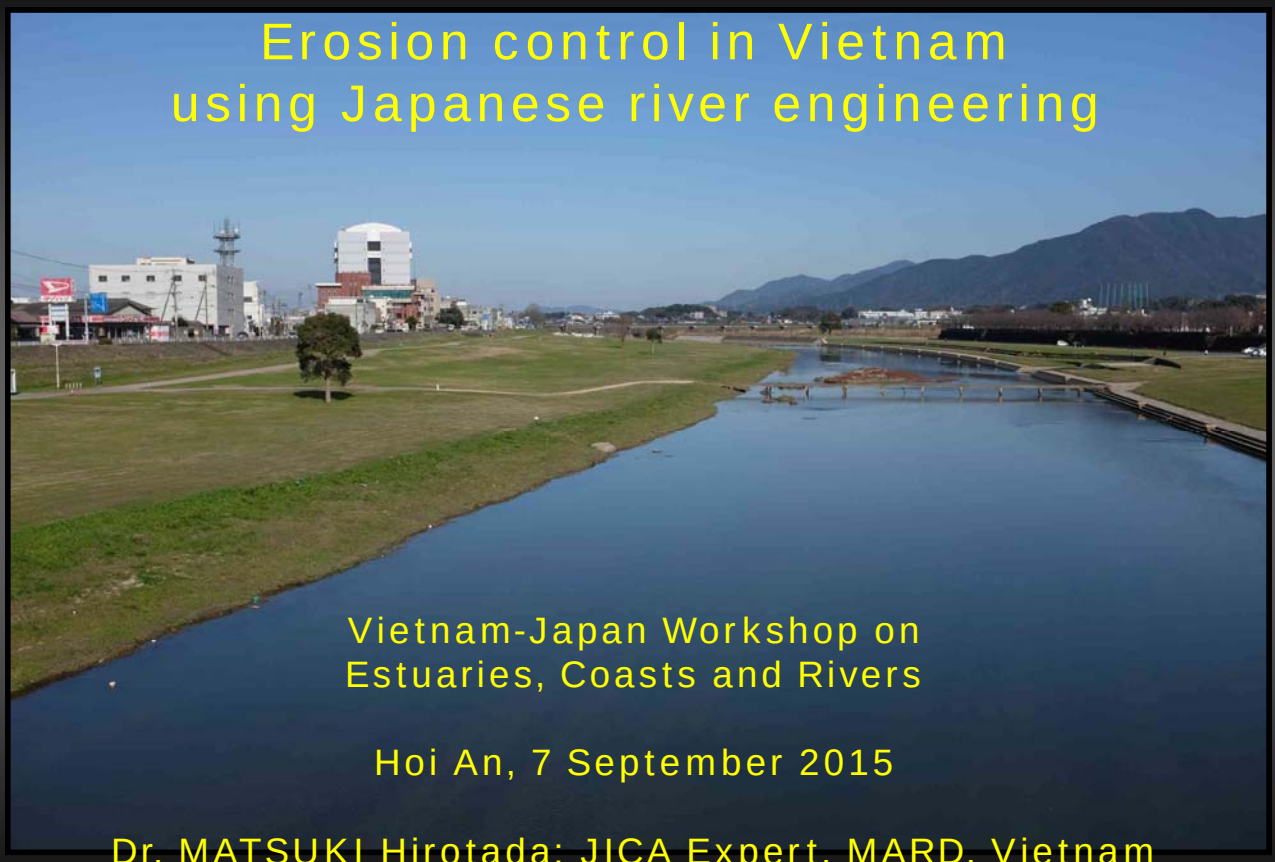
Erosion control in Vietnam using Japanese river engineering



Vietnam-Japan Workshop on
Estuaries, Coasts and Rivers

Hoi An, 7 September 2015

Dr. MATSUKI Hirotada: JICA Expert, MARD, Vietnam

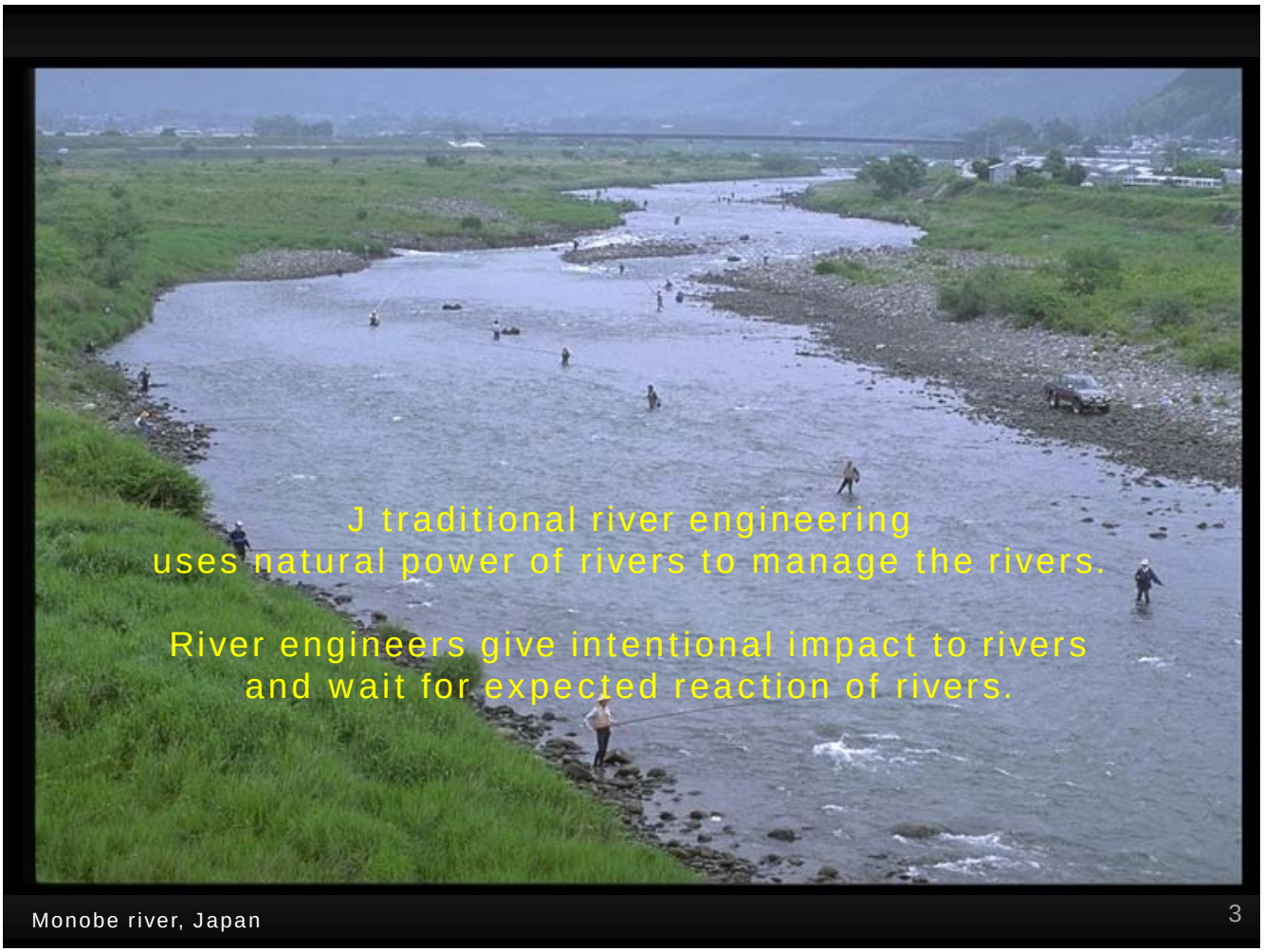
Onga river, Japan

Project for Building Disaster Resilient Society in Vietnam has activities for
"small-scale and low-cost riverbank protection works".

In 2010, JICA and Hue DARD conducted a riverbank protection work at Kim Ngoc Village, Hue Province.

The main structure is bamboo foot protection and it is designed using Japanese traditional river engineering.

Niyodo river, Japan



Monobe river, Japan

Fuji river, Japan

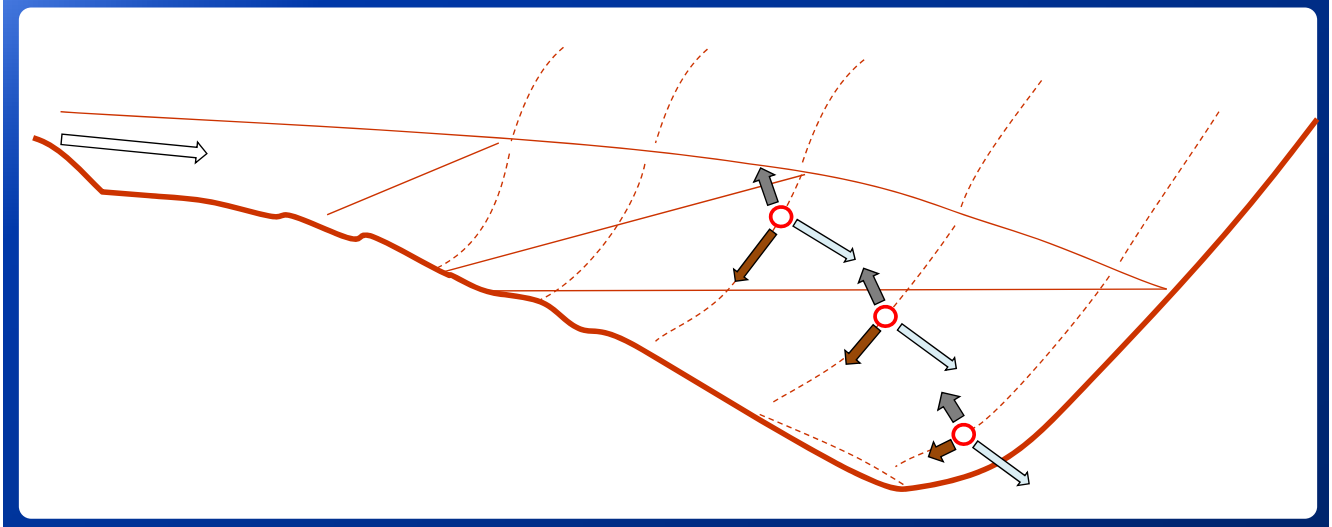
Onga river,Japan

Key concept is “River Makes River”.

Kiso river, Japan

Kagami river,Japan

Equilibrium in flow

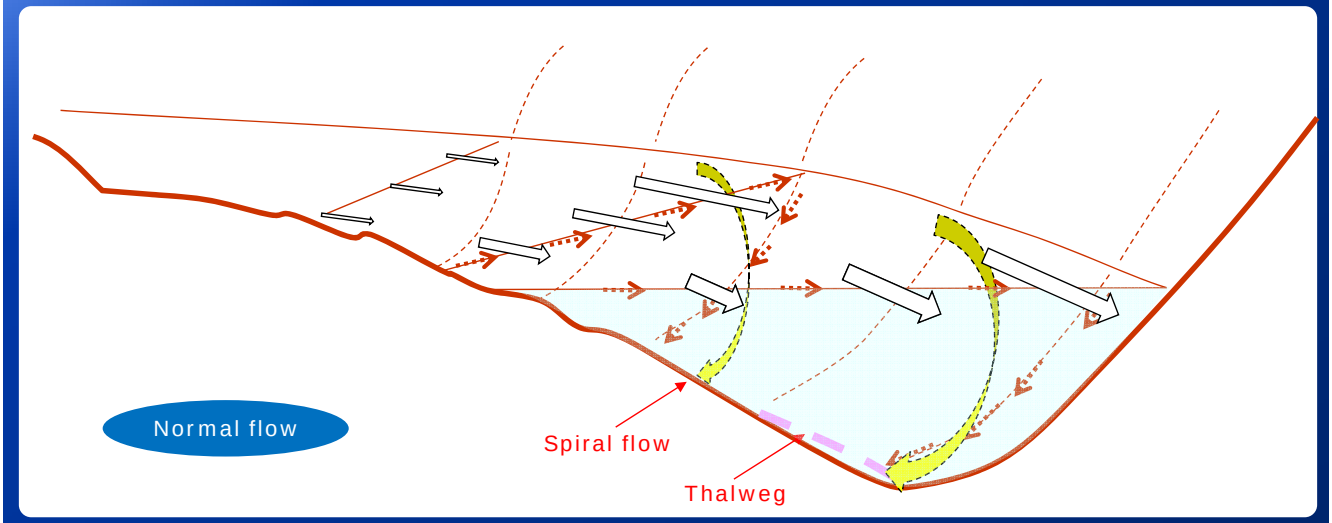


Water flow has tractive force which works on the riverbed.

Sediment resists against it with gravity and friction.

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

Spiraling flow



When a river bends, due to centrifugal force,
surface fast-moving water shift outside
causing counter flow at bottom.

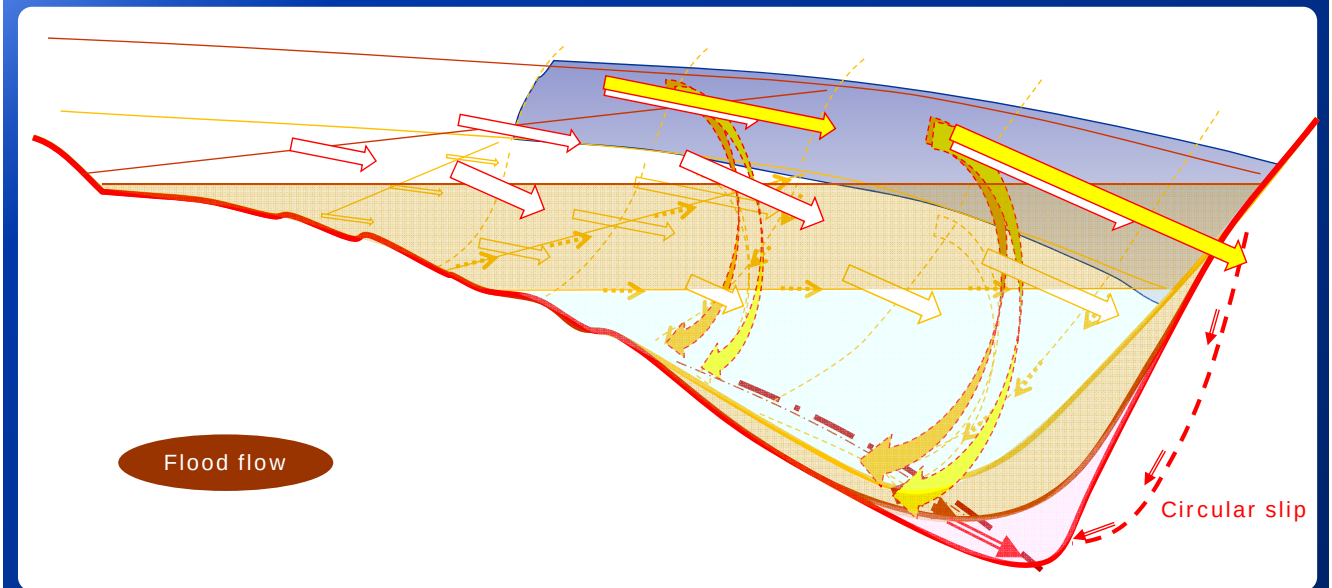
So a river make spiral flow at a concave bank,
which scours riverbank and riverbed leaving a thalweg.

Thalweg shift

During a flood, water rises higher and runs faster.
Spiraling flow becomes larger and scours more.
So the thalweg shifts downward and outward.

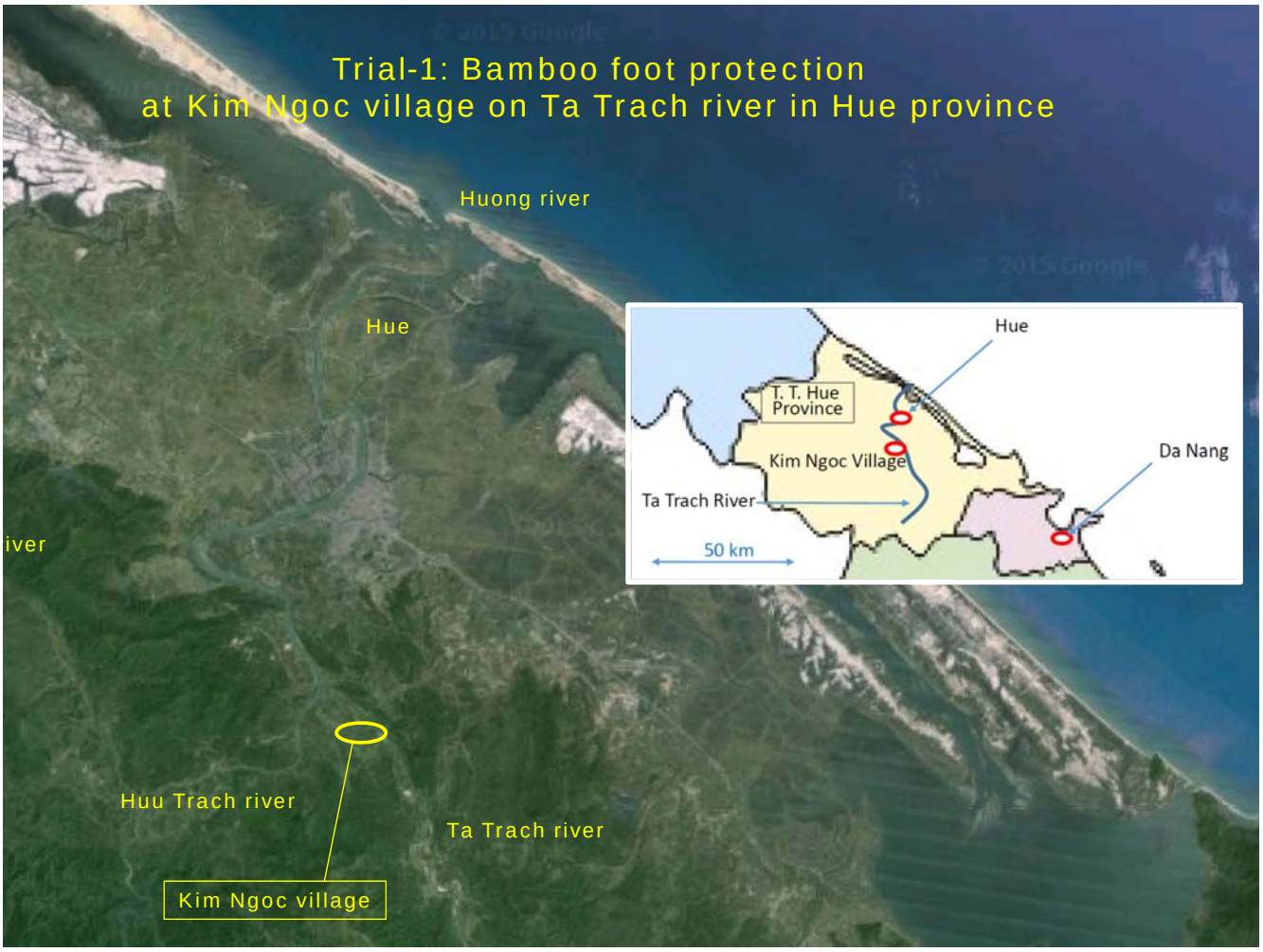
After a peak, the flow looses power and deposits sediment.
So the thalweg shifts back to upward and inward.

Thalweg invasion



If slope protection covers revetment,
smaller roughness makes flow faster/
Stronger spiral flow comes closer to the riverbank.
A circular slip damages the protection and the riverbank.

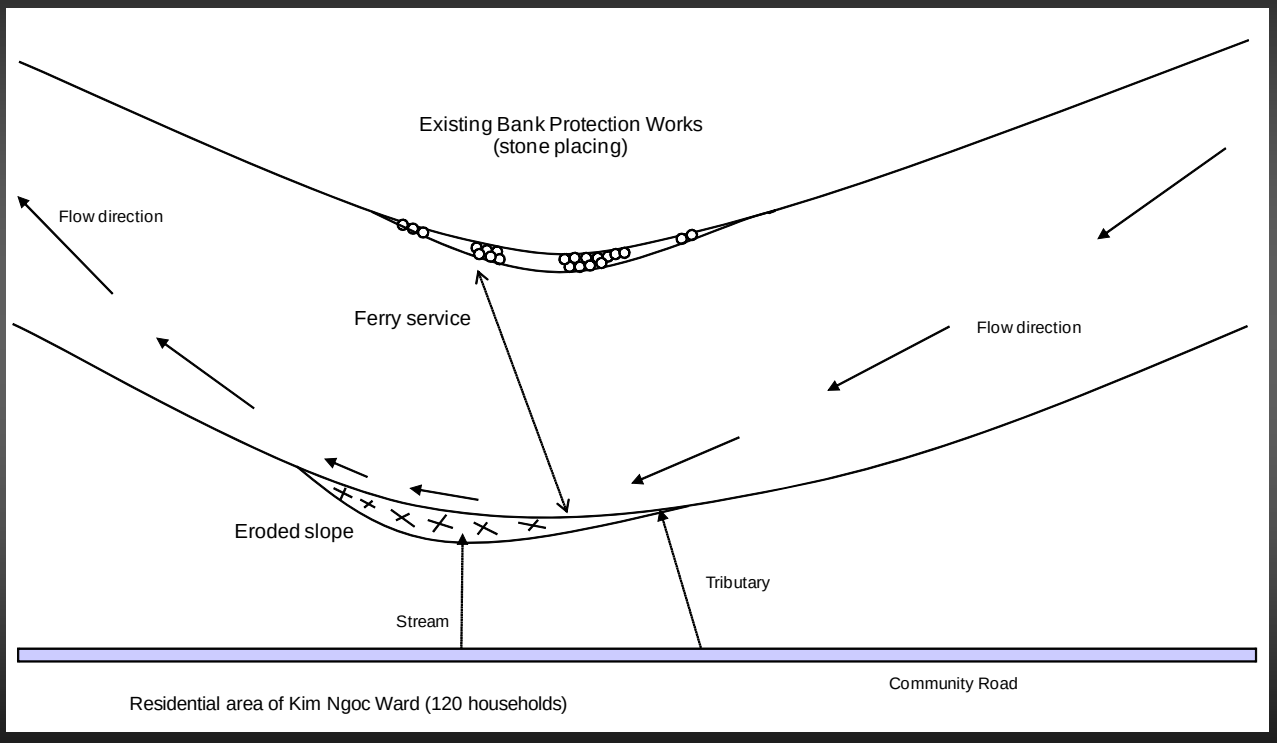
Trial-1: Bamboo foot protection at Kim Ngoc village on Ta Trach river in Hue province



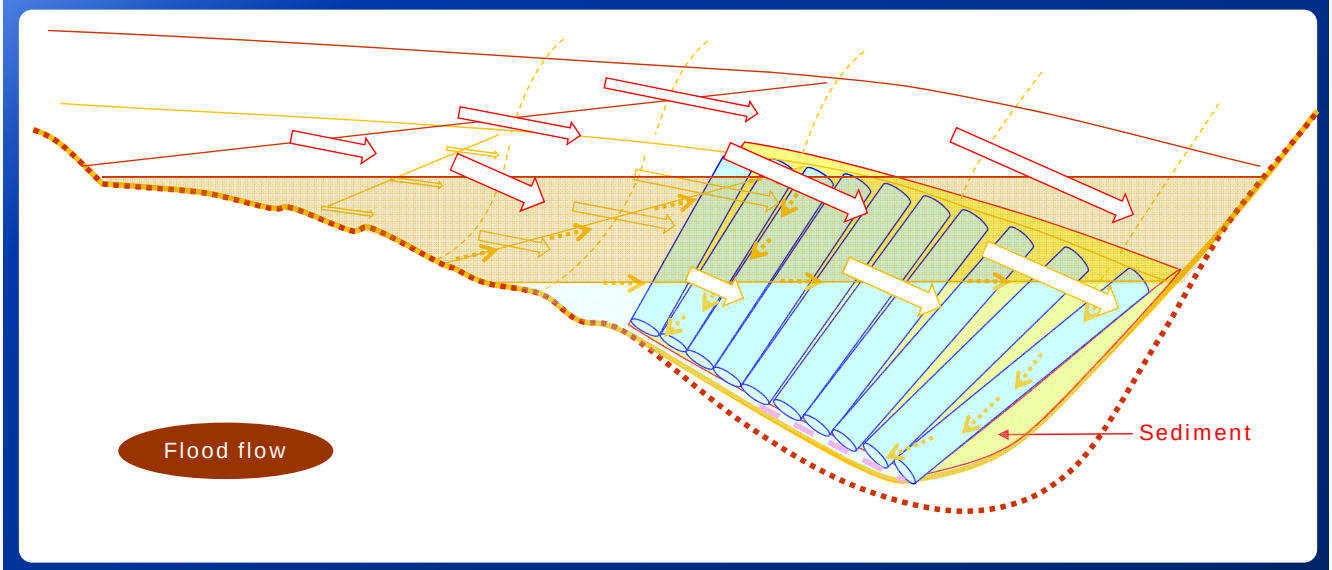
Eroded riverbank at Kim Ngoc village

Eroded riverbank after Flood 2009

Sketch of eroded bank (Kim Ngoc, 2009)



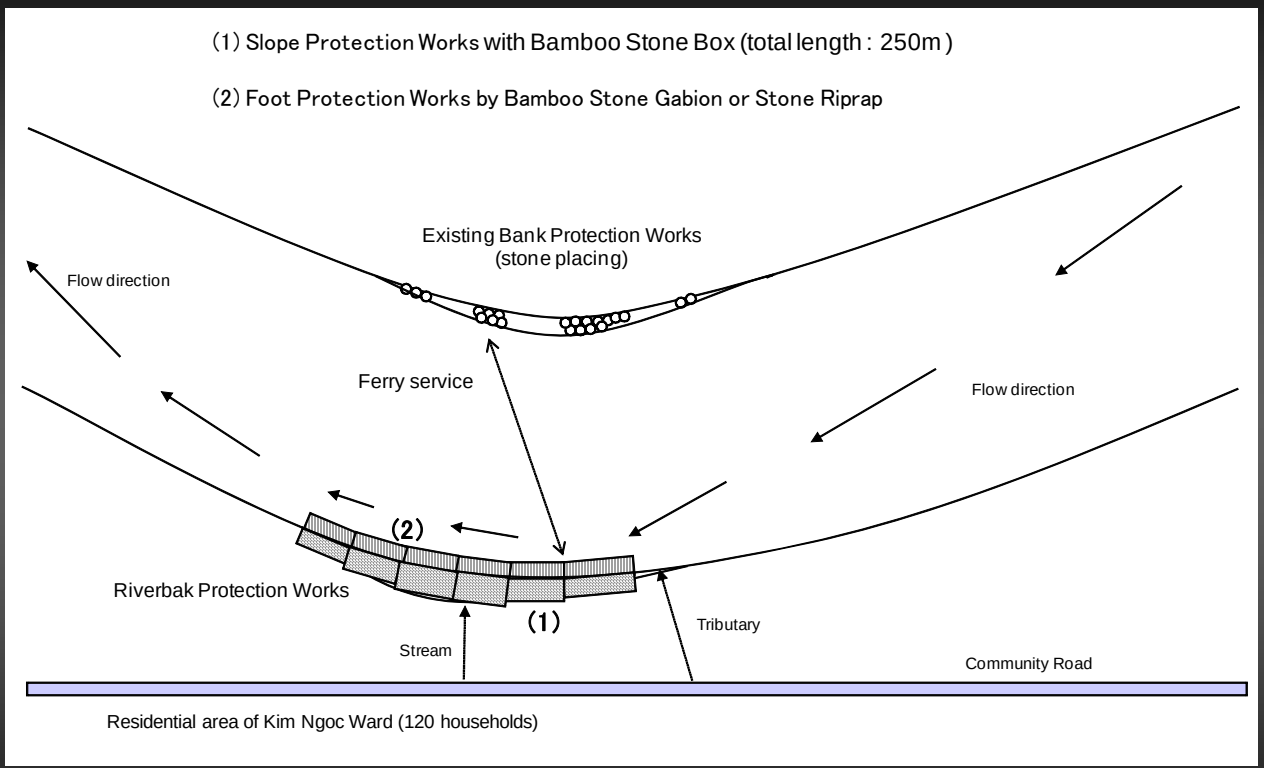
Impact to the river (Kim Ngoc)



+ Aim: to protect riverbed → Foot protection

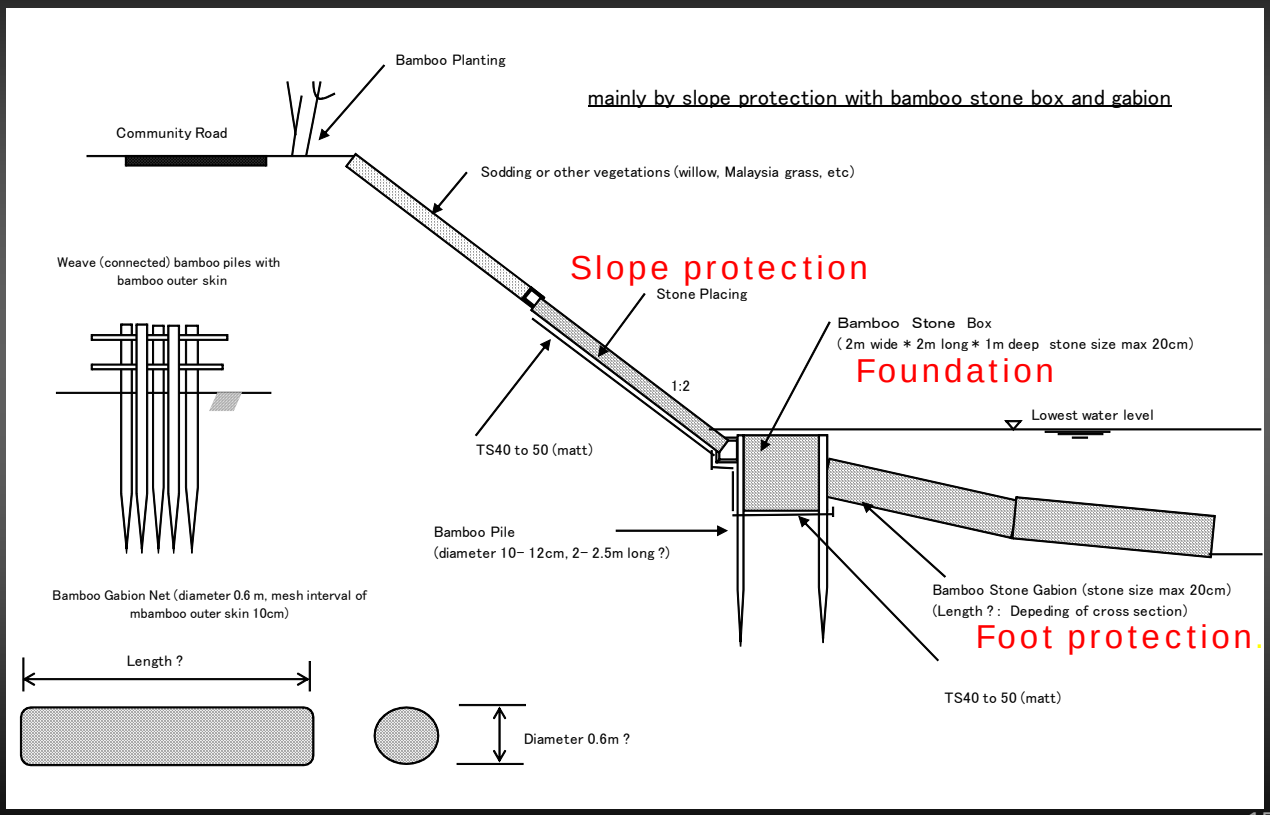
+ Material: strength
availability
volume
cost
→ Bamboo, Stone

Layout of erosion control facilities (Kim Ngoc, 2010)



To cover the eroded riverbank, a revetment was installed.
The system has slope protection, foundation and
foot protection made of bamboo gabion under the water.

Structure of revetment (Ngoc Khanh, 2010)



Bamboo dragon constructed by local people (2010)

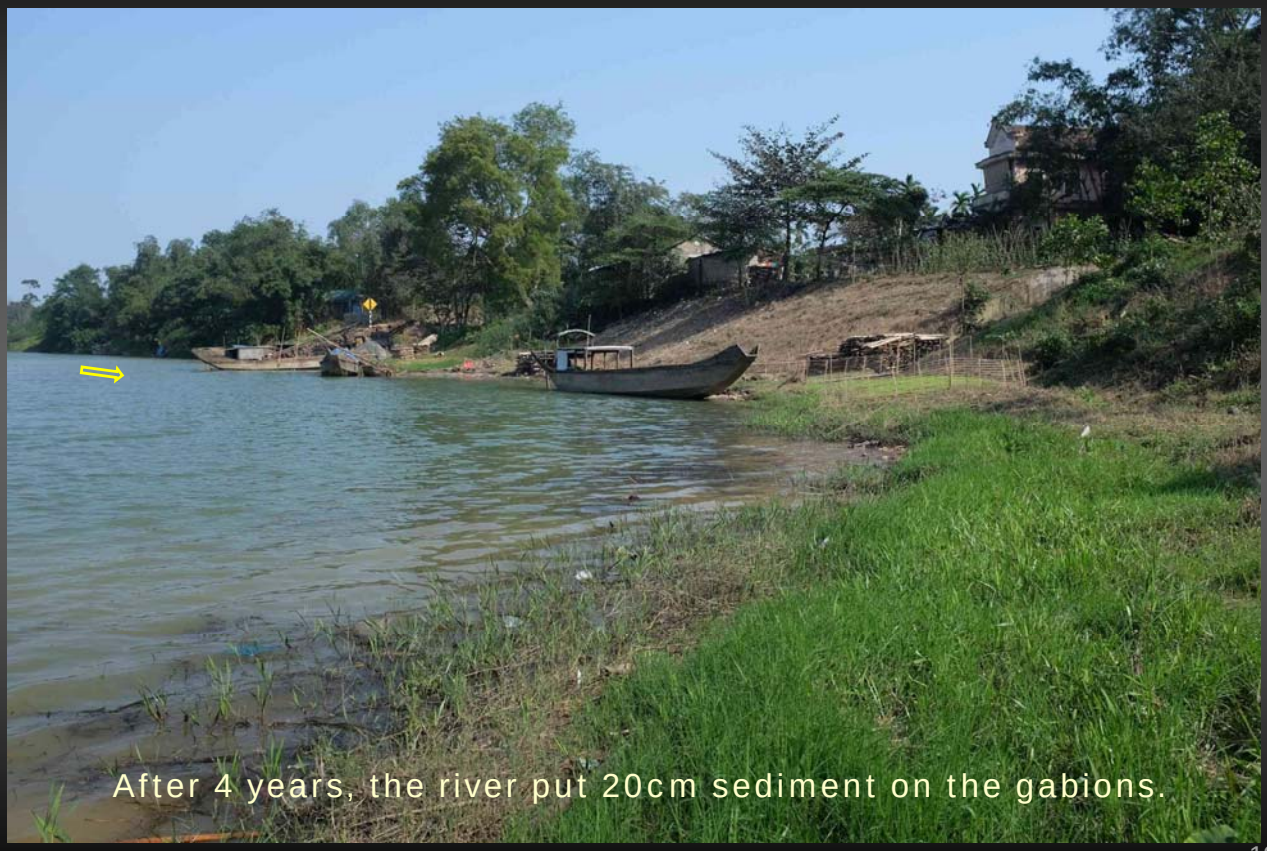
Rebetment completed with bamboo dragon (2010)

Kim Ngan Wa Jin Hue (2010)

After completion

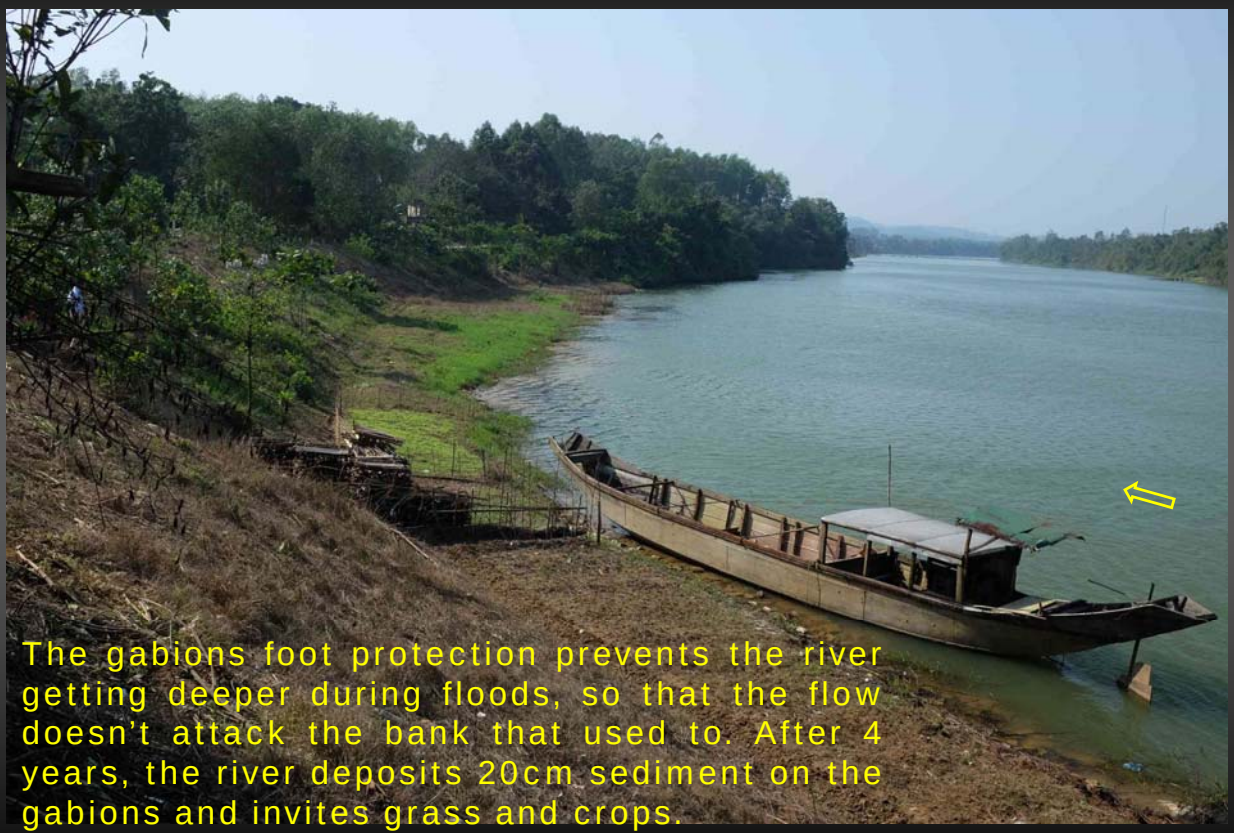
Bamboo dragon mattress 2 years after construction (2012)

Sediment on the foot plotection (Kim Ngoc, 24/1/2014)



Vegetation on the sediment (Kim Ngoc, 24/1/2014)

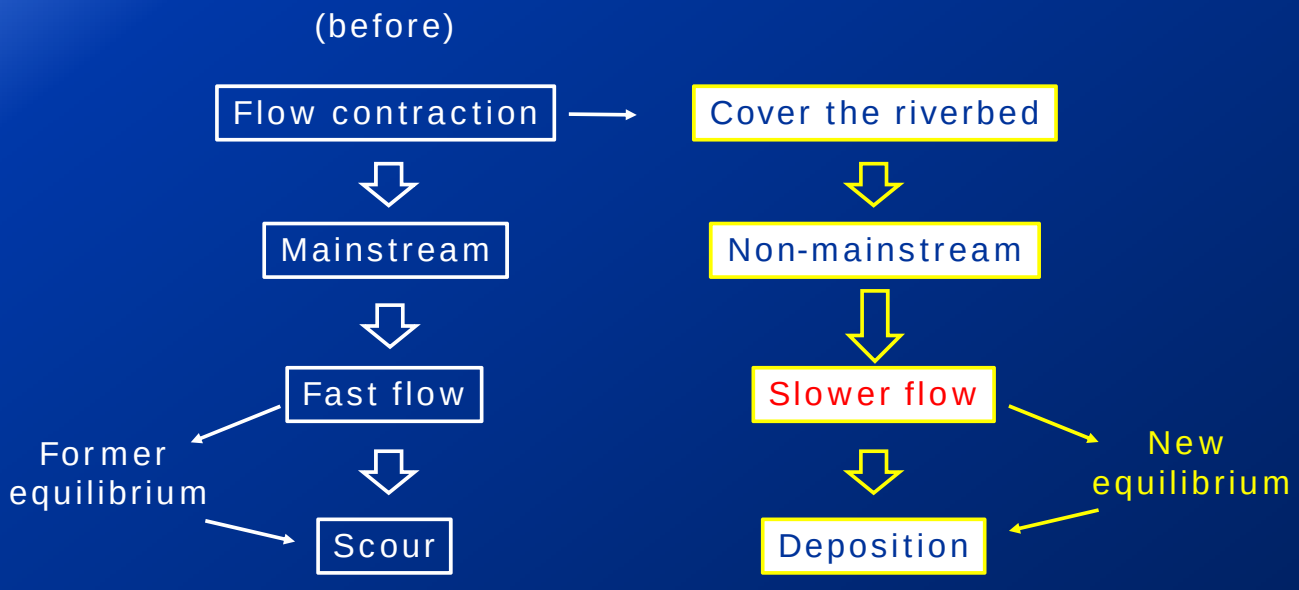
Bamboo dragon 4 years after construction



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.

Reaction by the river (Kim Ngoc)

The foot protection pushes out the thalweg beyond it.



The river put sediment on the eroded bank.

Over vegetation (14/8/2015)

Over plantation on the sediment (14/8/2015)

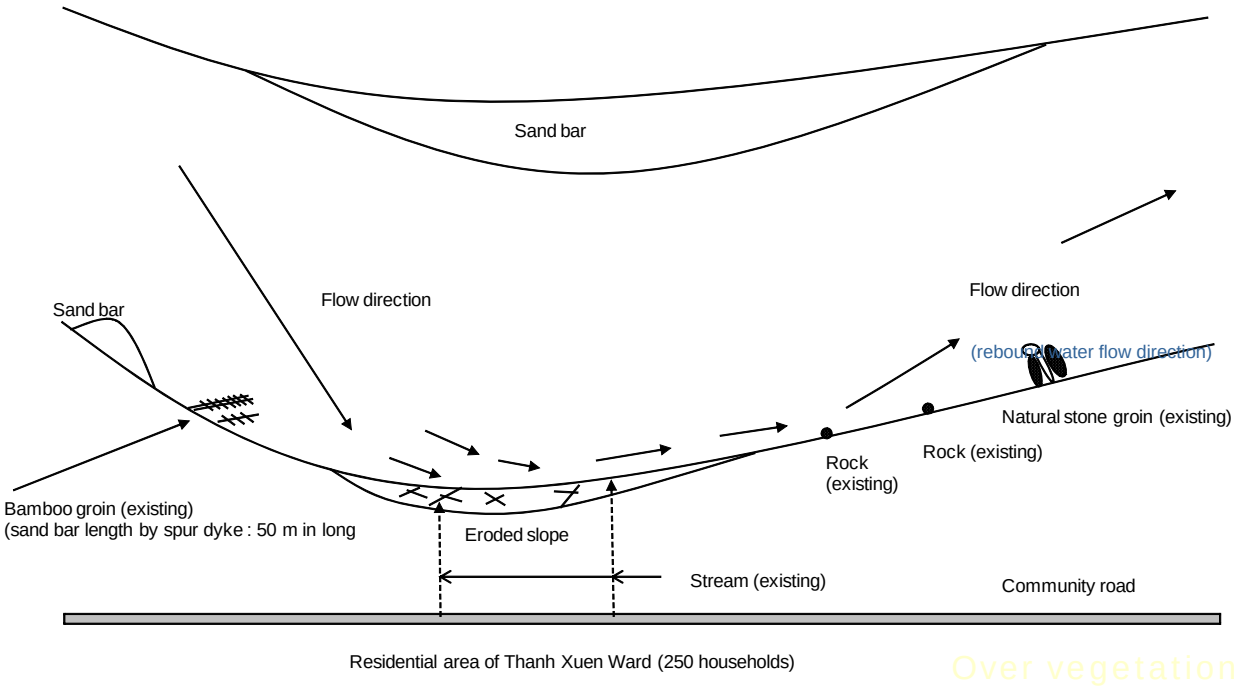
Trial-2: Masonry groyen and guide wall at Thanh Xuyen village on Thu Bon river in Quang Nam province

Eroded bank at Thanh Xuyen village

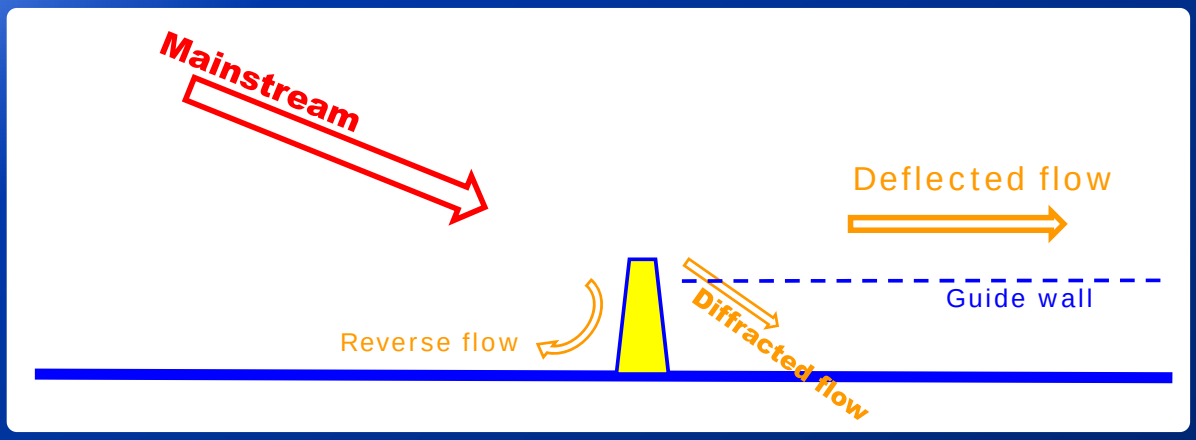
Eroded bank after Flood 2009

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

Sketch of eroded bank (Thanh Xuyen, 2010)



Impact to the river (Thanh Xuyem)



+ Aim: to move away mainstream → Single groyne with guide wall

+ Material: strength, availability, volume, cost → Rock; Bamboo; Stone

Layout of erosion control facilities (Thanh Xuyen, 2010)

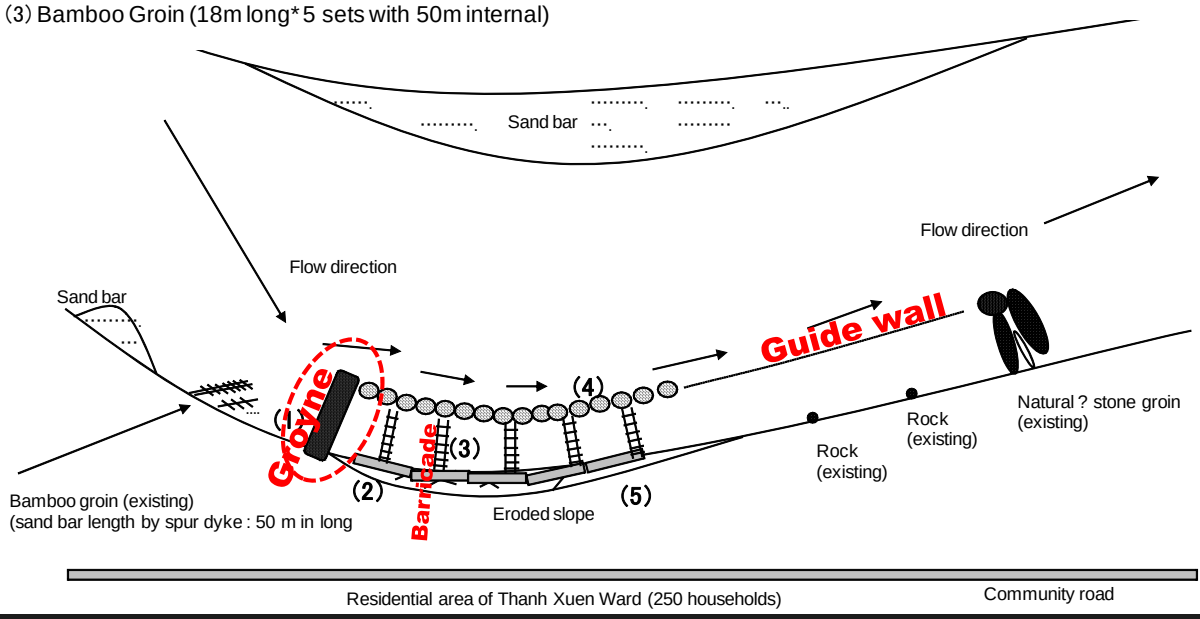
(1) Stone Groin (total length : 20m)

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

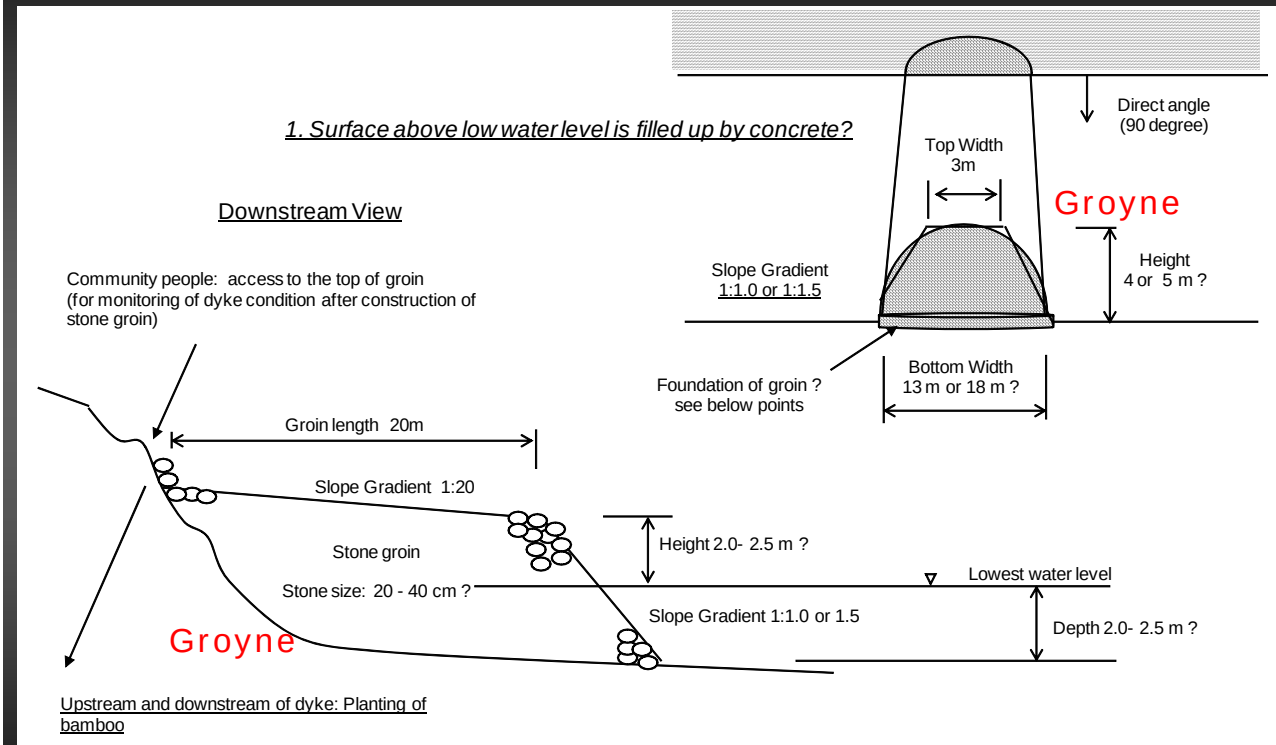
(3) Bamboo Groin (18m long* 5 sets with 50m internal)

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

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

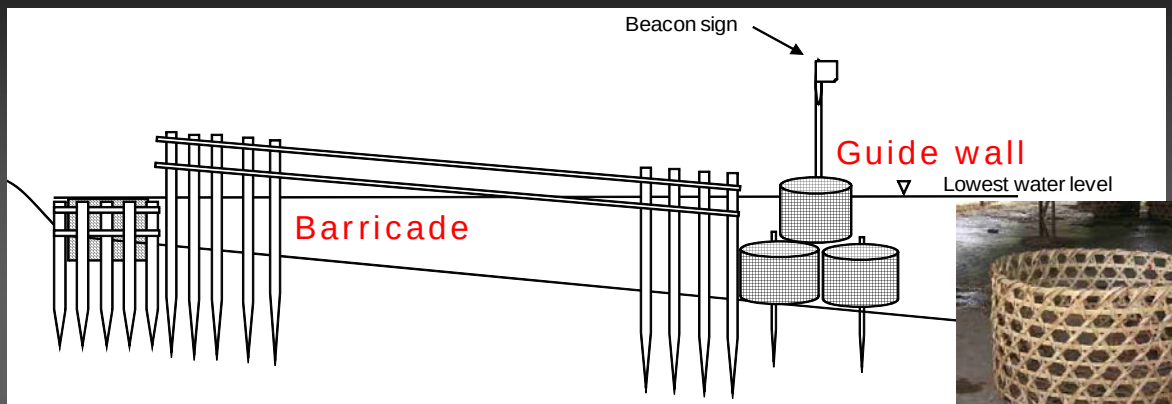


Structure of groyen (Thanh Xuyen, 2010)



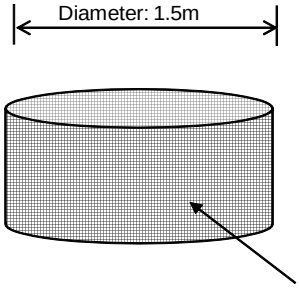
Points to be reconsidered *Foundation of groin: can be replaced by gravel bag (not only sand, material of bag ?)*

Structure of guide wall (Thanh Xuyen, 2010)



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)

Bamboo Stone Gabion



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 completed (Thanh Xuyen, 2010)

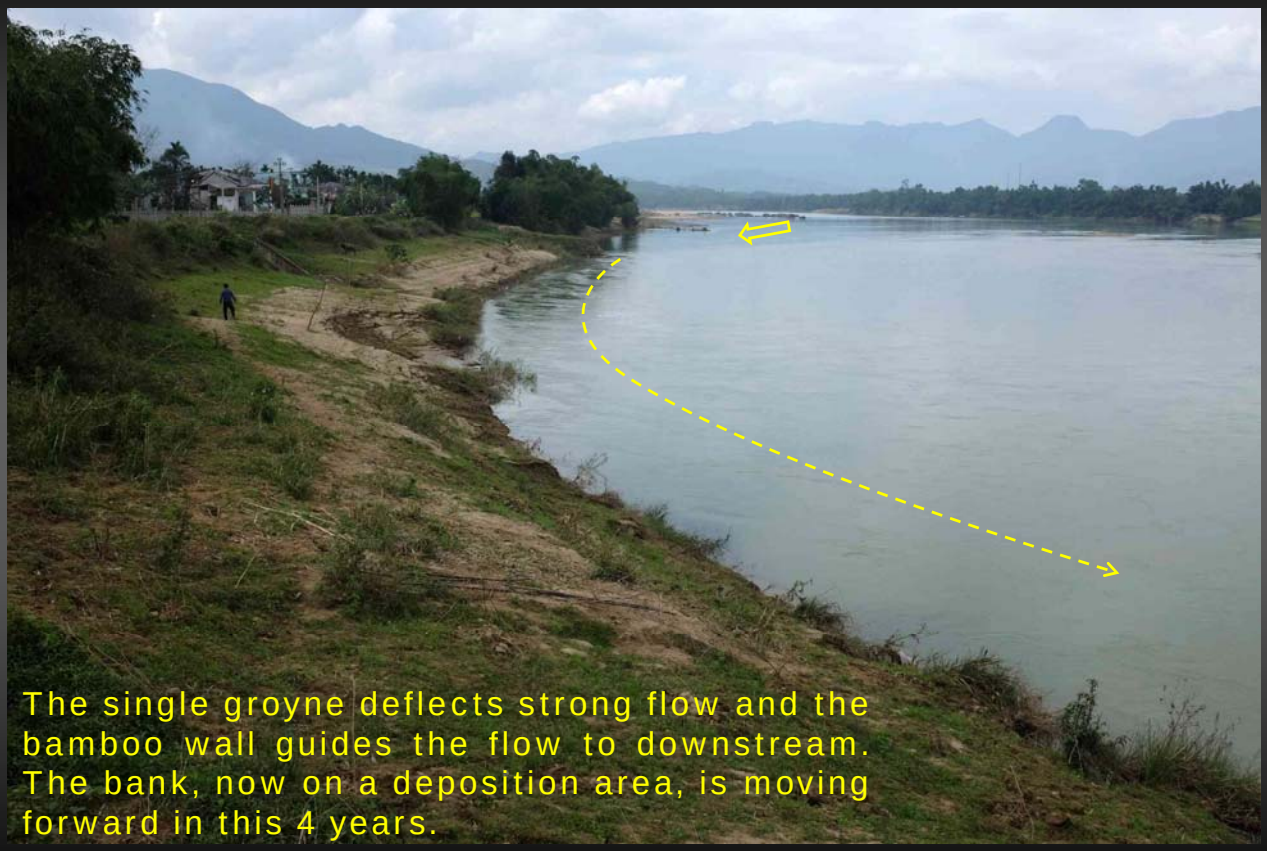
Bamboo guide wall under the water (Thanh Xuyen, 2010)

After completion

Sedimentation after 4 years (Thanh Xuyen, 2014)

Masonry groyne after 4 years (Thanh Xuyen, 26/1/2014)

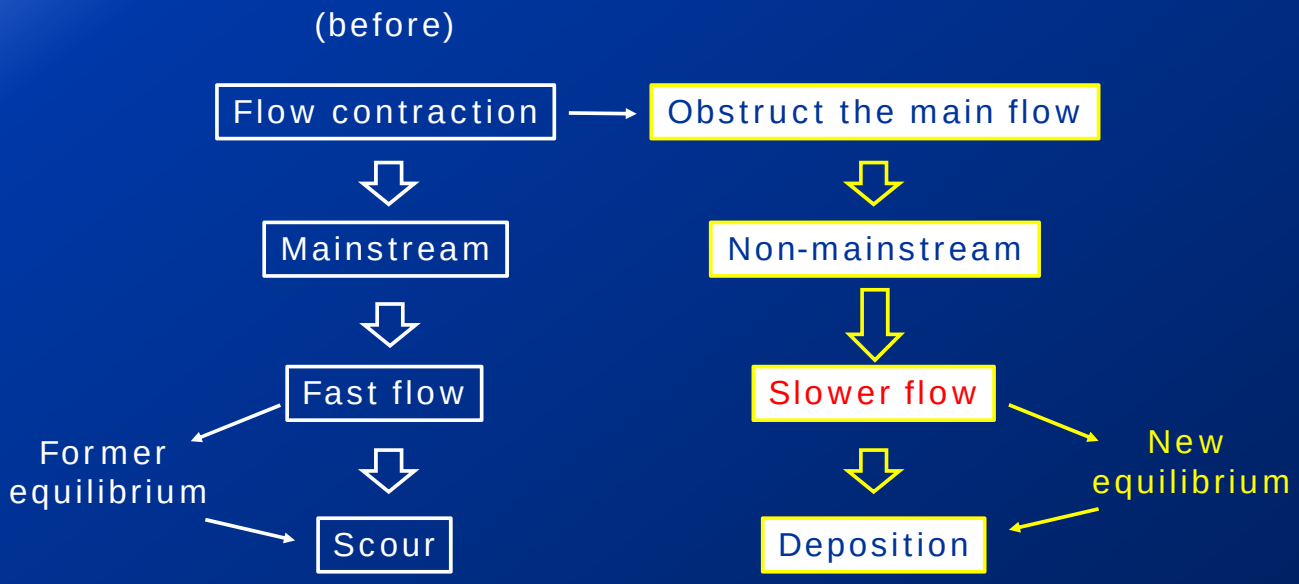
Sediment on the riverbank (Thanh Xuyen, 26/1/2014)



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.

Reaction by the river (Thanh Xuyen)

The groyne deflects the thalweg beyond the guide wall.



The river put sediment on the eroded bank.

Vegetation on the sediment (Thanh Xuyrn, 16/8/2015)

Cultivation on the sediment (Thanh Xuyen, 16/8/2015)

Lessons learnt from Kim Ngon and Thanh Xuyen

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

- thalweg control on riverbank is an effective method rather than direct protection on riverbank.

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

For erosion control, “River Makes River” tell us
- to make flow slower in front of the eroded bank.

Then the river seeks a new equilibrium
- to stop scouring and start deposition. on eroded bank.

Discussions for rivers in Vietnam

(1) Lessons learnt from rivers
River engineers have to learn from rivers in advance and take try-and-check procedure.

(2) Cost validity
River engineers should design facilities within limited initial cost and building in maintenance cost.

(3) Reparability
Local material and local labors is a key factor to secure reparability of facilities.

(4) People’s participation
Local people should be monitors of the facilities a the first beneficiaries of defensive infrastructure.

(5) River engineer’s ability
Local authorities should give opportunities for river engineers to brush up their skills and foster successors .

Messages of Japanese traditional river engineering

J-river engineering in the 19th century shows us deep messages to manage rivers and society sustainably within budgetary limitation.

- to manage a river by interaction with the river
- to minimize damage in the river basin
- to modify techniques in accordance with local conditions
- to maintain facilities in daily/yearly livelihood of people

To do that, we can use groyne and revetment but today's Japanese standards describes them quite abstractly:

- Revetments cover dykes directly from flood flow.
- Groynes deflect or decelerates flood flow to protect dykes.

That means engineers should design facilities one by one.

Study manuals but don't adopt a method.

"Originate" a unique technique, "adapt" it to each site,

and "share" experience of trials.

Continuous groynes
at Quang Son commune
on Rao Nan river,
Quang Binh Province
(29/1/2015)

Combinational groynes
at Duc La commune
on La river,
Ha Tinh province
(14/7/2015)

We can share good/bad experience
with river engineers and people living with rivers.

To be continued.