

BANK EROSION CAUSES AND SOLUTIONS



Colin Thorne

Nottingham University

colin.thorne@nottingham.ac.uk

OVERVIEW

1. Mechanics of bank erosion
 - a. Flow processes
 - b. Bank Slumping
2. Sequence of bank erosion
3. Causes of bank erosion
 - a. Localized
 - b. System-wide
4. Solutions to bank erosion problems

1. Mechanics of bank erosion

Coarse soil banks

Banks formed in
sand and gravel
wash away -
especially during
high flows



Fine soil banks



Banks formed in sand, silt and clay are different. They wash away during **high flows** but also **slump** – especially **when wet**

Deep cracks
weaken steep
banks



Flow erosion and weakening lead to slumping



Water draining **Over** the bank can also cause problems



Groundwater seepage can cause 'pop-out' failures



Isolated trees can sometimes fall over or
blow down: *trees on banks need friends*



Many banks have different soils in layers

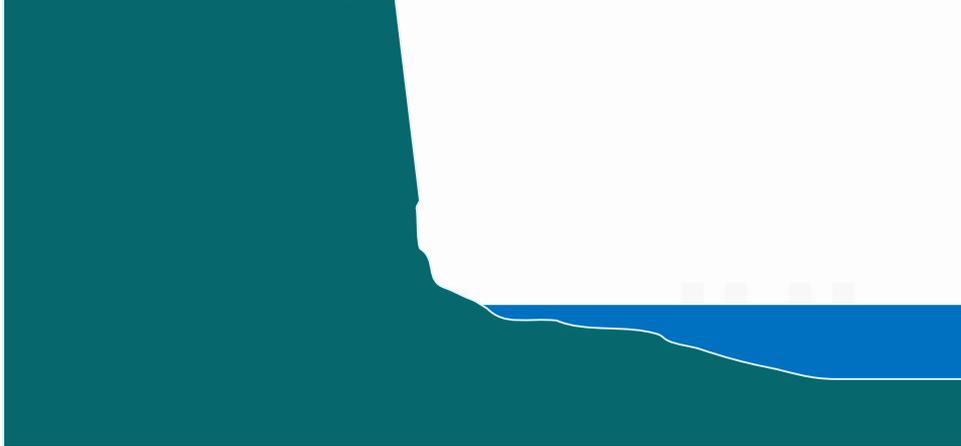


Layered banks fail
by first:
**washing away of
the lower bank**
and then
**slumping of the
upper bank**

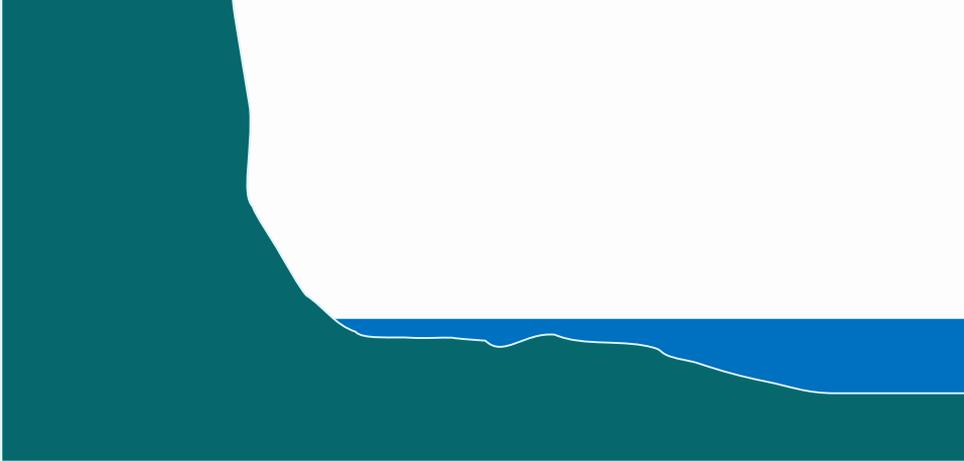


Sequence of bank erosion

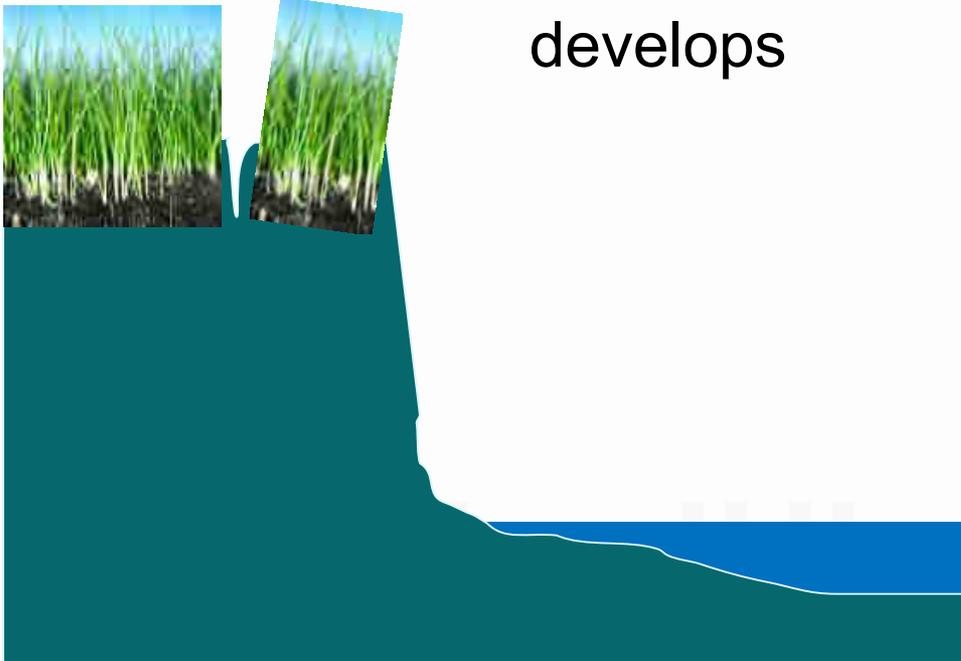
Toe erosion
steepens bank



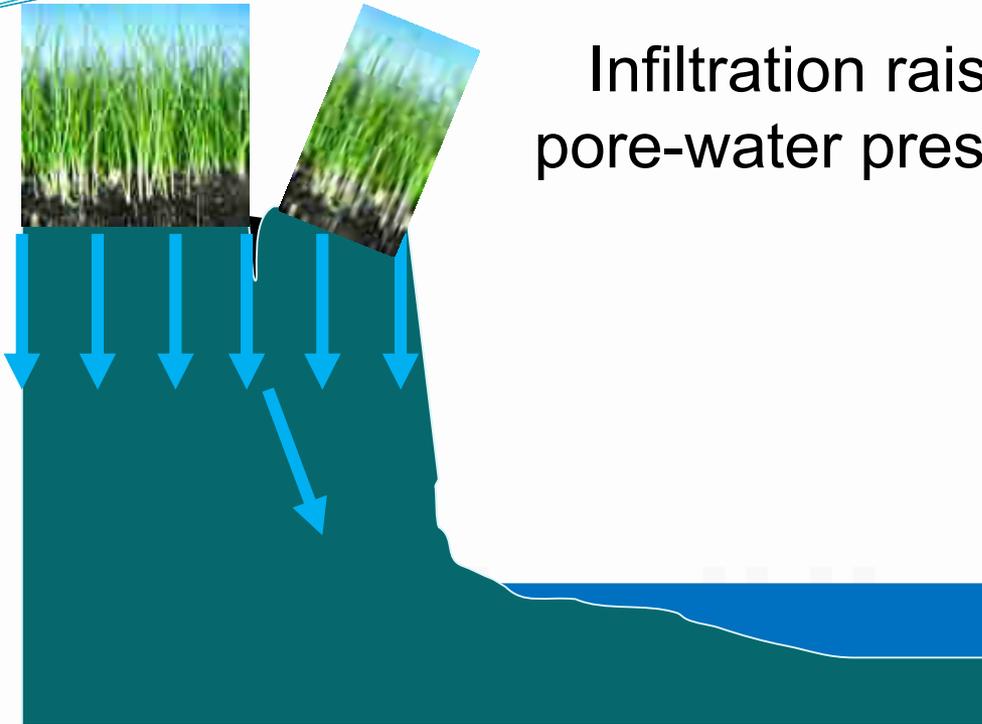
Vertical face



Tension crack
develops

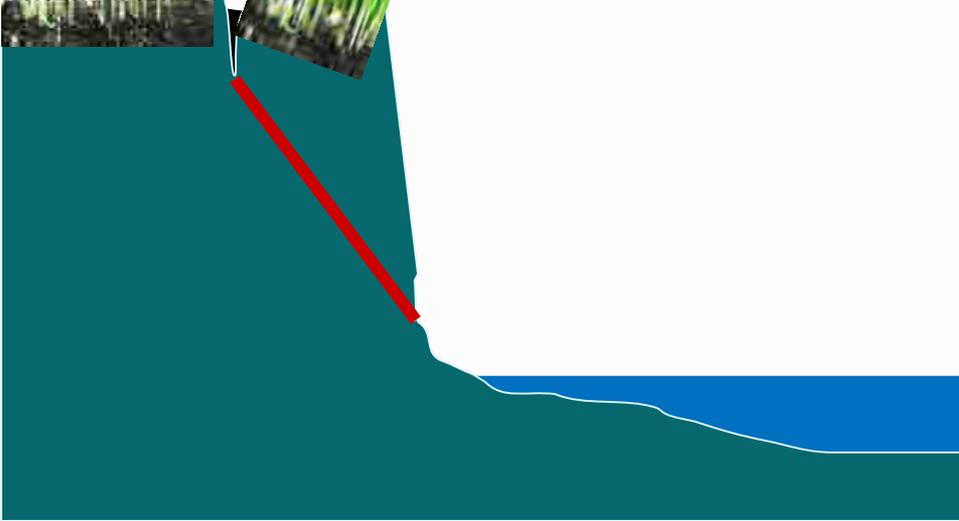


Infiltration raises
pore-water pressure

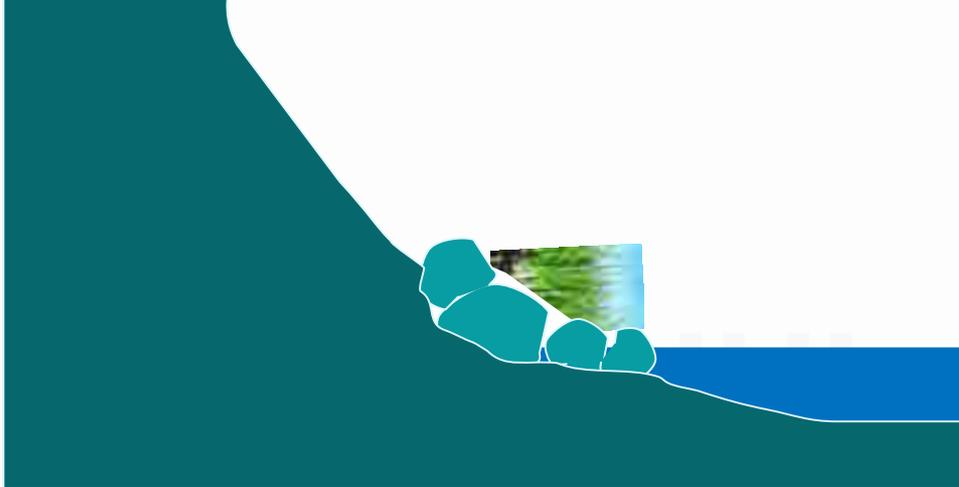




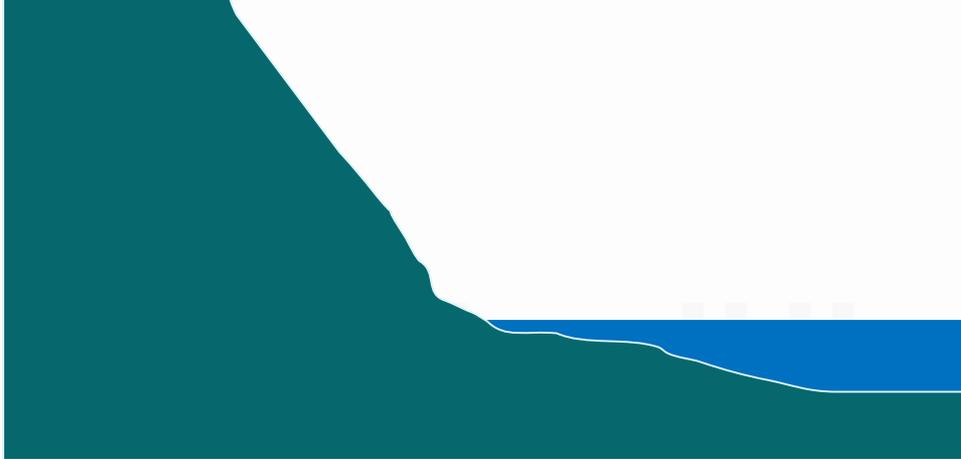
Bank fails by shearing



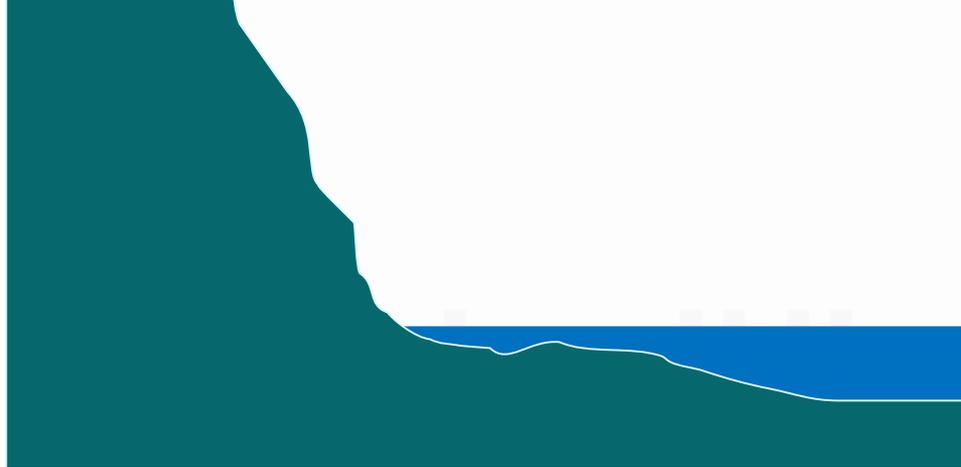
Bank failure
debris collects at toe



Erosion removes
the failed debris



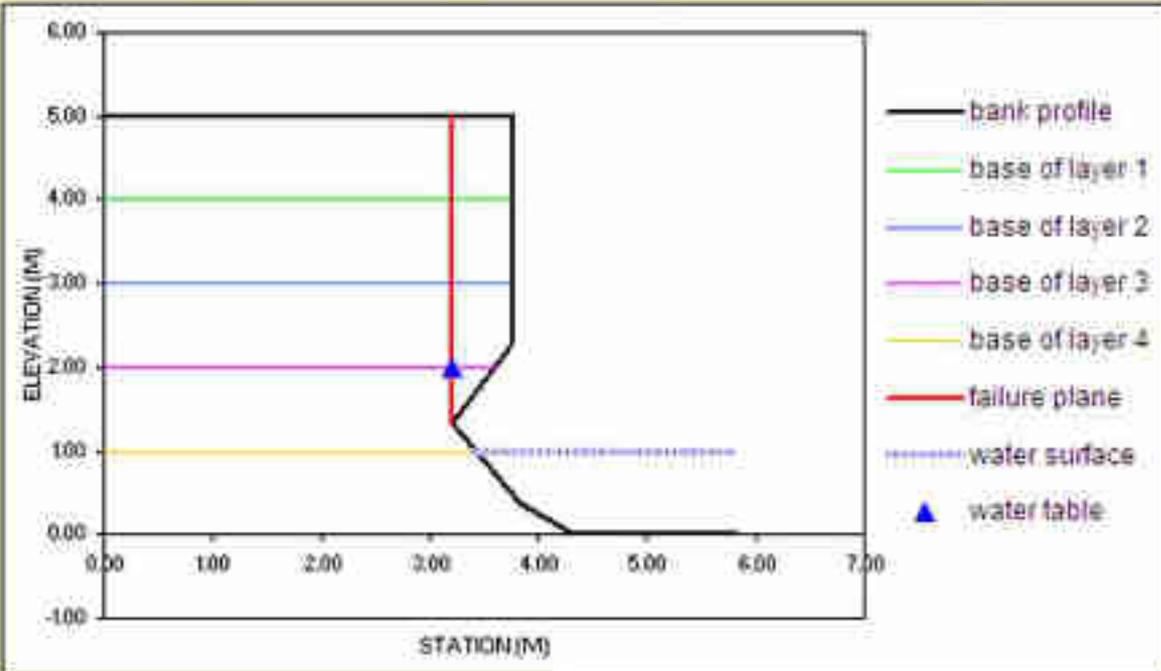
Bank steepening
starts again



Select material types, vegetation cover and water table depth below bank top

(or select "own data" and add values in "Bank Model Data" worksheet)

Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Bank top vegetation cover (age)	Reach Length (m)
Gravel Angular sand Rounded sand Silt Stiff clay	None	100				
					Vegetation safety margin	Constituent concentration (kg/kg)
					50	0.001



Water table depth (m) below bank top

3.00 Use water table Input own pore pressures (kPa)

Own Pore Pressures	kPa	Pore Pressure From Water Table
-6.79	Layer 1	-24.53
-12.71	Layer 2	-14.72
-12.71	Layer 3	-4.91
1.55	Layer 4	4.91
3.52	Layer 5	15.21

Factor of Safety

0.93 **Unstable**

Failure volume	180	m ³
Sediment loading	313609	kg
Constituent load	314	kg

Export Coordinates back into model

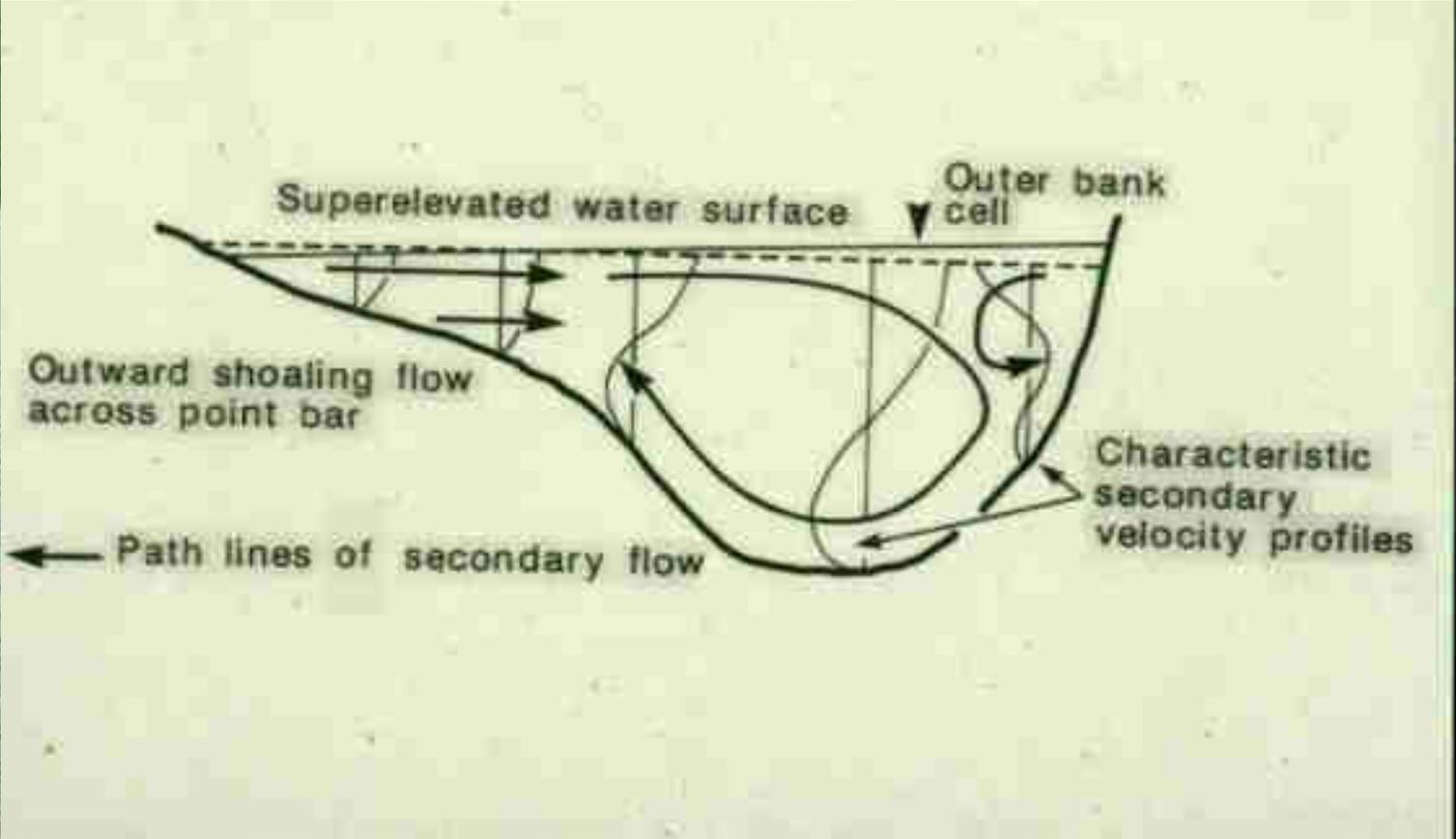
USDA BSTEM – Bank Stability and Toe Erosion Model:
<http://www.ars.usda.gov/research/docs.htm?docid=5044>

Other factors are important to bank erosion

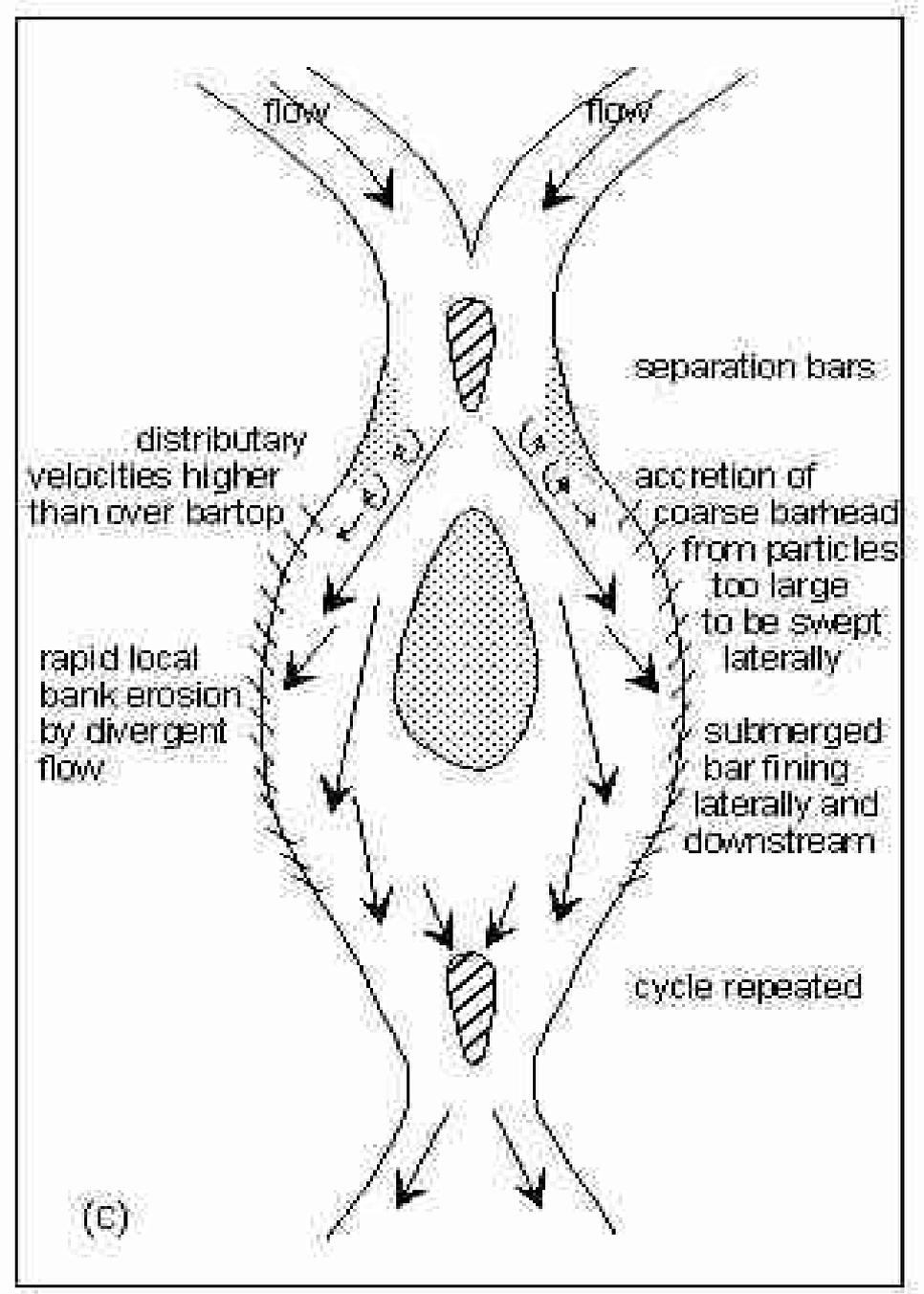


Causes of bank erosion

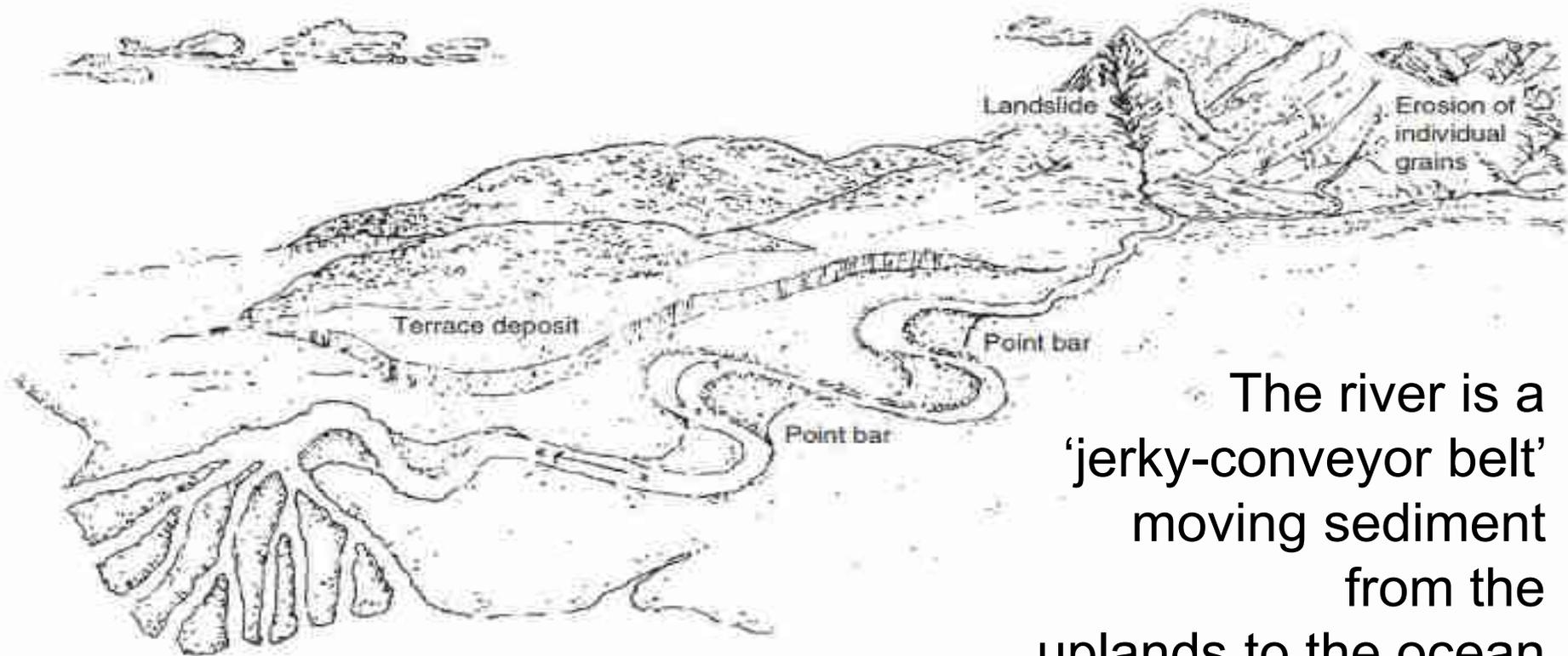
Localized Erosion is often caused by a river bend



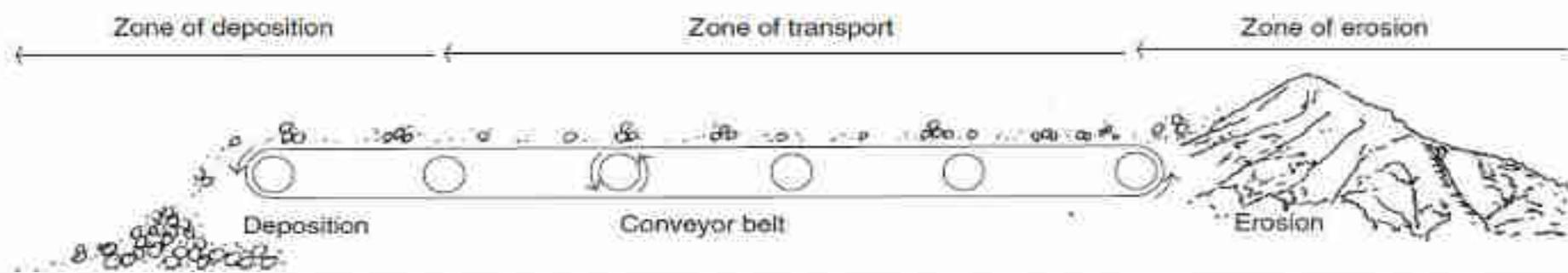
Localized Erosion
is often caused by
a braid bar



System-wide Erosion is caused by connectivity in the drainage and sediment transfer system

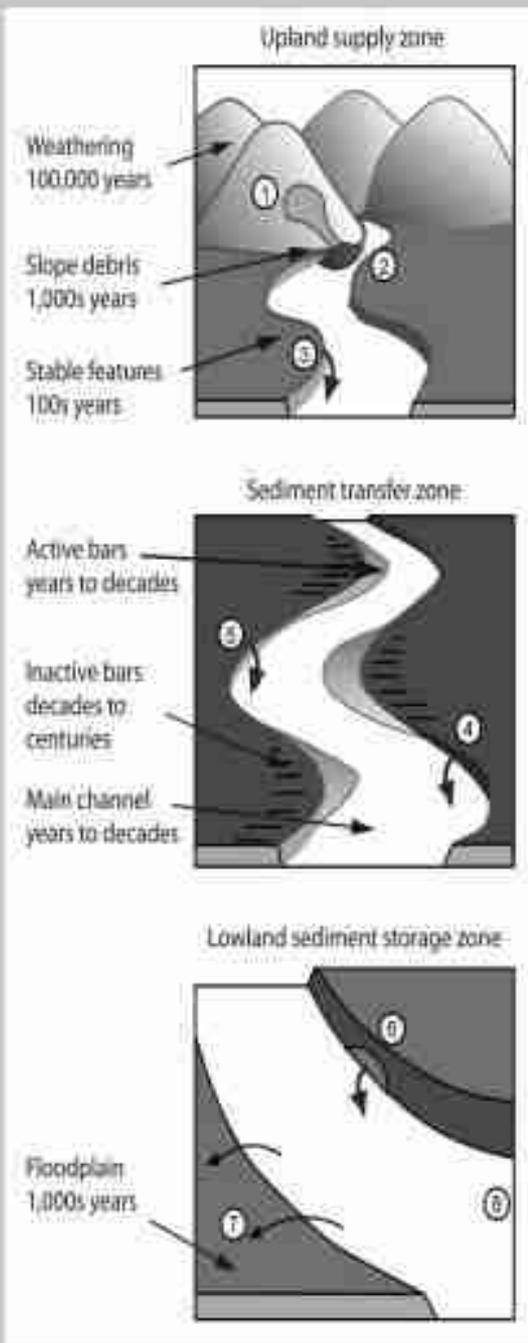


The river is a 'jerky-conveyor belt' moving sediment from the uplands to the ocean

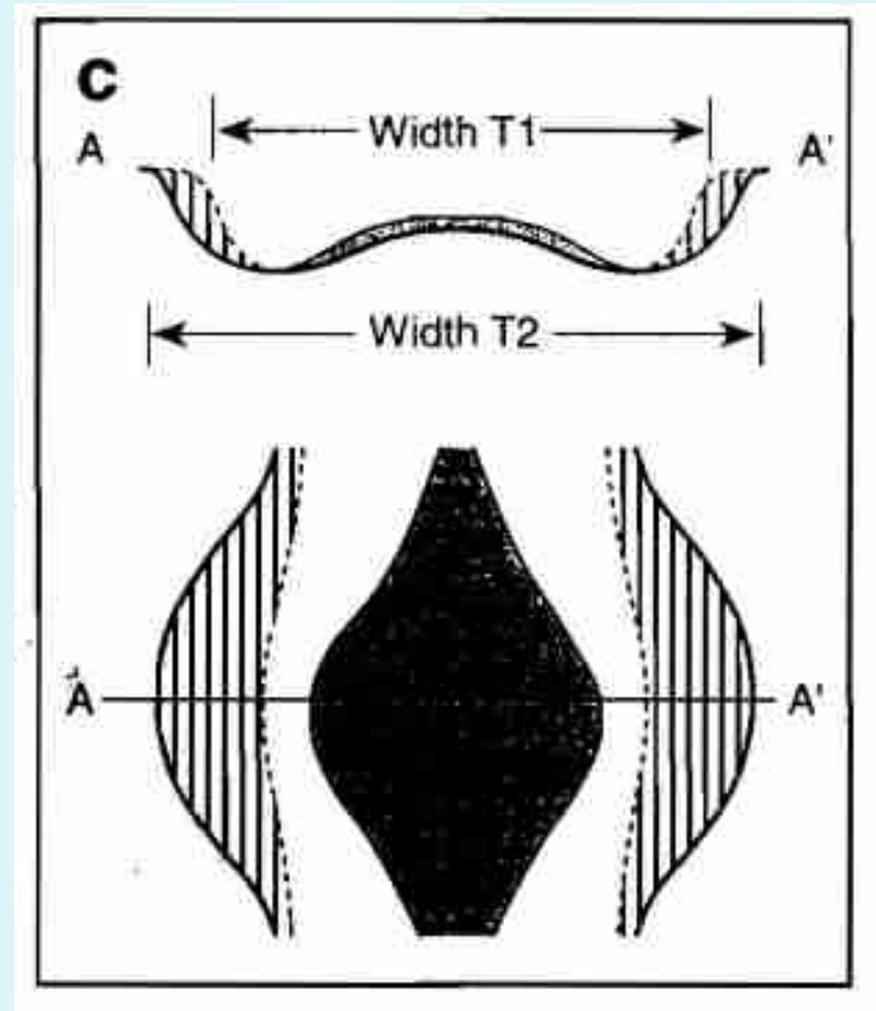
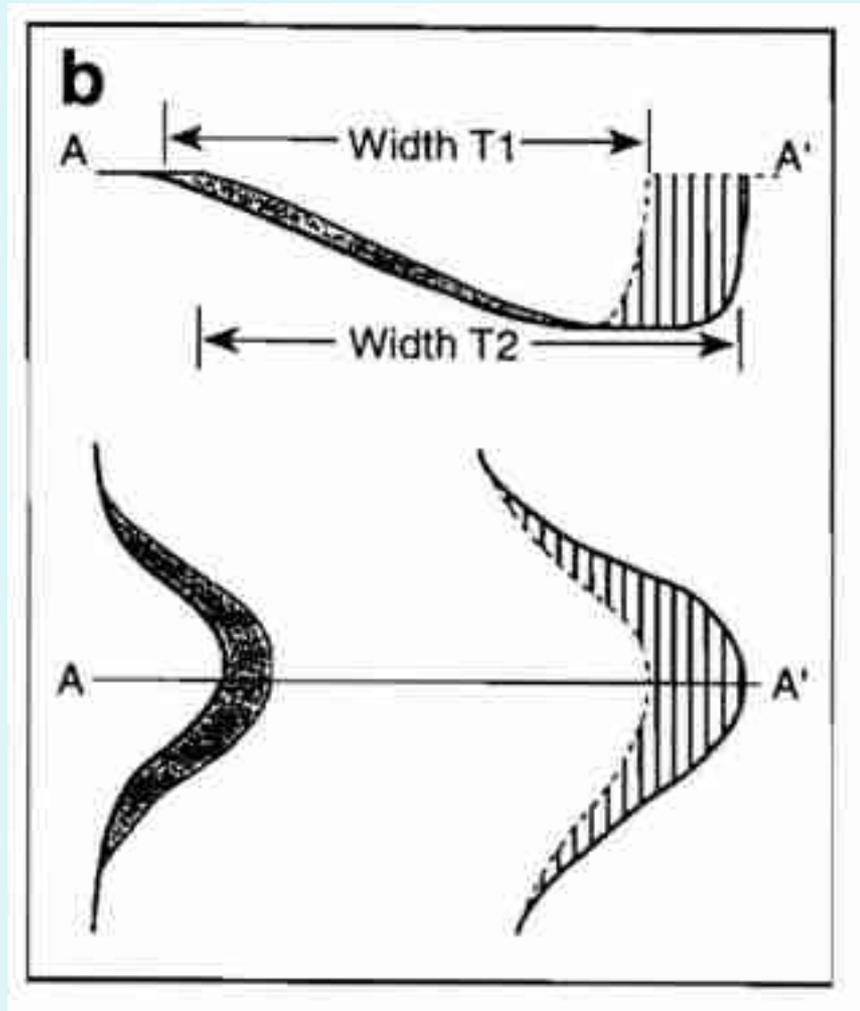


The knock-on effect

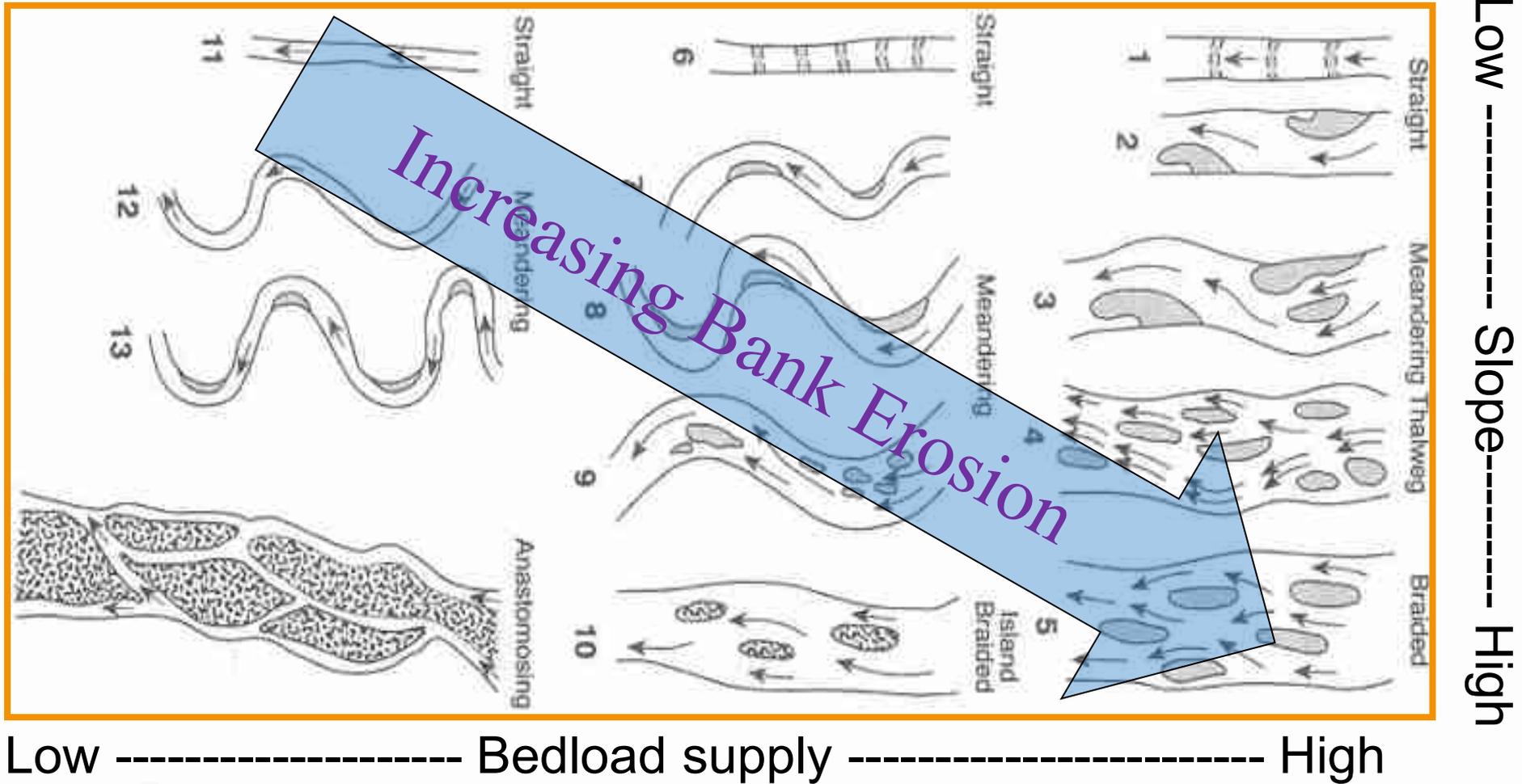
- Increased sediment supply in headwaters
- Increased sediment exchange in middle reaches accelerates lateral migration
- Fine sediment is deposited in lower course of the river and on the floodplains



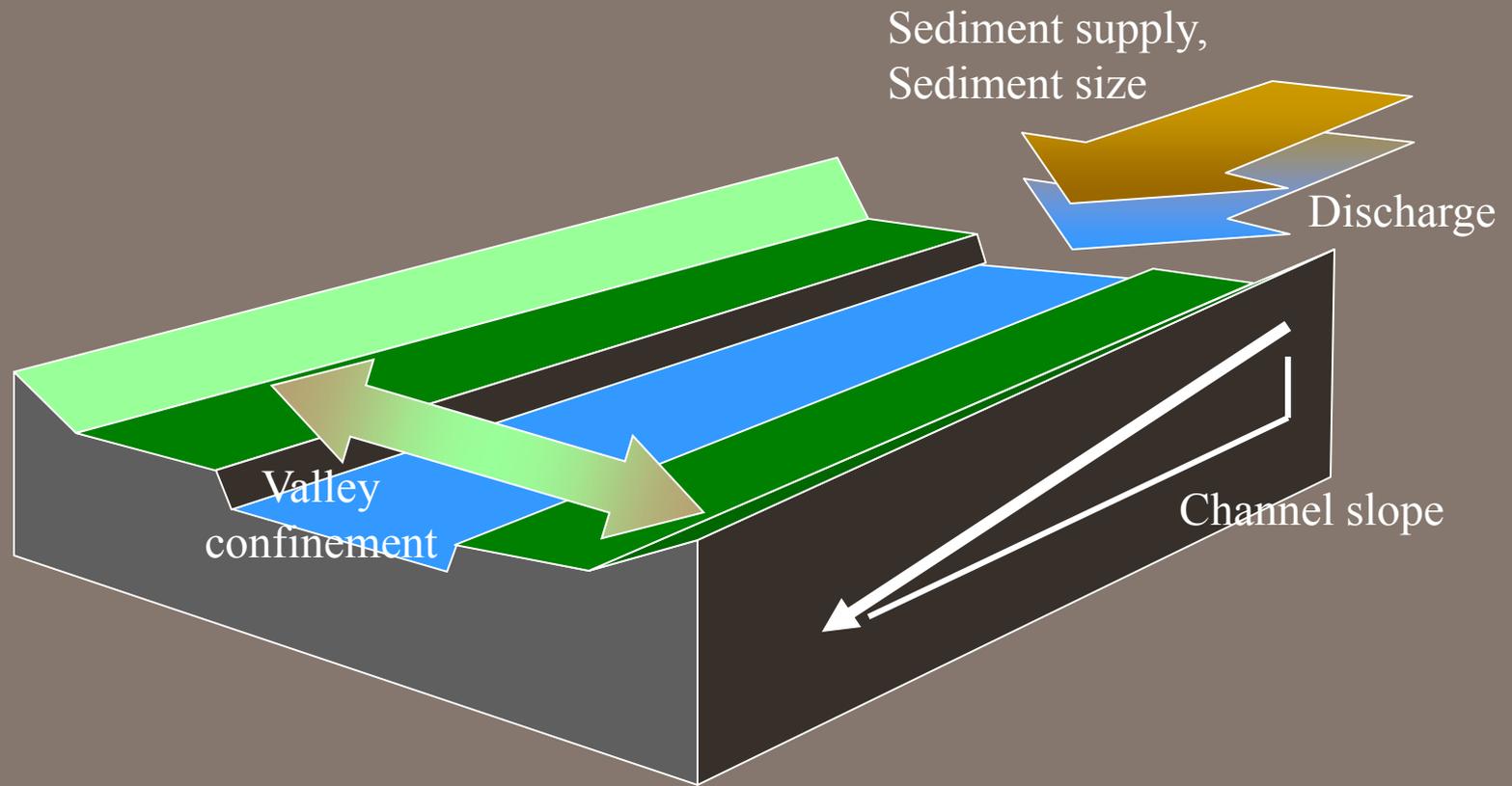
Bank erosion caused by increases in bar sizes and rates of movement



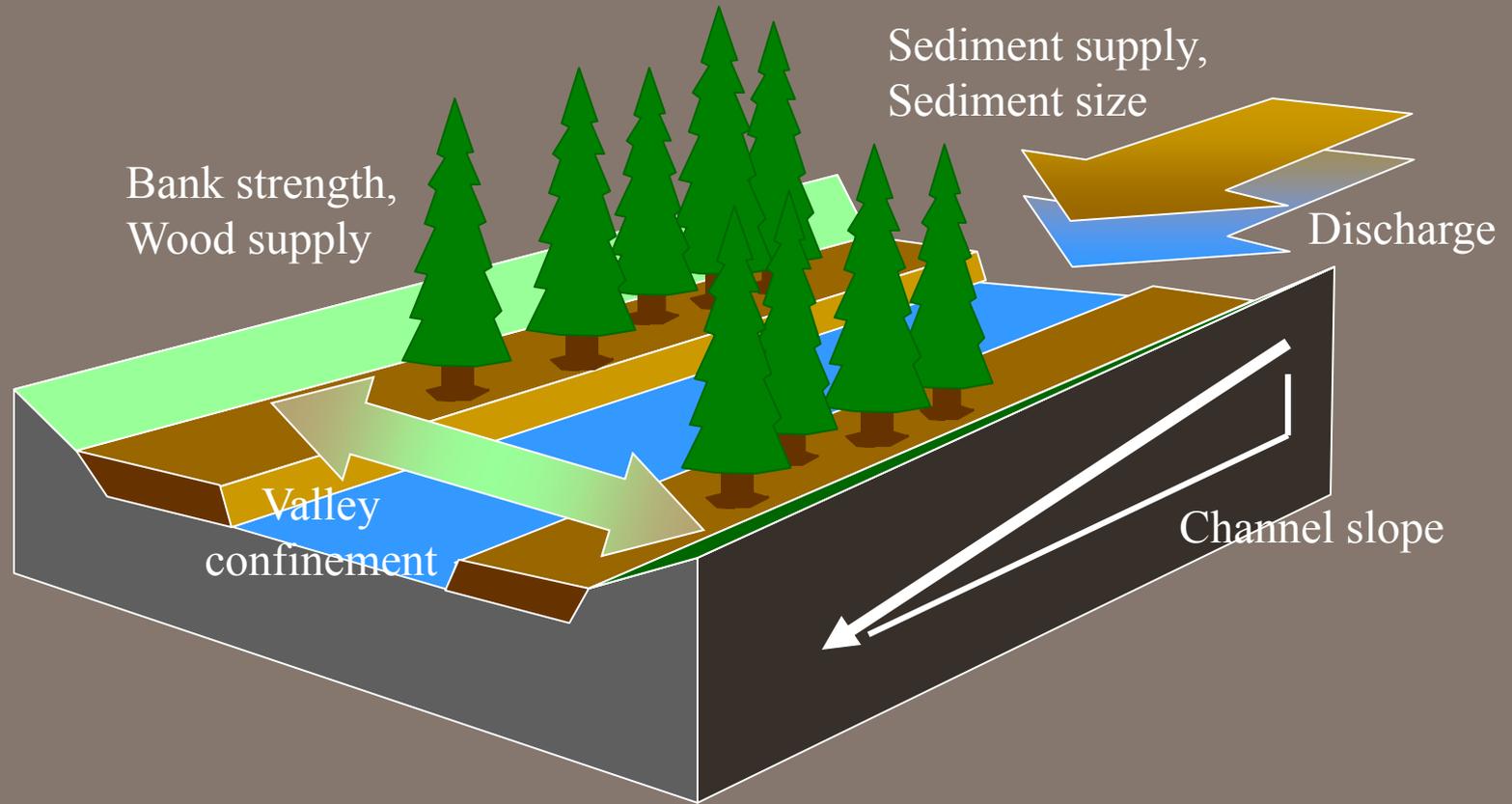
Extreme bank erosion caused by a switch from straight to meandering or braided planform



SOLUTIONS TO BANK EROSION PROBLEMS

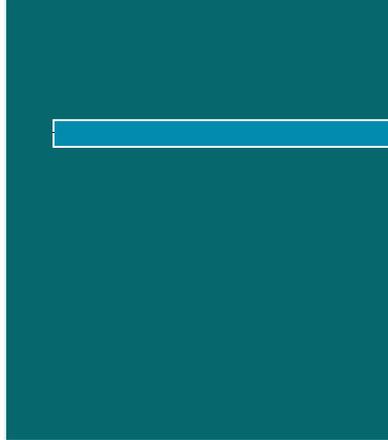


Controls on Channel Form and Migration



Trees and Large Wood do influence Channel Form and Migration

Vegetation



Drainage



Toe protection

Bank protection projects should address three key issues:

- a. Reinforcing the Soil
- b. Draining Excess Seepage Pressures
- c. Protecting the Bank Toe

ADD VEGETATION TO THE BANKS



5/20/2000

USE BIOENGINEERING



USE DIFFERENT BIOENGINEERING





USE A WOOD TOE

USE BIOENGINEERING WITH A WOOD TOE



USE BIOENGINEERING WITH A ROCK TOE



USE A PARTIAL ROCK WEIR



USE BIOENGINEERING WITH A PARTIAL ROCK WEIR



USE A FULL ROCK WEIR



USE BIOENGINEERING WITH A FULL ROCK WEIR



USE 'ENGINEERED LOG JAMS'





USE GROINS



USE JETTIES



USE A WOOD REVETMENT



USE A ROCK REVETMENT



USE A WOOD AND ROCK REVETMENT



USE YOUR IMAGINATION



KEY STEPS TO SUCCESSFUL BANK PROTECTION:

1. Identify the CAUSE of erosion;
2. Identify the MECHANICS of erosion;
3. Know if the problem is LOCAL or SYSTEM-WIDE;
4. Know if the problem is SHORT- or LONG-TERM;
5. Forecast LOCAL and OFF-SITE impacts/responses;
6. Consider the RISKS and BENEFITS
 - is the protection strong enough - will it work?
 - is it affordable (including maintenance costs)?
 - will it harm or help fish - can I get a permit?