G202 River Systems

I. General Concepts

A. The work of running water
1. rivers = "gutters" of continents
2. river work = erosion and transportation
3. driving force: climate and gravity
4. result: sculpting of the landscape

B. Fluvial - is a generic term that refers to processes pertaining to running surface water

1. Overland flow- general sheet flow of water downslope.
2. Streamflow- channelized concentration of flowing surface water.

C. Topographic Considerations

1. Valley- lowlying area that is totally or partially occupied by a stream channel

2. Interfluve- the high land above valley sides that separates adjacent valleys ("between rivers")

a. drainage divides - hill or ridge areas that separate watersheds

D. Running water and erosion

1. Erosion = denudation and stripping of land surface

2. Erosion Processes

a. Rain impact or splash erosion

(1) controls
(a) vegetative cover < rain impact
(b) infiltration capacity of ground (permeability)

b. Sheet Erosion-
(1) overland flow as sheets of water on earth's surface

c. Rill Erosion-
(1) channel erosion on scale of inches to feet

d. Gully Erosion-
(1) larger, channelize flows carrying the potential for large amount of sediment.

(2) Deforestation and devegetation can result in greatly accelerating the erosion process.

(a) construction / clearing
(b) forest fires

3. Erosion by stream flow: large-scale channels

a. Hydraulic Shear Force- shear force exerted by moving water on sediment particles, has drag effect on moving sediment.

b. Abrasion- impact from collisions of pebbles and boulders during stream transport result in physical fragmentation.

c. Corrosion: chemical erosion by river water

E. Sreamflow Parameters: (controlling factors)

1. Discharge of channel: volume of water flowing in channel per unit time (e.g. Gal / min)
   a. precipitation controlled - the amount of discharge in a river is controlled by climate and rainfall patterns

   b. "Normal Discharge" - volume of water is contained well within the river channel boundaries

   c. "Flood Discharge" - volume of water exceeds the carrying capacity of the river channel, and the water overflows onto the surrounding floodplain

2. Velocity- rate of water flow (V=distance / time)
   a. Controlling factors

      (1) Gradient of the channel or the longitudinal slope of the stream channel;
         (a) > Gradient > Velocity, < Gradient < Velocity
      (2) bed roughness / friction
         (a) > roughness < velocity, <roughness > velocity

3. Stream Gradient Calculations
   a. Gradient = rise / run = change is elevation per unit horizontal distance
      (1) find two contour lines that cross the stream channel
      (2) determine the elevation difference between the two contour lines by looking at the contour interval
      (3) measure the channel distance between the two contour lines
      (4) calculate the gradient

4. Flow path:
   a. turbulent flow: irregular swirls and eddies in the current path

F. Transportation of Sediment

1. Dissolved Load: dissolved minerals and salts are carried in water as ions in solution.

2. Suspended Load: fine particles of clay and siltare carried in suspension within the body of stream flow without ever touching the streambottom.

    a. Suspended load tends to comprise the largest portion of total stream load.

3. Bedload or Traction Load: sand, gravel, and boulders are commonly tranported along thestream bed interface

    a. saltation- bouncing of particles on channel bottom
    b. sliding or creep of large particles

G. Capacity vs. Competence of a Stream

1. Capacity- expression of the potential load that a stream can transport, in vol. of material per unit area.

2. Competence- the largest particle diameter that the stream is capable of transporting given its velocity and shear force

H. Deposition: sediment placed in storage (NOTE: in my short hand notation "<" is "decrease" and ">" is "increase")

1. Condition of deposition: < gradient of stream bed, < flow velocity, < velocity then < shear force and work capacity, ==== deposition.

2. Sites of deposition by rivers

    a. floodplains adjacent to river channel
    b. lakes / reservoirs
    c. deltas: sediment deposited at the mouth's of rivers
    d. ocean basins, continental shelf
    e. "ALLUVIUM": stream deposited debris.

II. River Morphology

A. Plan shape of channel
1. straight channels
2. meandering = sinuous, single channel
3. braided: multiple channels

B. Drainage Patterns: often strongly controlled by underlying geology/structural relationships.

1. Dendritic- branch-like pattern with random merging of streams at acute angles. Most common pattern, commonly associated with relatively homogenous underlying geology

2. Trellis Pattern- rectangular drainage pattern with elongated valleys connected in trellis fashion by cross-cutting water gaps. Commonly found in fold belts with alternating layers of erosionally soft, and resistant rock

3. Radial Pattern - radially away from center high point, such as a volcano.

C. River Landforms

1. Channel - the main gutter in which the water flows
2. Floodplain

    a. Floodplain- lowlying area adjacent to stream channel that is occasionally inundated with water.
        (1) technically - floods every 2-3 years, according to some river hydrologists
    b. During overbank conditions, sediments are carried out onto the floodplain, and subsequently deposited upon flood recession.

3. Meander Bend

    a. Stream Meandering: lateral erosion and movement of stream course from side to side
    b. Point Bar

        (1) Inside Meander Bends: sites of deposition via relative decrease in flow velocity, dropping load on inside bends

    c. Cut bank
        (1) Outside Meander Bends: sites of erosion via centrifugal force and helical flow pattern, high velocity/high shear zones.

4. Natural Levees: ridge of sandy sediment deposited along channel sides during flood event

5. Oxbow Lakes: meander loops that are cut off by erosion and isolated as lakes

6. Terraces - abandoned floodplains
    a. the floodplains are left stranded high and dry as the river erodes vertically, incising a deeper part of the valley

7. Alluvial Fans - fan-shaped deposits of river sediments, typically at the mouths of steep mountain canyons
    a. sediment is deposited as the fluvial energy decreases, when the river exits the mouth of the canyon
    b. net result: deposition at mouth of canyon in fan shape

8. Deltas - fan-shaped accumulation of sediments where rivers empty into standing bodies of water
    a. deltaic deposition results from energy decrease once the river hits the quiet body of water

b. Lacustrine Deltas (deltas built by rivers flowing into lakes)
c. Marine Deltas (deltas built by rivers flowing into the ocean)
(1) e.g. the Mississippi River delta

III. Time and Evolution of Fluvial Landscapes

A. Landscape elevations and topography = function of erosion and uplift through time

1. over time, landscape will undergo denudation unless rejuvenated by uplift and / or tectonic process

B. Base Level Of River

1. Ultimate level to which river will erode = sea level
2. Surface above base level = site of erosion
3. Surface below base level = site of deposition

C. Landscape Maturity

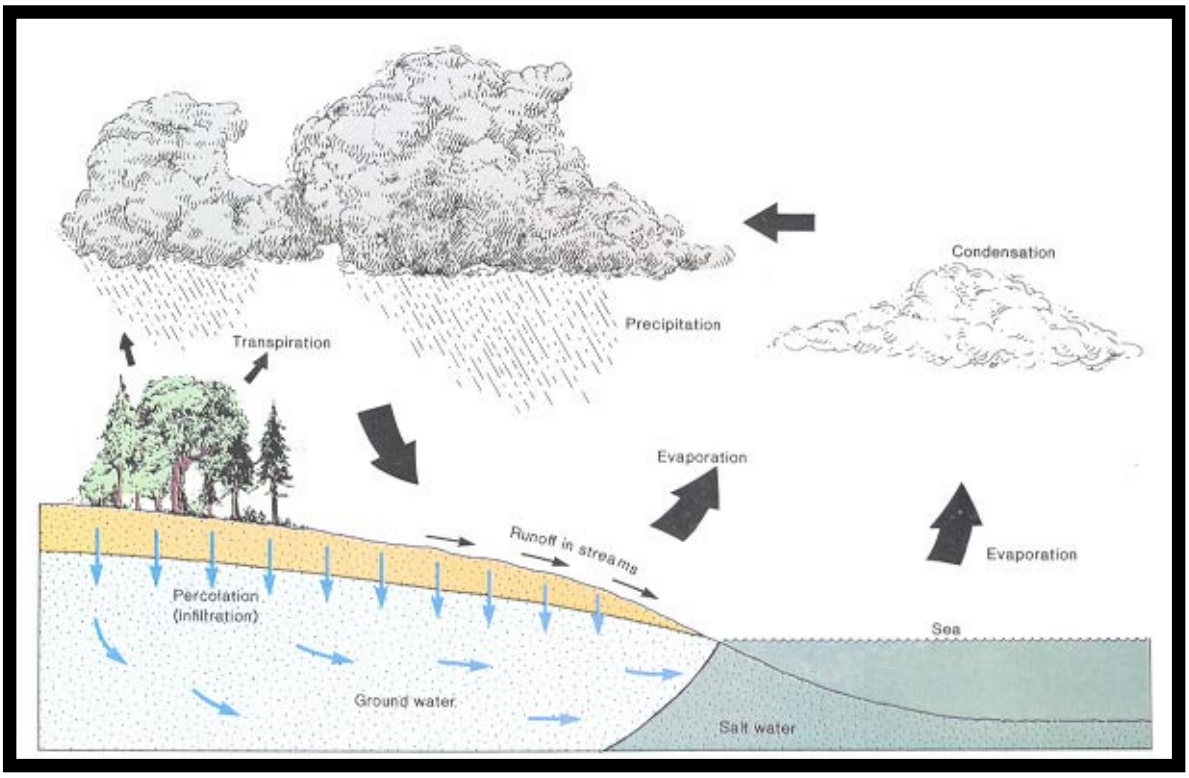
1. Youth: straight, steep and rapid
2. Mature: sinuous, moderate slopes
3. Old Age: very flat topography, oxbow lakes, highly meandering

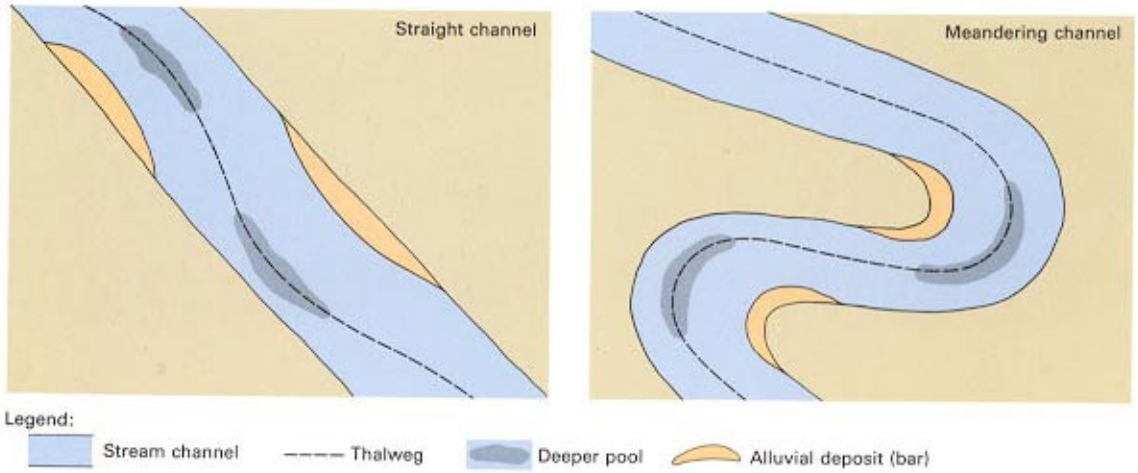
IV. Watershed Analysis

A. Watershed = a unit of land that collects all the surface drainage for a given stream or river
1. Defined on the basis of drainage divides or ridges that separate surface flow into each adjoining watershed

B. Water Budgets
1. Calculations of water volumes in the form of precipitation and surface runoff into streams
2. Important for landuse / water resource issues

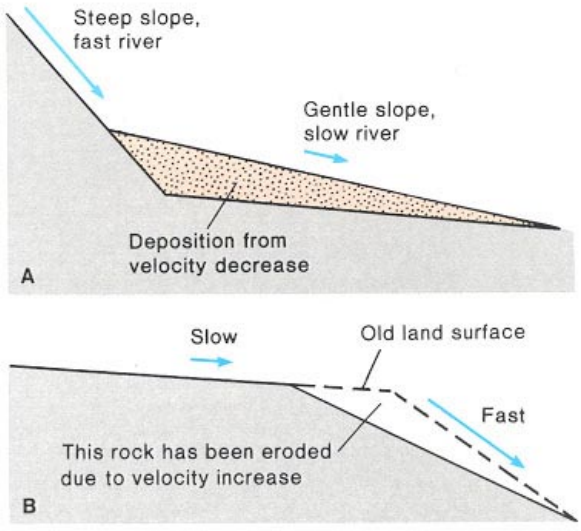
Hydrologic Cycle and Fluvial Systems

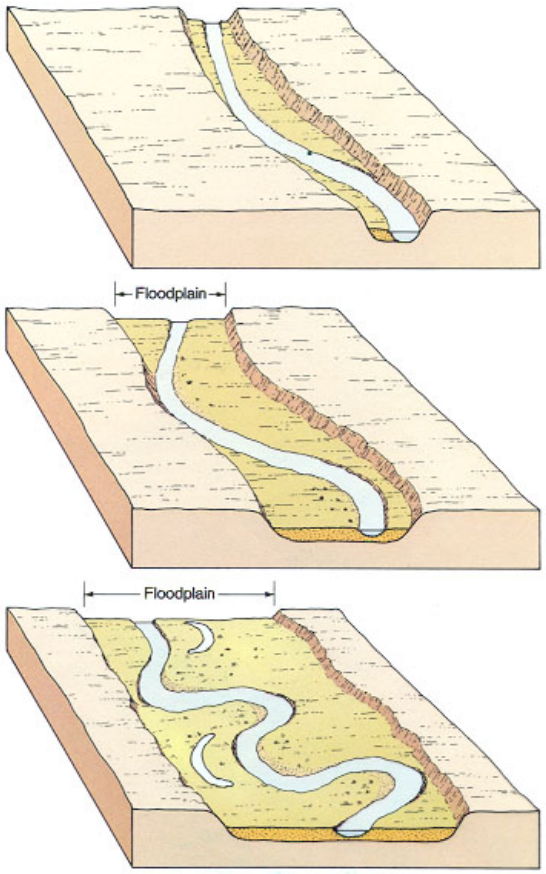




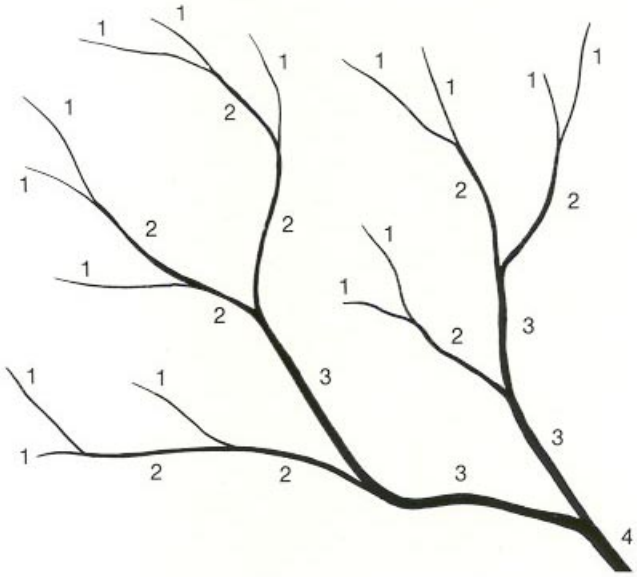
Point Bars / Cut Banks

Alluvial Fans

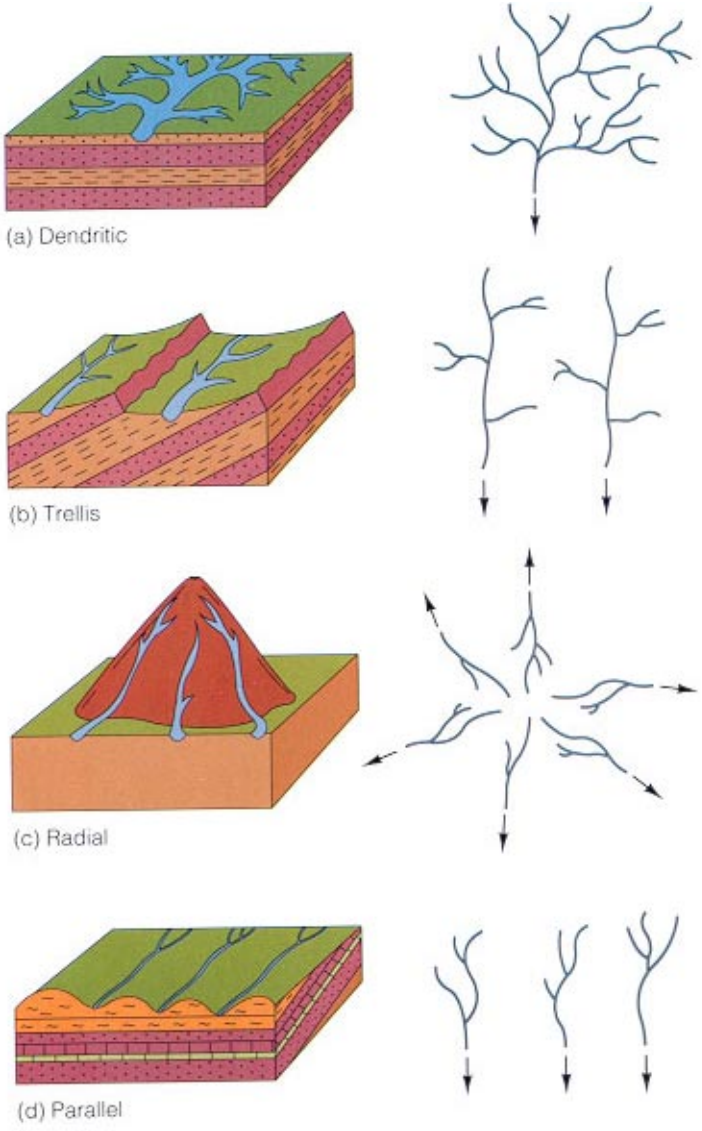




Floodplain Evolution



Strahler Stream Orders



Drainage Patterns