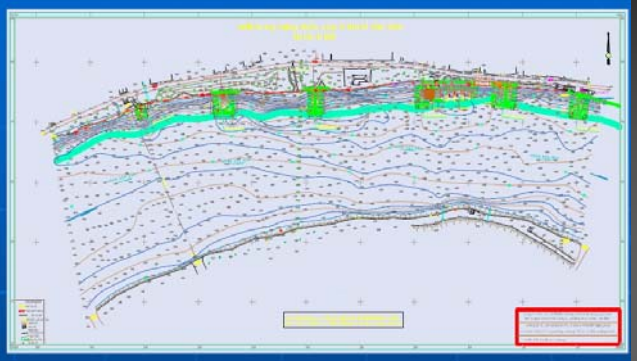
Design of groyne

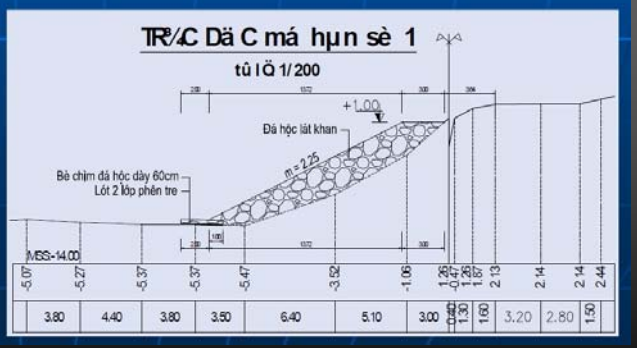
1. Structure

- Solid, dense, permeable and stabilized on rough riverbed;
- Paved riprap;

2. Arrangement

- Total is 6 groins
- Groin is right angle to thal-weg line;
- Groin 1: located at site which is directly affected by the flow (a little bit downward);
- Groin 1: low height (same height to riverbank elevation or opposite bank), short, foundation of groin head is protected by riprap;
- Groin 2: located at site which is not affected by eddy flow from groin 1;
- Purpose of groin 2 is to reduce the velocity of flow, so groin 2 is a little bit longer and shorter than groin 1;



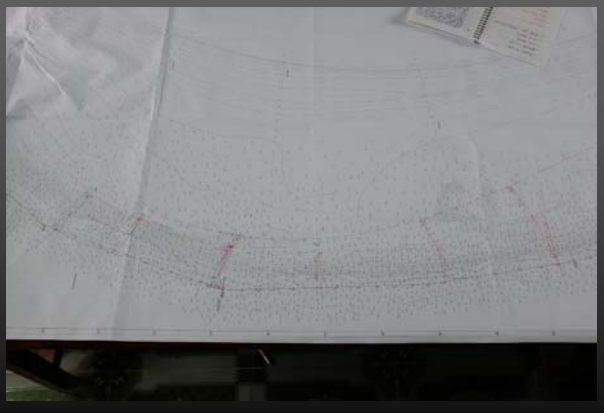


Necessary slope protection

Groynes completed in 2014

2-4. Thalweg control
- La river at Duc La commune, Ha Tinh (2015)

Site designing on 2 February 2015



Groynes for thalweg control

- Groynes let the river scour riverbed around its head part.
- Flood flow connects the scour holes to develop a thalweg.
- The thalweg attracts strong spiral flow to go downstream.
- The river stops riverbank erosion and starts sand deposition.

Design process

Step 1: Field/boat survey to find out visible and touchable damages

Step 2: Bathymetric survey to draw a contour map

Step 3: Buried thalweg under the normal water level

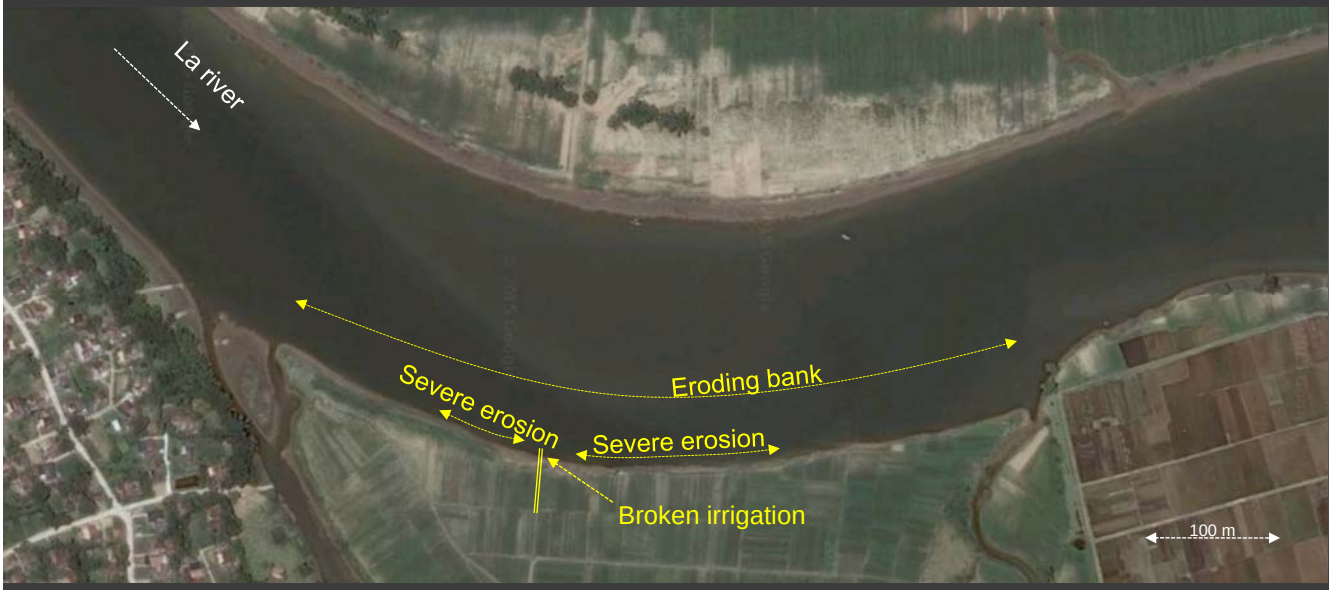
Step 4: Active thalweg which might cause the damages

Step 5: Design thalweg witch doesn't come close to the riverbank

Step 6: Groyne layout staring from the crucial point

Step 7: Groyne design to guide the thalweg to downstream

Step 1: Field/boat survey to find out visible and touchable damages



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Step 7: Groyne design to guide the thlweg to downstream

- All groynes should touch at right angle to the design thalweg.
- Their crowns should not higher than the riverbank and the opposite-deposition.
- The 1st and 2nd groynes should have a steep-angle (m=1.50) head on rock mattress.
- The 5th and 6th groynes should be a low structure declining in less than m=5.00.

Construction work on 15/22 April 2015

3. Recommendations for Mekong Delta

In delta areas,
small size sediment is sensitive for tractive force and
a thalweg is easily changeable on the wide channel.

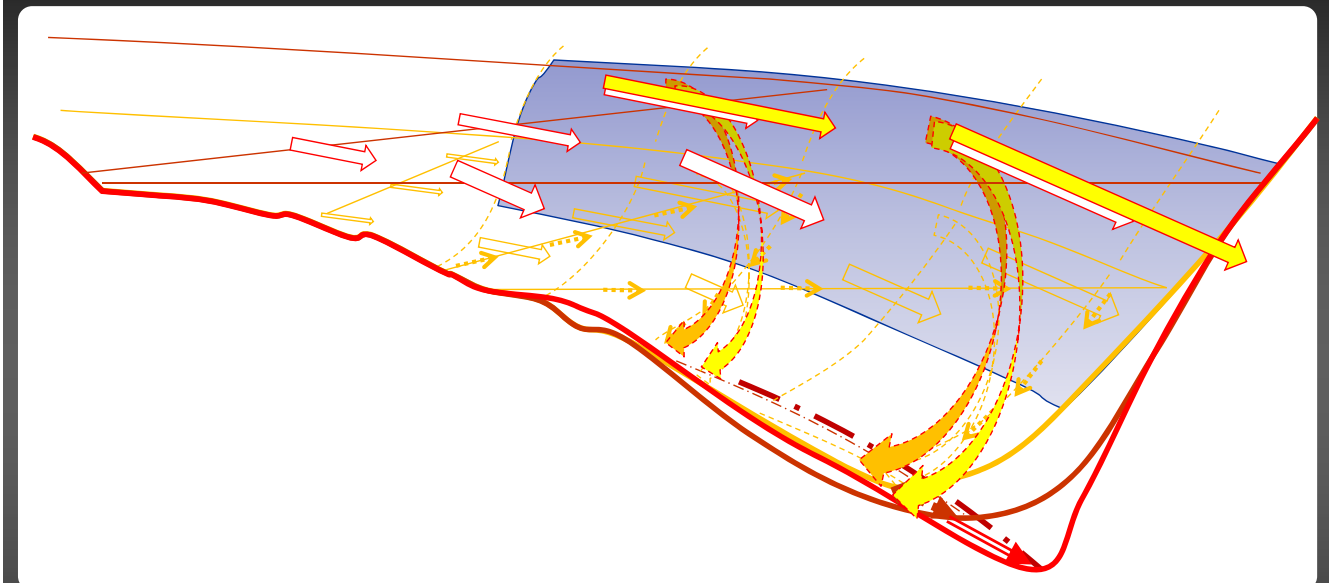
Those conditions are severe for riverbank management but challengeable to use the concept of "rivers make the rivers".

Be aware that
- riverbed and riverbank show us a power balance in flood, so that stronger flow promotes erosion and milder flow puts sediment.

- flood-end period is a chance to get sediment.

- Erosion control is thalweg management on riverbed, rather than revetment on riverbank.

Rough-less disease (Be careful!)



Revetments cover a dyke and decreases roughness.
Smaller roughness make flow velocity faster and the spiral flow comes closer to the riverbank. Enlarged tractive force scours deeper to destroy the revetments.

Soda mattress (Recommendable!)

Soda mattress is used in slow-flowing rivers as riverbank protection or riverbed stabilization works. It has flexibility and resiliency enough to prevent excessive local scour.
Its fascine materials best fit fine silt in delta areas.

For erosion control in Mekong Delta,
there are 7 recommendations to be reconsider.

- Check geology, topography and river morphology.
- Understand eroding-depositing process.
- Use scientific theory and experimental know-hows.
- Learn from the river and design at the site.
- Order local material for cost-cutting and reparability.
- Never make faster flow near riverbanks.
- Gain sediment on the riverbanks from floods.



Finally I would like to continue this discussion at the site.
Thank you very much.