STREAMS

Key terms

- stream
- river
- longitudinal profile
- stream valley
- floodplain
- drainage basin
- tributary
- drainage divide
- sheetflow
- rill
- laminar flow
- turbulent flow
- wetted perimeter
- gradient
- discharge
- traction
- saltation
- suspension
- base level
- graded stream
- braided vs. meandering (characteristics)
- sinuosity
- secondary flow (meander bend)
- bar
- point bar deposits
- flood
- levees
- avulsion

Outline

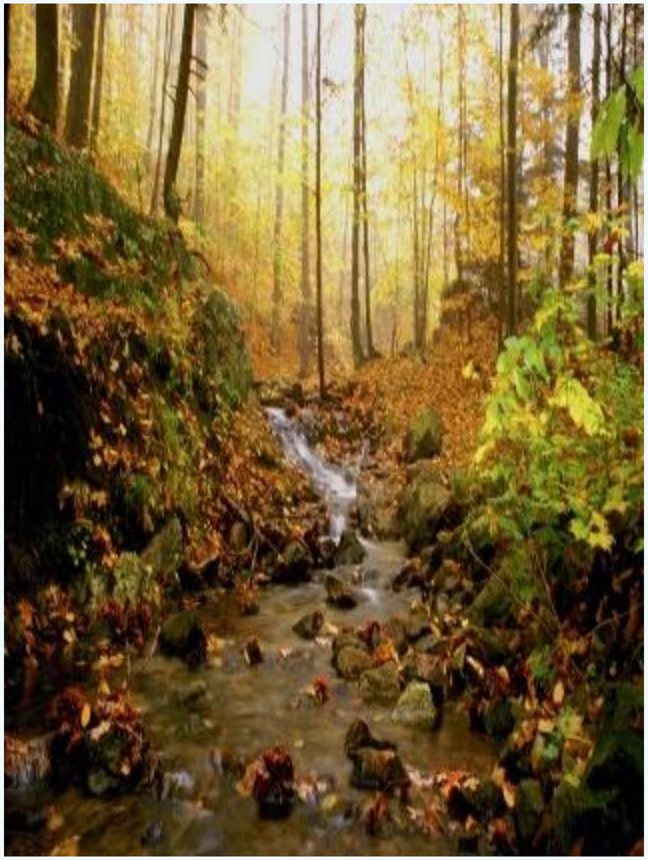
Today:

1. Importance of streams
2. Streams vs rivers; stream components
3. Hydrologic cycle and streams
4. Stream's functions; hydraulic parameters and load
5. Base level and graded steam concepts
6. Types of streams
7. Floods

Stream vs river

- Streams are any flowing body of water
- Rivers are major branches of a stream system

Fraser River, BC



Stoney Creek, Texas

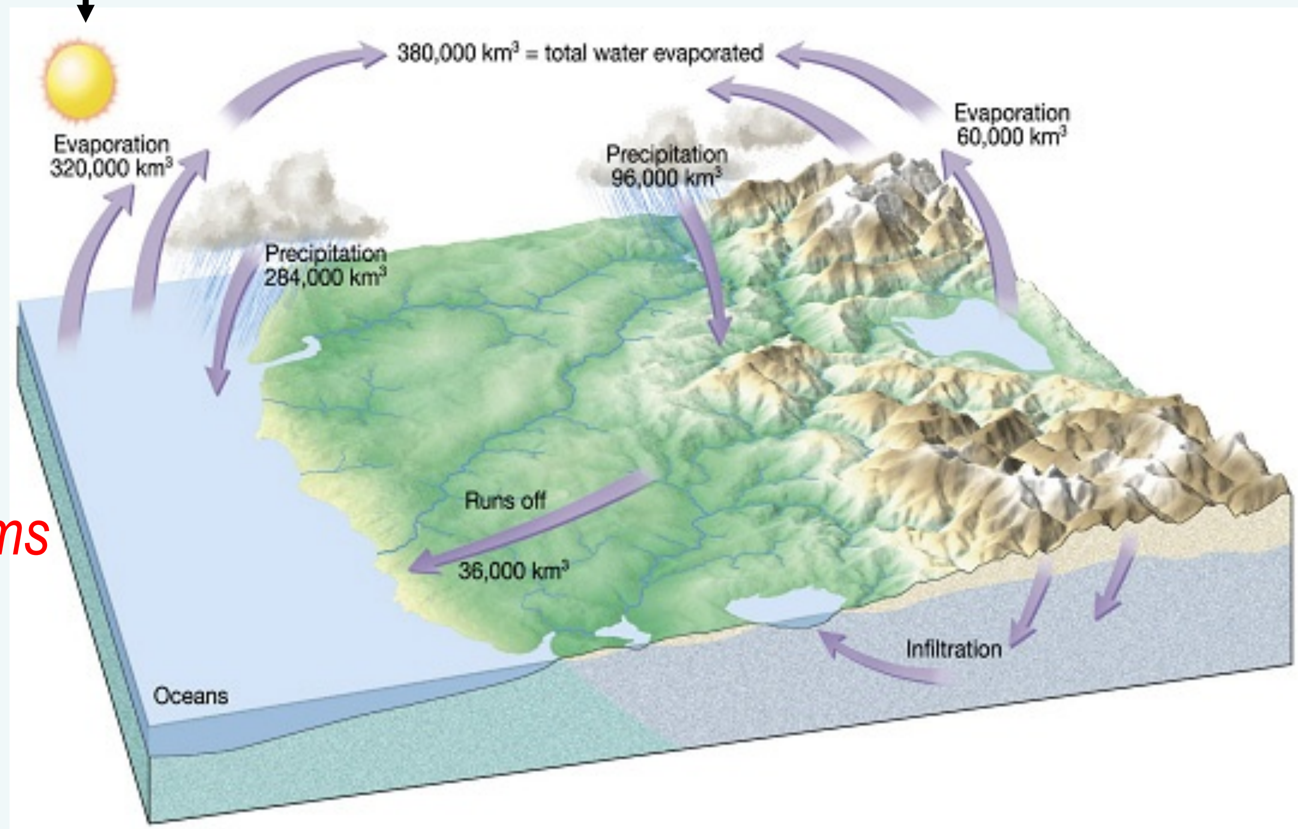
- Stream flow → f (plate tectonics, climate system)

Hydrologic cycle - the movement of water between the ocean (hydrosphere), air (atmosphere), and land (lithosphere).

Energy source: Sun

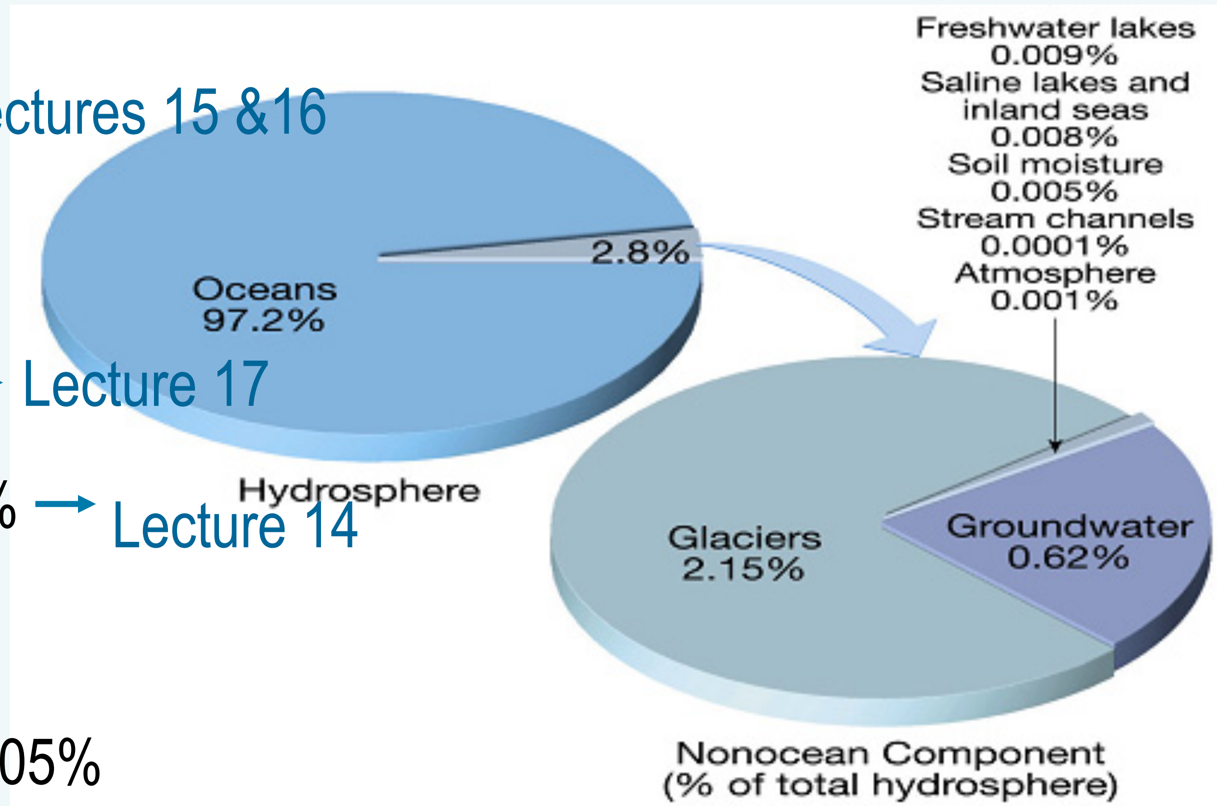
PROCESSES:

- evaporation
- precipitation
- transpiration
- runoff → *streams*
- infiltration



Hydrologic cycle

Distribution of Earth's water



1. Oceans: 97.2% → Lectures 15 &16

2. Freshwater: 2.8%

    2a. glaciers: 2.15% → Lecture 17

    2b. groundwater: 0.62% → Lecture 14

    2c. other

        lakes: 0.009%
        soil moisture: 0.005%
        atmosphere: 0.001% → Lectures 19 & 20
        streams: 0.0001% → *So, why do we care?*

Importance

Streams are major geological agents of change in landscapes (transfer material from the highs to the lows – plane out relief)

Streams provide pathways for inland colonization of continents

e.g. Jacques Cartier
Lewis and Clark

Most cities are built on floodplains of rivers

Agriculture

Importance

Streams are also excellent playgrounds …




Stream system components

The three basic parts of a stream:

Longitudinal profile: cross-sectional view of the stream bed (red line)

1. valleys: sloping area around the stream

2. channels: bottom of valley, where water flows

3. floodplains: flat area in valley level with top of channel. Portion of the valley that can be flooded

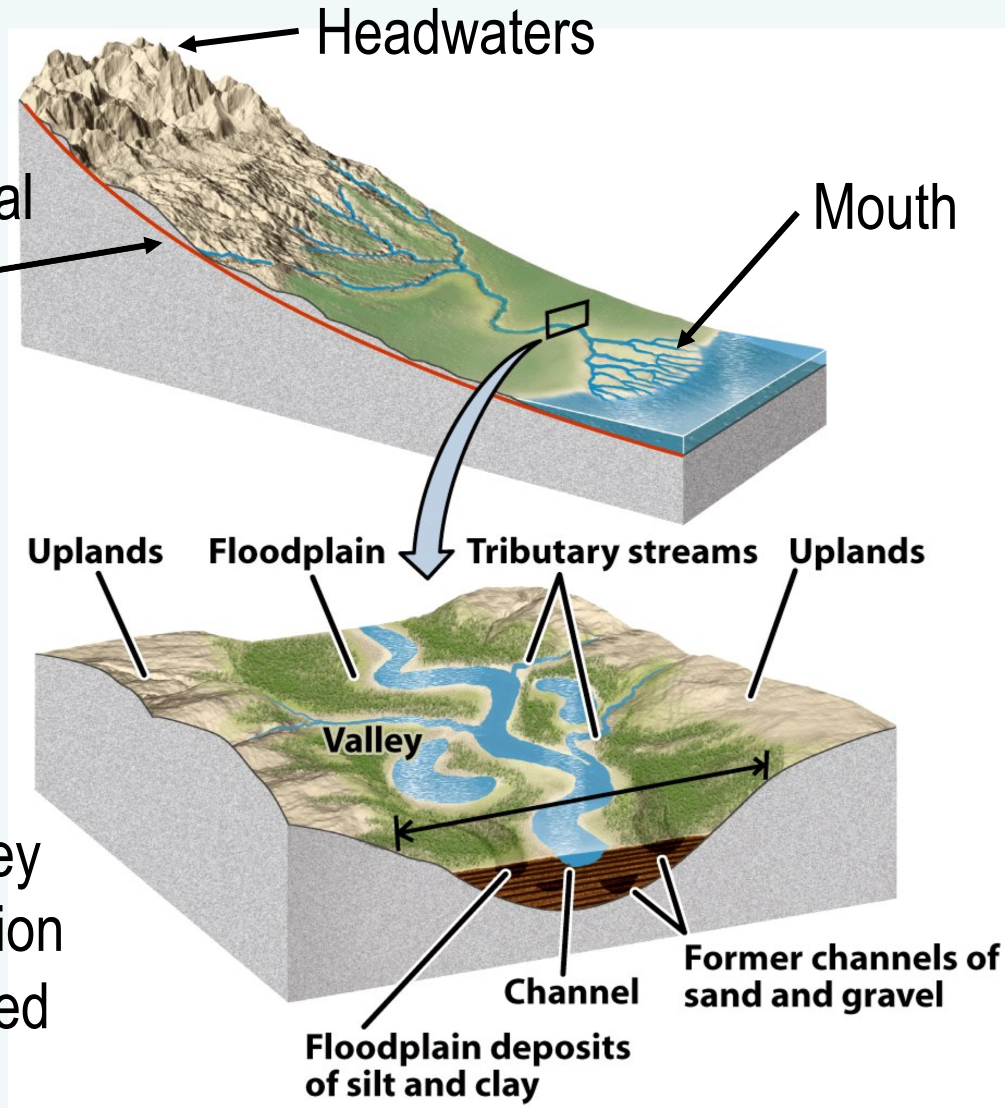


Figure 18-1
Understanding Earth, Fifth Edition

Stream system components

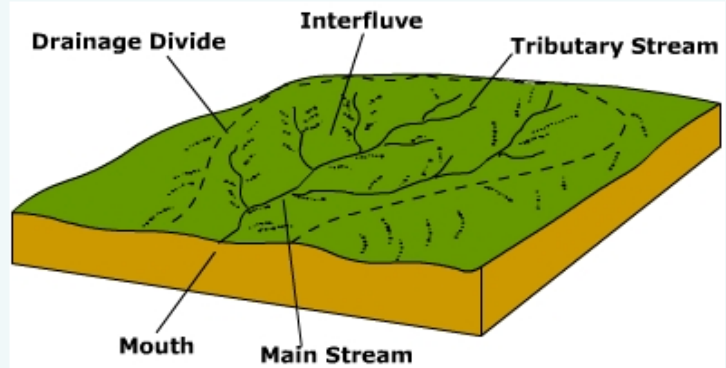
Drainage basins

Some terminology:

Drainage basin: total area drained by a stream and its tributaries

Tributary: small stream flowing into a larger one (con*tribut*es)

Drainage divide: ridge of high ground dividing one drainage basin from another (red line – imaginary!)



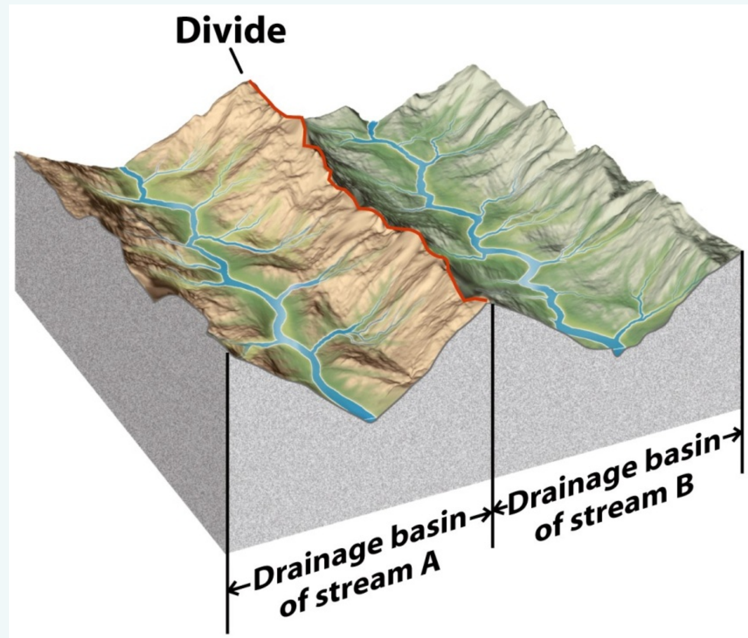
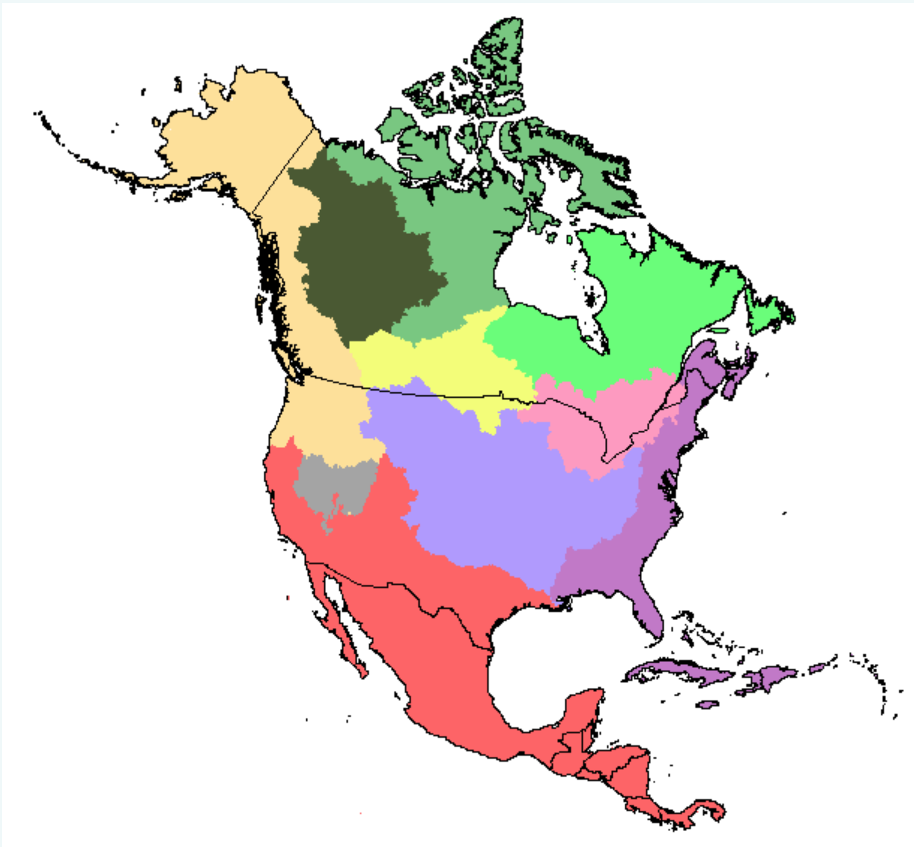


Figure 18-5
Understanding Earth, Fifth Edition

Drainage basins

Largest drainage basin of N. Am.?

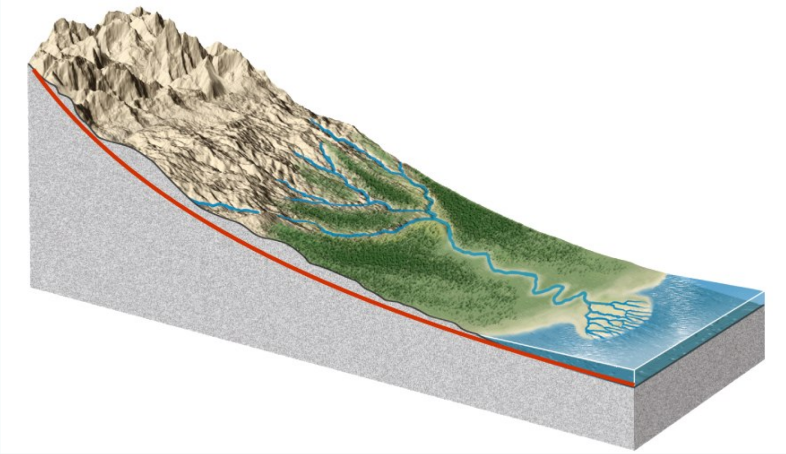


Ottawa River drainage basin

Stream actions

Stream's job = plane out relief

via channelized flow (most efficient)



Accomplished through:

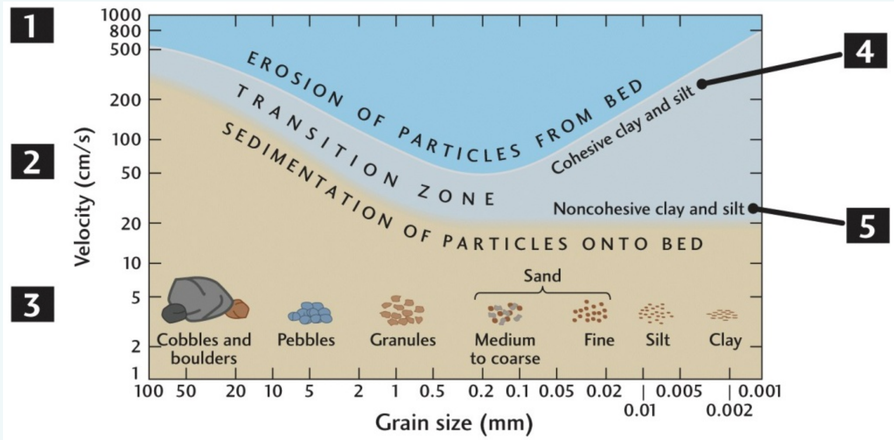
1. erosion
2. transport
3. …

Stream actions

CONTROLS on stream action (erosion vs. transport vs. deposition):

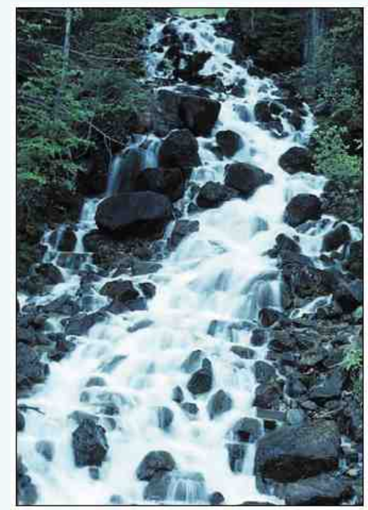
a) hydraulic parameters

e.g.: …



b) stream morphology

e.g.: …



c) material (eroding into and/or transporting)

Hydraulics and channel geometry

a) **gradient (L):** ▽ height/distance (cm-m/km)
↓ in L downstr.

b) **discharge (Q):** Q (m^3/s) = U (m/s) x A (m^2)
Q ↑ downstr. - from collection of tributaries

c) **depth (d) & width (w):** channel size ↑ downstr.; also, ↑ A = ↓ friction; larger streams have higher U

d) **velocity (U):** average U ↑ downstr.; less bed roughness, higher Q, larger channels (overcome the lower L)

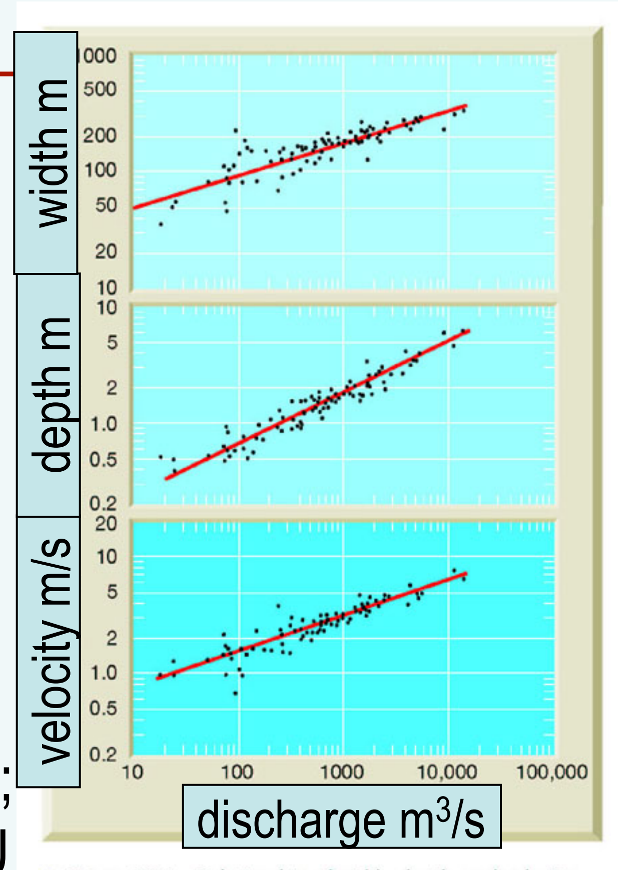
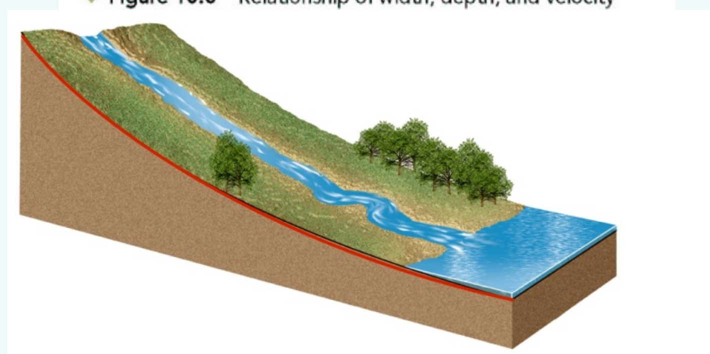


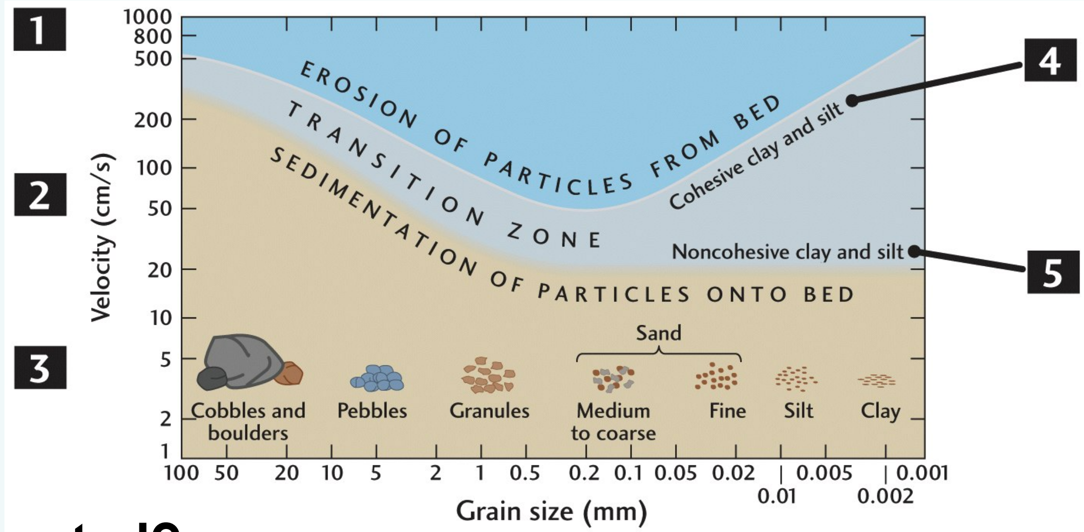
Figure 10.6 Relationship of width, depth, and velocity



How is sediment transported ?

Streams erode and transport colossal amounts of sediments; *continents → oceans*

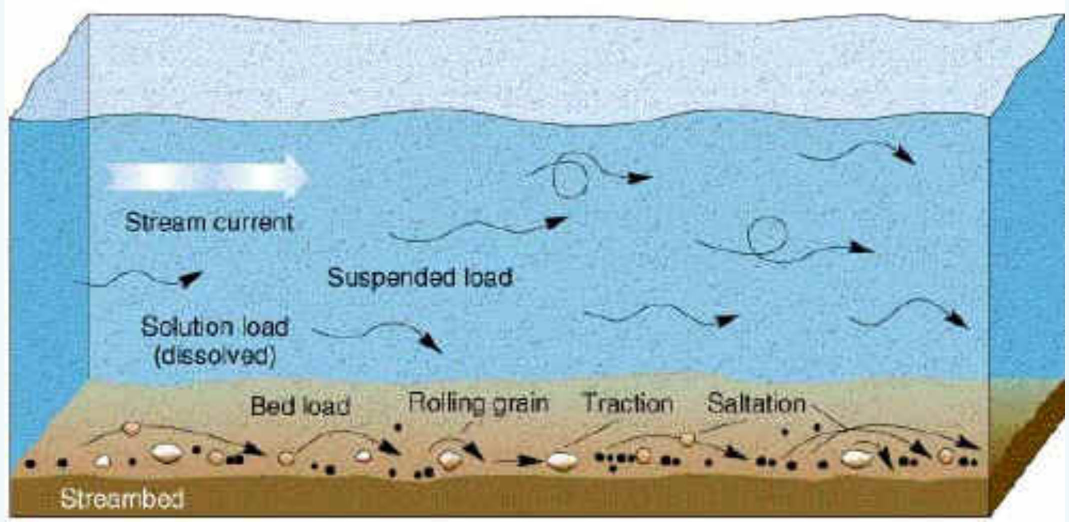
Largest river on planet?



How are these sediment transported?

Modes of sediment transport

Traction – along the bed
Saltation – periodically lifts off into the flow
Suspension – in the fluid
Solution – dissolved load

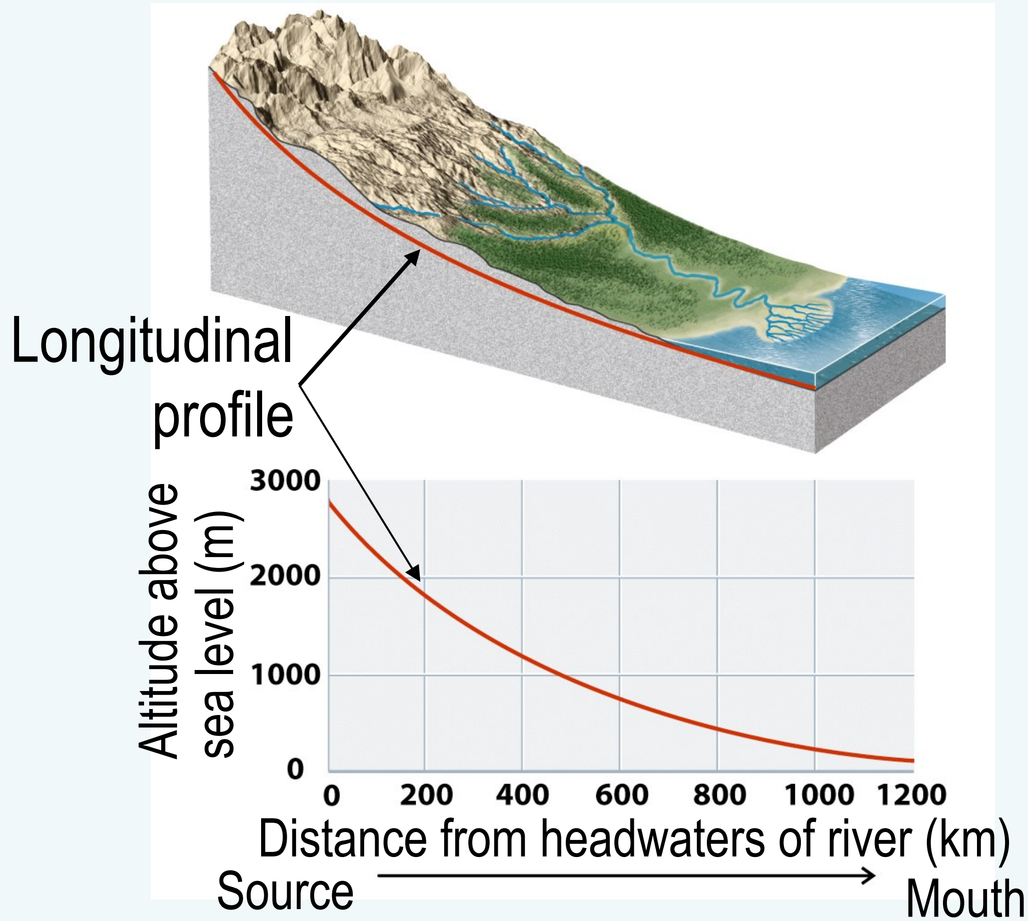


Base level and graded streams

Interplay between erosion, transport, and deposition → f(base level)

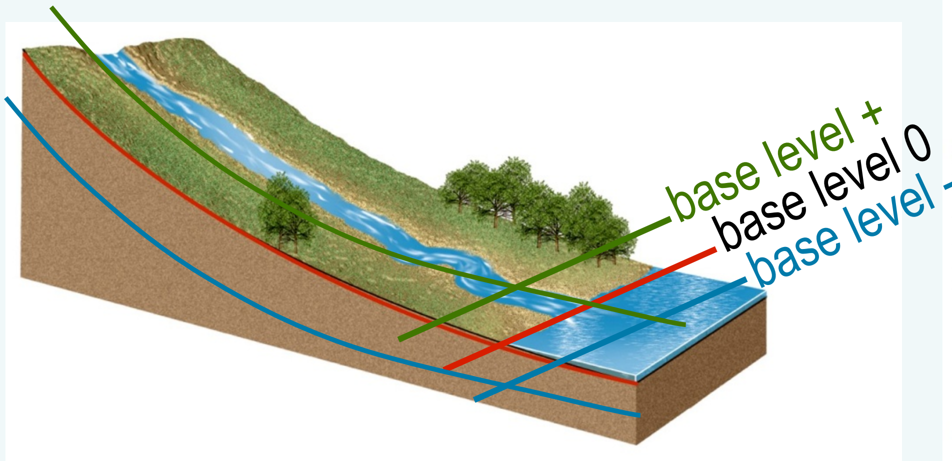
Base level: level below which a stream cannot erode
e.g. sea level, lake level, dam

Graded stream: equilibrium state where channel geometry and hydraulic parameter enable the stream to transport its load with neither deposition nor erosion.



Base level and graded streams

Changes in base level result in an adjustment in the longitudinal profile

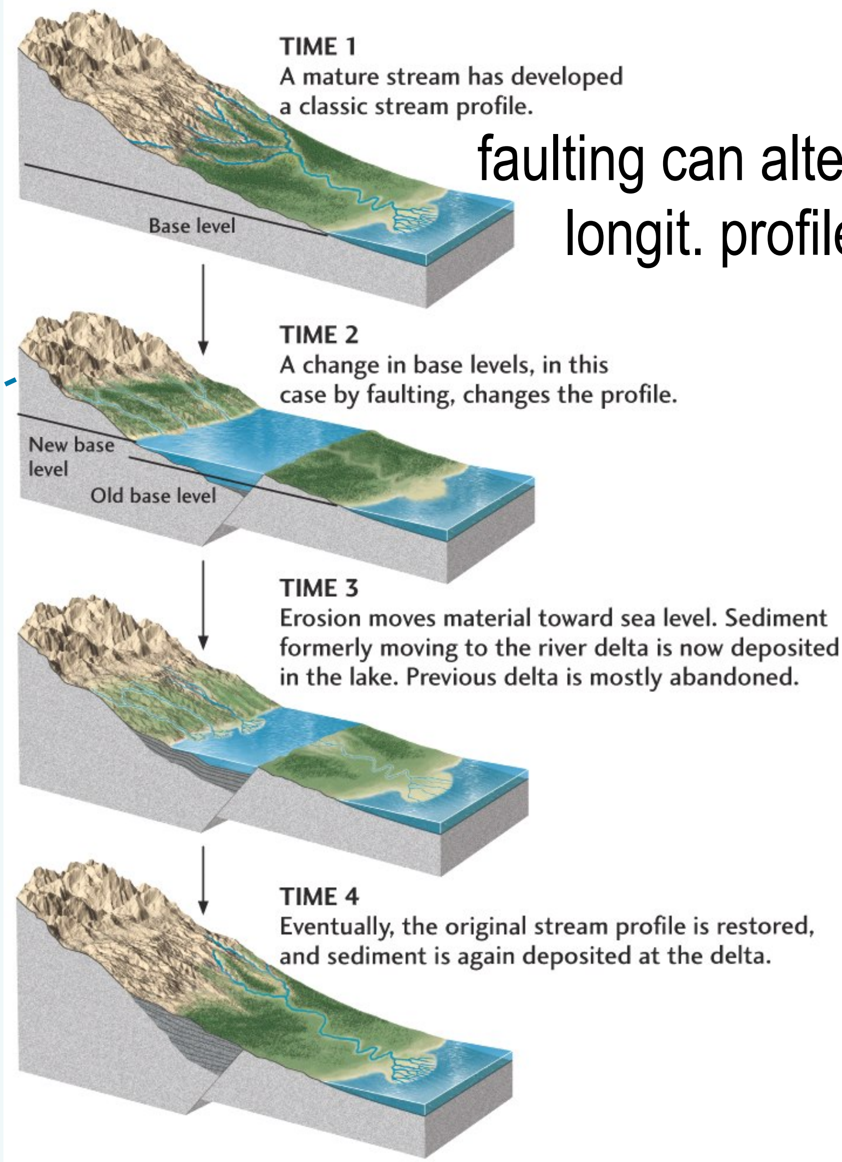


1) Increase in base level

longitudinal prof. adjusts by: ↑ deposition

2) Decrease in base level

longitudinal prof. adjusts by: ↑ erosion
↑ transport



faulting can alter longit. profile

Types of stream systems

Two end-members: 1) BRAIDED rivers and 2) MEANDERING rivers

Type of channel pattern based on:

- discharge
- sediment size and load
- gradient
- climate (precipitation, vegetation, temperature, …)
- subsidence rate
- bank stability

Channel pattern

Braided if interlacing network of channels

Braided rivers

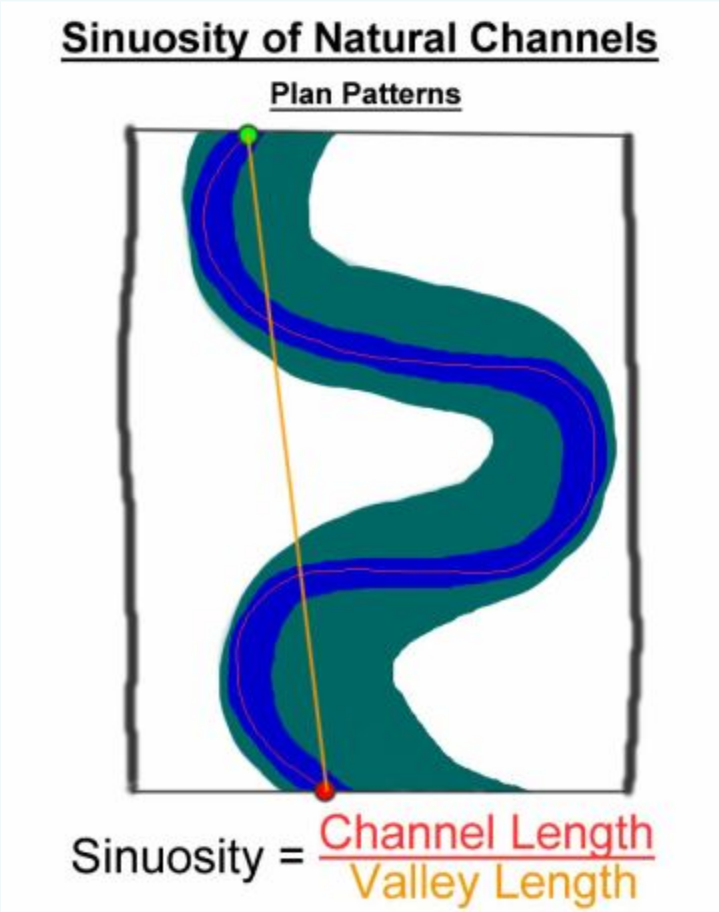
rapid and irregular discharge
higher slopes
erodible banks
rapid channel migration
abundant coarse sediment
in-channel bars (lense of sediment)

** video*

Channel pattern

Meandering if channel sinuosity* > 1.5

** channel length / length of valley*



Channel pattern

Meandering if channel sinuosity* > 1.5

** channel length / length of valley*

Meandering rivers

lower and more regular discharge

lower slopes

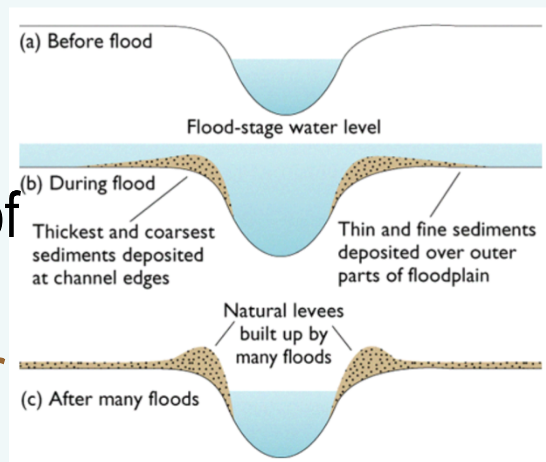
cohesive banks

slower more regular channel migration

abundant fine sediment

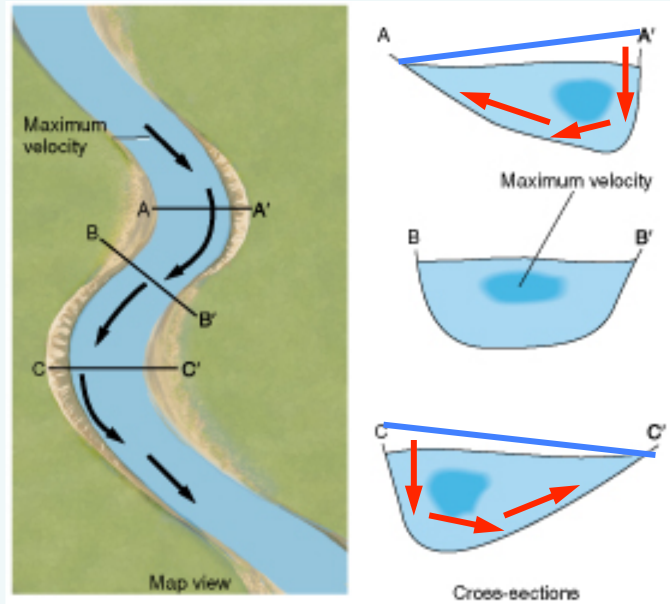
+

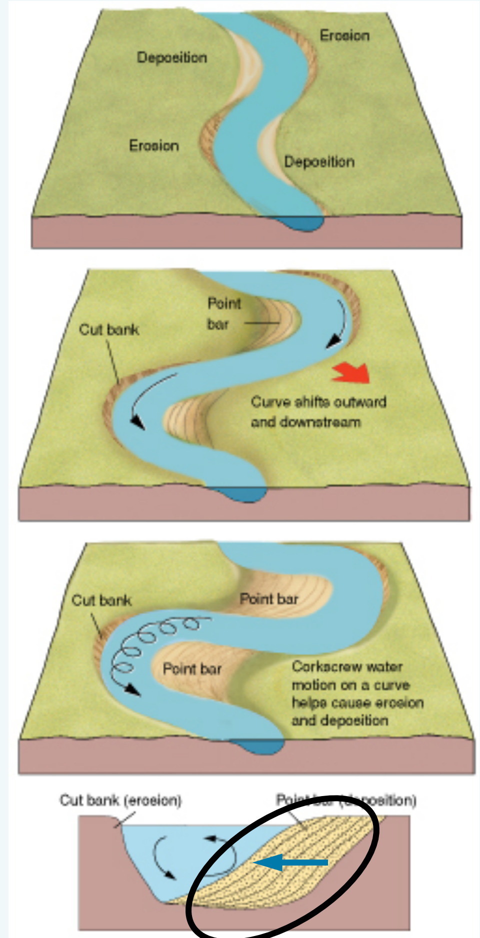
well developed levees (build-up of river banks → foods) & point bar deposits



Channel pattern

Flow in meandering channels





Cross-channel flow (secondary flow)

+

Downstream flow

Helicoidal flow pattern

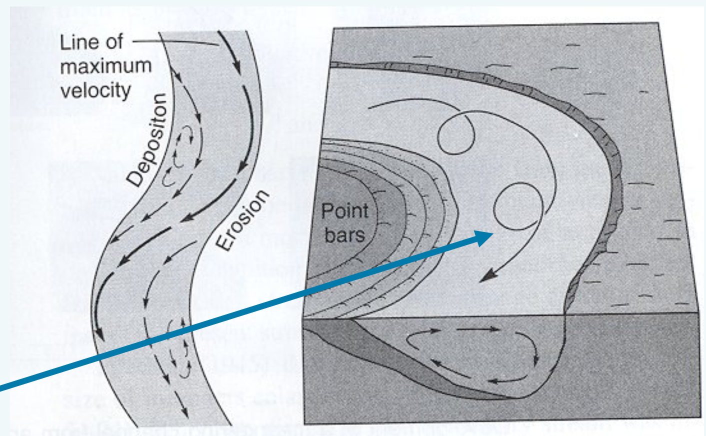
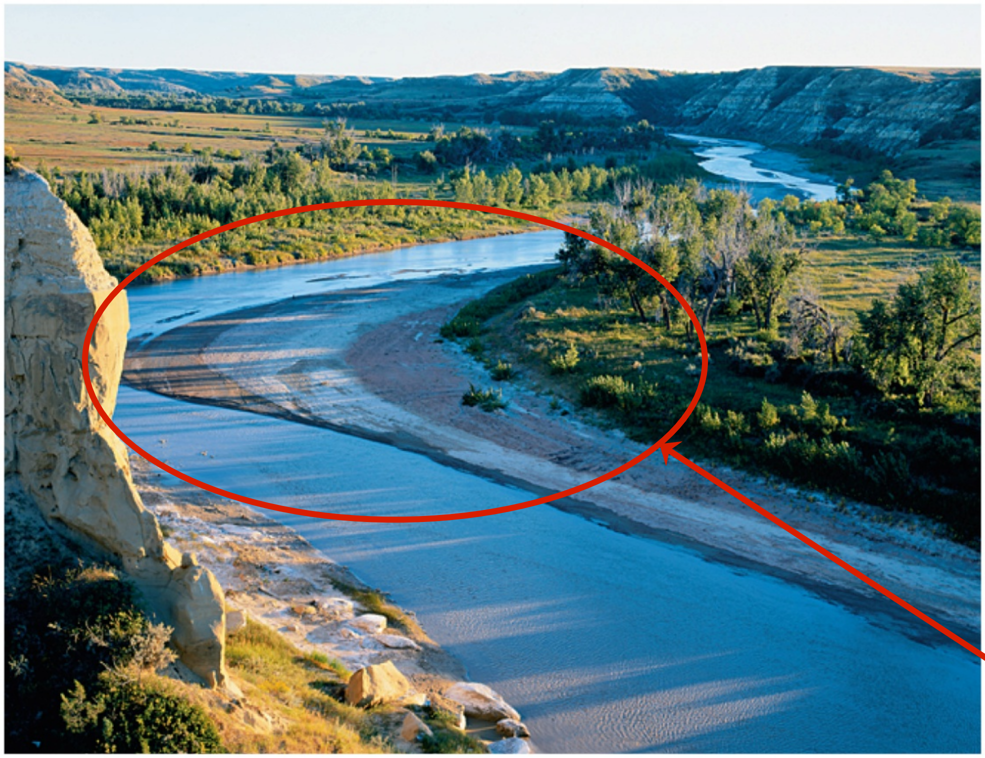


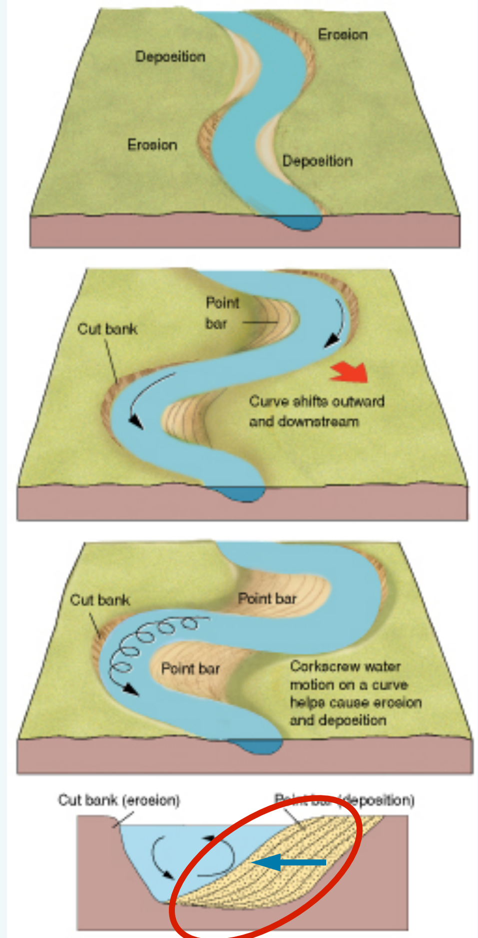
FIGURE 5–25
Helical flow in a meander.

point bar deposits along inner bank

Channel pattern

Consequence of secondary flow =
POINT BAR deposits


Point bar



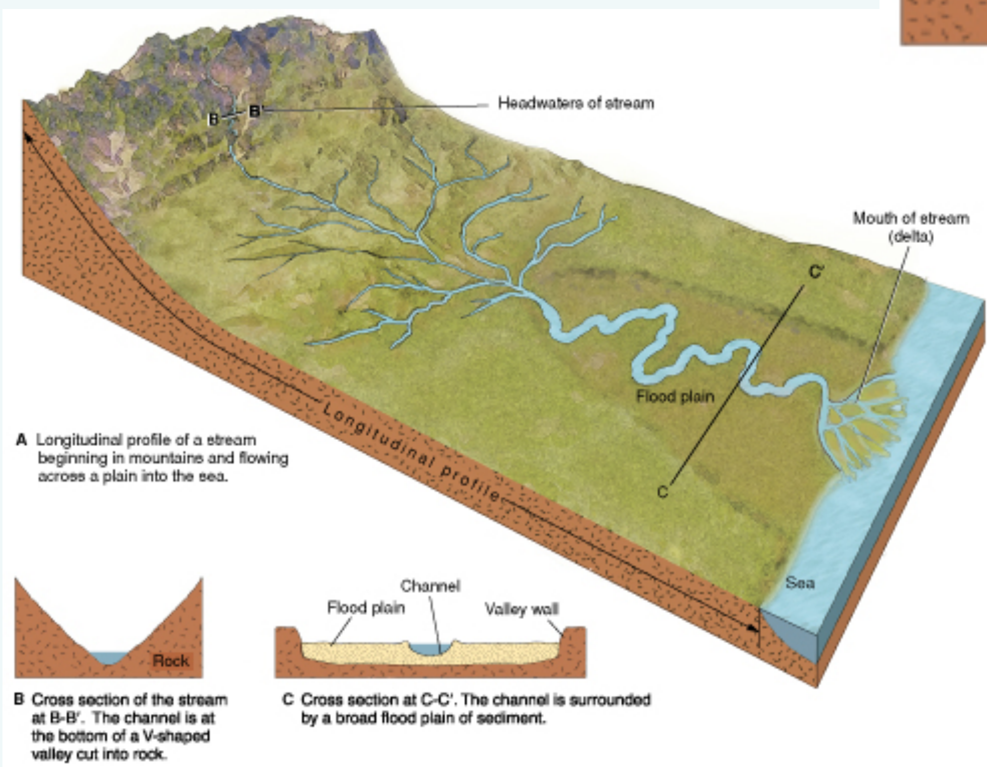
point bar deposits along inner bank

* *animation*

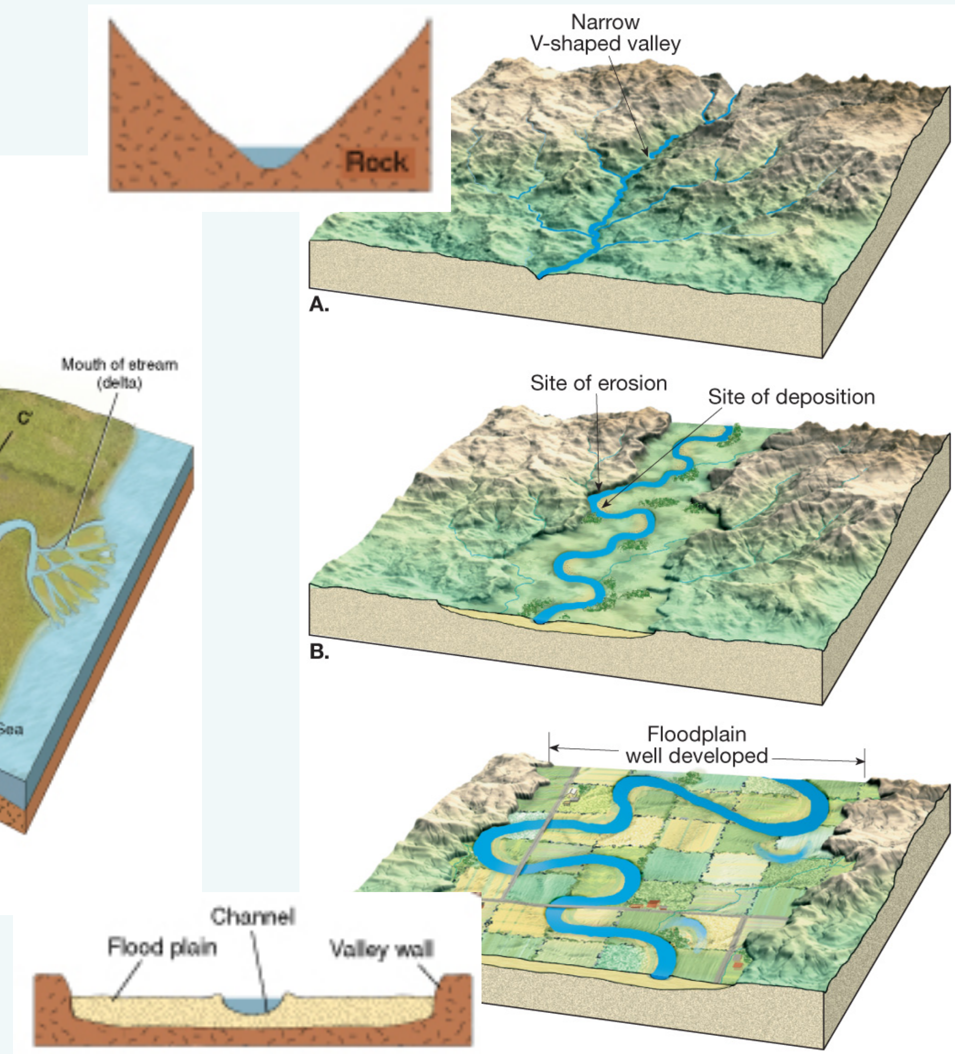
Channel pattern – evolution (in space and time)

Slope? / Sinuosity? / Floodplain?

Space



Time



Floods - when streams leave their beds

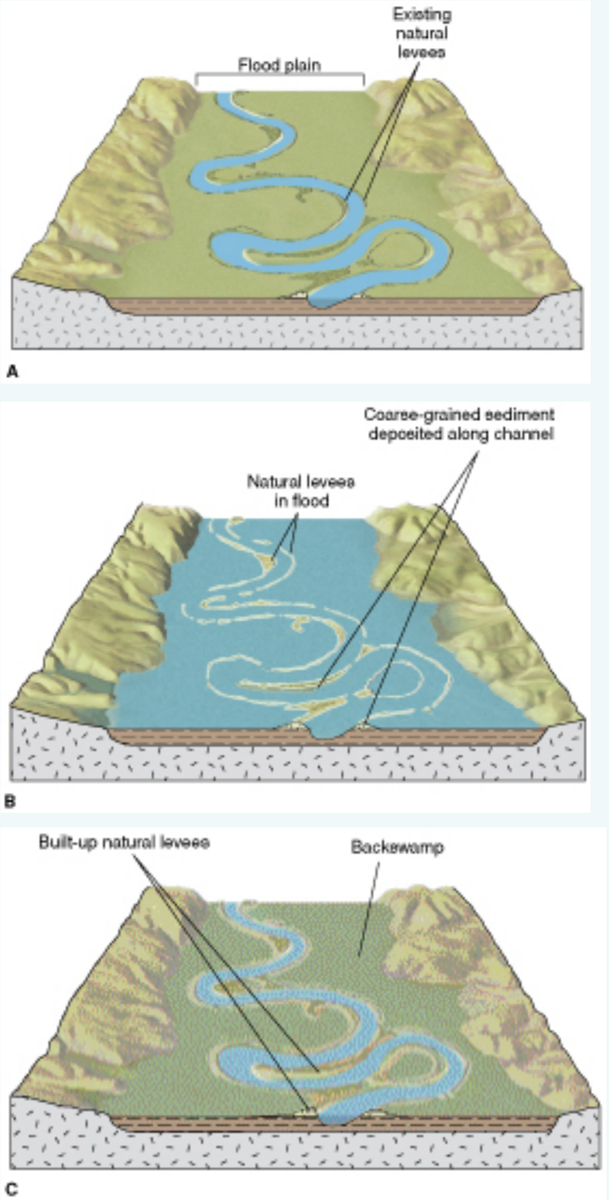
Flood – when discharge > stream capacity
→ stream overflows its banks
NATURAL process

Causes -

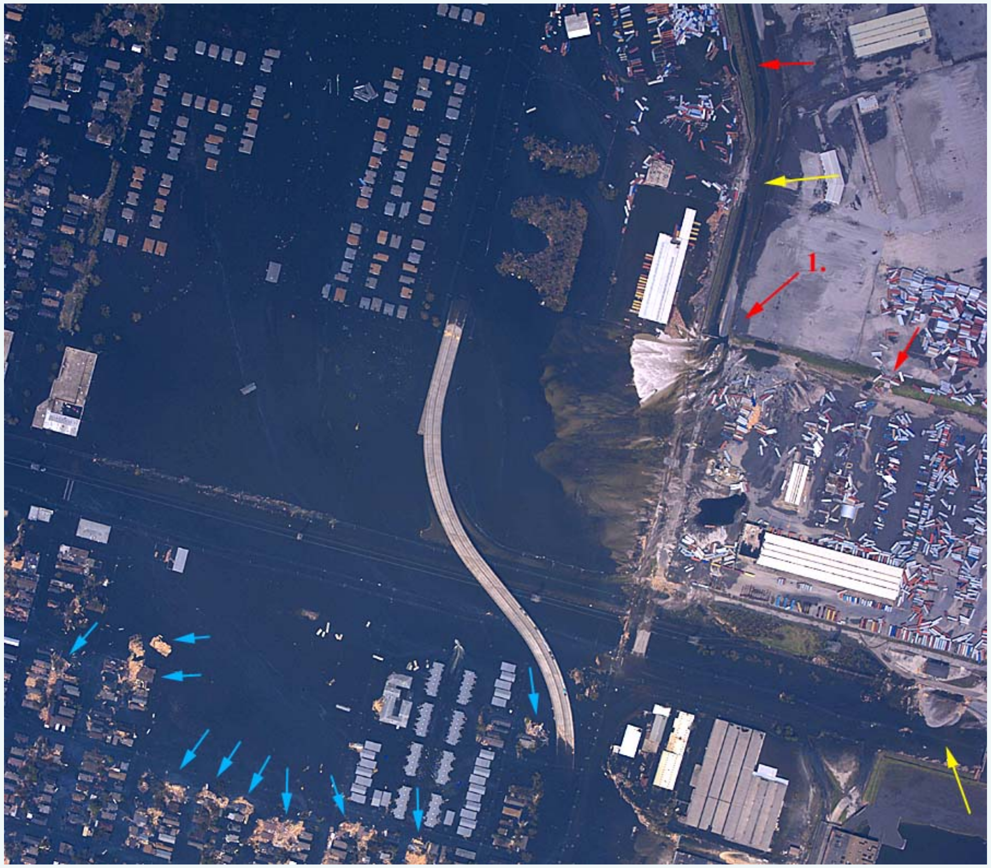
- ...
- rapid snow melt
- ice-jam
- ...

Contributing factors:

- low infiltration rate
- topography



Floods - when streams leave their beds



Artificial levee breach – New Orleans
(Hurricane Katrina, August 2005)

Ice-jam

Flood consequences –

HUMAN impact

- life loss, disease, water contamination

MATERIAL impact

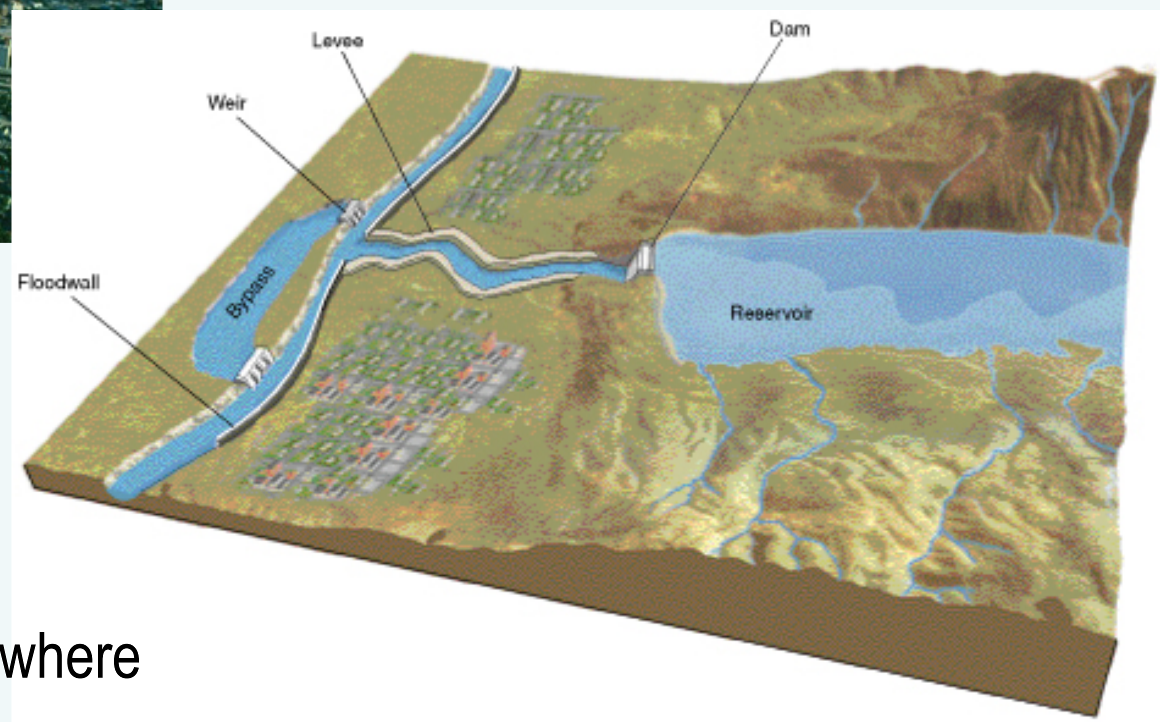
- destruction or damage of property and infrastructures

LANDSCAPE modification

- erosion (high discharge)
- sedimentation (reduced velocity → channel invades floodplain)
- channel avulsion

Floods - when streams leave their beds

Impacts – One of the most deadly and destructive geologic hazard; Why?



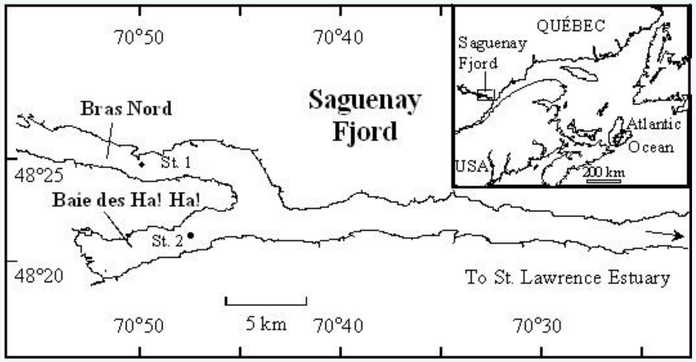
Controls -

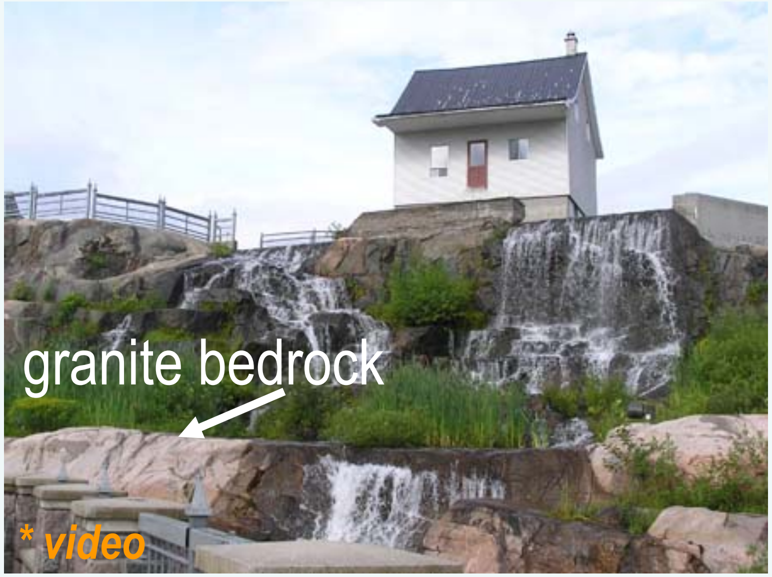
- artificial levees
- dams
- channelization
- … nothing & live elsewhere

Floods – The 1996 SAGUENAY RIVER flood

Area received 260 mm of rain in 2 days!

700 million $ in damage!





Floods – other recent examples

Gaspésie – mid-December 2010

- over 250mm of rain in 3 days
- hundreds of evacuated
- flooded roads, houses, etc.
- $$$ in damage

Rivière-au-Renard

Bonaventure

Floods – other recent examples

Australia – January 2011

Brisbane, QNLD

A few numbers …

- 343mm of rain in 24 hrs (some areas)
- monsoon rains linked to La Niña
- 1 million km^2 affected (larger than B.C.)
- 200 000 people affected; 22 towns
- 10 billion$; Australia's most costly natural disaster
- 45% increase in global grain price (damaged Australian wheat crop)


Coraki, NSW