IOWA'S EMERGING WATER ISSUES

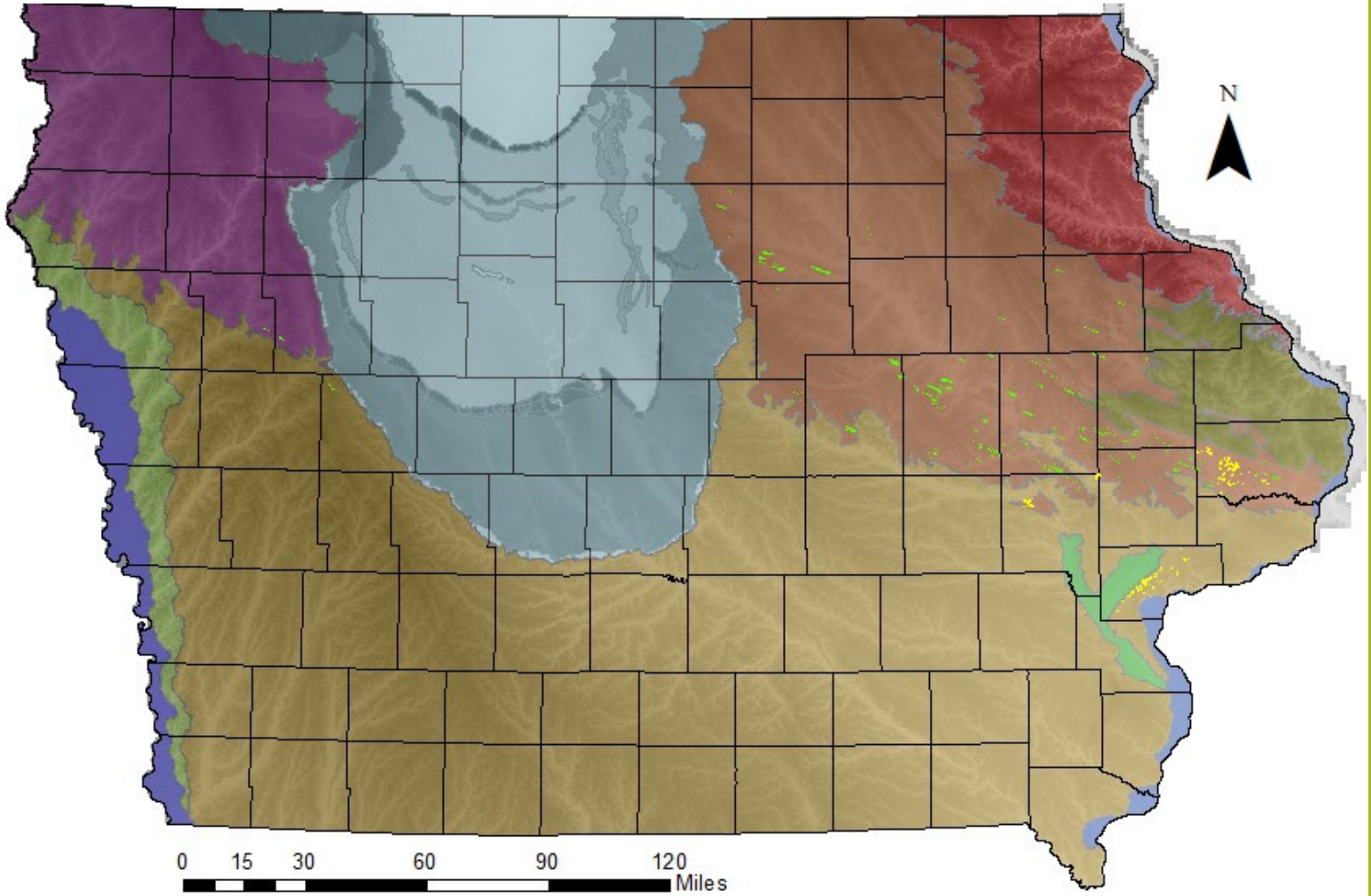
Processes, Products, Characterization, Mitigation

University of Northern Iowa – Iowa DOE – Iowa Public TV

Global Sedimentary Transport

- Rivers 85 to 90%
- Glaciers 7%
- Groundwater and Waves 1 to 2 %
- Wind and Volcano less than 1%

Geomorphology



GEOMORPHOLOGY

- Simply defined → the study of landforms

- More complete definition → the study of landforms and landscapes, the processes that produce them, and how they evolve (change) through time

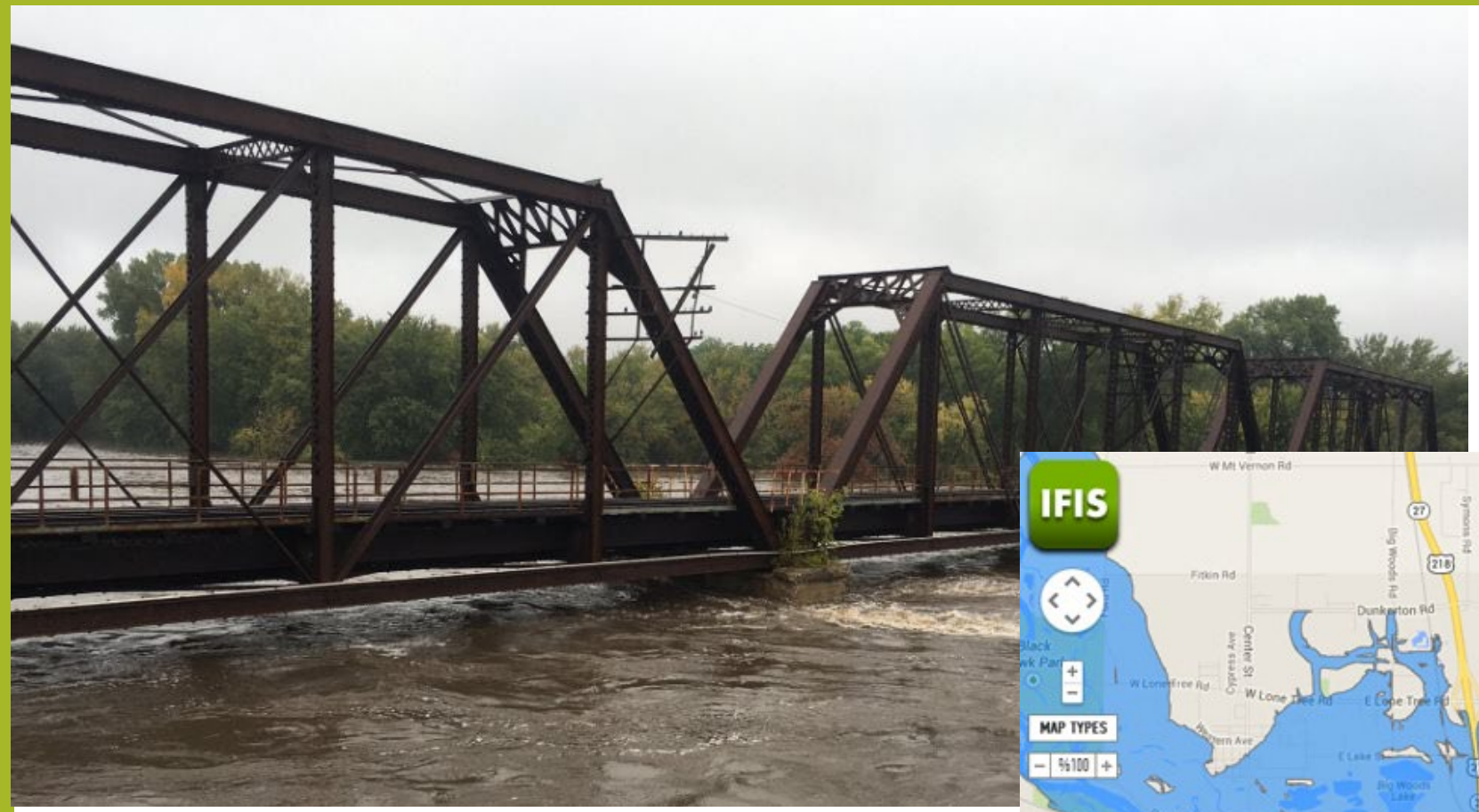
Fluvial Geomorphology

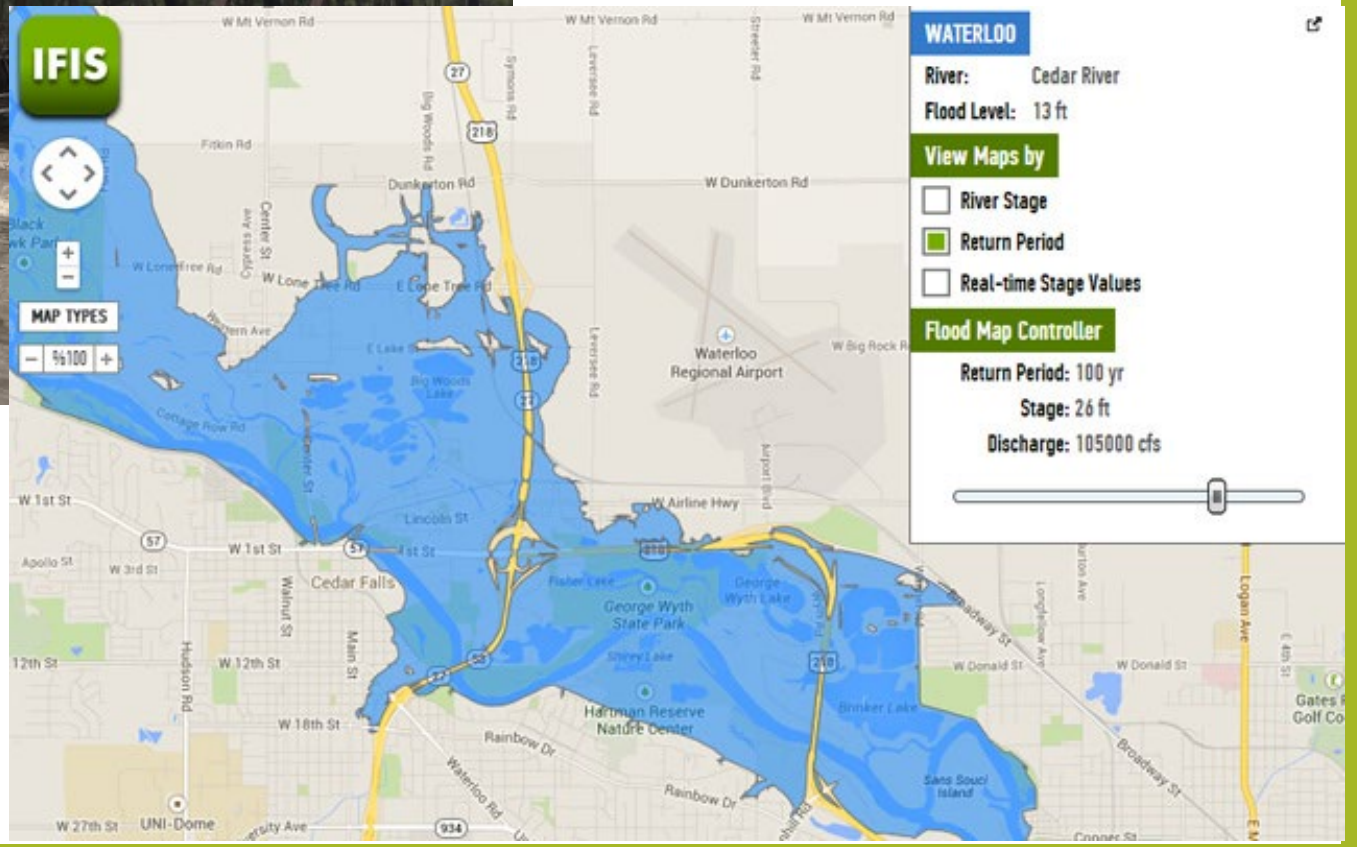
- Critically important to understanding
  - Landscape evolution
  - Human landscape connectivity

- Regional (tectonic and climatic) vs.
  Local controls (discharge, Vegetation, sediment type/load)

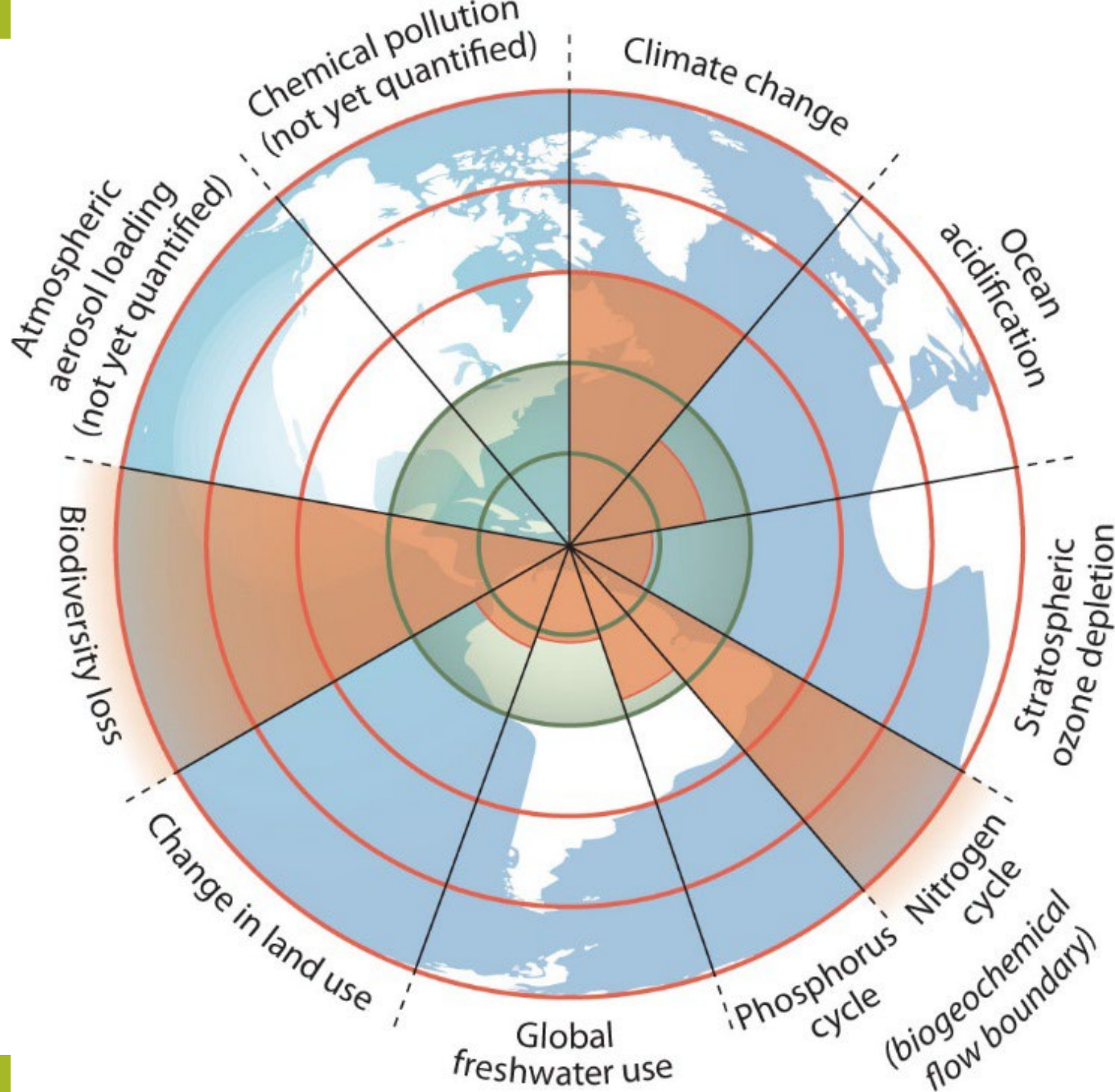
Anthropogenic vs. Natural change

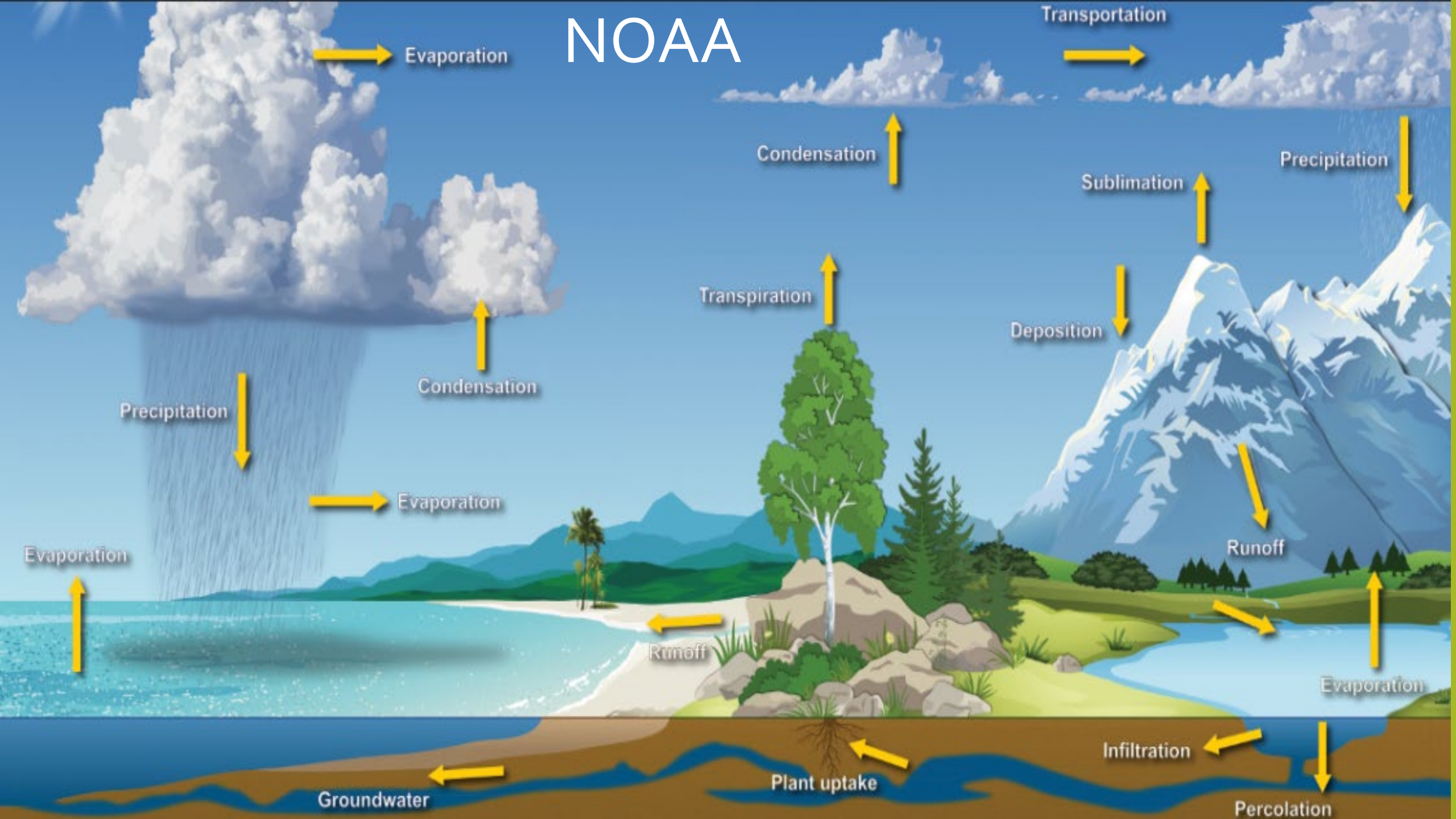
Floods

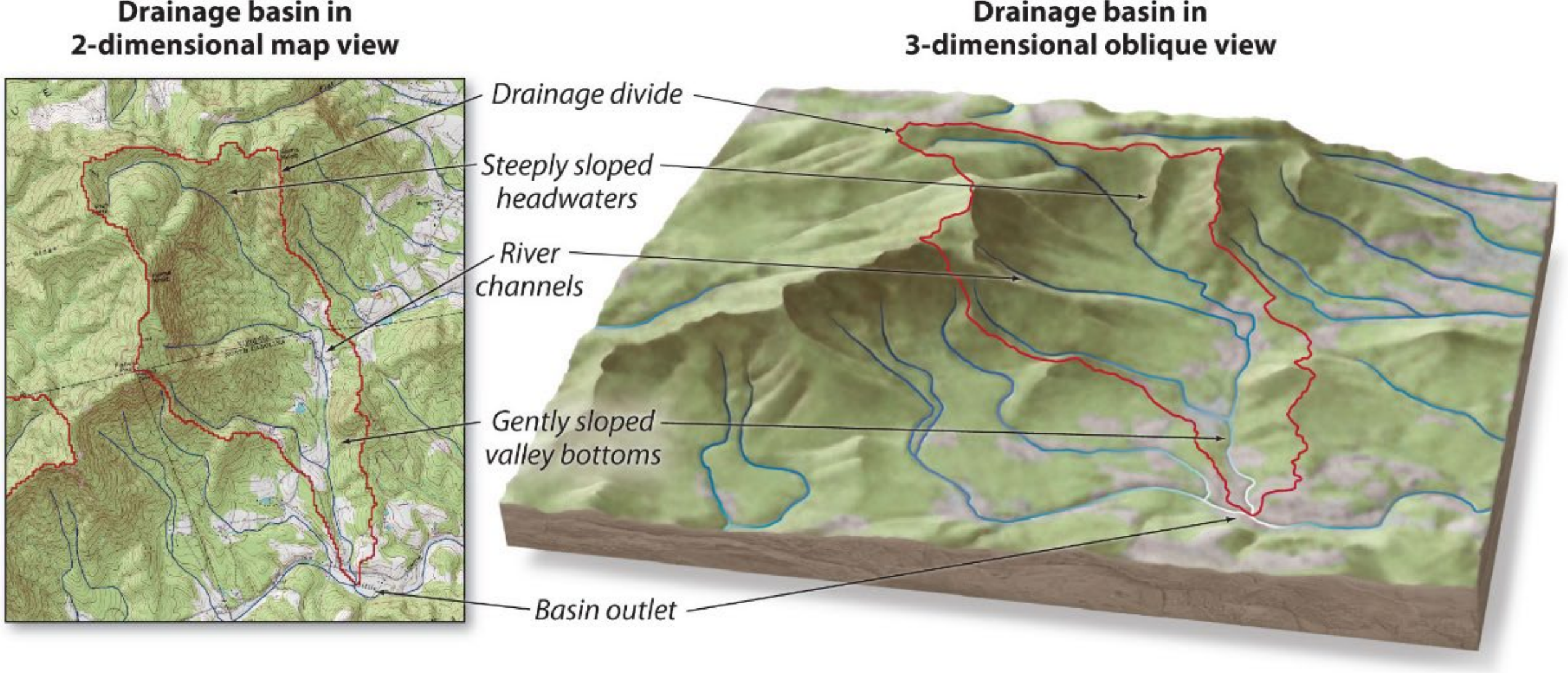



IFIS
MAP TYPES
WATERLOO
River: Cedar River
Flood Level: 13 ft
View Maps by
River Stage
Return Period
Real-time Stage Values
Flood Map Controller
Return Period: 100 yr
Stage: 26 ft
Discharge: 105000 cfs
Cedar Falls
Waterloo Regional Airport
George Wyth State Park
Hartman Reserve Nature Center
UNI-Dome
W Mt Vernon Rd
Dunkerton Rd
W Dunkerton Rd
W 1st St
W 12th St
W 18th St
W Airline Hwy
Lincoln St
Rainbow Dr
Broadway St
W Donald St

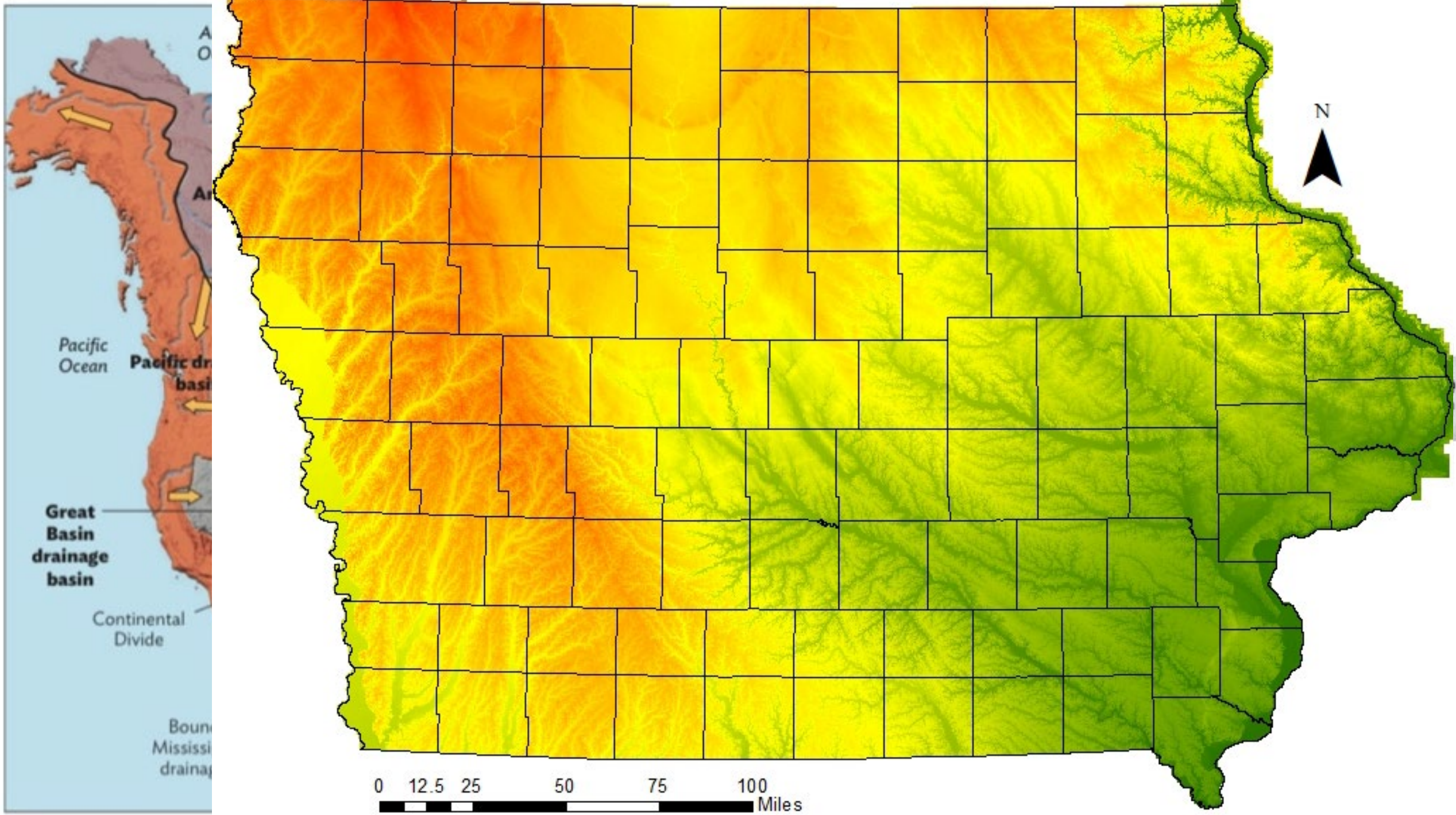
Rockstrom, 2009, Nature




NOAA
Evaporation
Transportation
Condensation
Precipitation
Sublimation
Transpiration
Deposition
Condensation
Precipitation
Evaporation
Evaporation
Runoff
Runoff
Evaporation
Infiltration
Plant uptake
Groundwater
Percolation



Drainage basins are the upslope area draining to a point along a stream and are a primary way by which geomorphologists subdivide landscapes. Separated by **drainage divides,** rivers and streams in drainage basins convey sediment from generally steep uplands to generally less steep lowlands and then onto an outlet defined as the end of the basin. Drainage basins contain streams of various sizes as well as smaller tributary drainage basins.

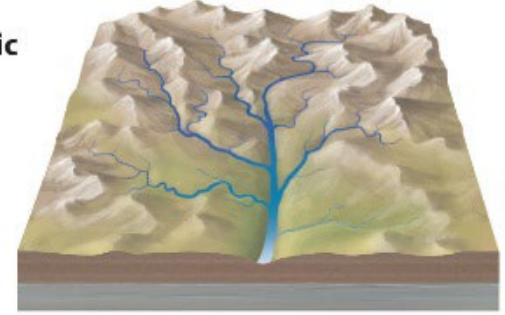

Pacific Ocean
Great Basin drainage basin
Continental Divide
N
0 12.5 25 50 75 100
Miles

Drainage patterns

Common in Iowa

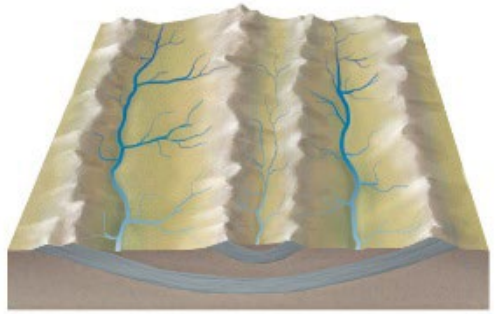
Dendritic

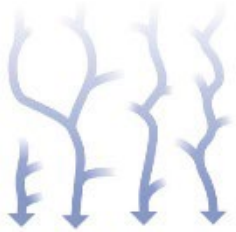
Dendritic



Dendritic drainage patterns are typical of channel networks developing on relatively homogeneous substrates, such as flat-lying sandstones of the Appalachian Plateau in western Pennsylvania.

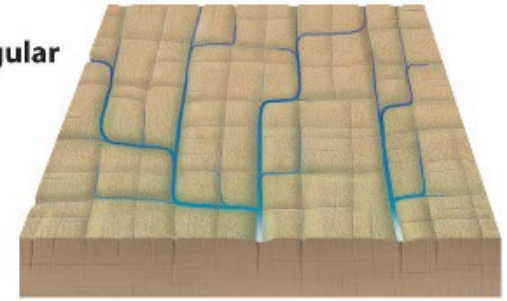
Trellis

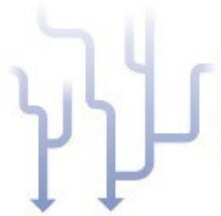




Trellis drainage networks strongly reflect underlying geologic structure and the strength contrast between different rock types. The Valley and Ridge Province of the Appalachian Mountains is a prime example of trellis drainage with easily eroded shales and limestones defining long, linear valleys where the main drainages flow. Shorter tributaries drain resistant sandstones and quartzites holding up the ridges.

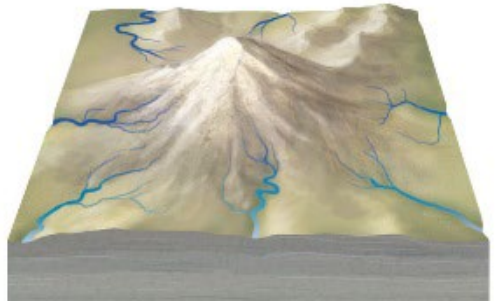
Rectangular

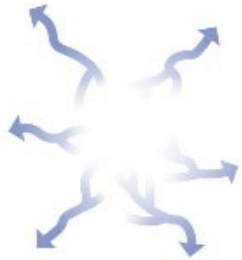




Rectangular drainage networks reflect strong control of stream orientation by the orientation of **joint sets** in lithologically uniform rocks. Rectangular networks are common in areas underlain by carbonate rocks, such as the North America midcontinent, where chemical weathering caused by enhanced groundwater flow etches joint patterns.

Radial





Radial drainage is most commonly found on volcanoes, where the shape of the constructed landform controls the orientation of stream channels. Stratovolcanoes, such as Mount Rainier, have radial drainage networks.

Sediment sourced from upland erosion (70%)

Sediment sourced from tributaries (20%)

Sediment sourced from landslides (10%)

Width of the arrows is proportional to the size of the source/sink.

Sources
Sinks

Sources
Sinks

An example sediment budget; values are different for every basin.

Sediment stored as colluvium at the base of hillslopes (50%)

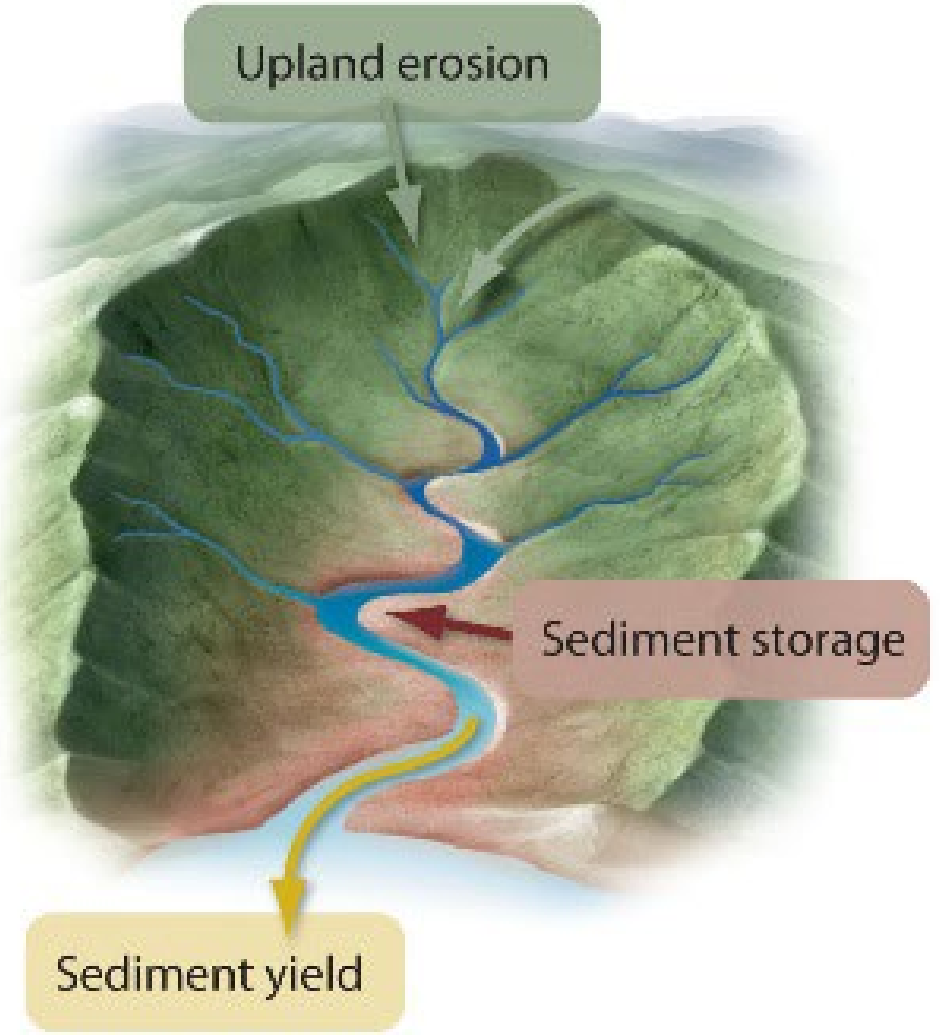
Sediment stored in valley-bottom terraces (30%)

Sediment yielded at river mouth (20%)

100 50 0

Percent of sediment budget

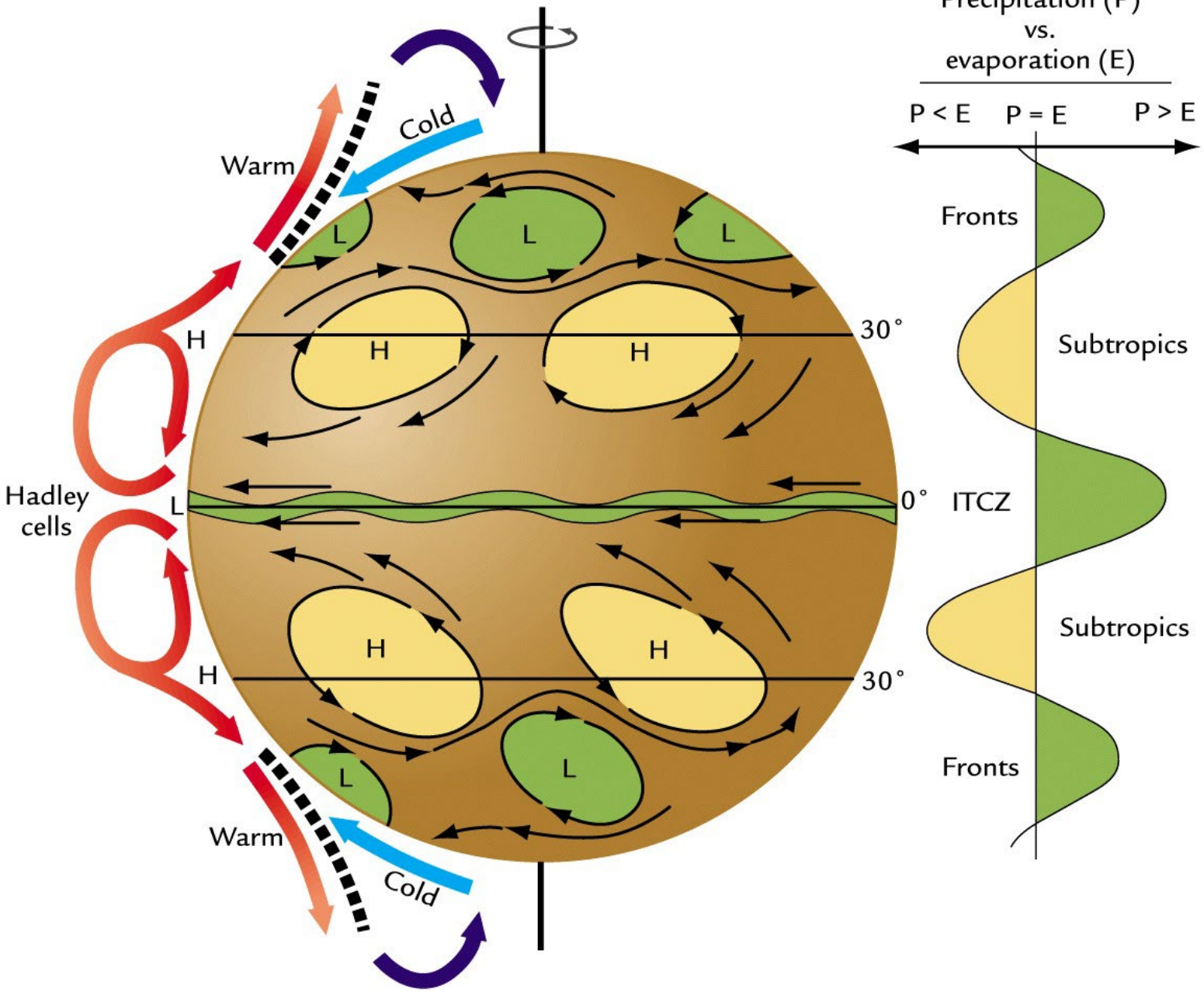
Sediment sources **Sediment sinks**



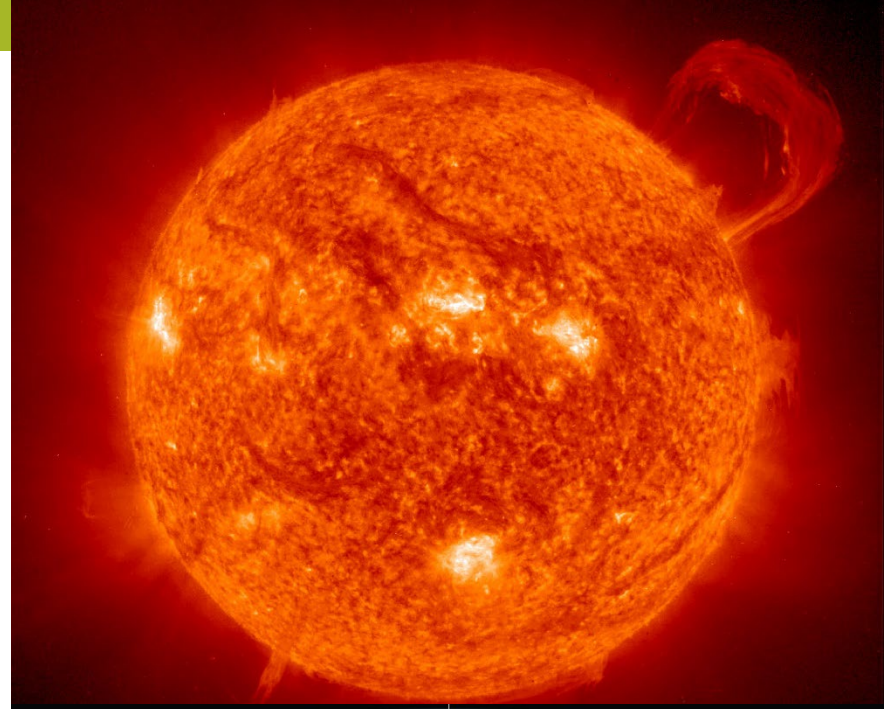
River Variables – Complex/Dynamic Systems

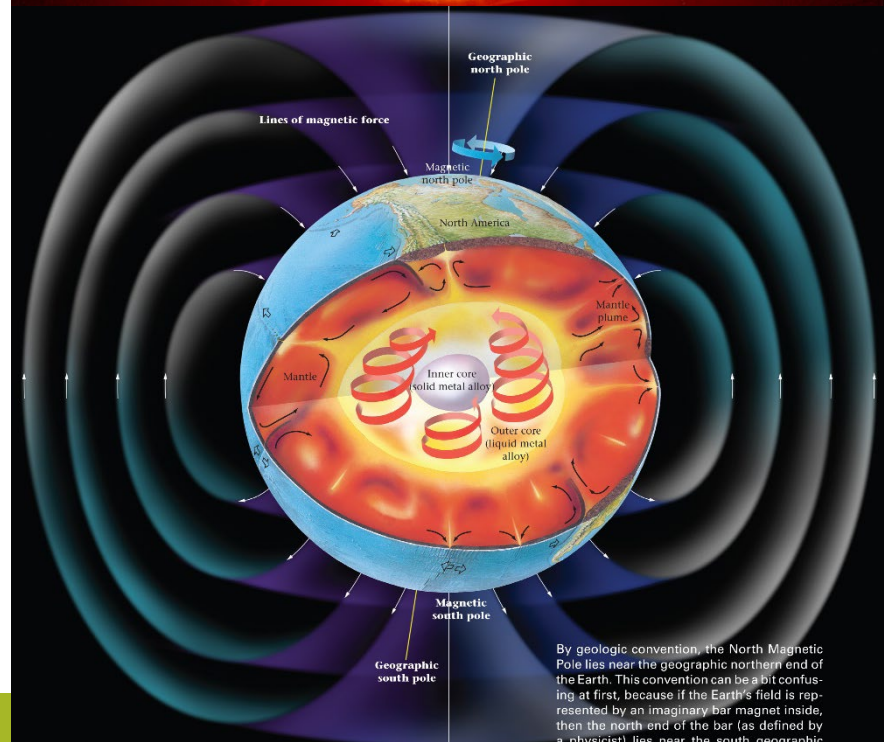
1. Stream velocity (m/s) or (ft/s)
2. Discharge (m^3/s) or (ft^3/s)
3. Gradient
4. Channel size and shape
5. Sediment load
6. Geologic environment
7. Vegetation
8. Anthropogenic modification
9 Hydrologic system/climate

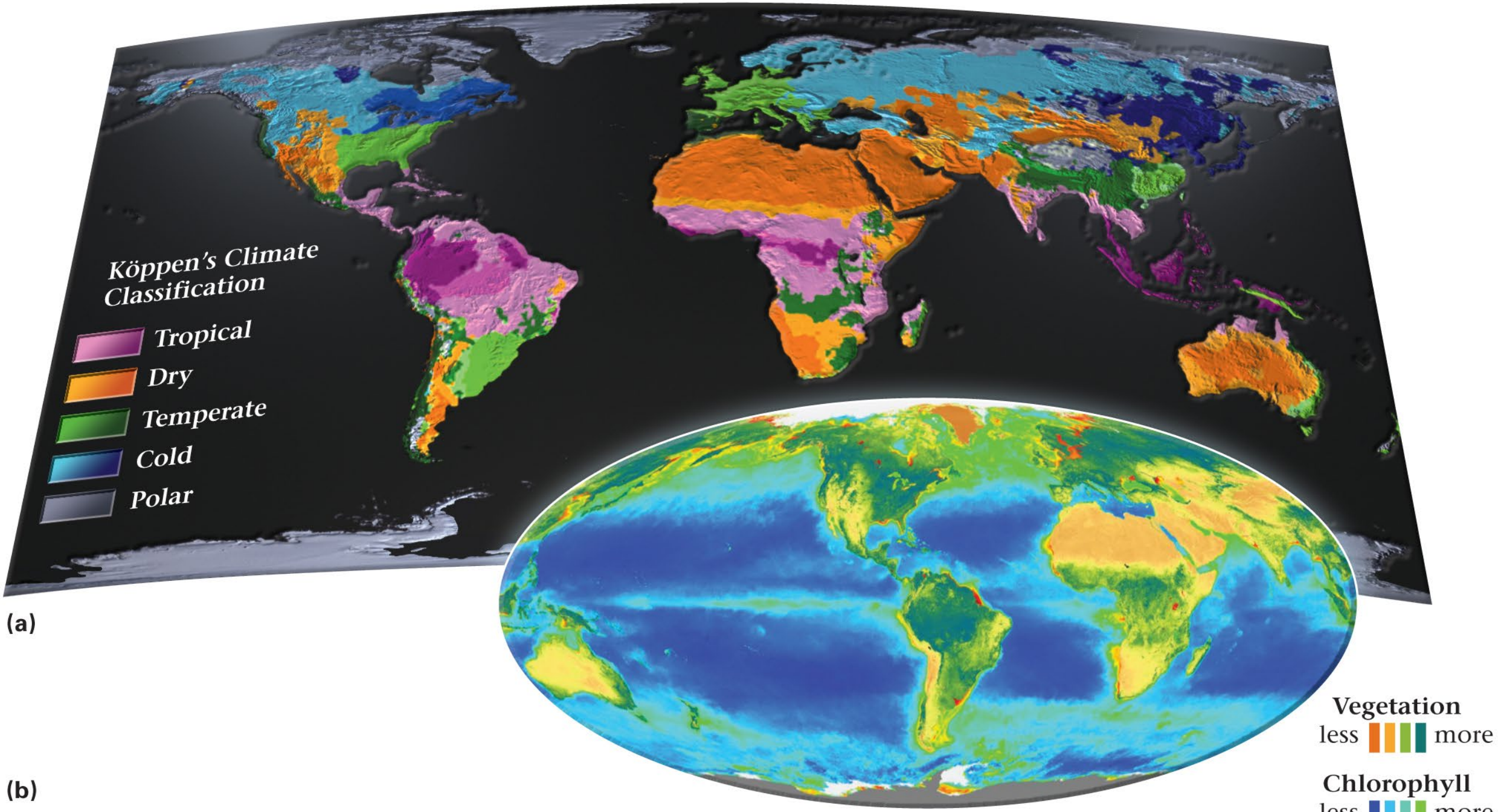
ENERGY


Warm
Cold
L
L
L
H
H
H
30°
Hadley cells
L
0°
ITCZ
H
H
H
30°
L
L
Warm
Cold

Precipitation (P)
vs.
evaporation (E)
P < E
P = E
P > E
Fronts
Subtropics
ITCZ
Subtropics
Fronts




Geographic north pole
Lines of magnetic force
Magnetic north pole
North America
Mantle plume
Mantle
Inner core solid metal alloy
Outer core (liquid metal alloy)
Magnetic south pole
Geographic south pole
By geologic convention, the North Magnetic Pole lies near the geographic northern end of the Earth. This convention can be a bit confusing at first, because if the Earth's field is represented by an imaginary bar magnet inside, then the north end of the bar (as defined by


Köppen's Climate Classification
Tropical
Dry
Temperate
Cold
Polar
(a)
(b)
Vegetation
less
more
Chlorophyll
less
more

Energy to the Fluvial System

- The conversion of *potential energy* (solar distillation and gravity) to *kinetic energy* and *heat* powers the fluvial system.
- Most of this energy is lost to turbulent flow.
- Only 2 to 4 % of the *potential energy* of water moving downhill is converted to mechanical (erosion) work and transportation.

Variable Energy

↓

Processes

↓

Change

↓

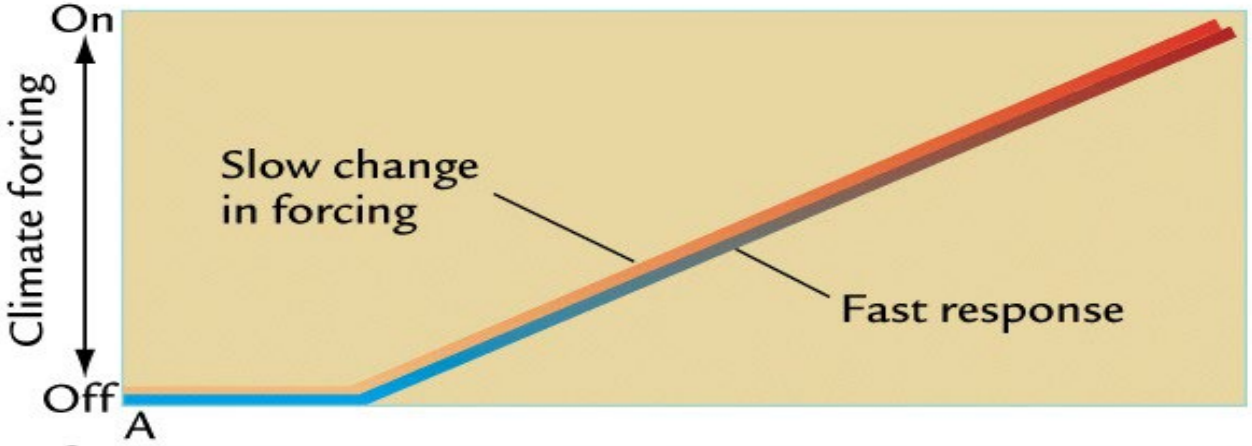
Products/landforms

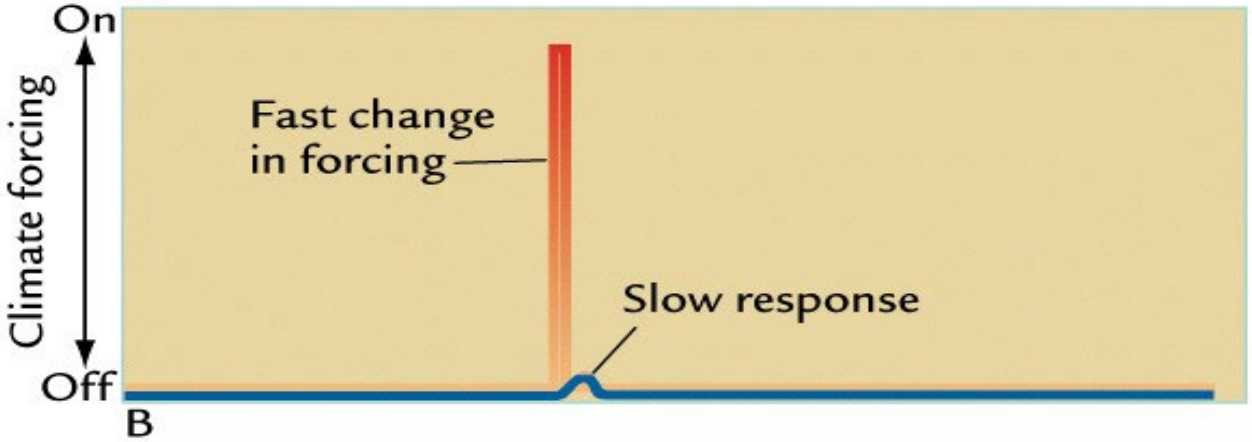
Energy considerations

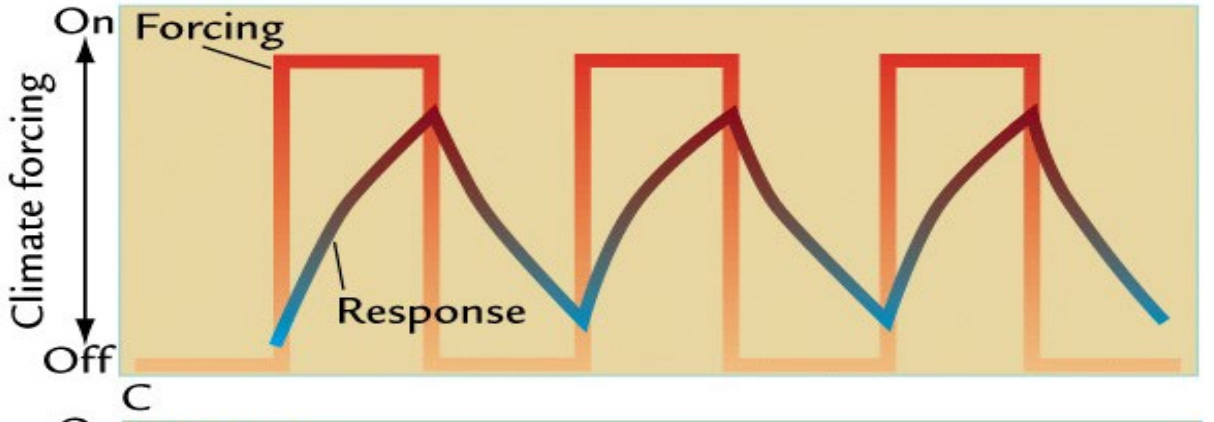
- Fluvial intensity varies among
  - climatic regions
  - along temperature gradients
  - precipitation types and volumes
  - altitude
  - vegetated zones
  - seasonal change
  - Human altered landscapes
- 1/3 of the Earth's land surface does NOT have run-off to the oceans.

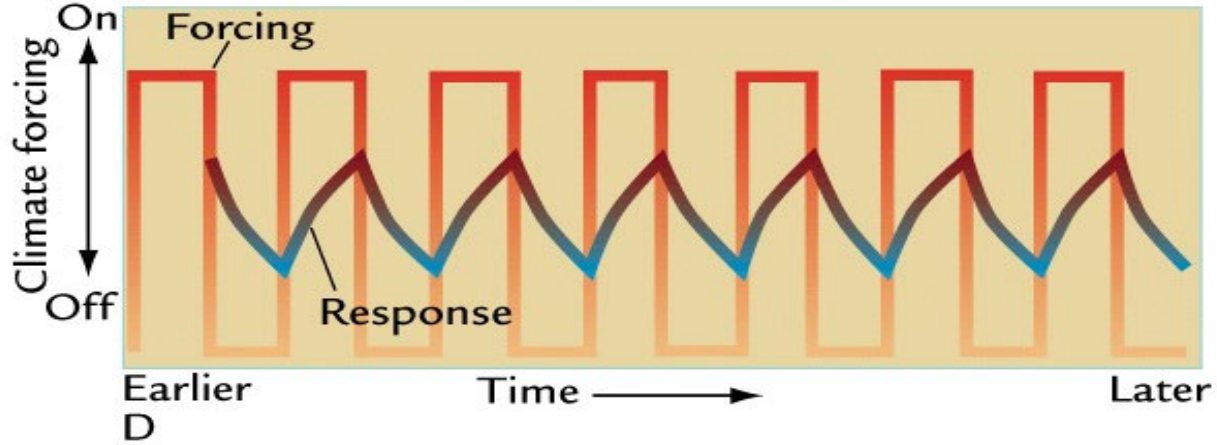
Geomorphic thresholds

Physical, Chemical and or Biological conditions that when reached or exceeded trigger a CHANGE in state or shift t a new range of average conditions.





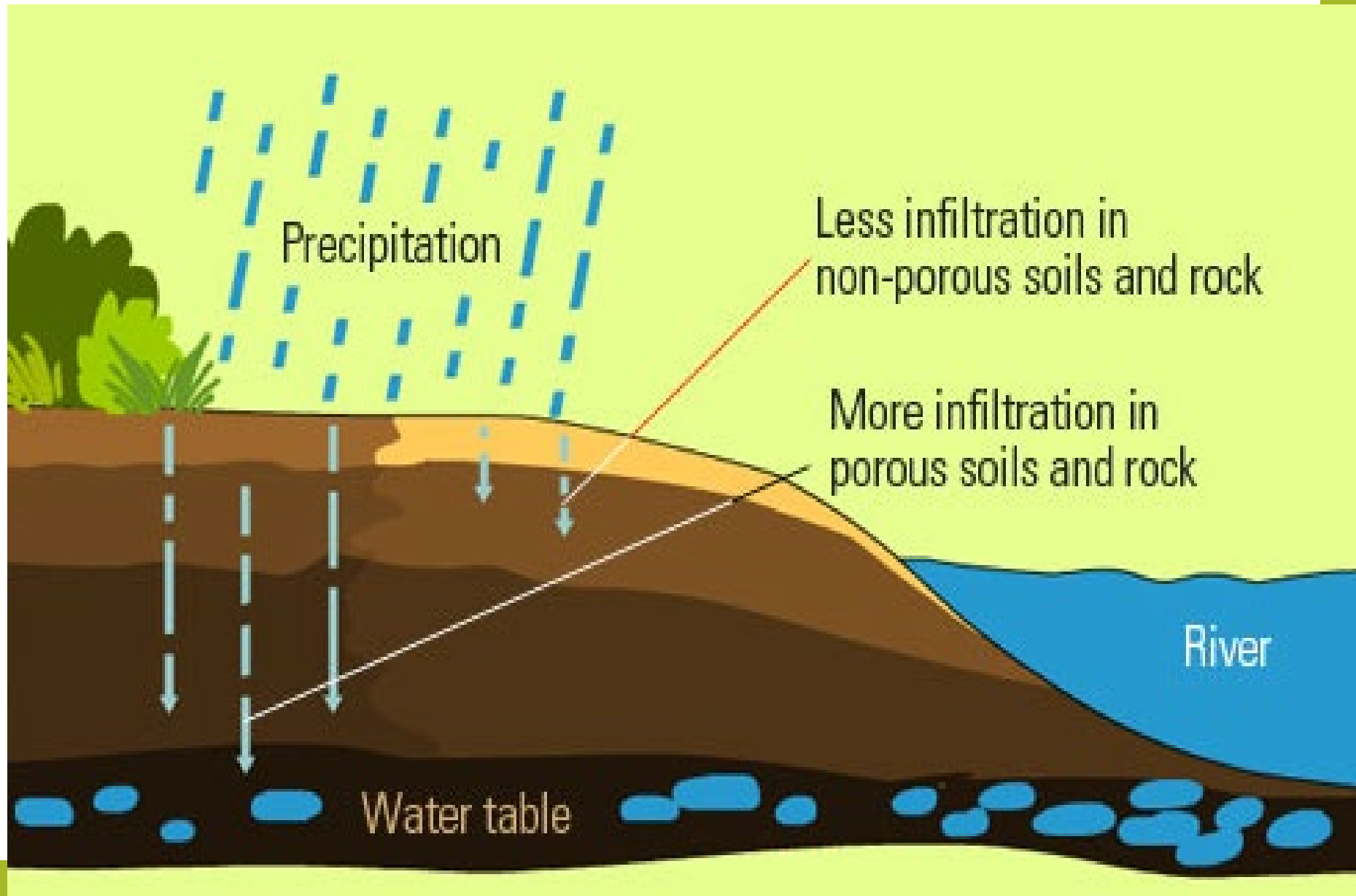


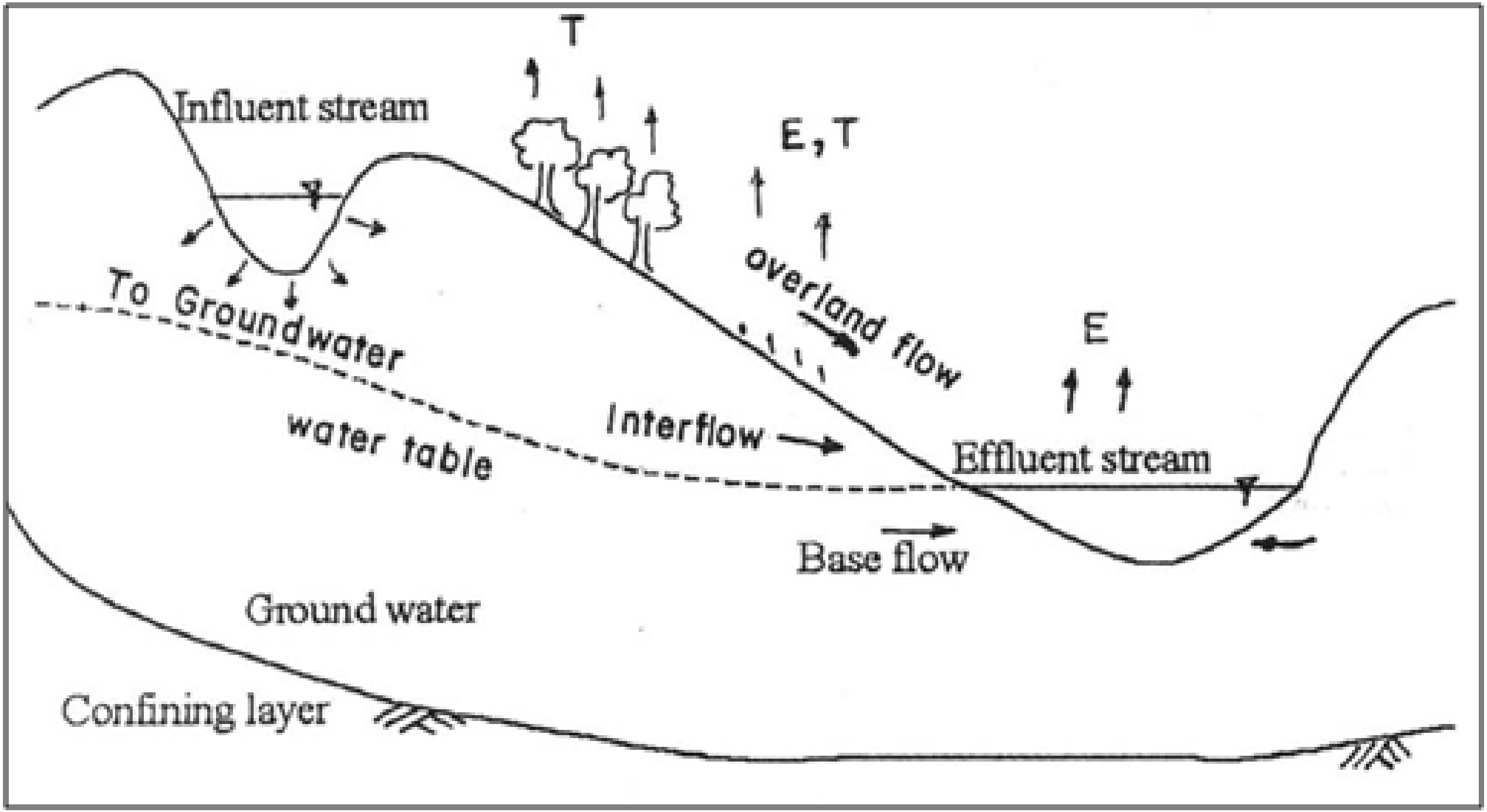


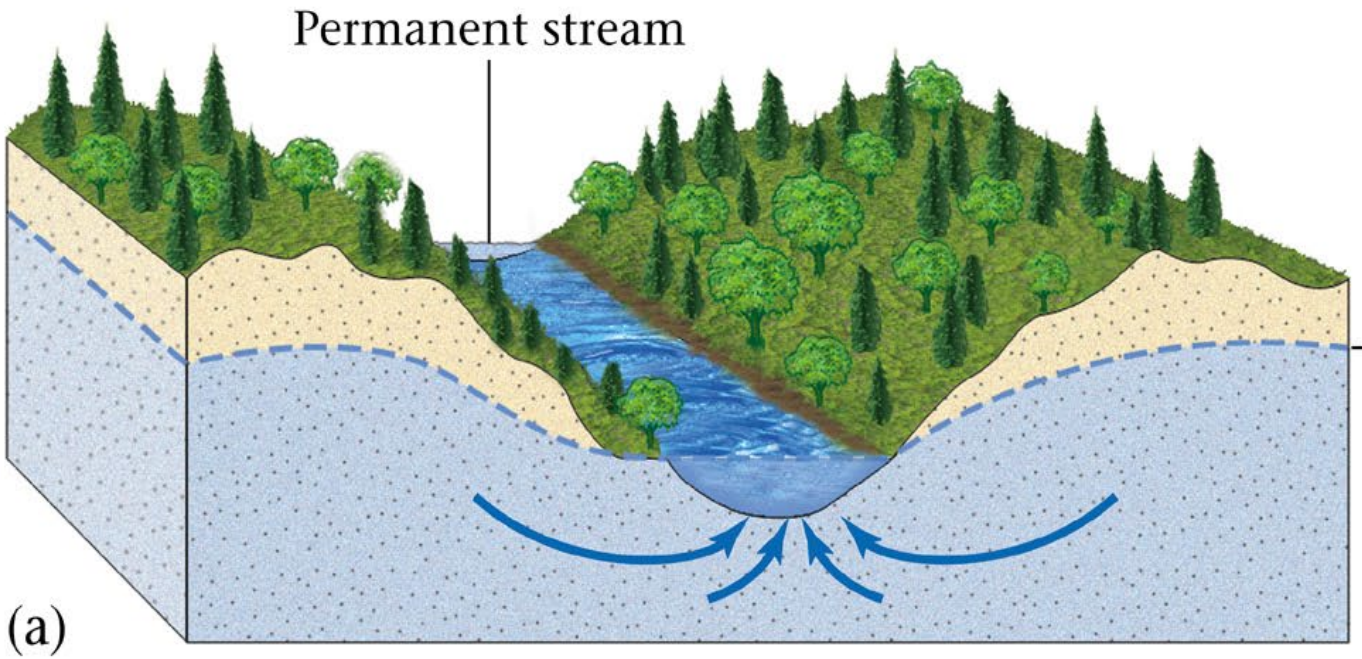
Flowing water

Primary Overland Flow Types

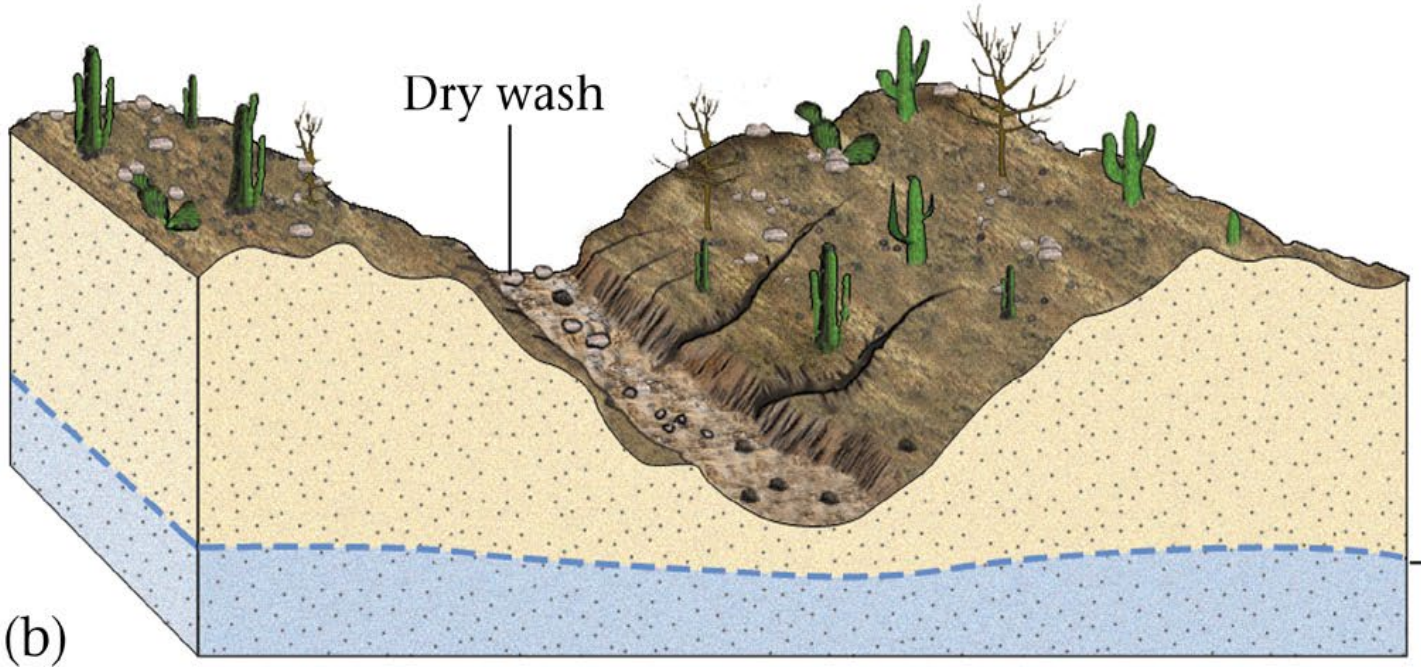
- Infiltration
- Through (Interflow)
- Sheet flow
- Channelized




T
Influent stream
E, T
overland flow
To Groundwater
water table
Interflow
E
Effluent stream
Base flow
Ground water
Confining layer



Effluent



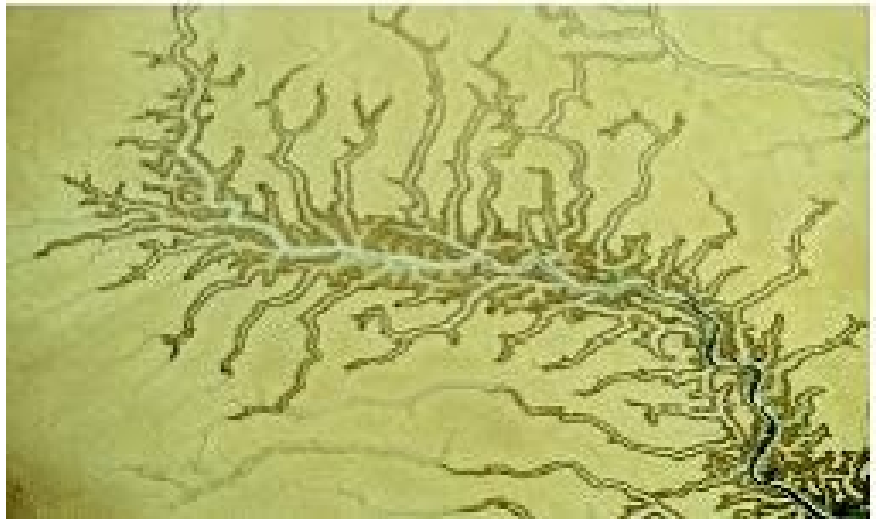
Influent

Sheet flow

- Occurs on bare low gradient surfaces, that have a scattering effect
  - suppresses impact energy and channel formation.
- Muddy water flows as a thin, slow moving surface layer.

Channel Development

- Piping and Sapping
- Rills
- Gulleys

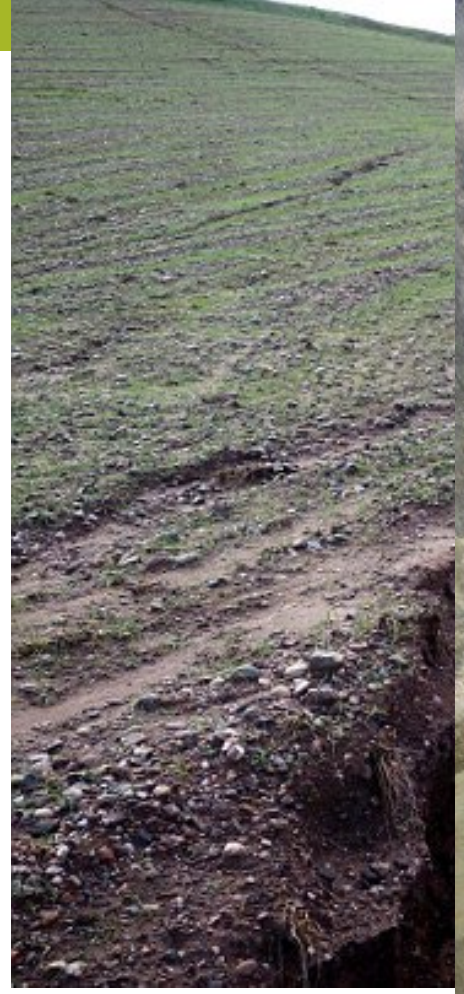


Rills

Threads of higher velocity and more turbulent current eroded small channels.

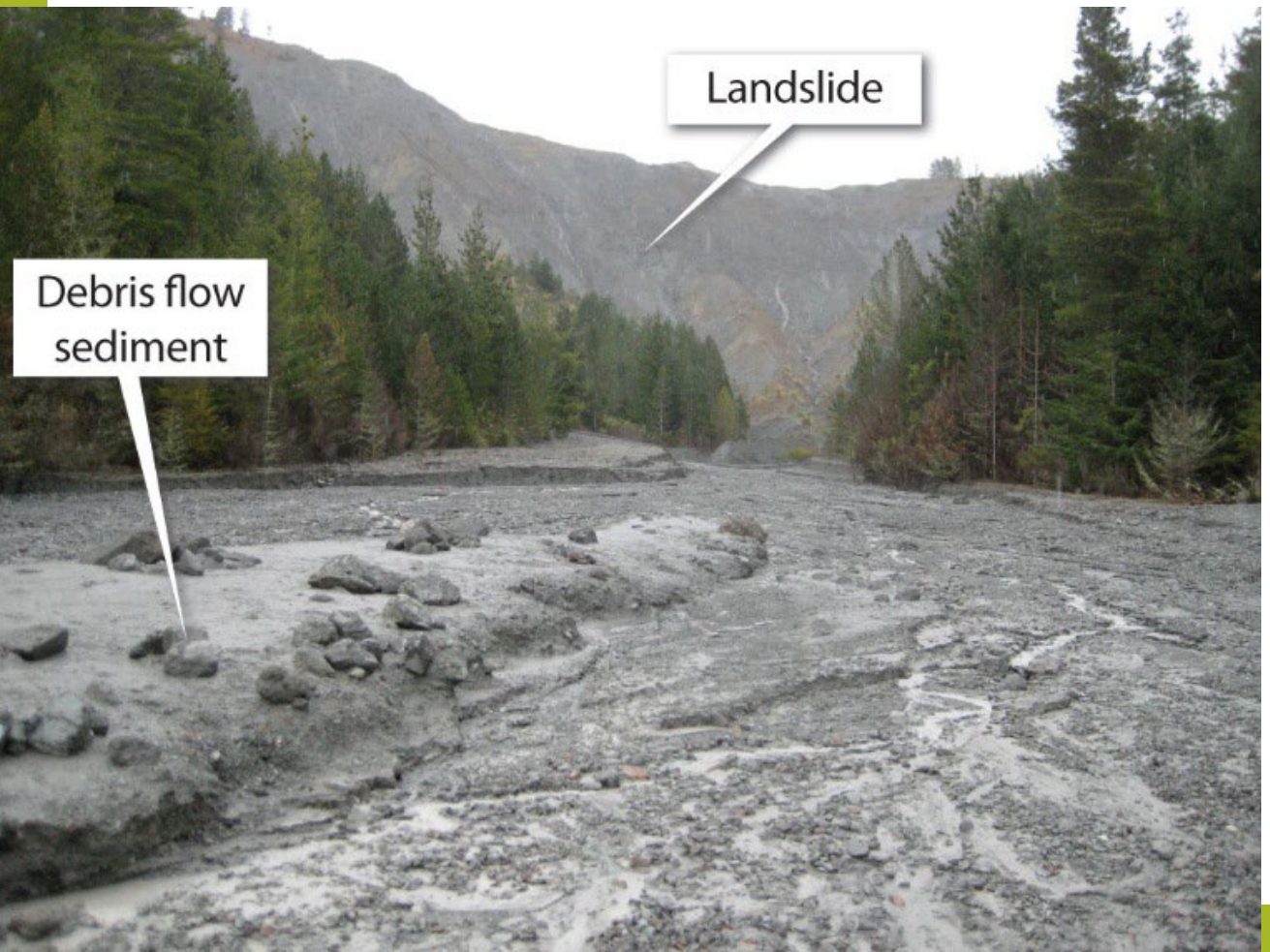
Gully

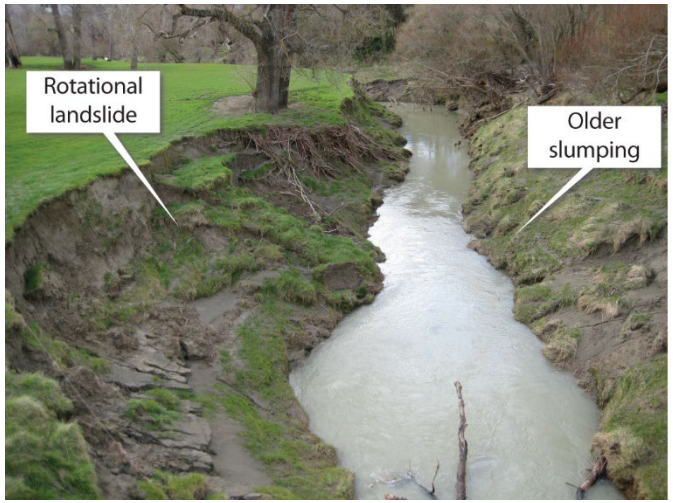
- A stream channel with distinct cut banks and commonly a steep head.
- agricultural practices.



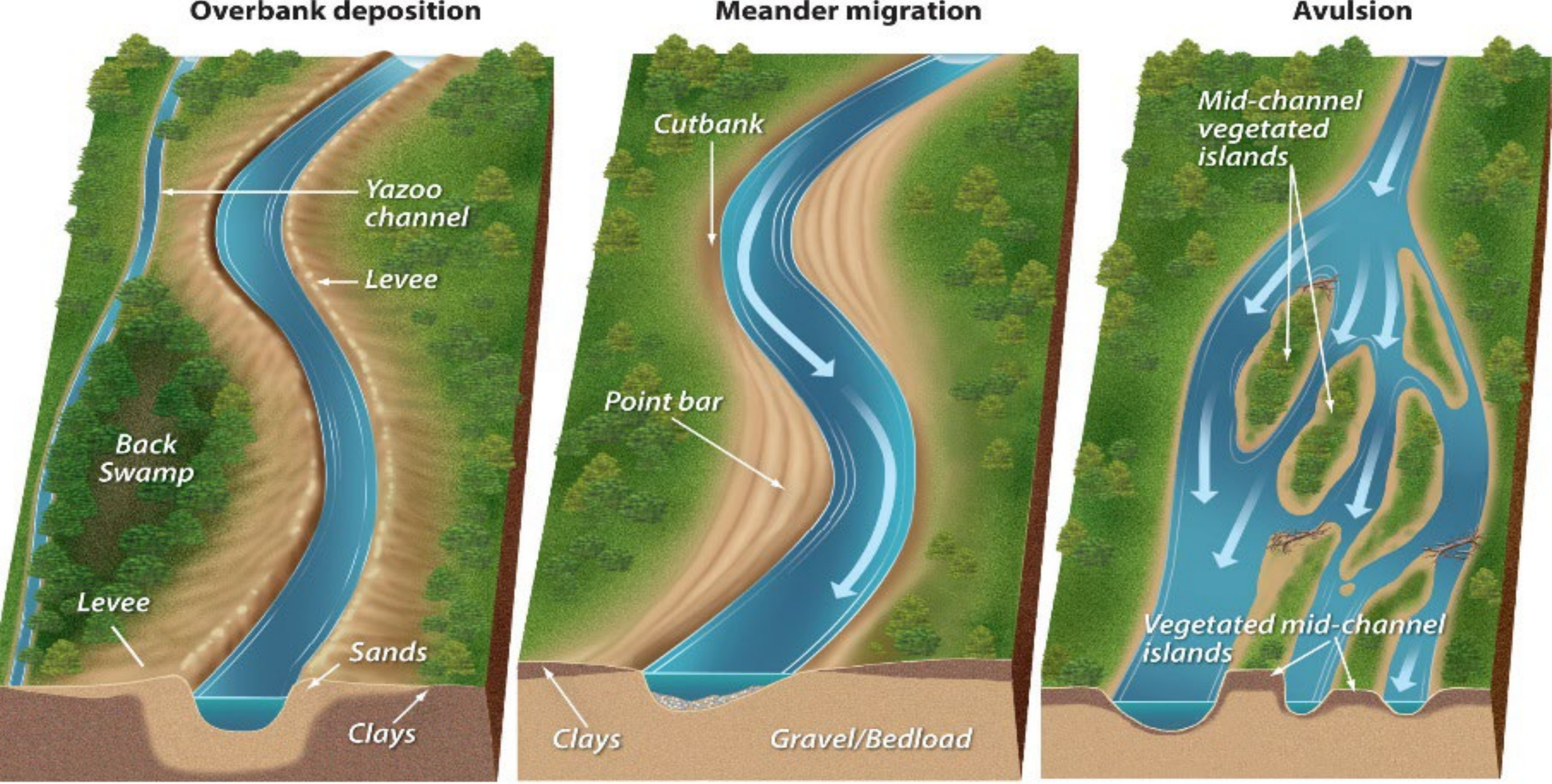
John Thomas – Hungry Canyons Alliance
http://www.goldenhillsrcd.org/hungry-canyons-alliance.html

Sediment supply / Bank Stability





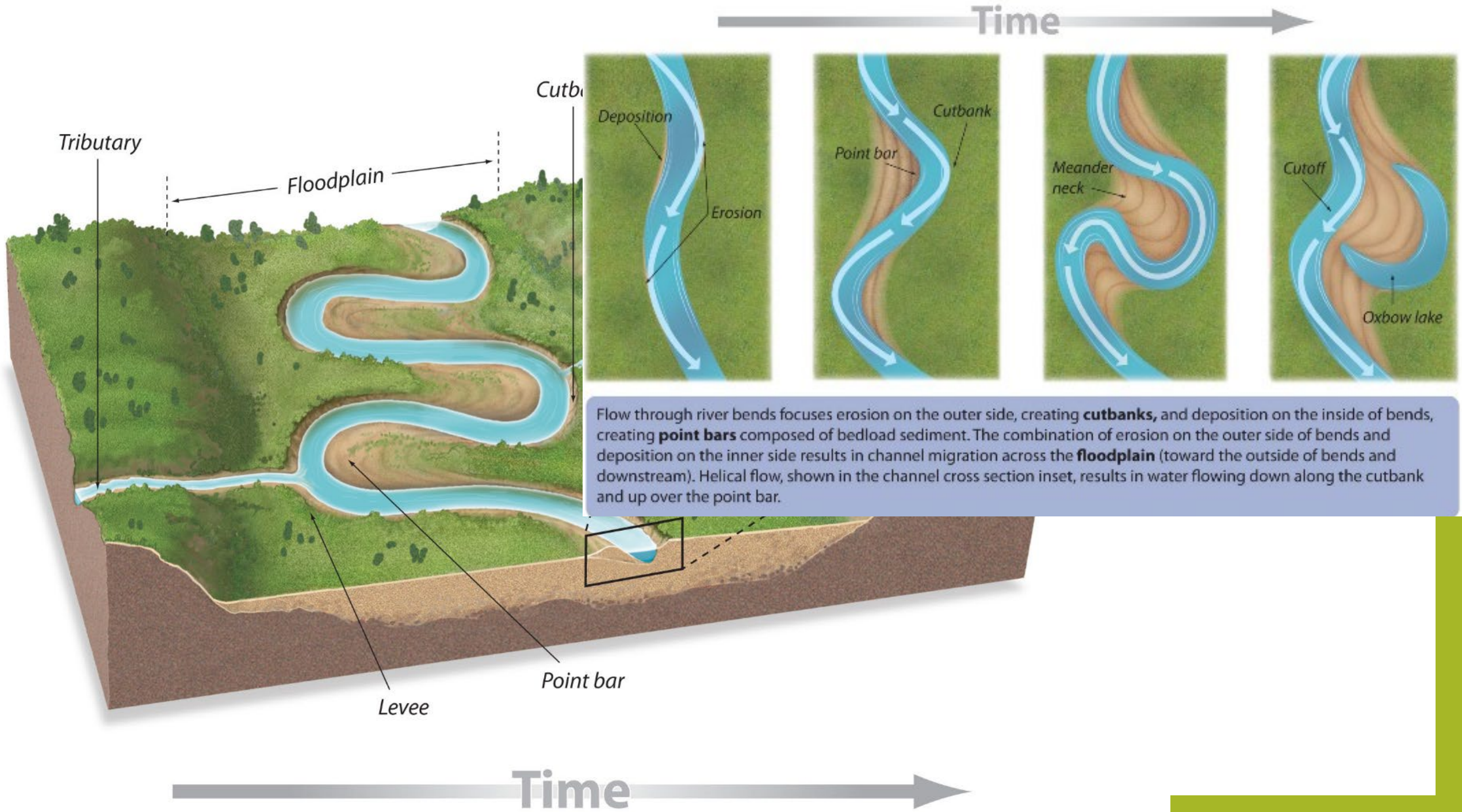
Channel Types



Lower Mississippi River, Louisiana

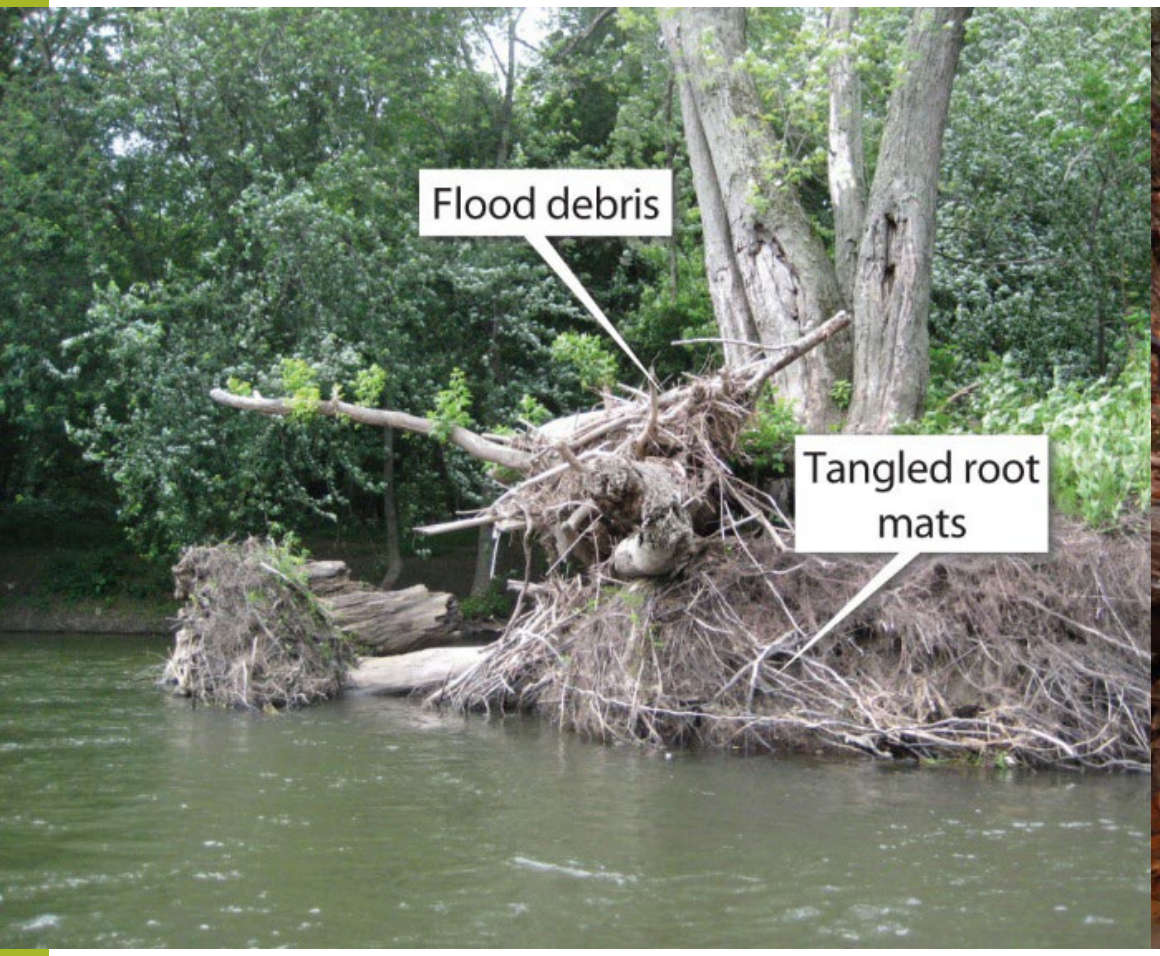
Mississippi River, Illinois

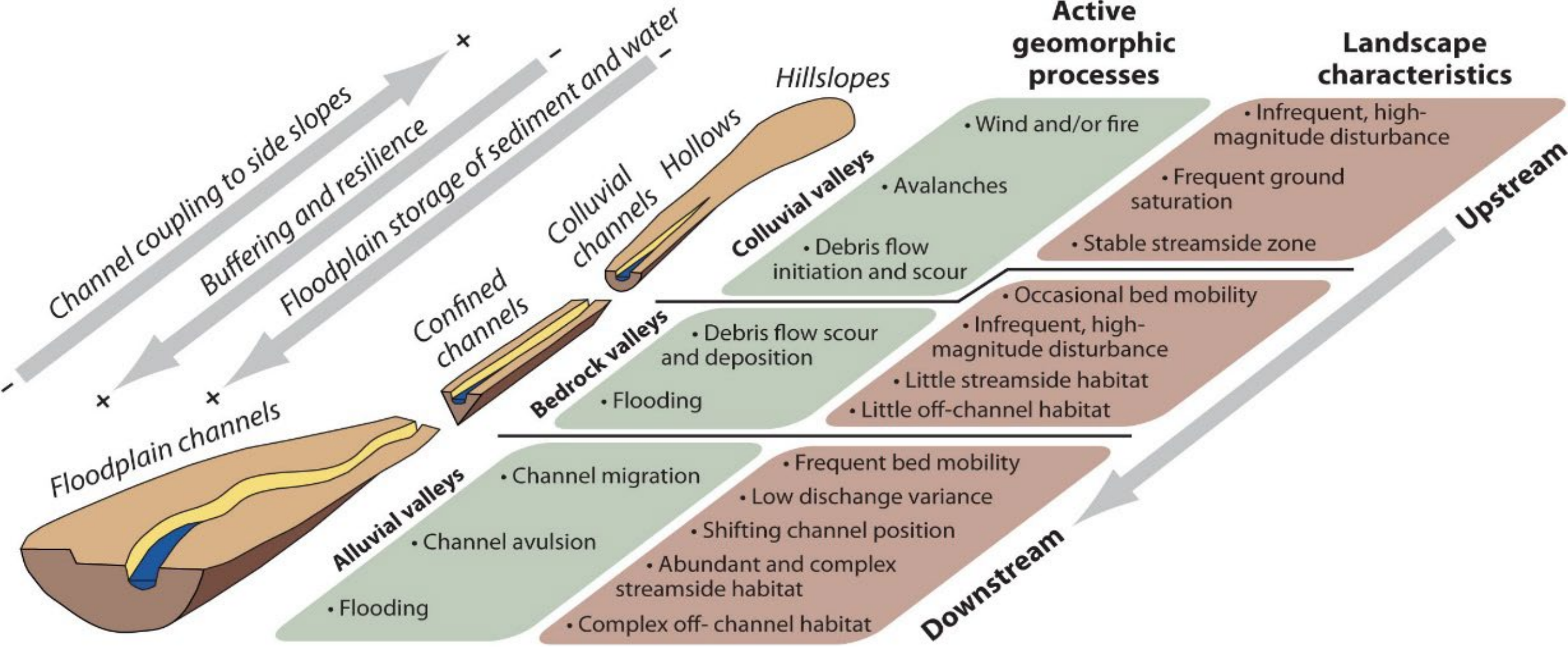
Queets River, Washington State



Flow through river bends focuses erosion on the outer side, creating **cutbanks,** and deposition on the inside of bends, creating **point bars** composed of bedload sediment. The combination of erosion on the outer side of bends and deposition on the inner side results in channel migration across the **floodplain** (toward the outside of bends and downstream). Helical flow, shown in the channel cross section inset, results in water flowing down along the cutbank and up over the point bar.

Vegetation/Riparian System





Drainage basins are composed of hillslopes and channels, including unchanneled slopes high in the basin uplands and large floodplain channels in the lowland. In between are colluvial channels, just downstream of channel heads, and there can be confined channels in steep bedrock valleys. The active geomorphic processes that shape and disturb the landscape change predictably downstream, and result in a suite of landscape characteristics. Not all landscapes include all of the landforms illustrated here.

Luna Leopold

"A river or drainage basin might be considered to have a heritage, rather than an origin."

First Chief Hydrologist at the USGS

http://eps.berkeley.edu/people/lunaleopold/

https://www.usgs.gov/news/lessons-learned-leger