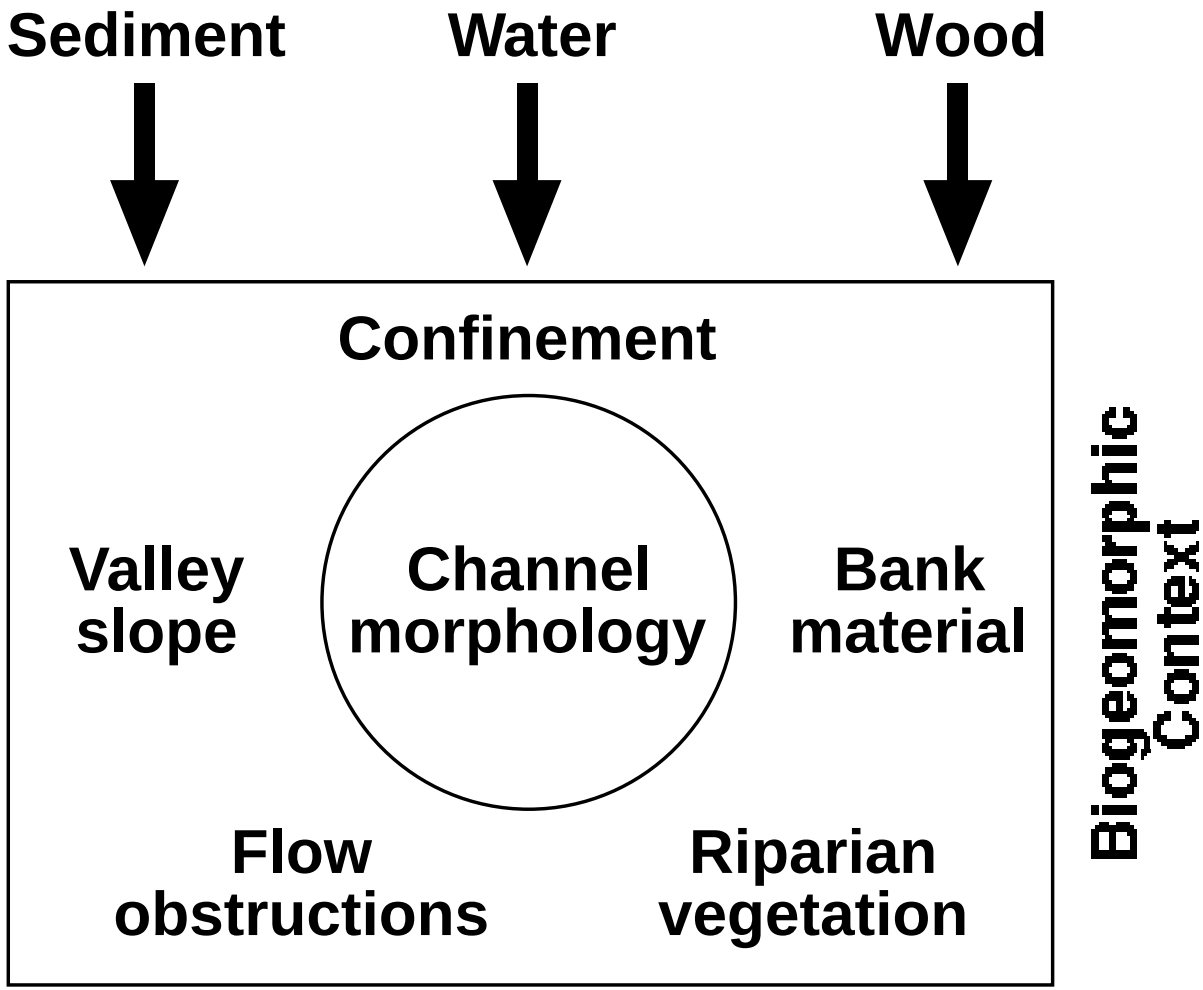
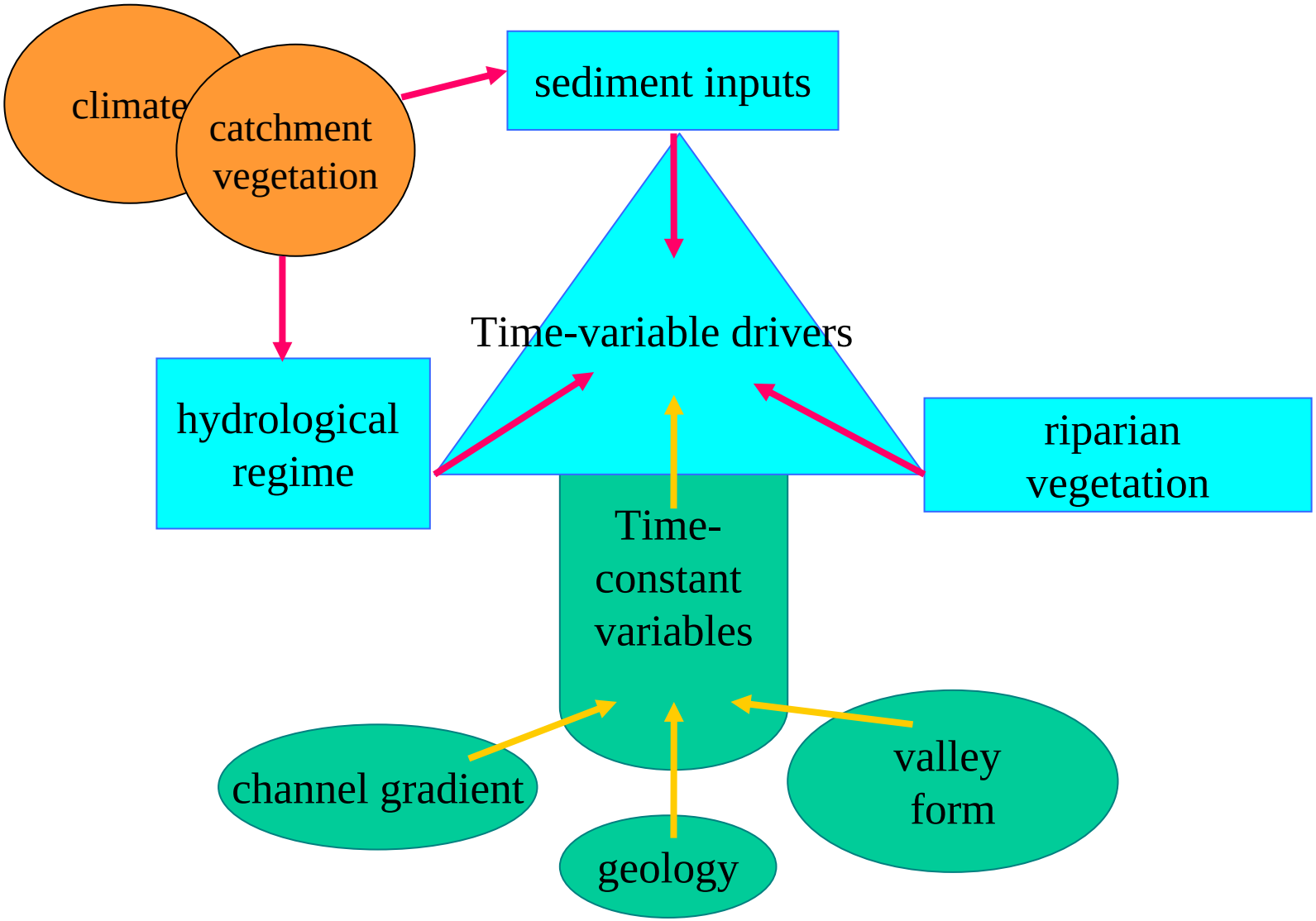

River Response

River Response





CHANNEL RESPONSE

CHANNEL TYPE

River Response: Case Studies

Skokomish River, Washington

Mount Pinatubo, Philippines

River Restoration: Engineered Log Jams

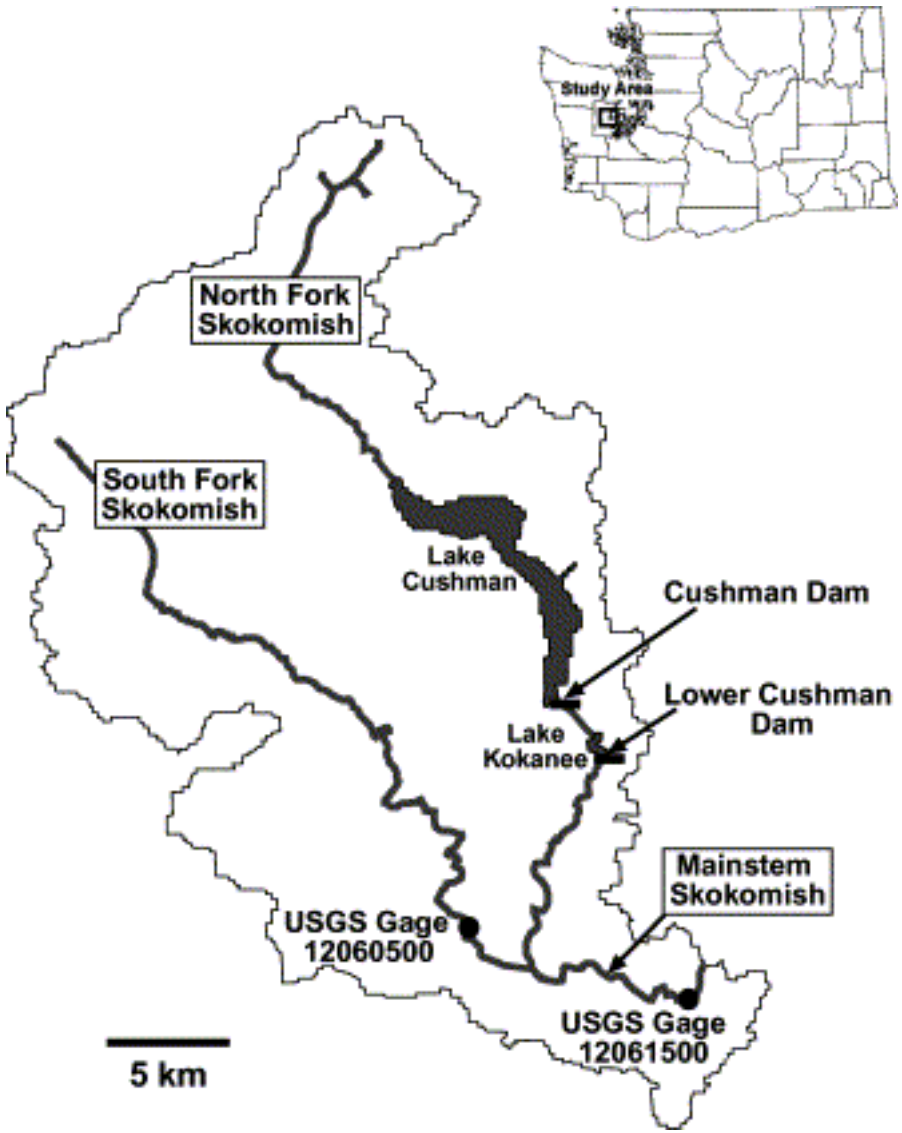
River Response:

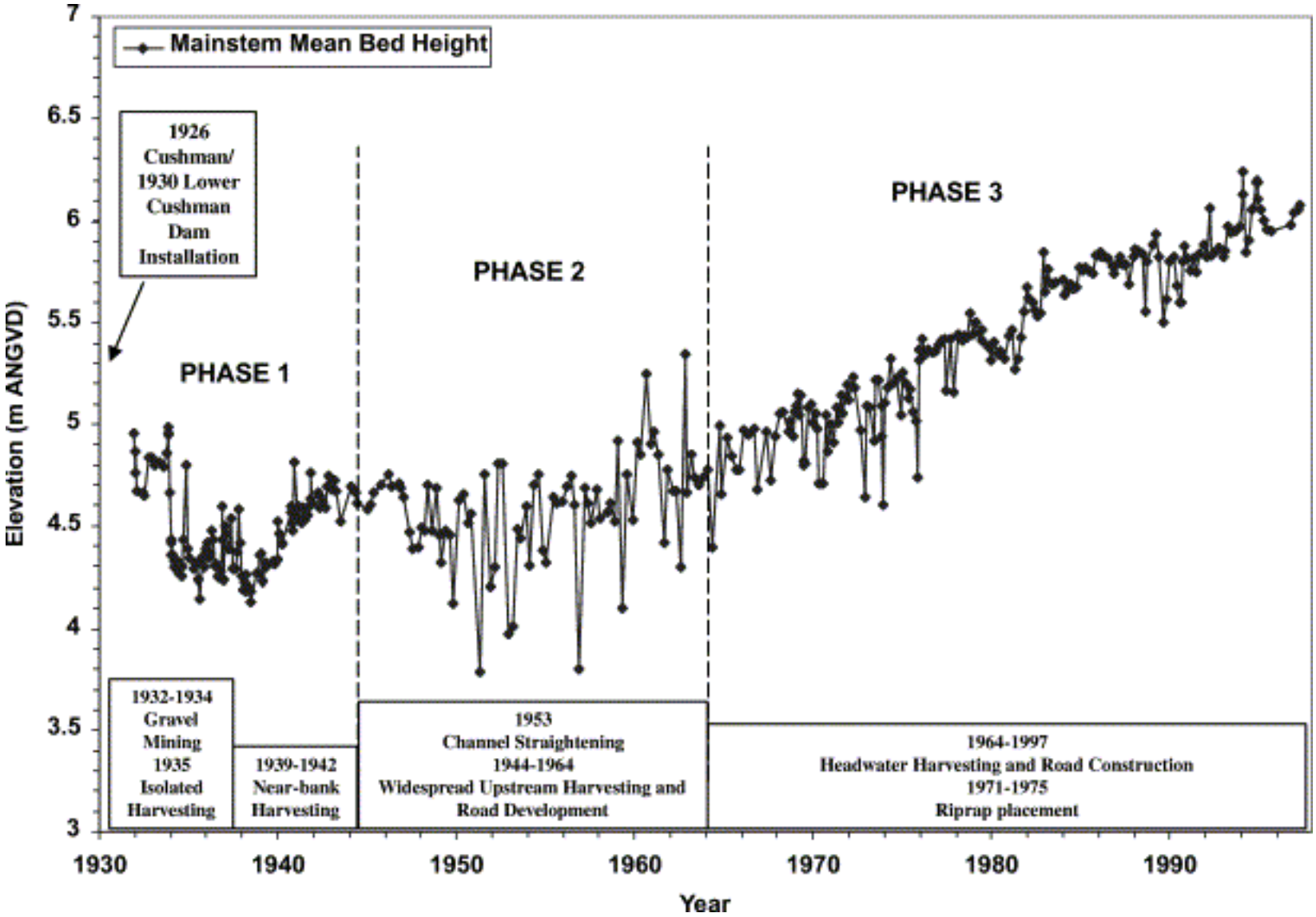
Skokomish River, Washington

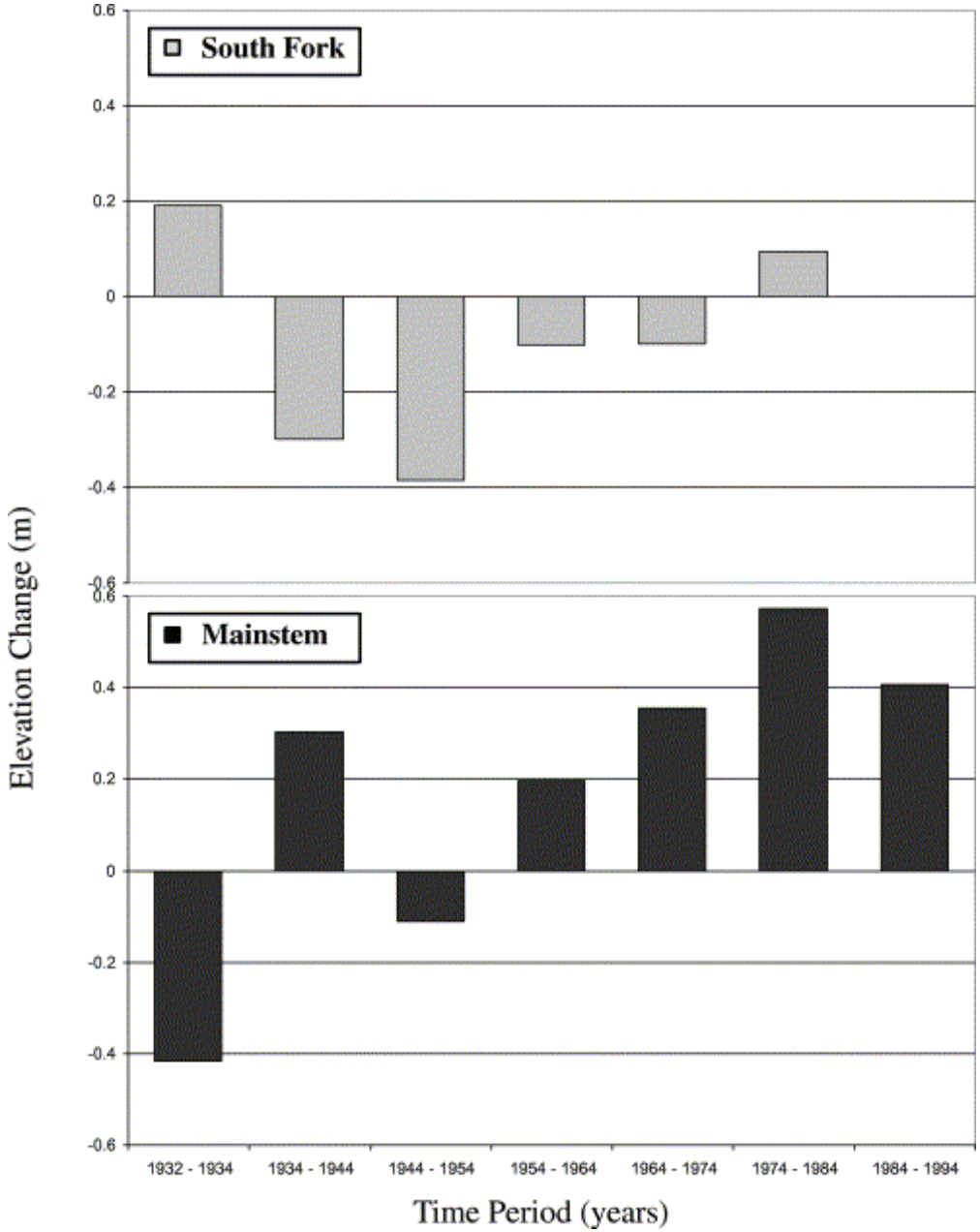
Response to intensive upland forestry in steep landslide-prone terrain

To Protect Your Rivers, Protect Your Mountains

– Emporer Yu of China, ca. 1600 B.C.


Study Area
North Fork
Skokomish
South Fork
Skokomish
Lake
Cushman
Cushman Dam
Lower Cushman
Dam
Lake
Kokanee
Mainstem
Skokomish
USGS Gage
12060500
USGS Gage
12061500
5 km

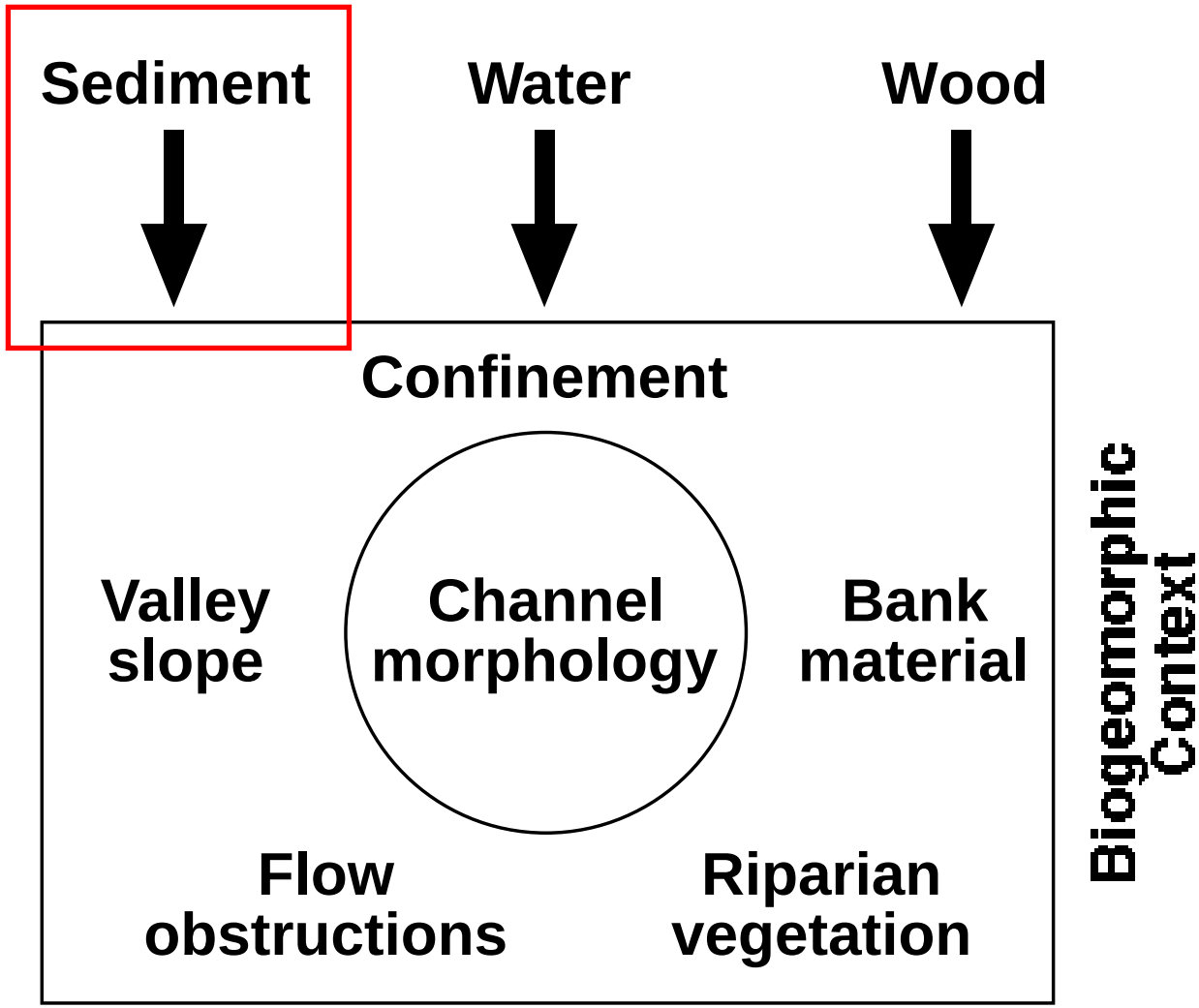

Mainstem Mean Bed Height
1926 Cushman/ 1930 Lower Cushman Dam Installation
PHASE 1
PHASE 2
PHASE 3
1932-1934 Gravel Mining 1935 Isolated Harvesting
1939-1942 Near-bank Harvesting
1953 Channel Straightening 1944-1964 Widespread Upstream Harvesting and Road Development
1964-1997 Headwater Harvesting and Road Construction 1971-1975 Riprap placement
Elevation (m ANGVD)
Year
7
6.5
6
5.5
5
4.5
4
3.5
3
1930
1940
1950
1960
1970
1980
1990


South Fork
Mainstem
Elevation Change (m)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
1932 - 1934
1934 - 1944
1944 - 1954
1954 - 1964
1964 - 1974
1974 - 1984
1984 - 1994
Time Period (years)

Skokomish River, Washington

River response to increased sediment input from landsliding in headwater channels triggered increased flooding not by increasing peak flows, or river runoff, but by decreasing the amount of water the channel could hold due to aggradation of the channel bed.

River Response



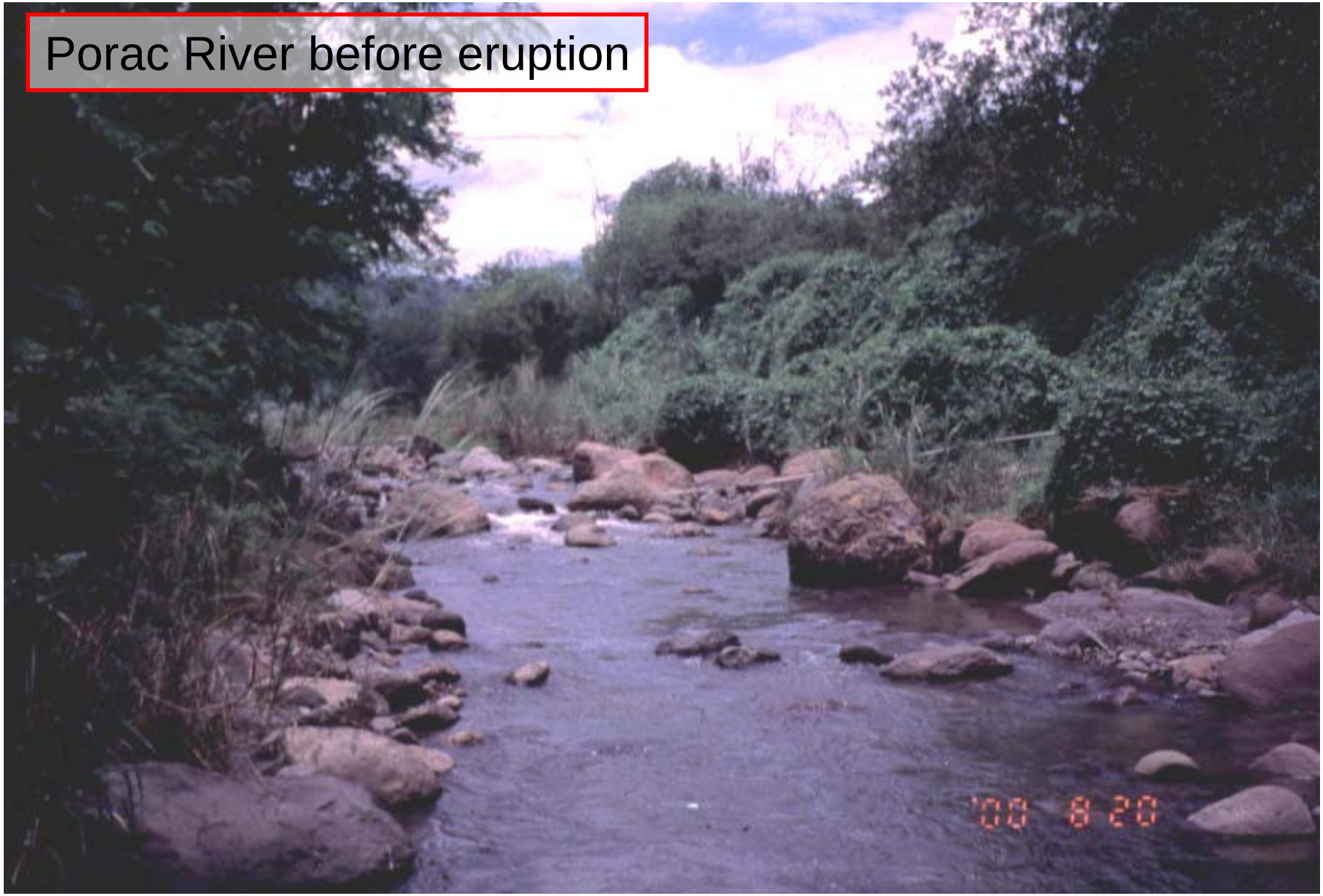
River Response:

Mount Pinatubo, Philippines

River response to massive volcanic disturbance.

June 15, 1991 Eruption of Mount Pinatubo

5-6 km^3 of pyroclastic materials erupted and subsequently deposited on flanks of volcano.


Porac River before eruption
'00 8 20


Pasig-Potrero River after eruption

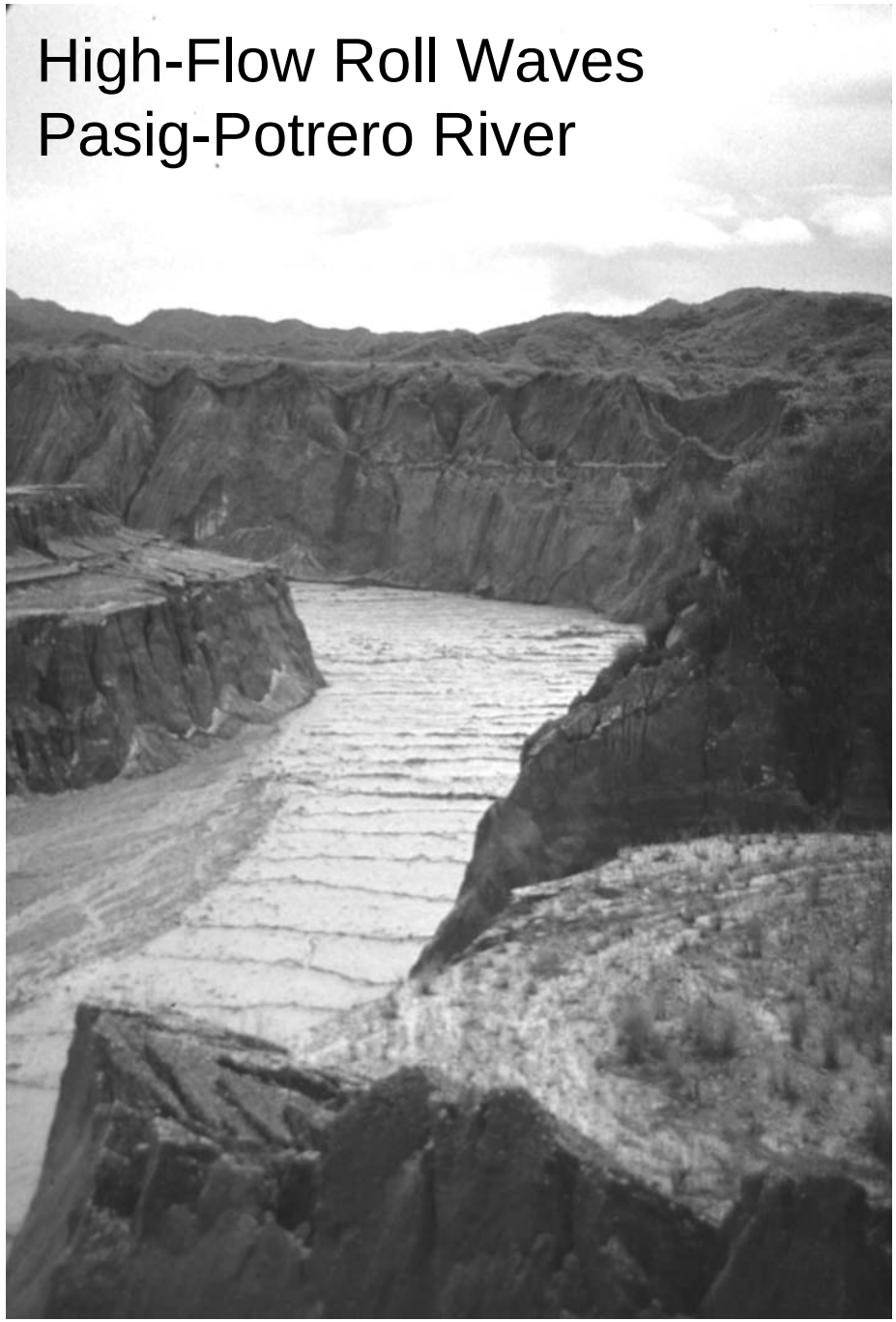
Increased sediment load leads to:

- finer grain size—changed cobble-boulder bed channels to sand-fine gravel bed channels.

- braided river morphology — changed single channel reaches into braided channels.

Antidunes

High-Flow Roll Waves
Pasig-Potrero River




High-Flow Roll Waves
O’Donnell River

Main Sediment Delivery Mechanisms to Pinatubo's rivers

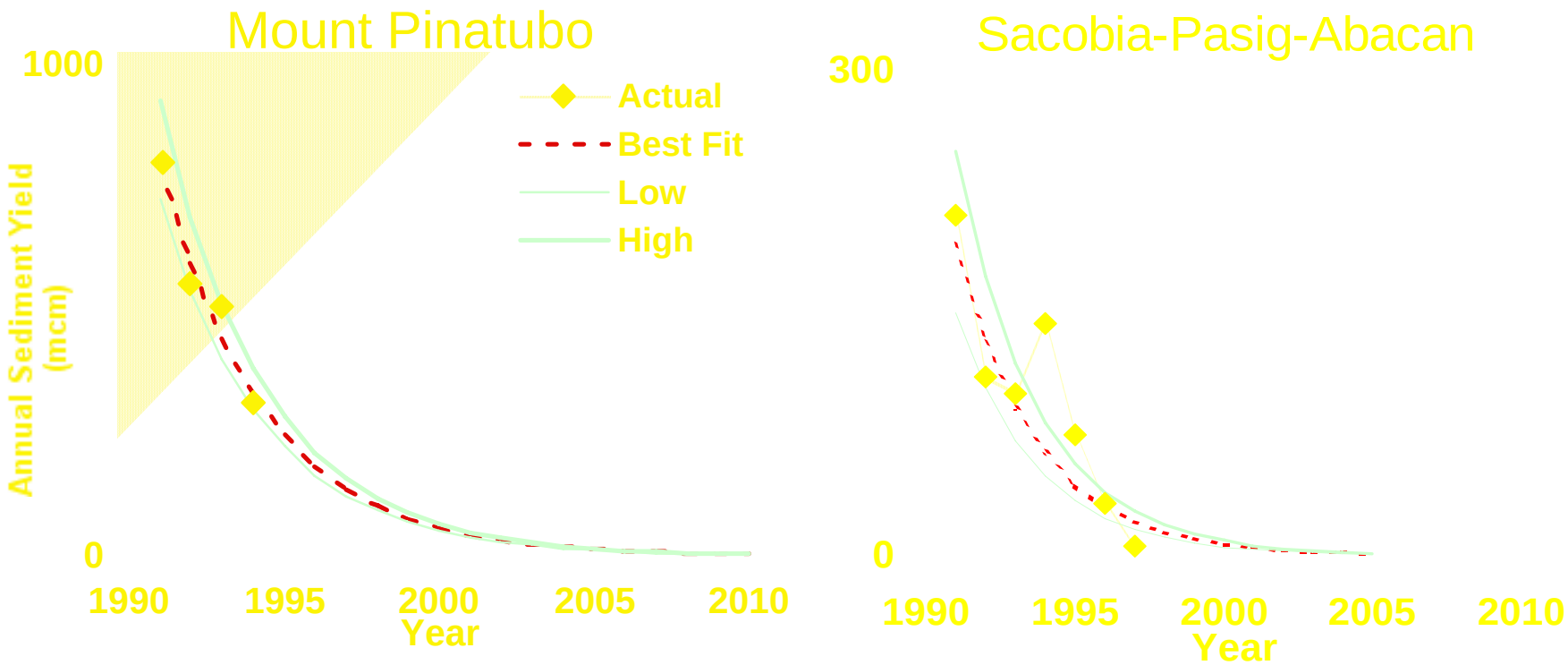
- Mass wasting of lahar terraces
- Erosion of rill fields
- Erosion of the channel bed

Mass Wasting

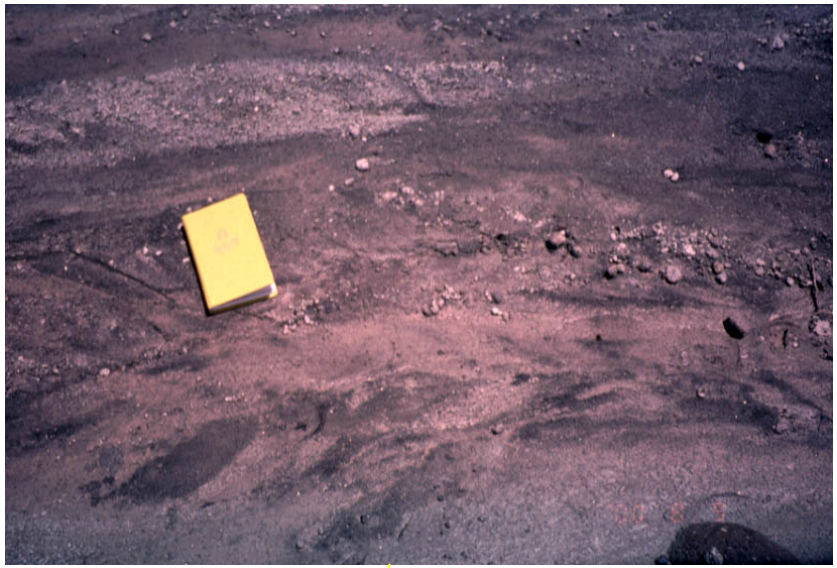
Sediment Mobility… “Rolling Rocks”

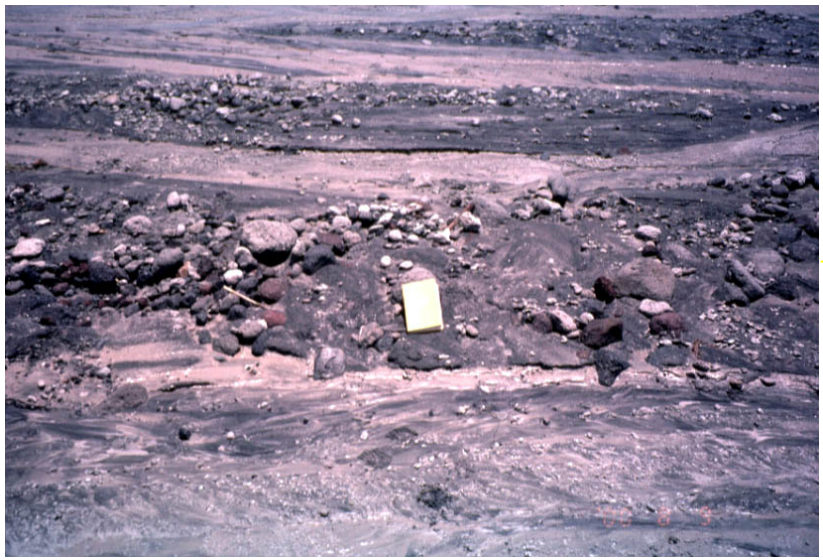


Exponential decay of post-eruption sediment yield



Bed Armoring: Development of Pebble clusters

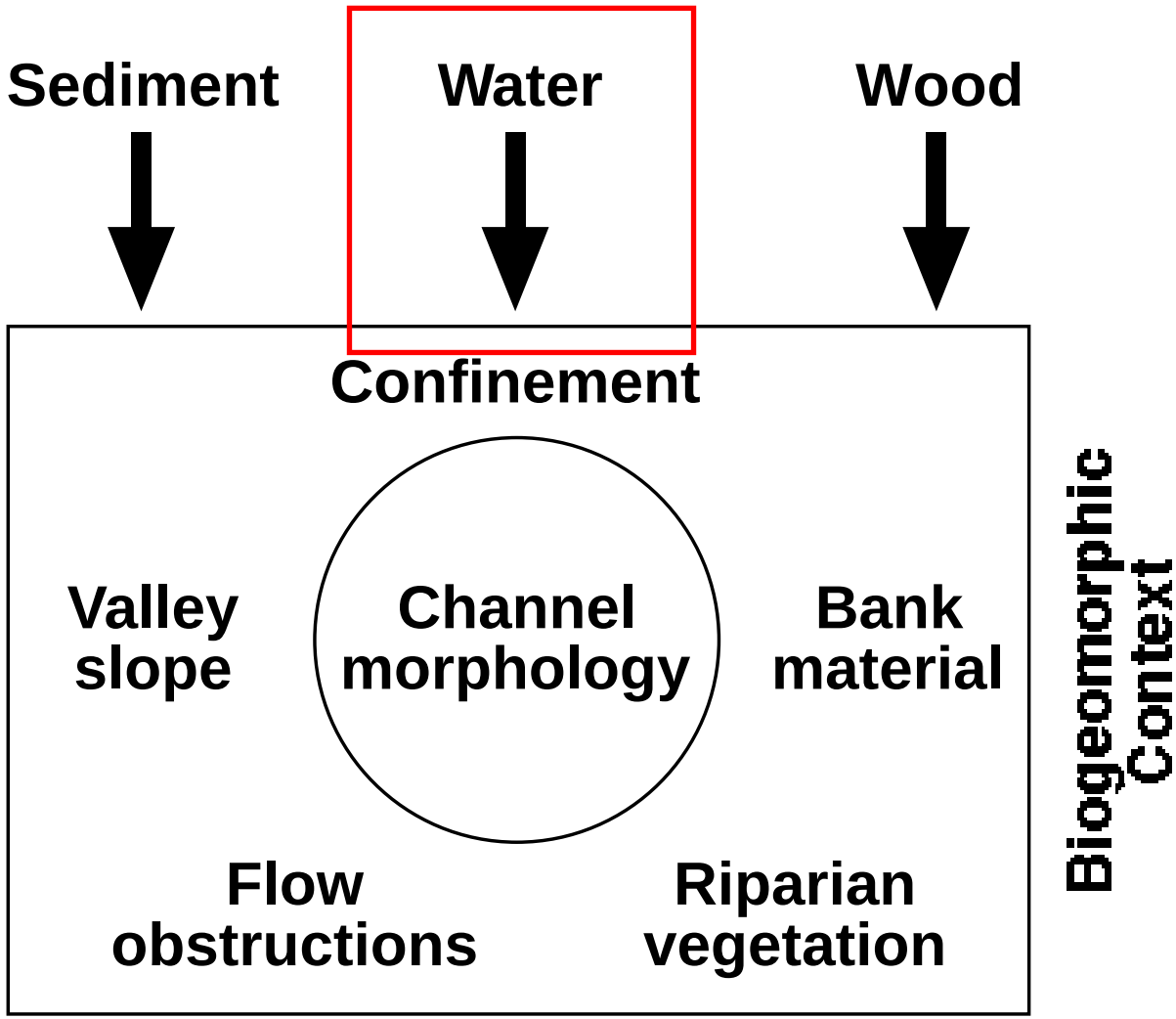




- Response of Pinatubo rivers illustrates the importance of sediment supply on channel morphology and processes

- Geomorphic recovery precedes ecological recovery

River Response

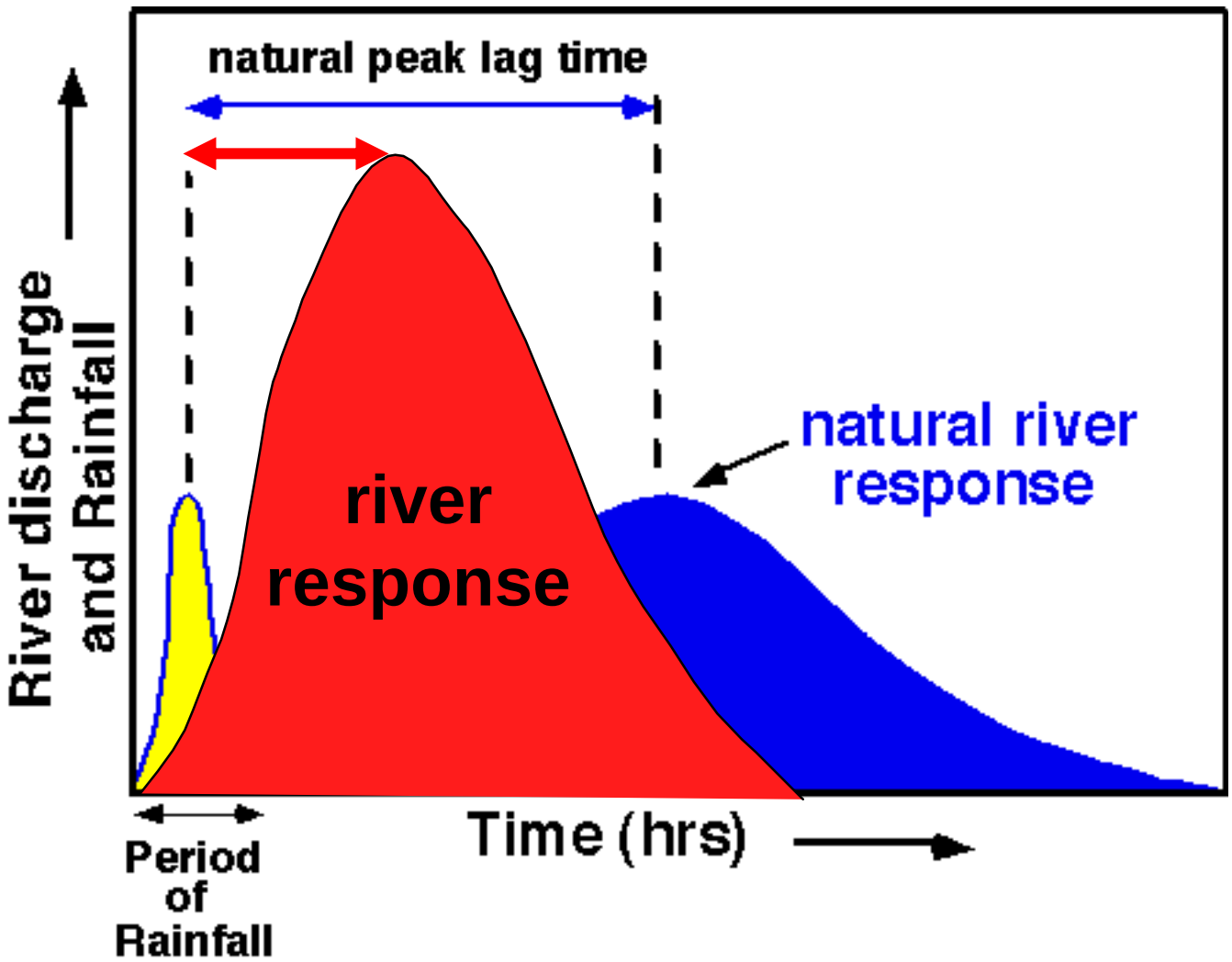


River hydrographs

Urbanized peak lag time

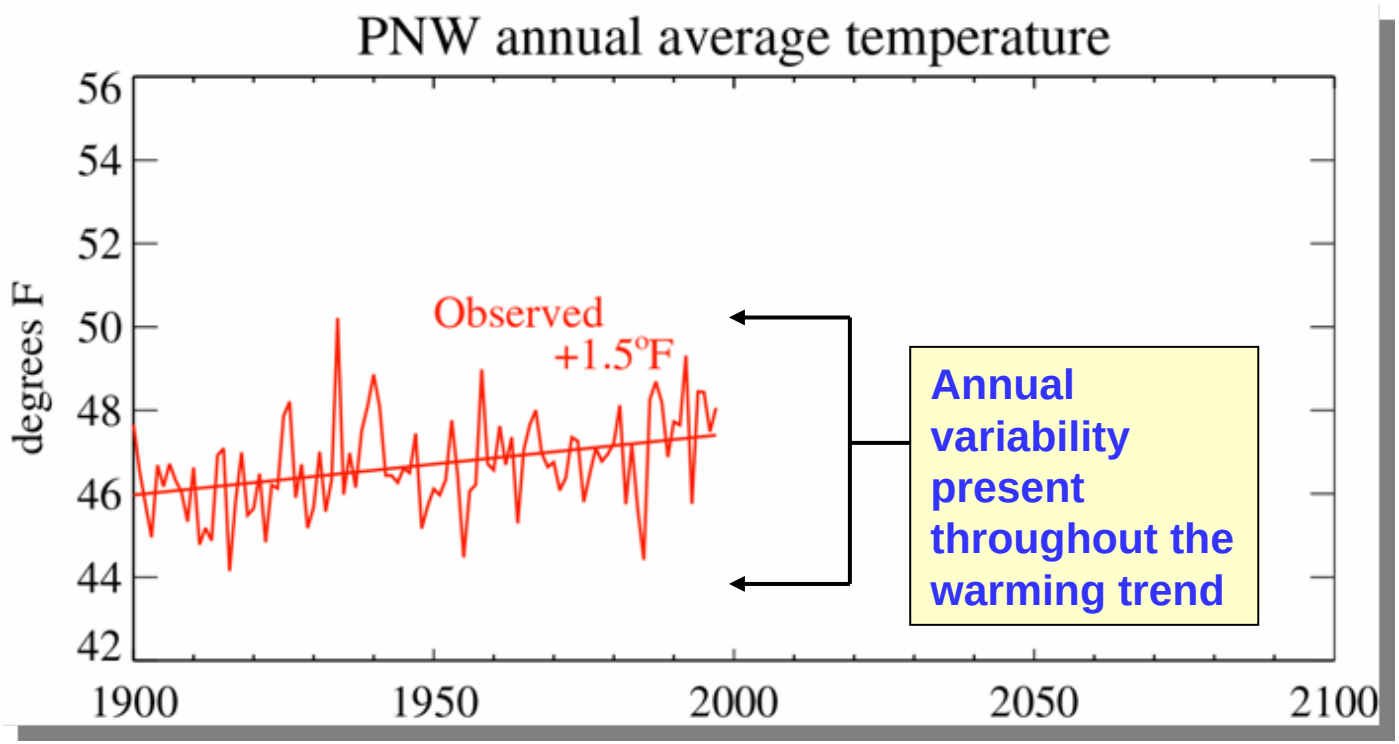
Shorter lag time

Higher discharge



In the Past Century:

The Pacific Northwest has gotten warmer and wetter



From 1900 to 2000, the average annual temperature increased 1.5°F

Projected PNW Climate Change

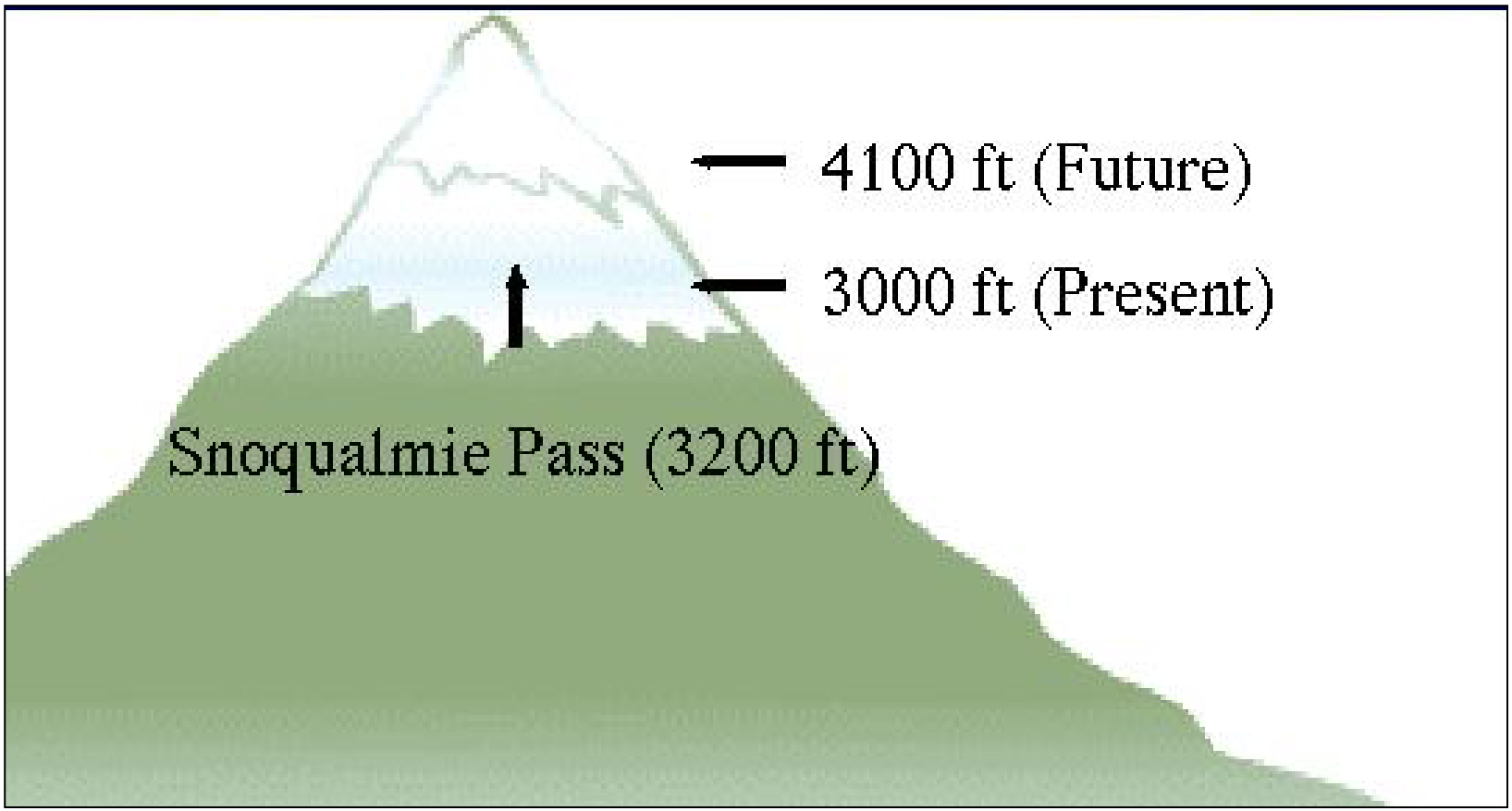
Projected changes in average annual temperature and precipitation for the 2020s and 2040s

2020s	Temperature	Precipitation
Low	+ 0.8 °F	+ 1.5 %
Mean	+ 2.7 °F	+ 6.9%
High	+ 4.6 °F	+ 14.4 %

2040s	Temperature	Precipitation
Low	+ 2.7 °F	- 3.3 %
Mean	+ 4.1 °F	+ 7%
High	+ 5.7 °F	+ 13.7 %

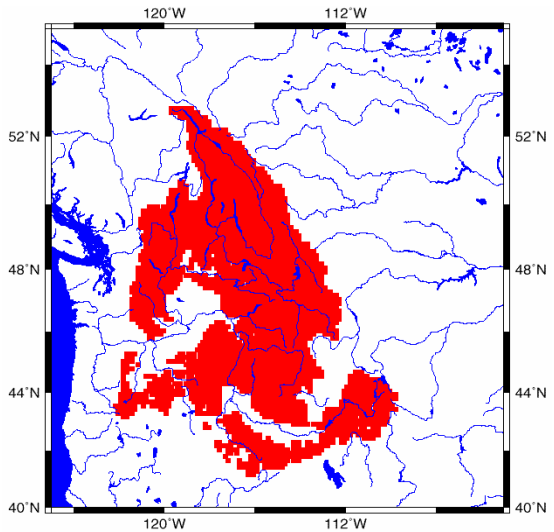
Based on an increase in equivalent CO_2 of 1% per year. Benchmarked to the decade of the 1990s.

Main Impact: Less Snow Overall

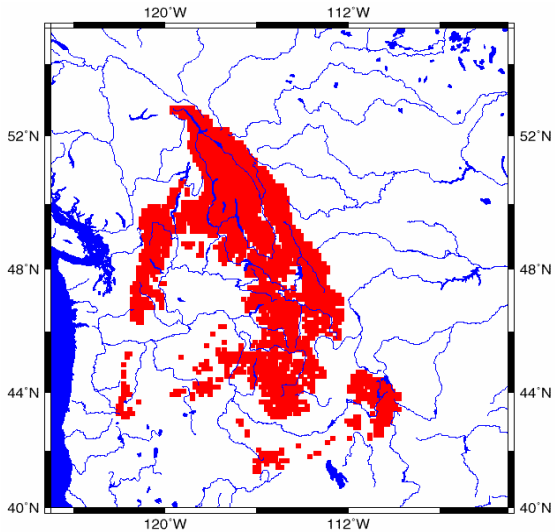


Snow Extent for the Columbia River Basin
April 1

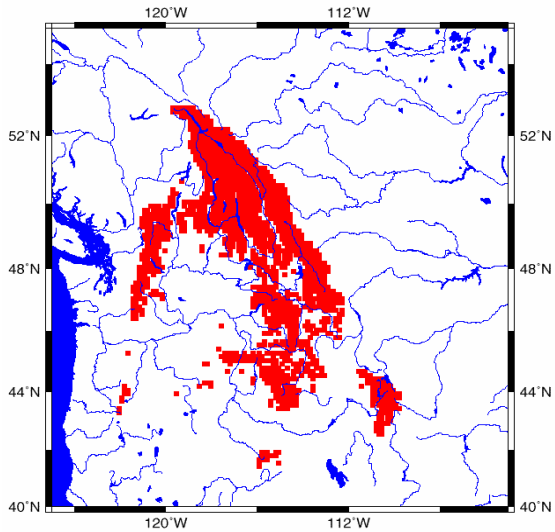
Current



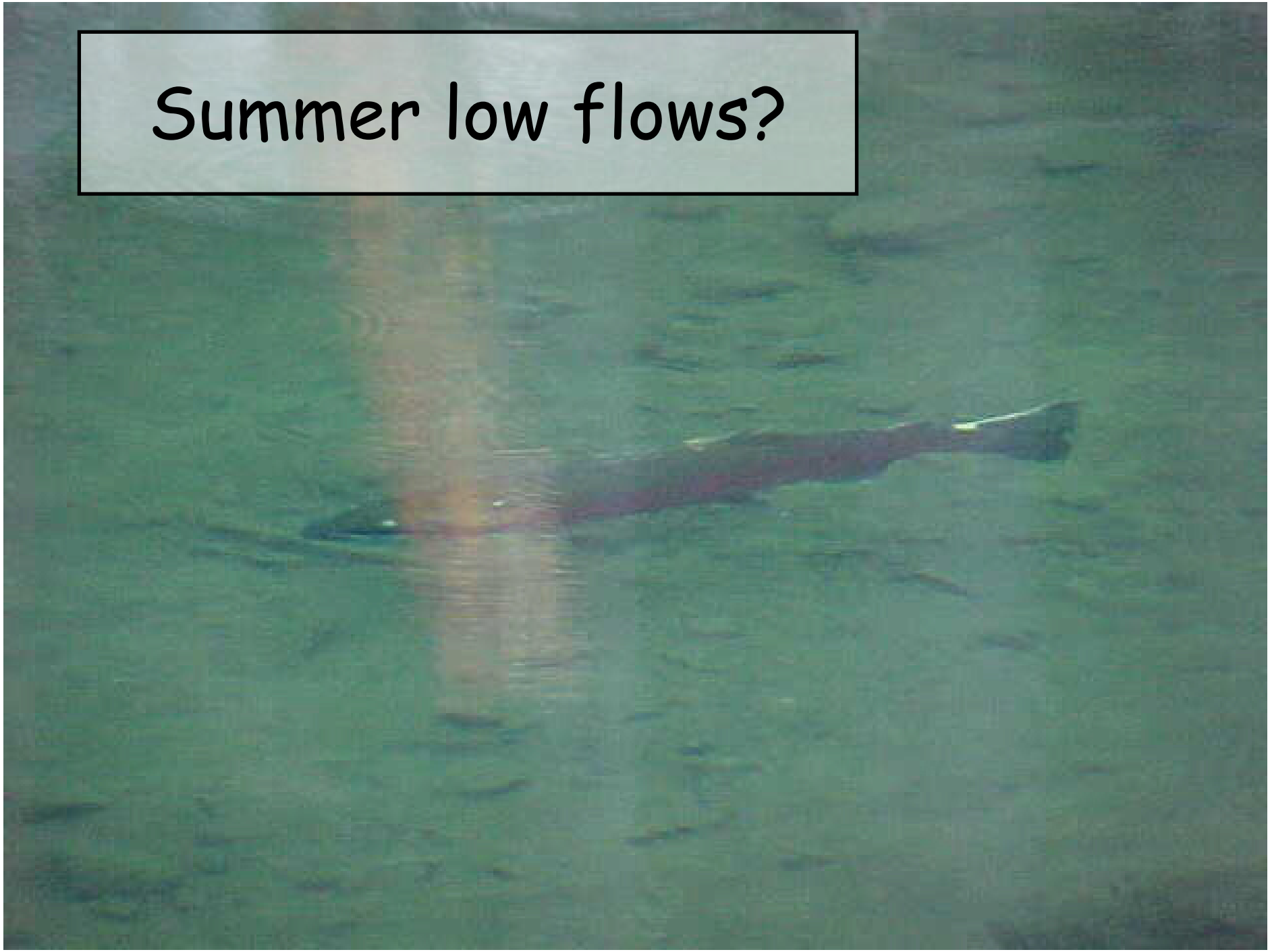
2020s



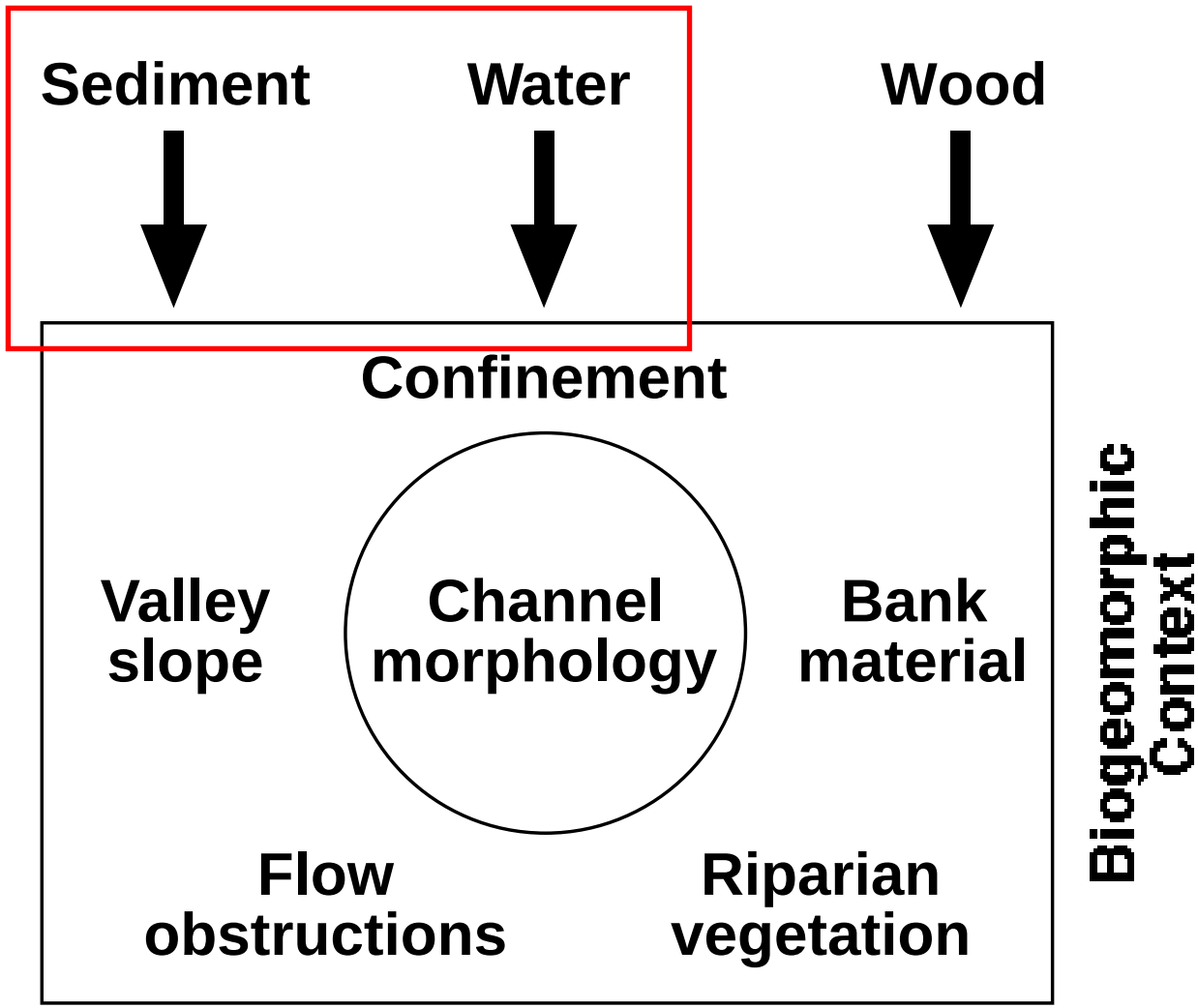
2040s



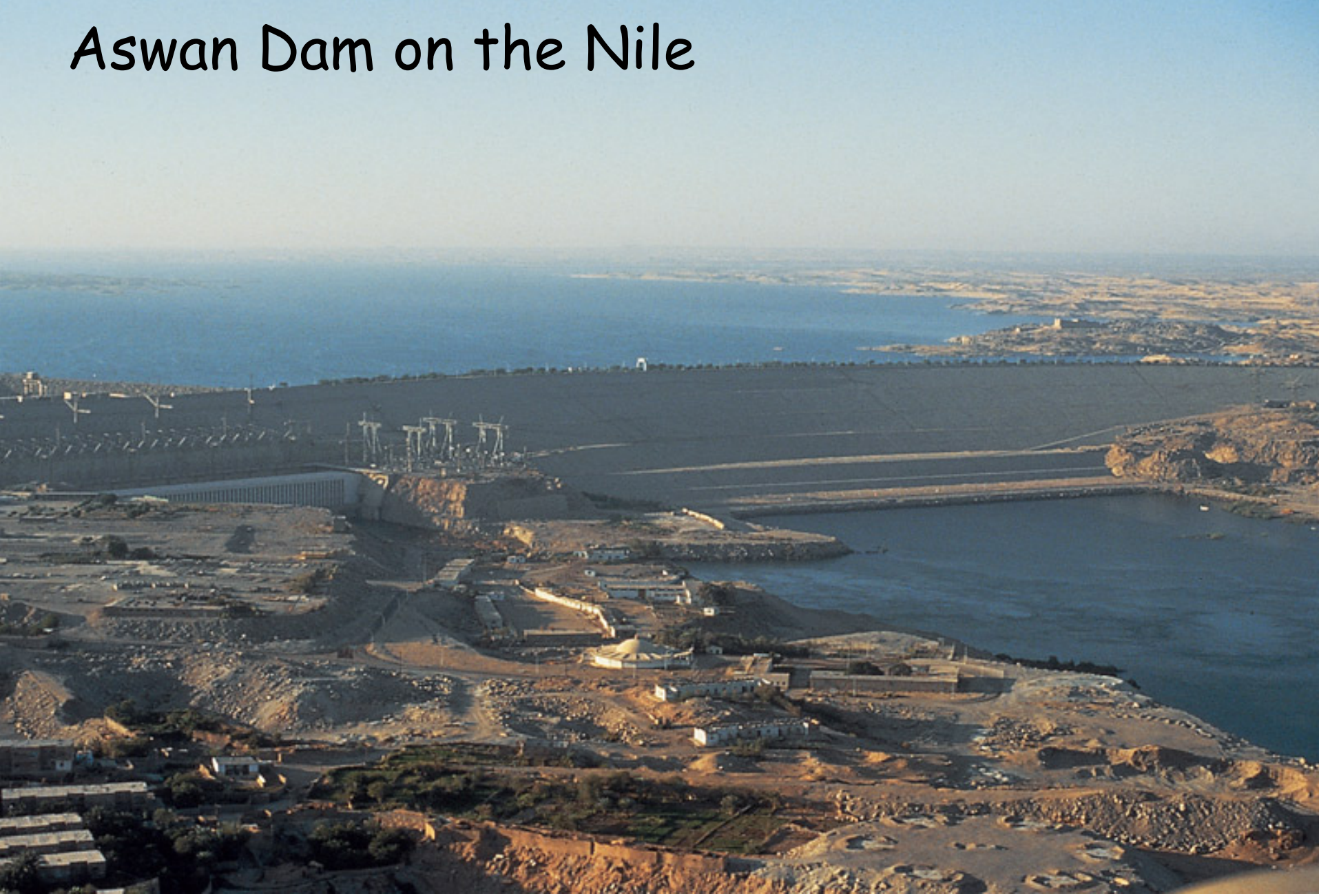
Summer low flows?



River Response: Dams



Aswan Dam on the Nile



Damming the Nile

- Ninety-eight percent of the Nile's load is suspended sediment.

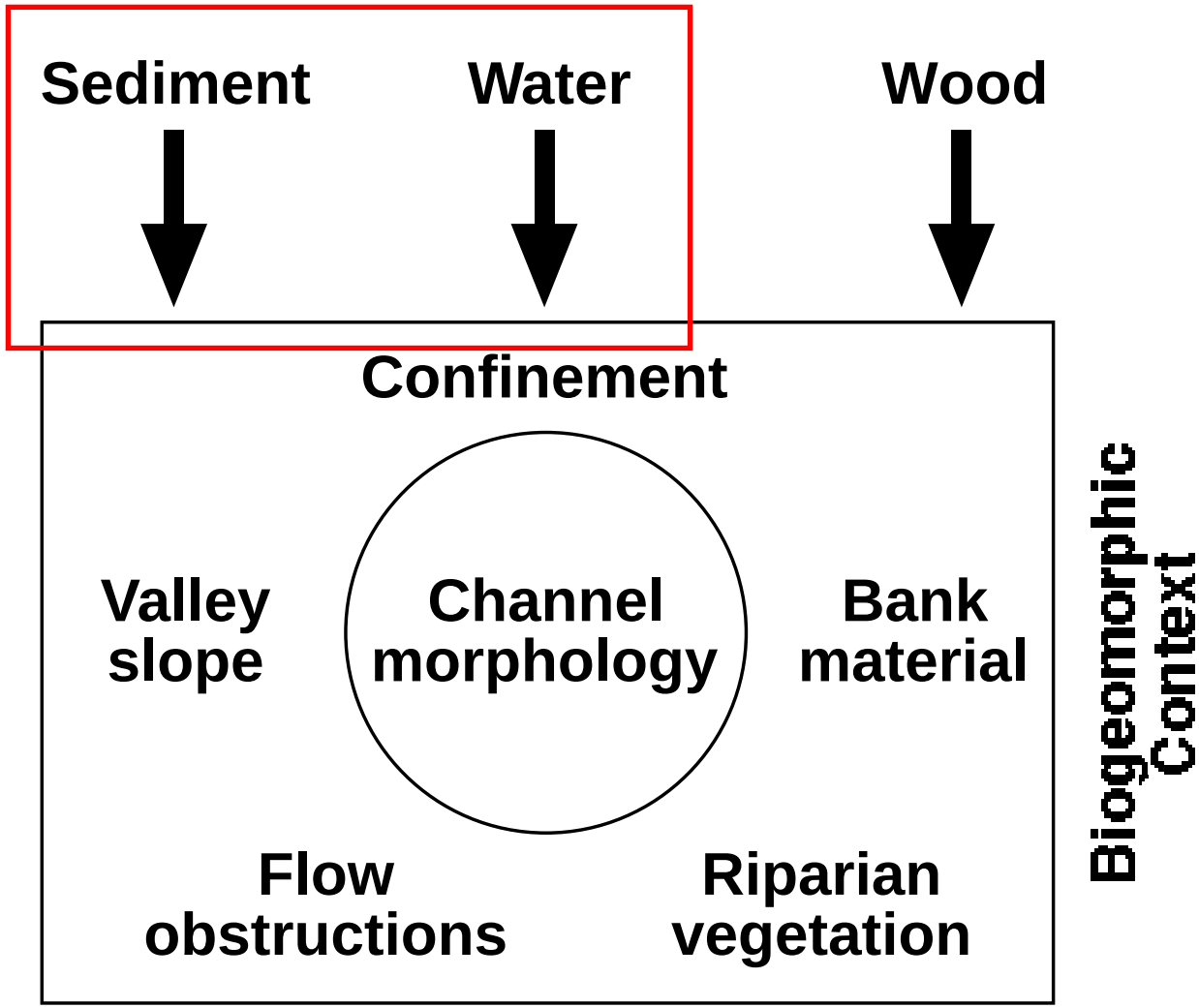
- Prior to construction of the Aswan Dam, an average of 125 million metric tons of sediment passed downstream each year.
  - The dam reduced this value to only 2.5 million metric tons.
  - Nearly all of the suspended sediment is now deposited in the reservoir behind the dam.

Damming the Nile

- Under natural conditions this sediment was carried downstream by floodwater, where much of it was deposited over the floodplain and delta, thus adding to the rich agricultural soils at a rate of 6 to 15 cm/century.

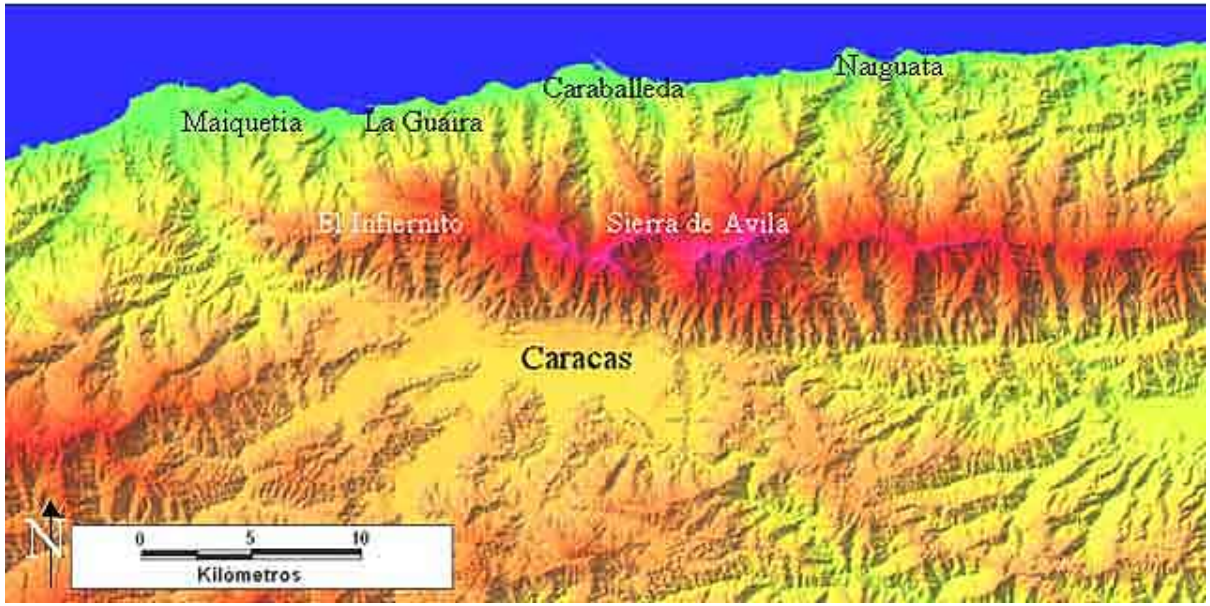
- Because the annual discharge of sediment has now been cut off, the Nile floodplain is no longer replenished annually and the coast has become increasingly vulnerable to erosion and salt build up.

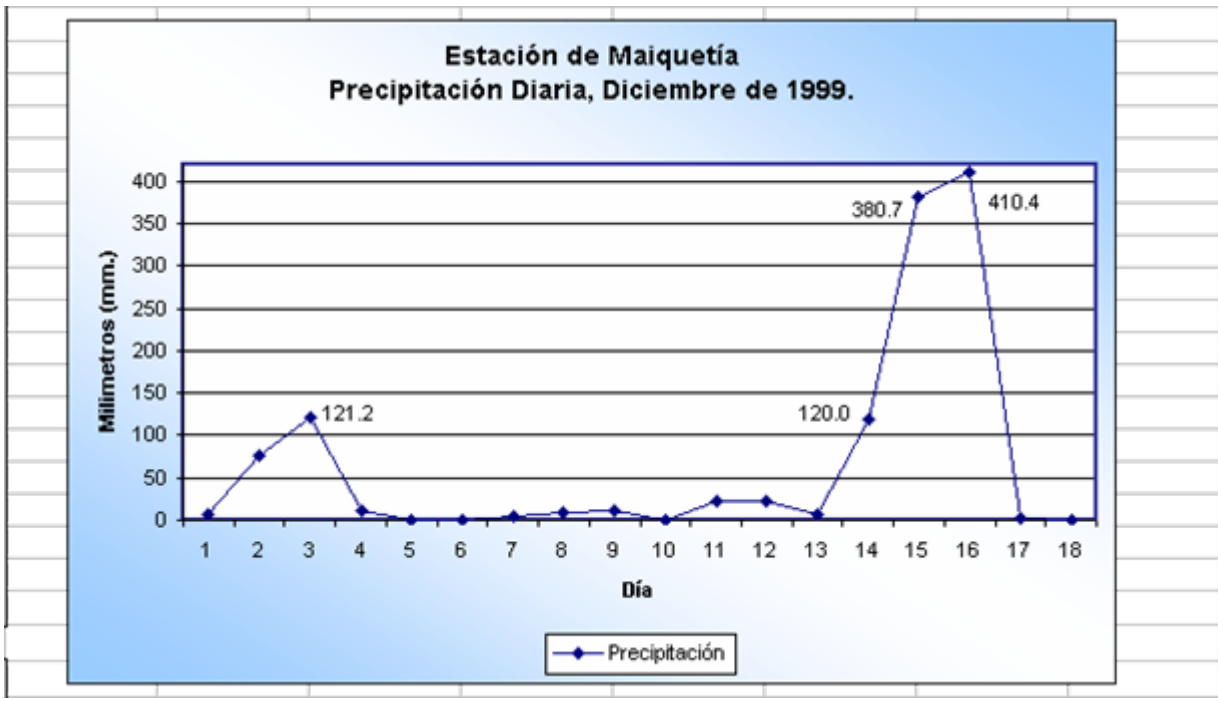
River Response: Dams



1999 Venezuela storm

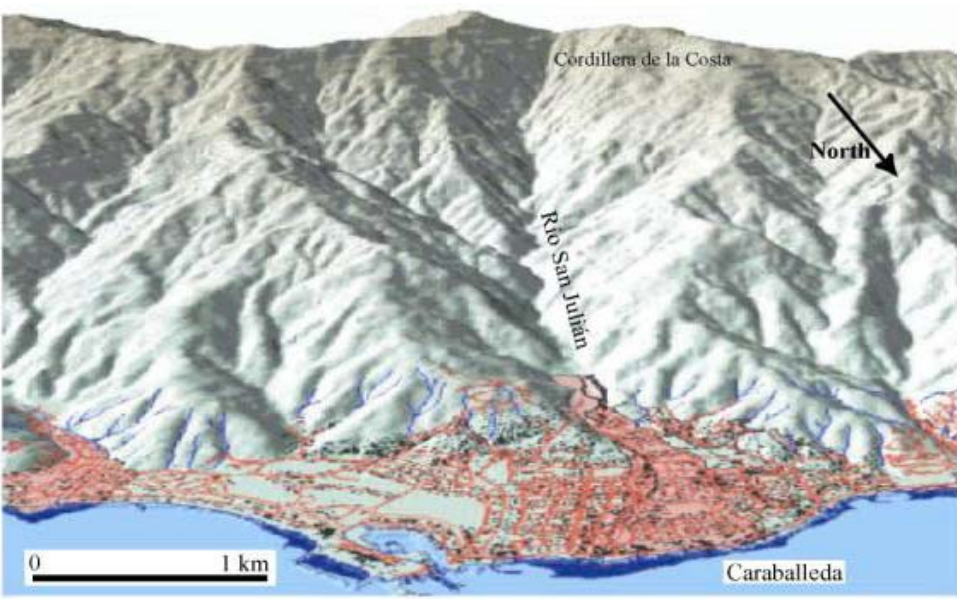
Almost 1 m of rainfall in 3 days !!!!

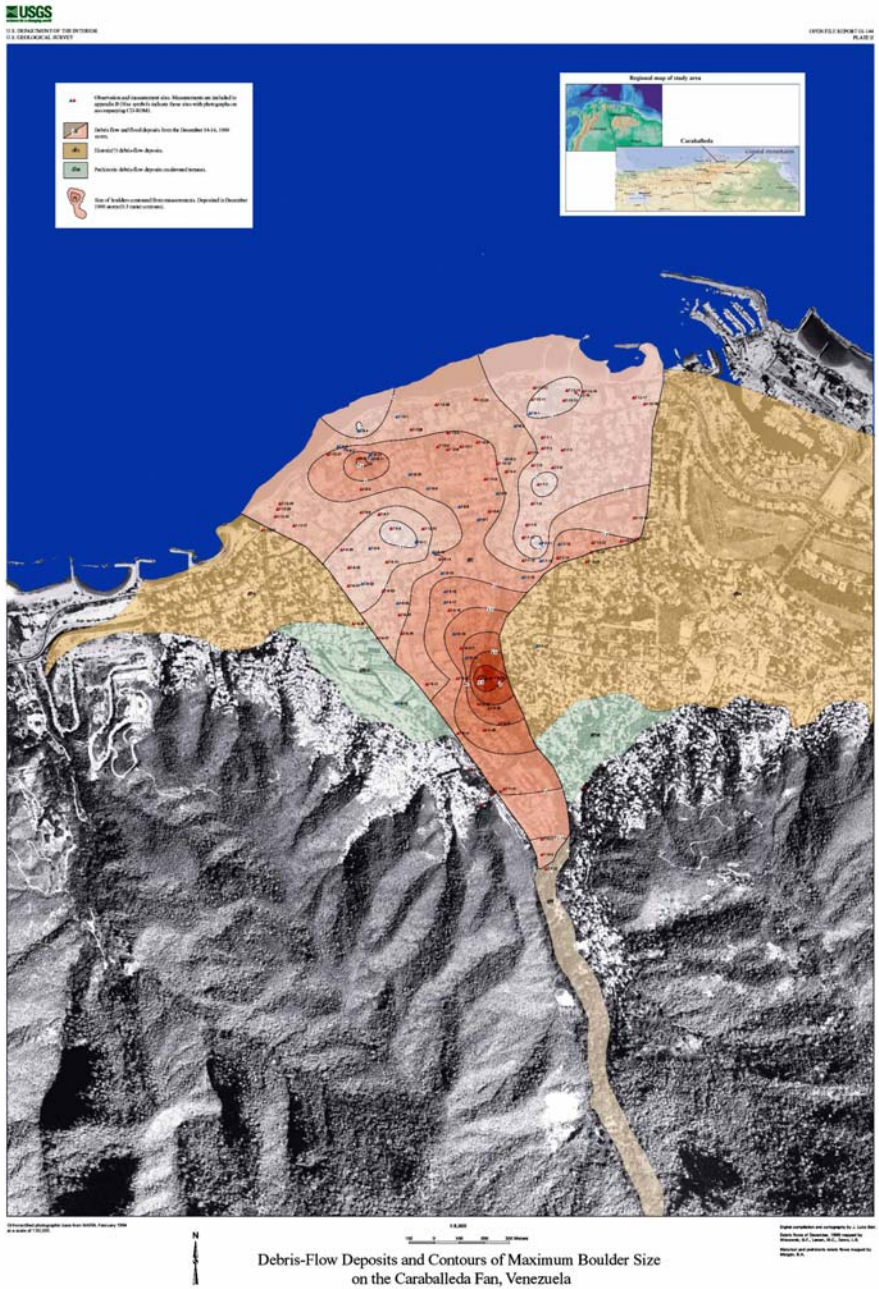




Carabelleda

Alluvial fan construction…





1999 Venezuela storm

Carabelleda

River Response:
A complex problem