Deltas and Environmental Perspective

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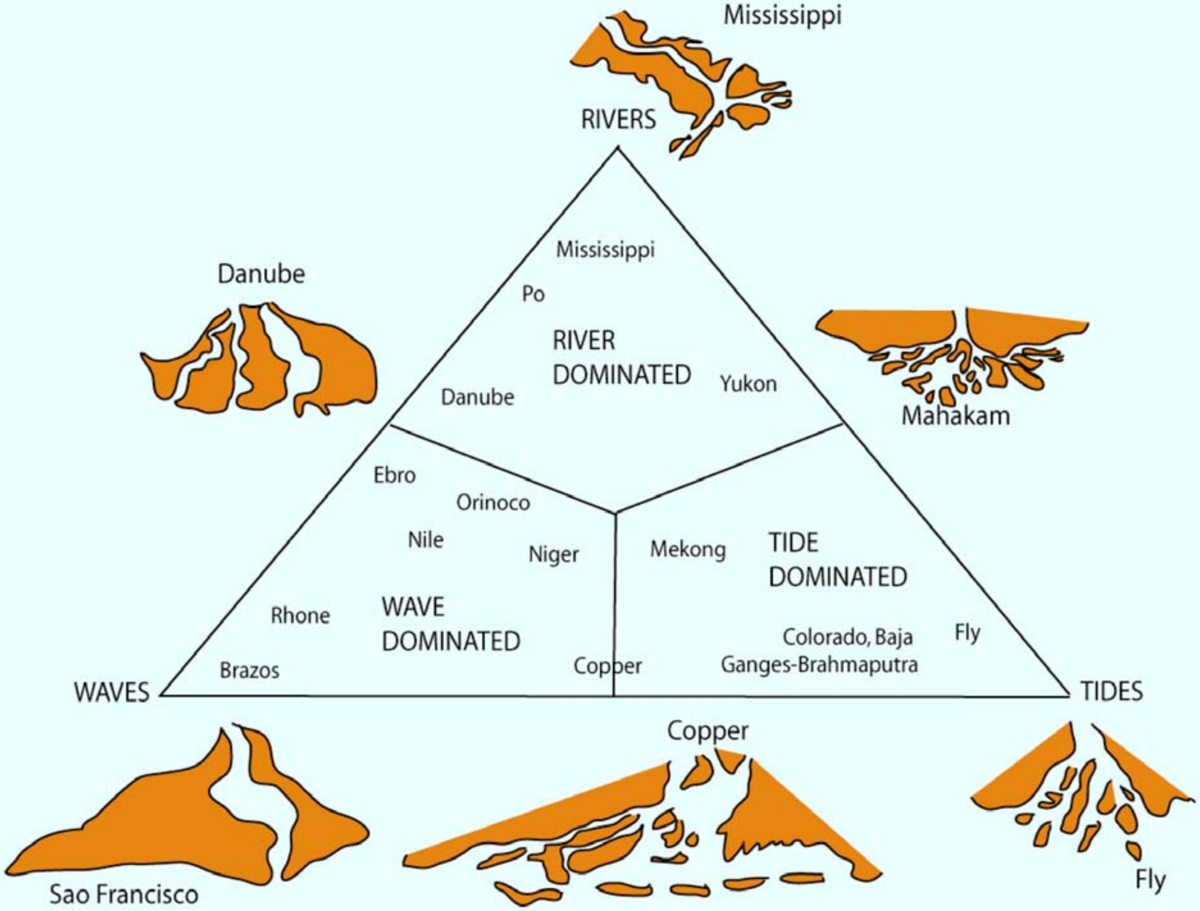
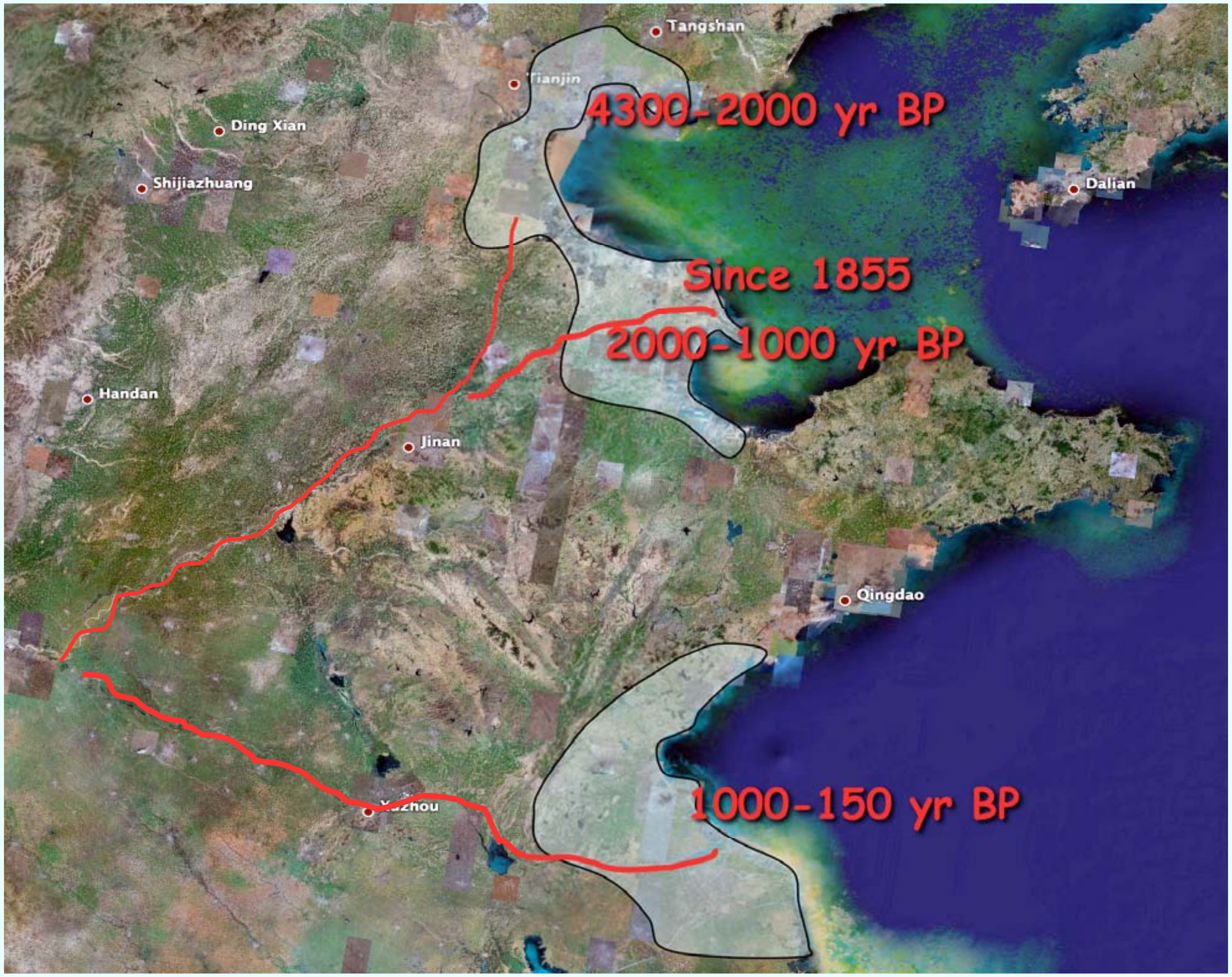
With the great help of A. Kettner, I. Overeem, E. Hutton, Y. Saito



Defining a delta's area:

1) the seaward prograding land area that has accumulated since 6 kyr, when global sea level stabilized within a few m of the present level (Amorosi and Miller, 2001).



Problem:

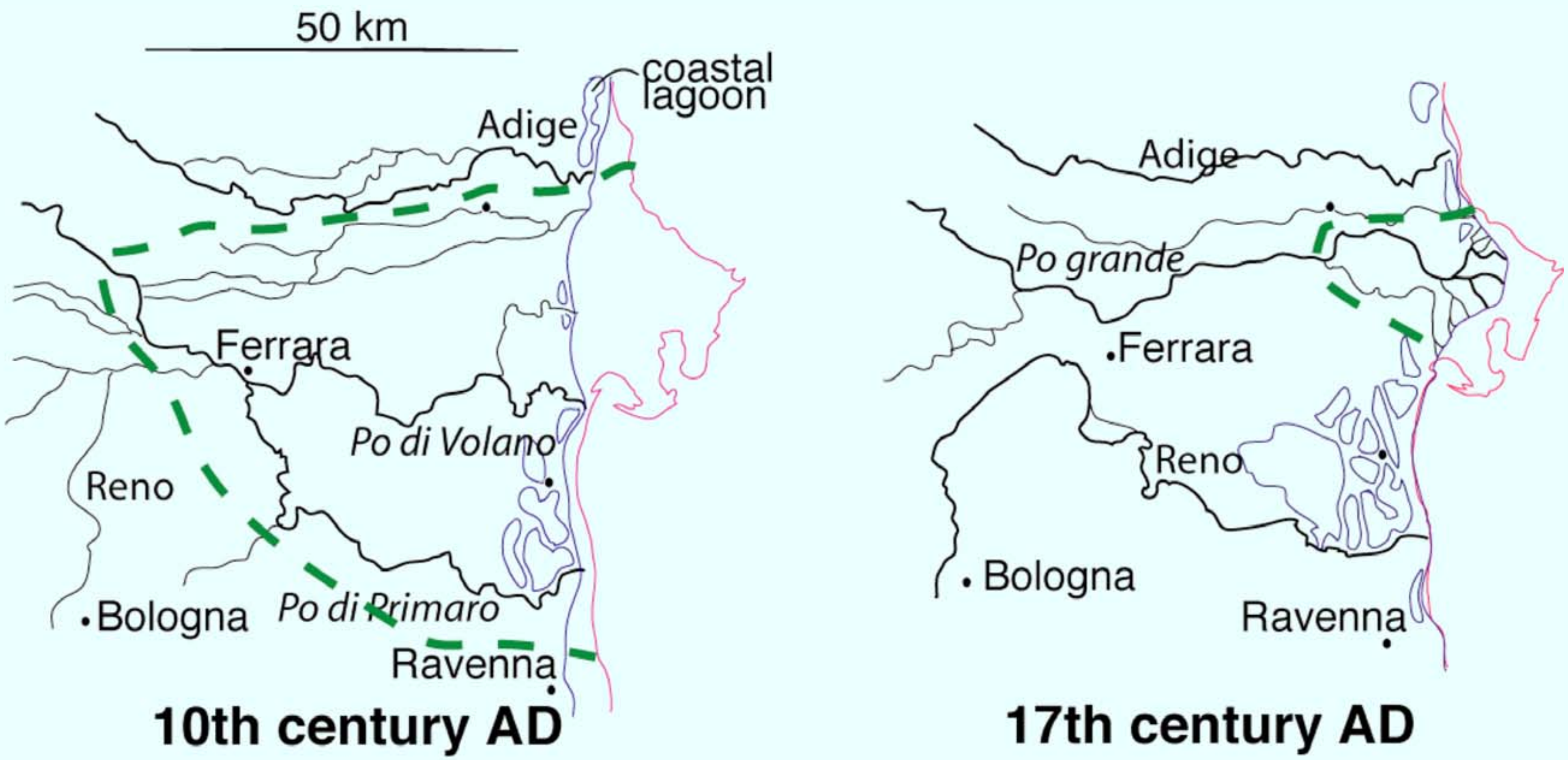
i) Relative sea level height is globally variable (i.e. SL did not stabilize everywhere at the same time);

ii) shifting river channels may disconnect deltaic lobes.

Defining a delta's area:

2) the seaward area of a river valley after the main stem of a river splits into distributary channels (Syvitski and Saito, 2007);

Problem: The split (or hinge) point can change over time



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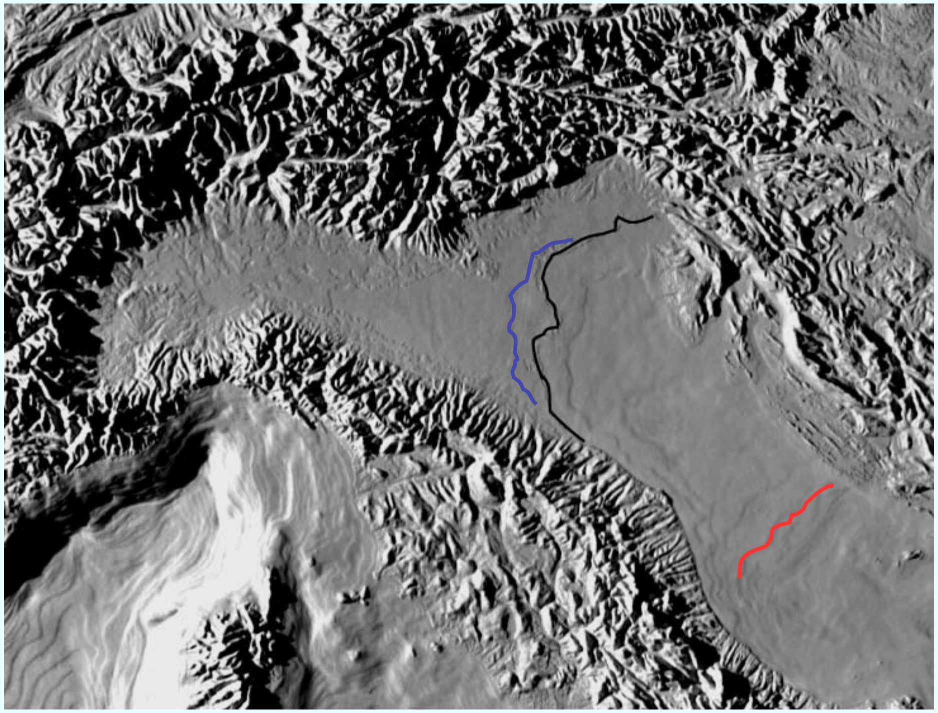
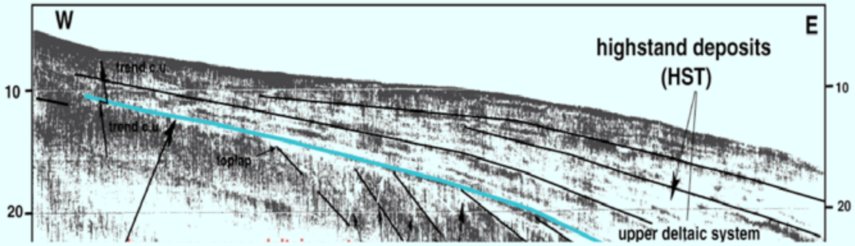
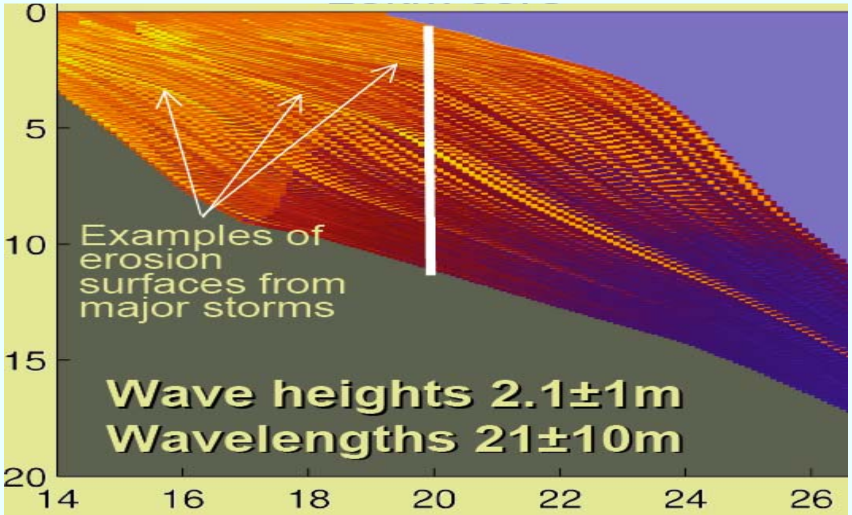
Defining a delta's area:

3) the area of a river valley underlain by Holocene marine sediments (Kubo et al., 2006);

Problem: While likely the most exact definition, this is a very difficult assessment, involving the collection and dating of boreholes (cores), and geophysical profiling over an expansive area; &/or time consuming numerical modeling.







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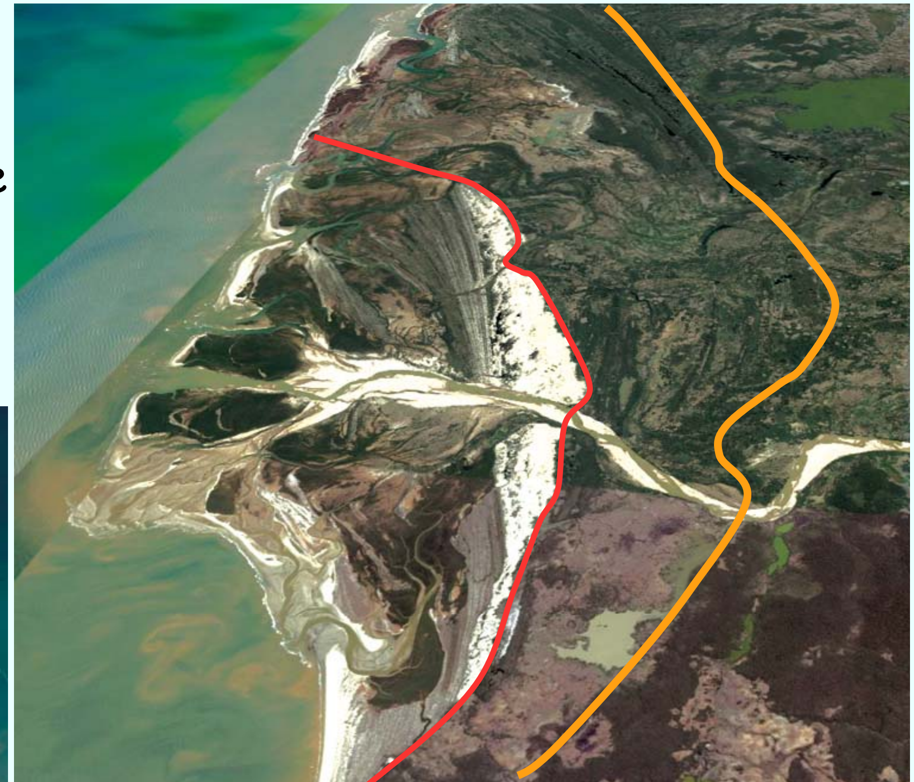
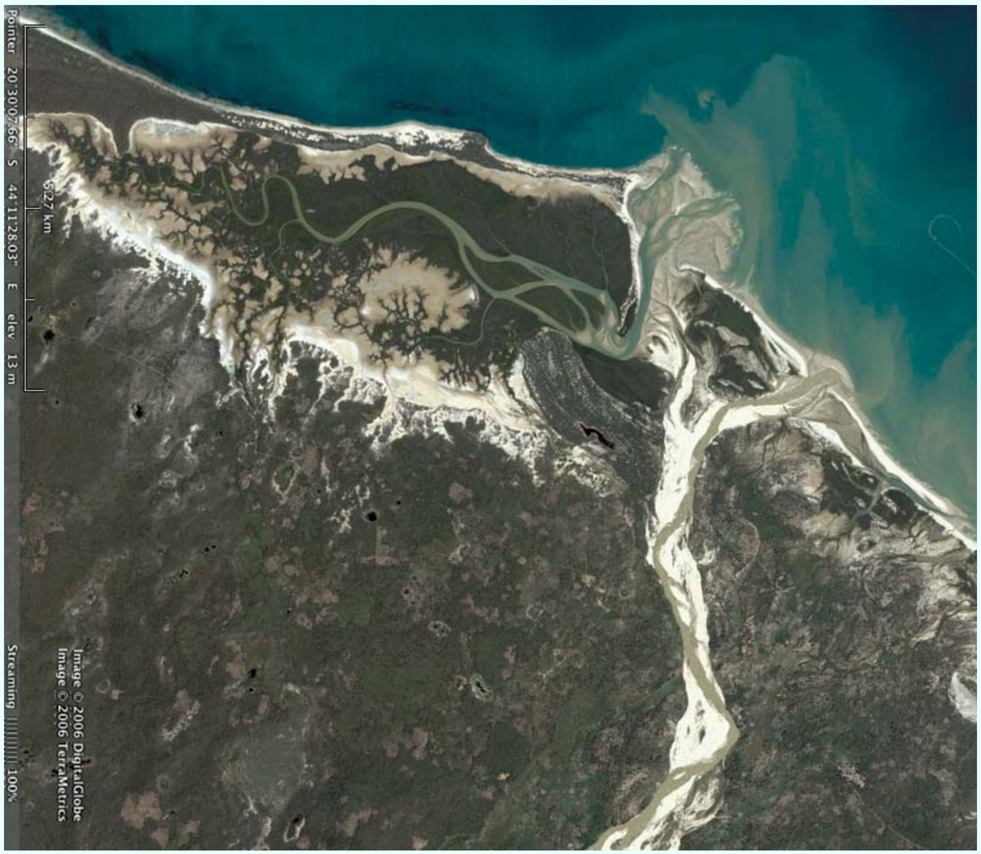
Defining a delta's area:

4) accumulated river sediment that has variably been subjected to fluvial, wave and tidal influences (Overeem et al., 2005);





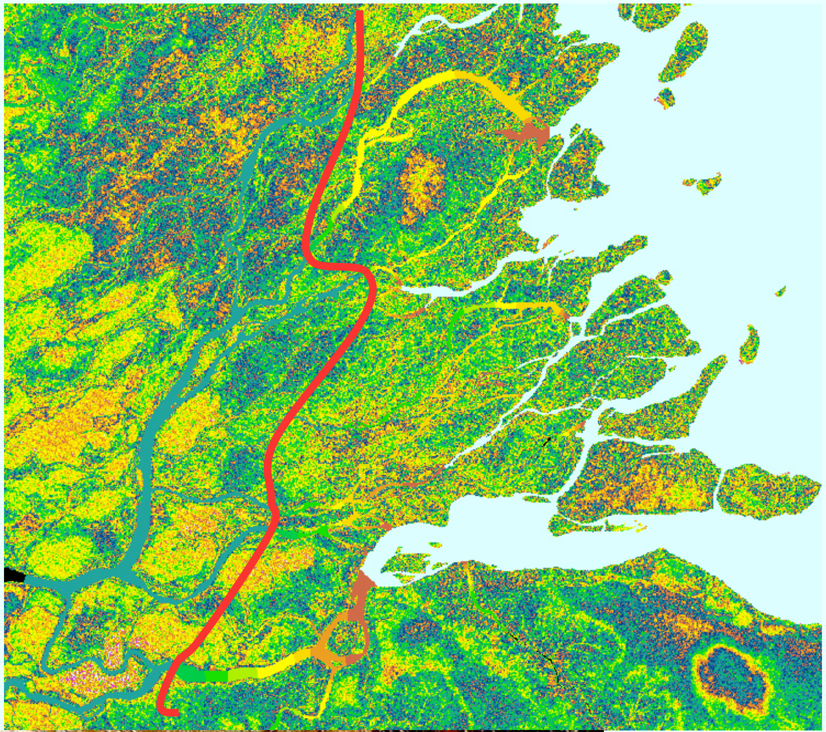
Problem:

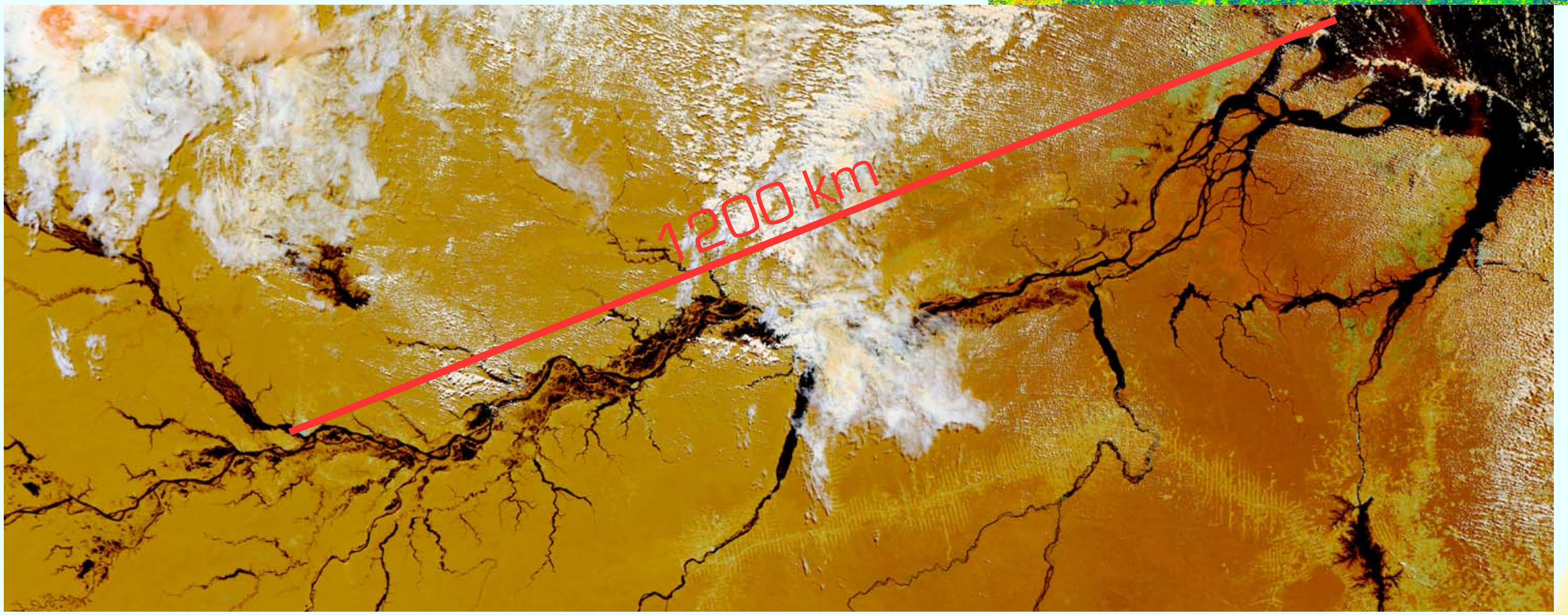
No time is specified. Is it Holocene or Pleistocene, or is it in the last few hundred years?

Defining a delta's area:

5) the area drained by river distributary channels that are under the influence of tides.

Problem: Is it saltwater intrusion? Or is it tidal damming?





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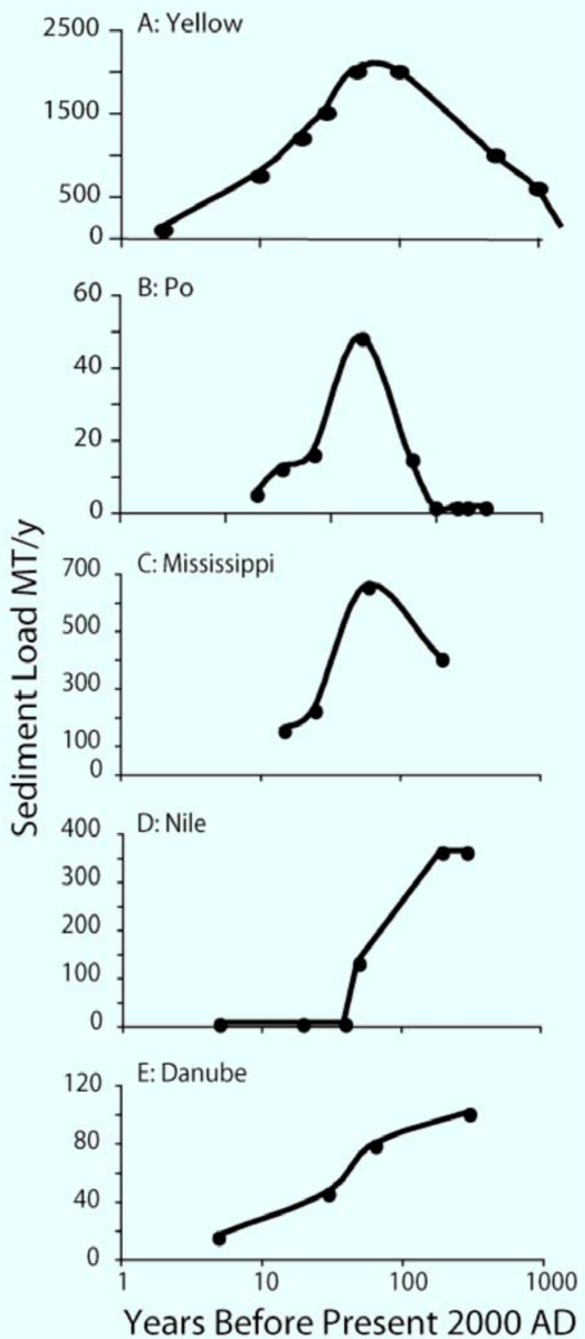


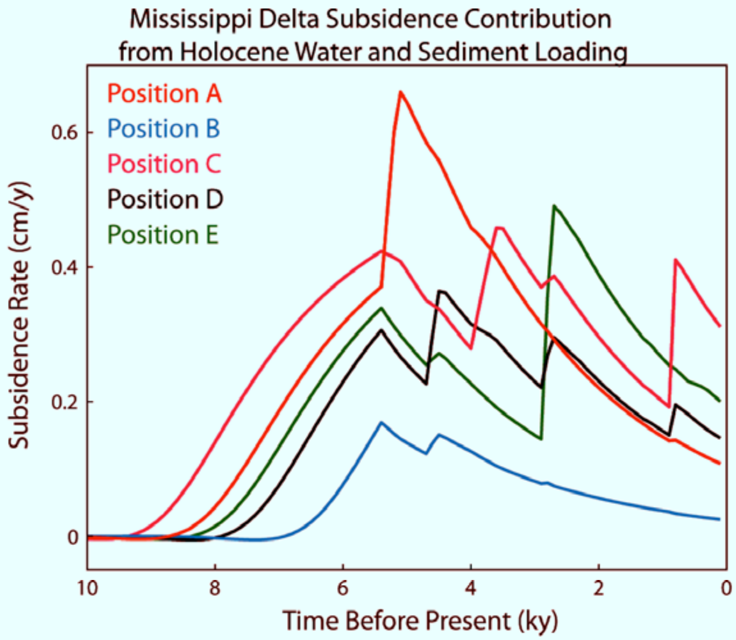
Sediment delivery to a delta is a function of drainage basin characteristics:

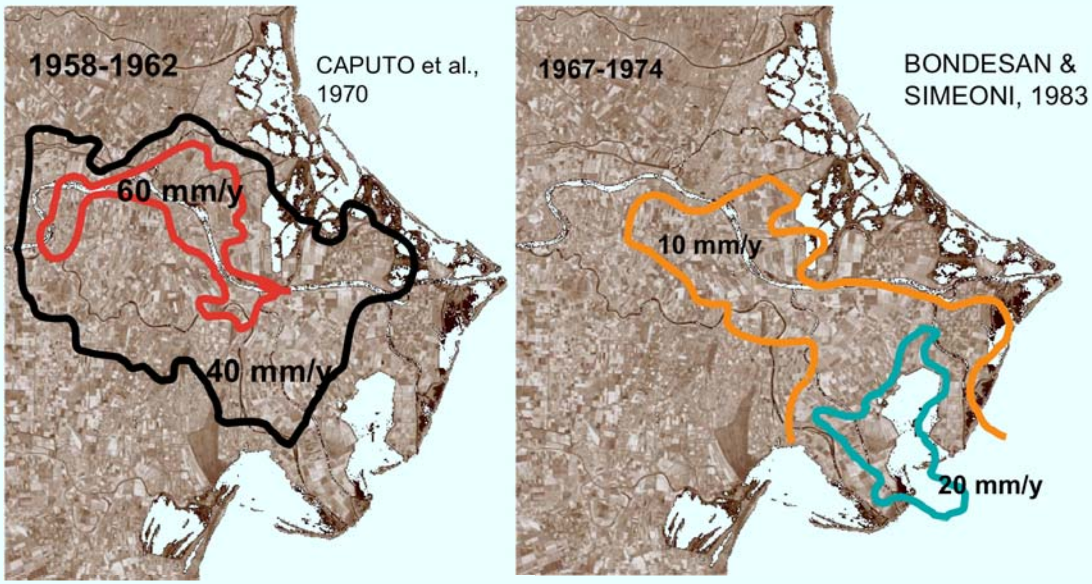
1) Basin area
2) Precipitation/runoff/water use: river discharge
3) Basin relief
4) Basin temperature
5) Basin lithology
6) Extent of glaciers
7) Human landuse: de- / re-forestation, mining, agricultural practices, urbanization, channel hardening, use of stop-banks
8) Level of impoundments: number, placement and size of reservoirs

Relative Sea level for Deltas

Natural RSL rates = Eustatic Rate + Isostatic Rate + Compaction
= (3.0 mm/y) + (0.3 to 3.8 mm/y) + (0.7 to 2.2 mm/y)
= 4.0 to 7.8 mm/y

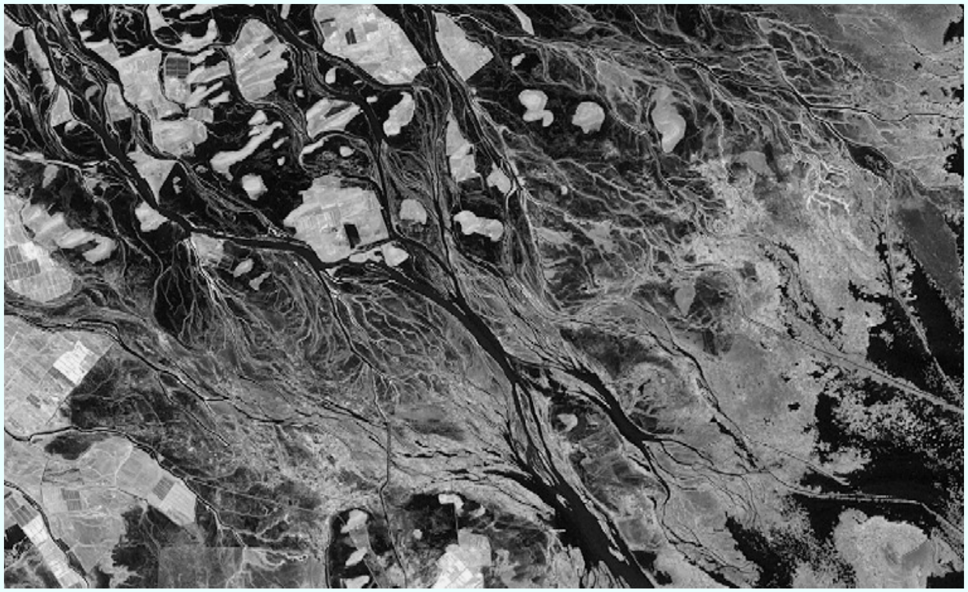
Accelerated compaction = petroleum & groundwater mining
e.g. Po in the 1950's: >60 mm/y — *down to 20 mm/y after controls*
Yangtze: 28 mm/y — *down to 3 mm/y after controls*
Niger (today): 25 to 125 mm/y
Chao Phraya (today): 50 - 100 mm/y



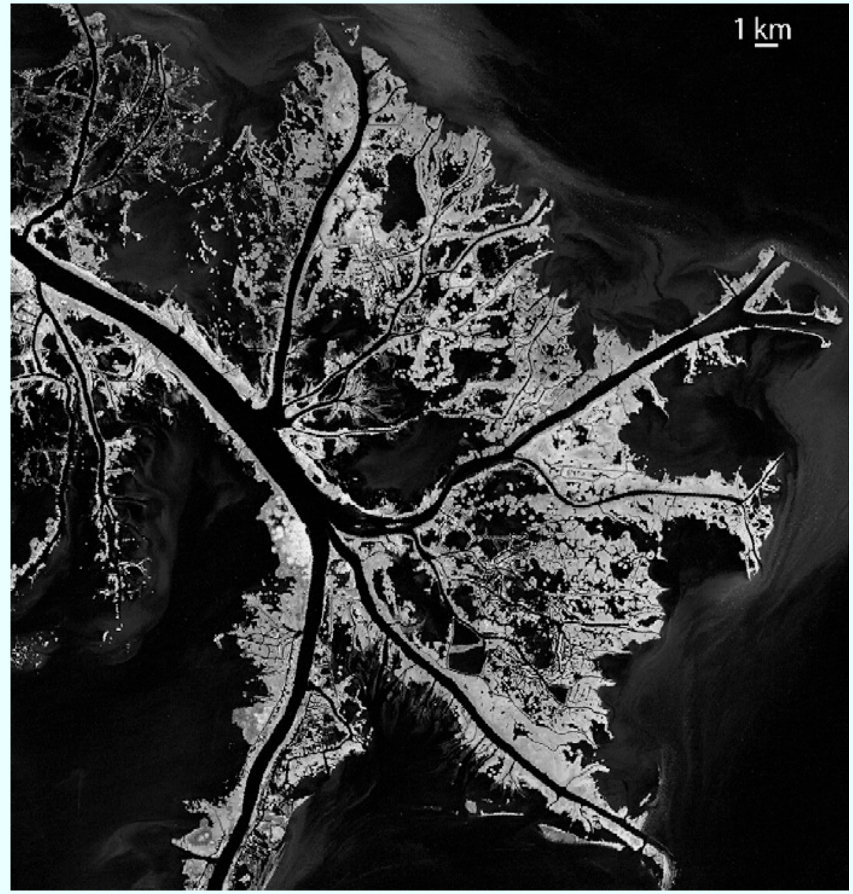


End-Member Deltas

Low Marine Energy: P_m:P_r ≤0.2



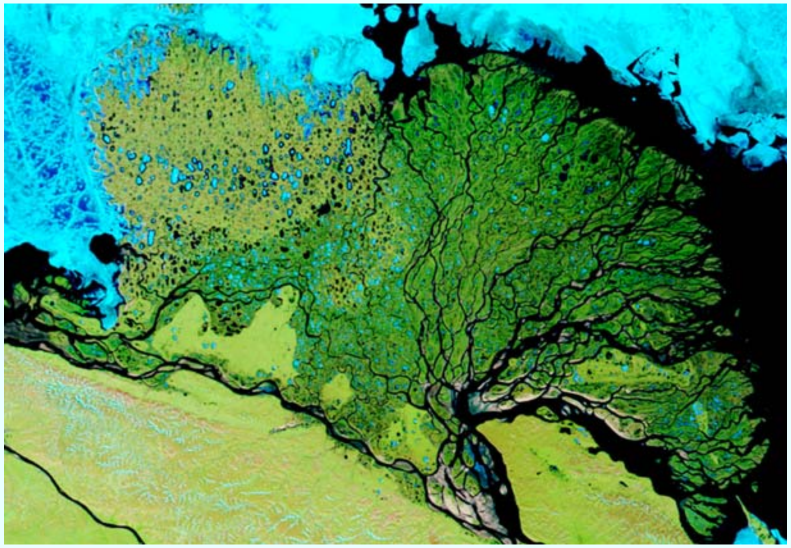
Volga: channel feathering



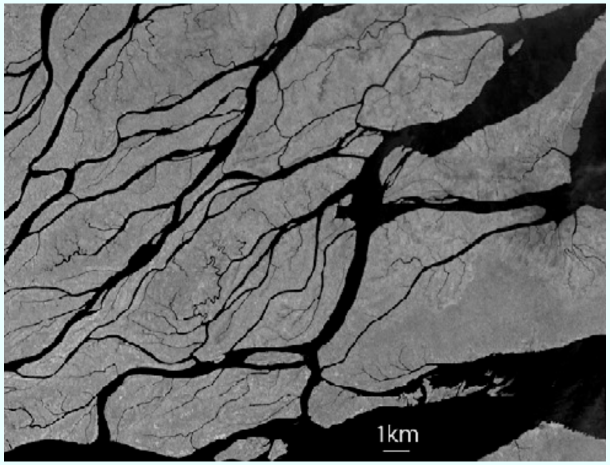
Mississippi: channel splitting

End-Member Deltas

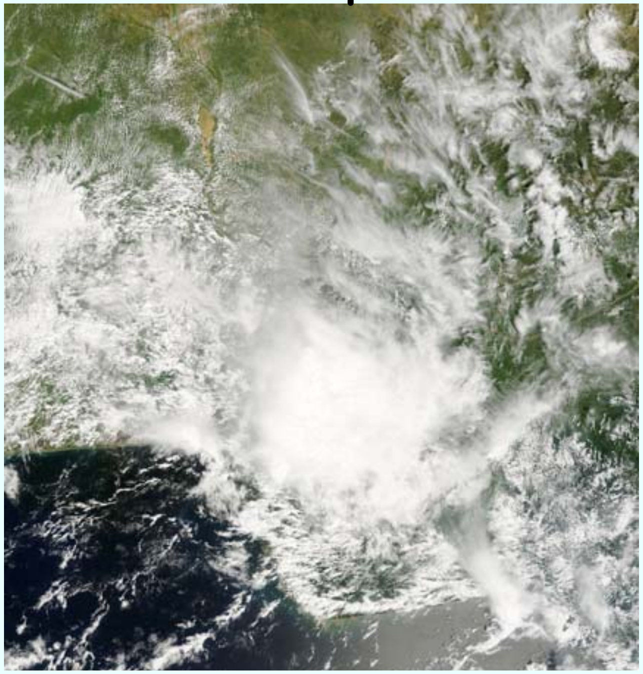
Polar



Lena: sea ice, permafrost, thermokarst, short seasonal discharge (Q_{mx}:Q_{av} > 3)



Tropical



Niger: intense convective rainfall

Orinoco: intense rainfall leads to runoff channels that influence the pathway and connectivity of the distributary channels

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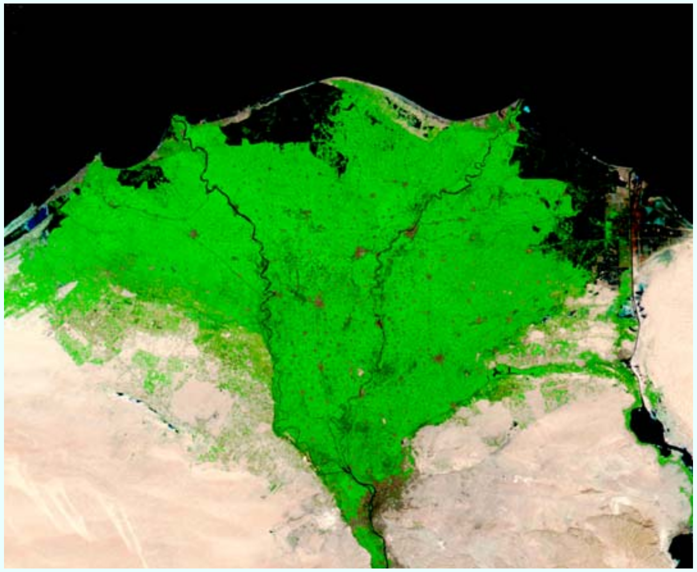
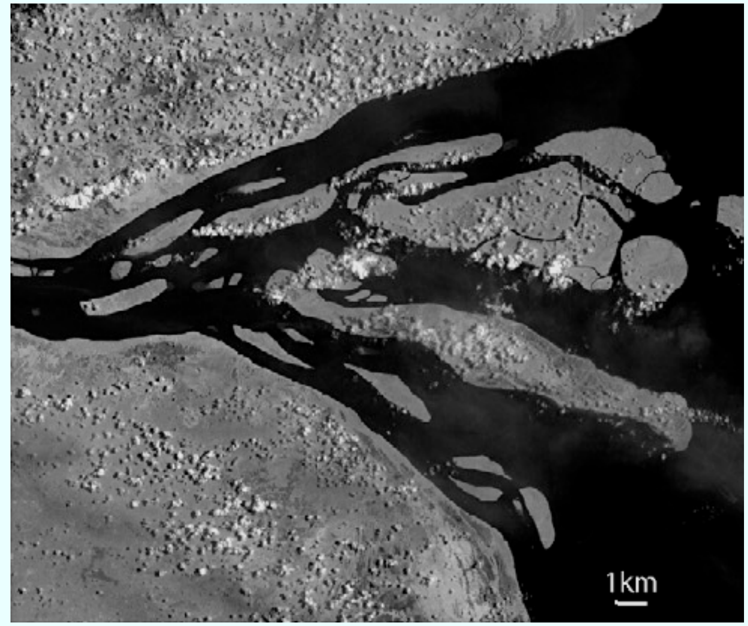
End-Member Deltas

Desert



Nile: Low Runoff (Q:A <0.03 m/y)

High Tide



Fly: high marine power, P_m:P_r >2.6; wide mouth to river width TC_w:Rw = 36

High Wave

Eel: high P_m:P_r ; few river mouths