Large deltas versus small deltas: Two different beasts

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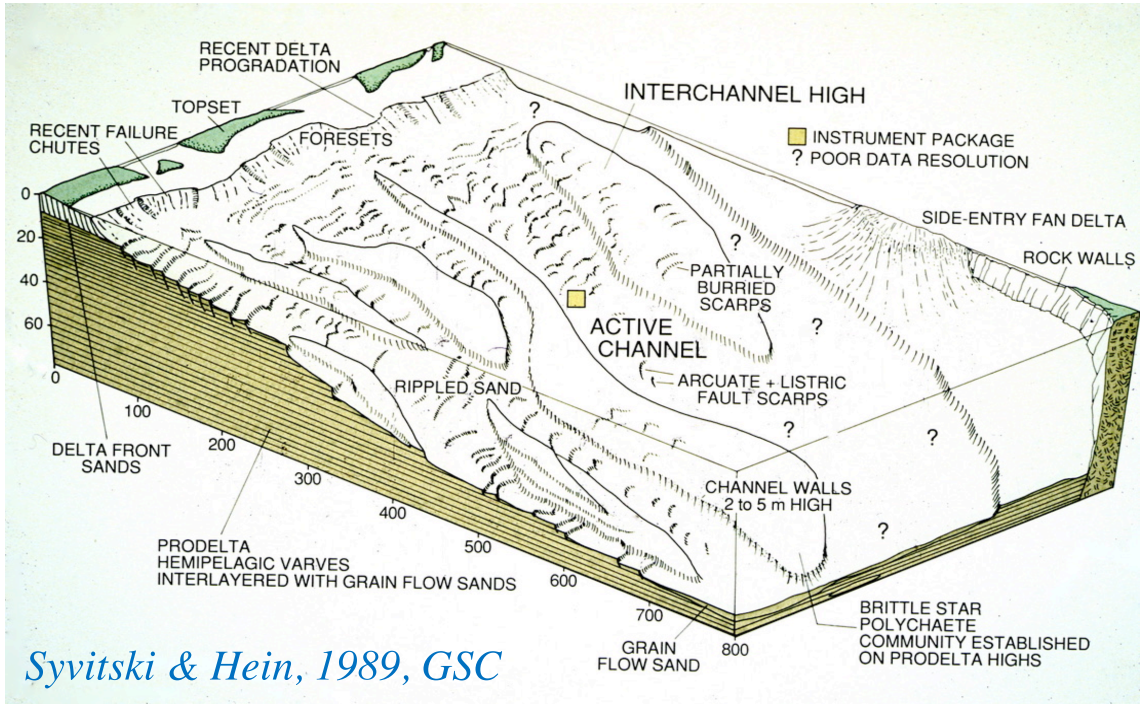

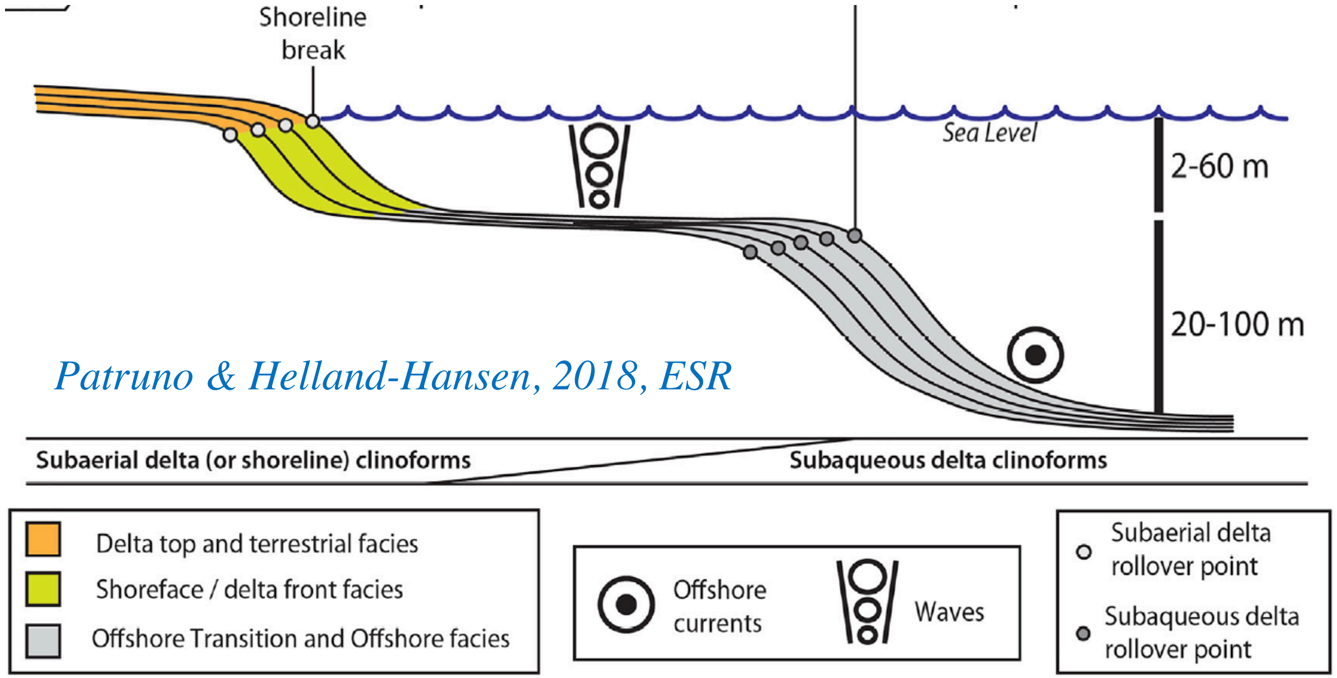

Smaller sand & gravel deltas entering deepwater fjords create classic shoreline foresets

Large silt and clay deltas create both shoreline and subaqueous-delta clinoforms

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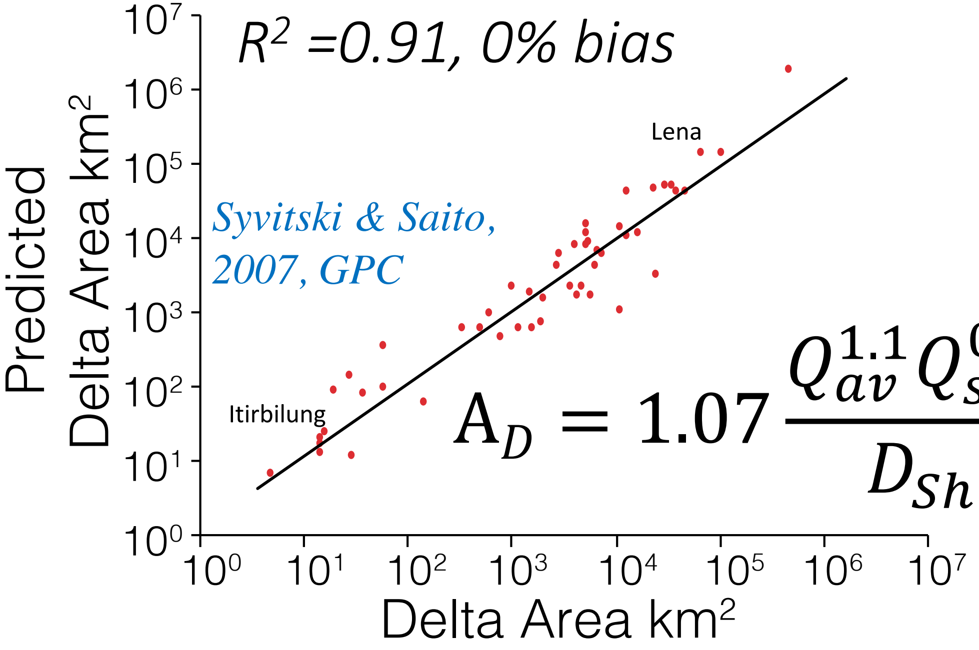
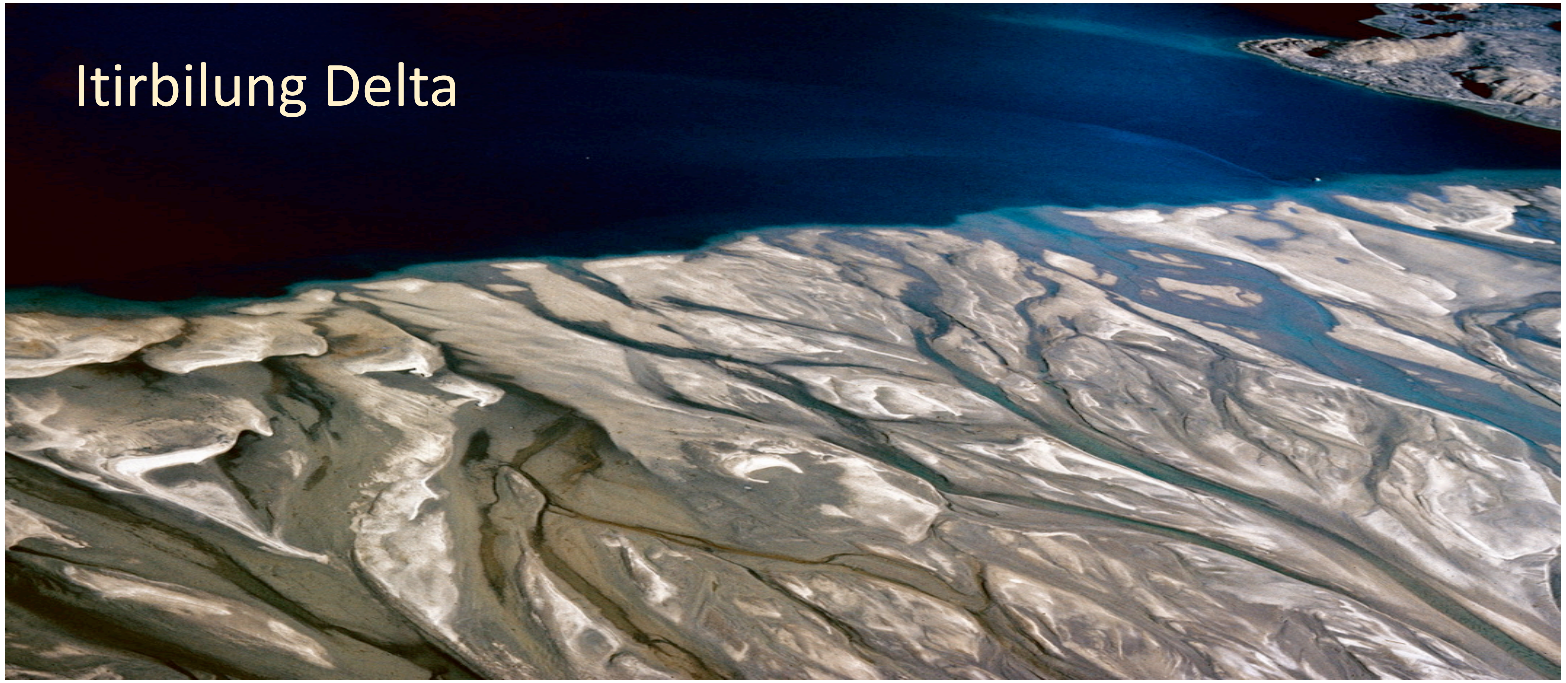
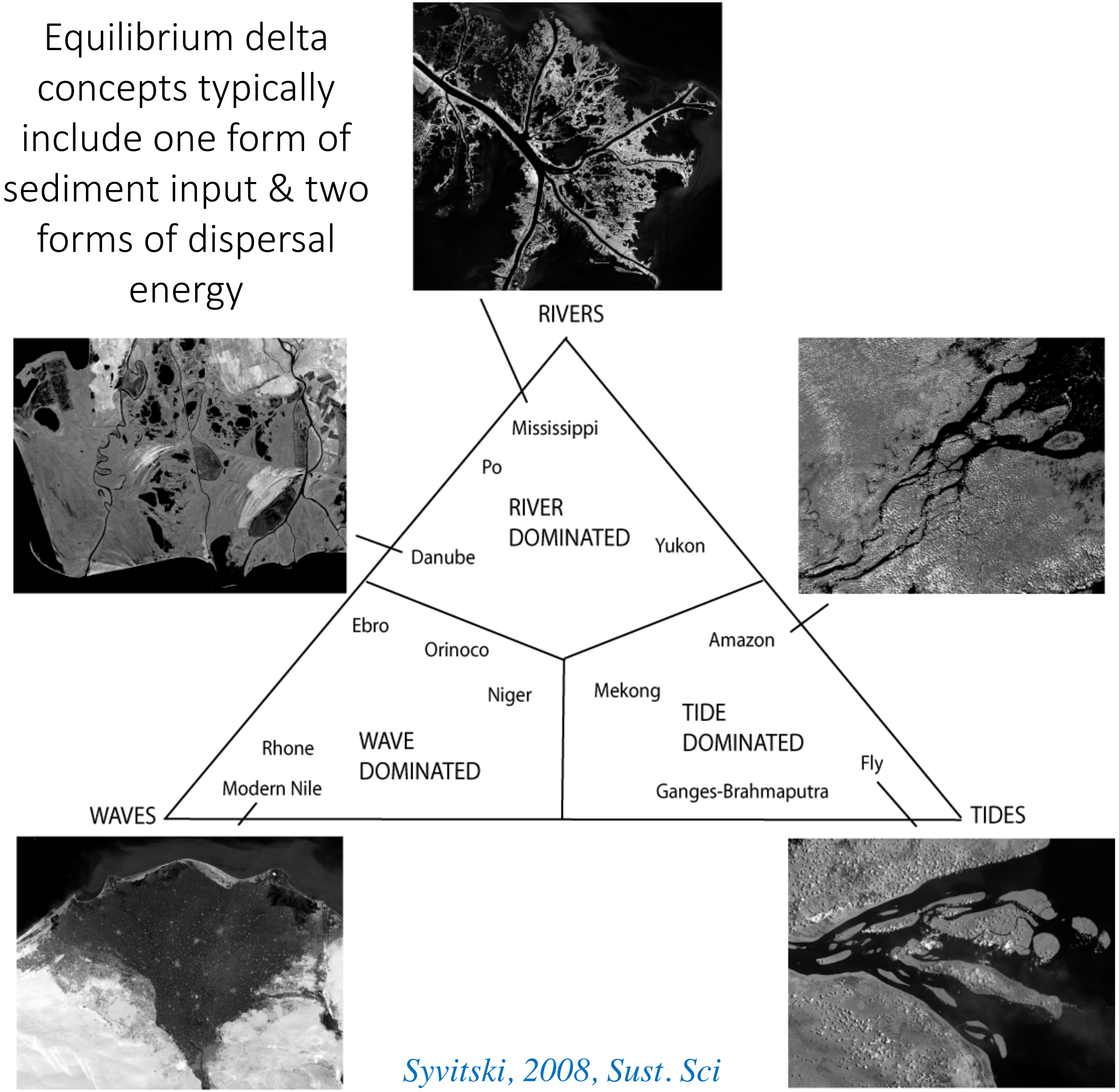


$$A_D = 1.07 \frac{Q_{av}^{1.1} Q_{s+b}^{0.45}}{D_{Sh}} \quad O: \frac{[10^6]\,[10^2]}{[10^2]}$$

Deltas are conditioned by drainage area, river discharge, sediment load, ocean energy, and human interaction.



Equilibrium delta concepts typically include one form of sediment input & two forms of dispersal energy



Syvitski, 2008, Sust. Sci

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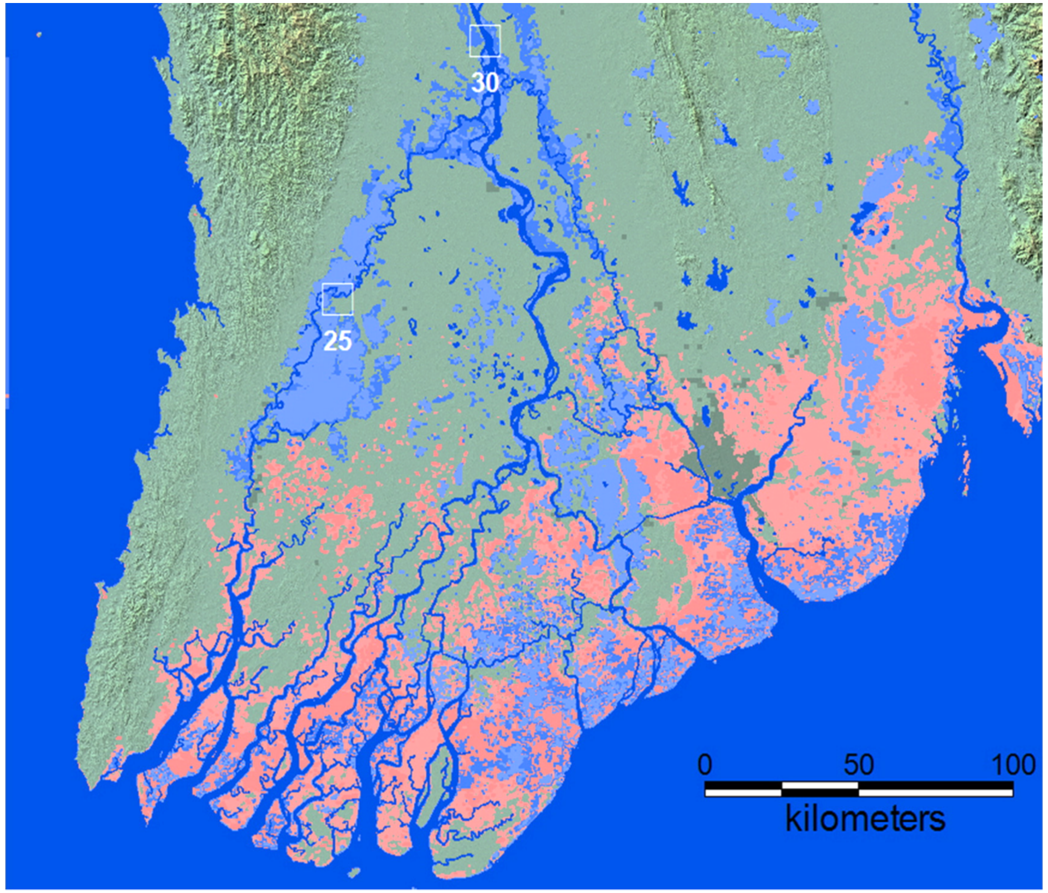
Brakenridge et al, 2017, ESR



Irrawaddy delta, Myanmar,
Cyclone Nargis flooding (2008 in pink),
Winter hydrography (2002, dark blue),
Monsoon flooding (2013 med. blue; 2014 light blue).

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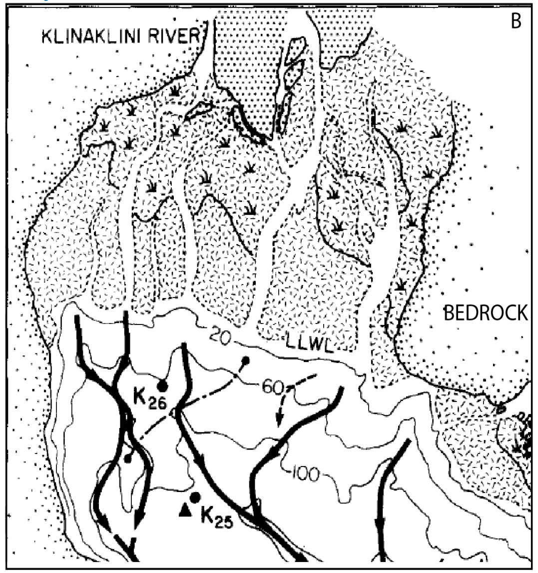
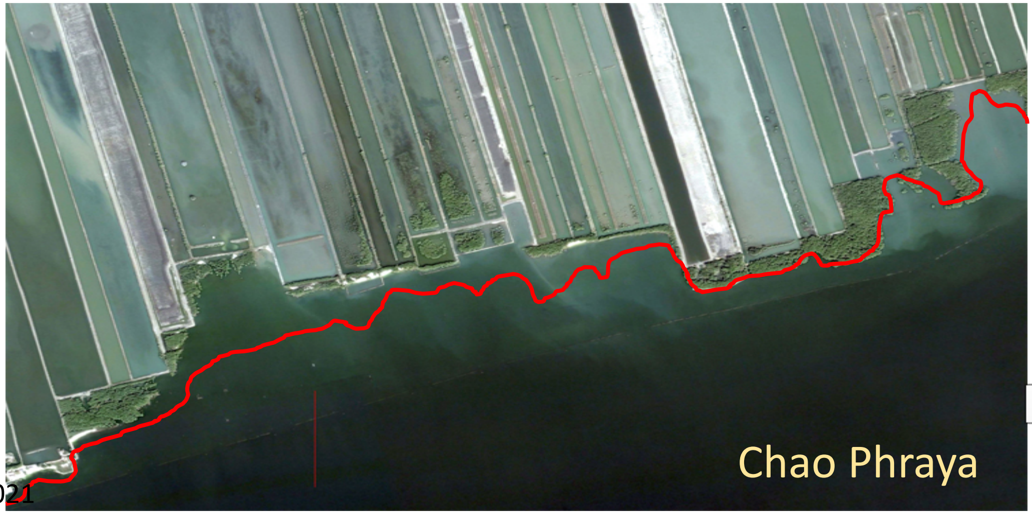
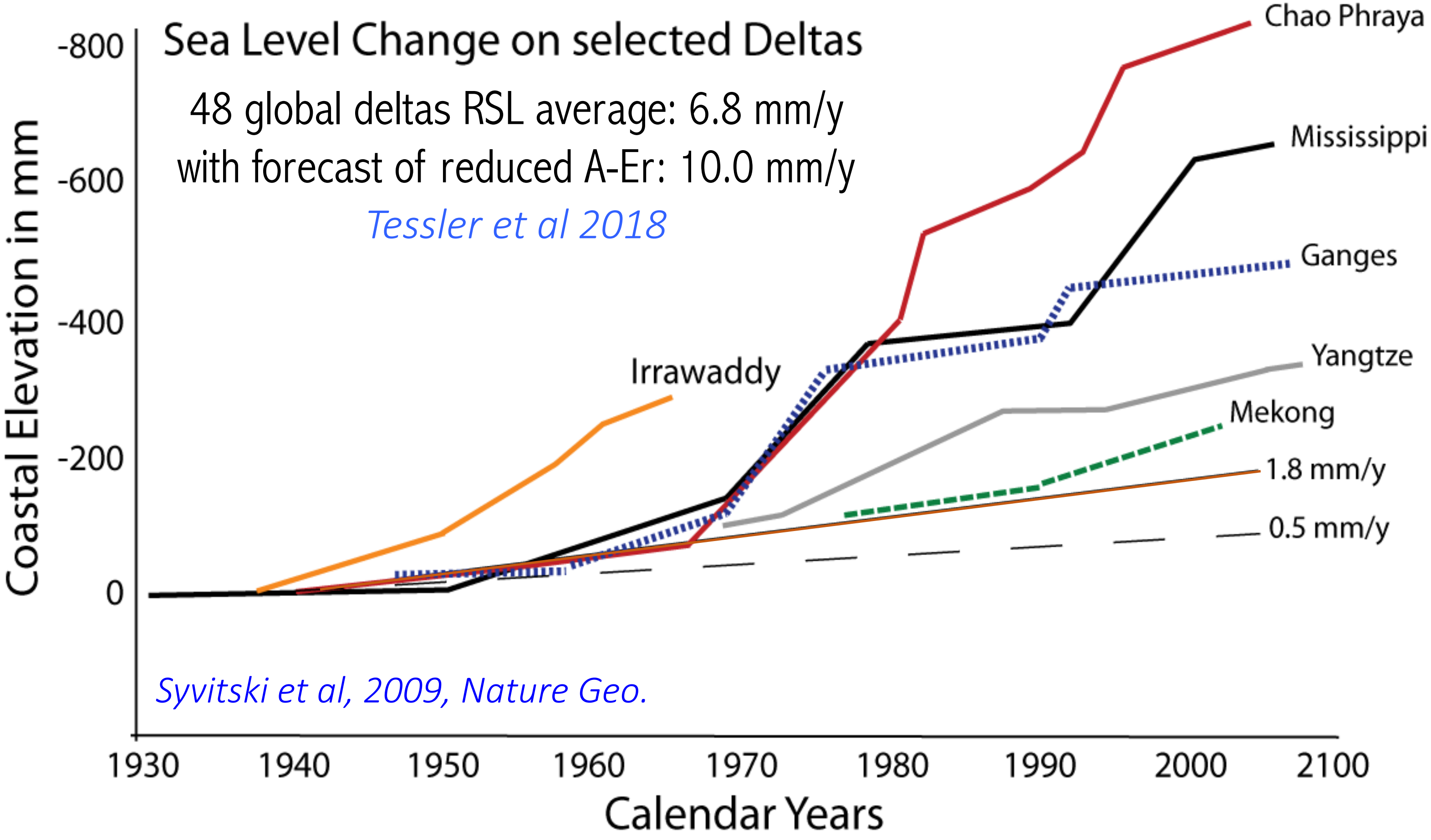
marine process that add sediment to a delta:
storm surges, tidal pumping, alongshore transport

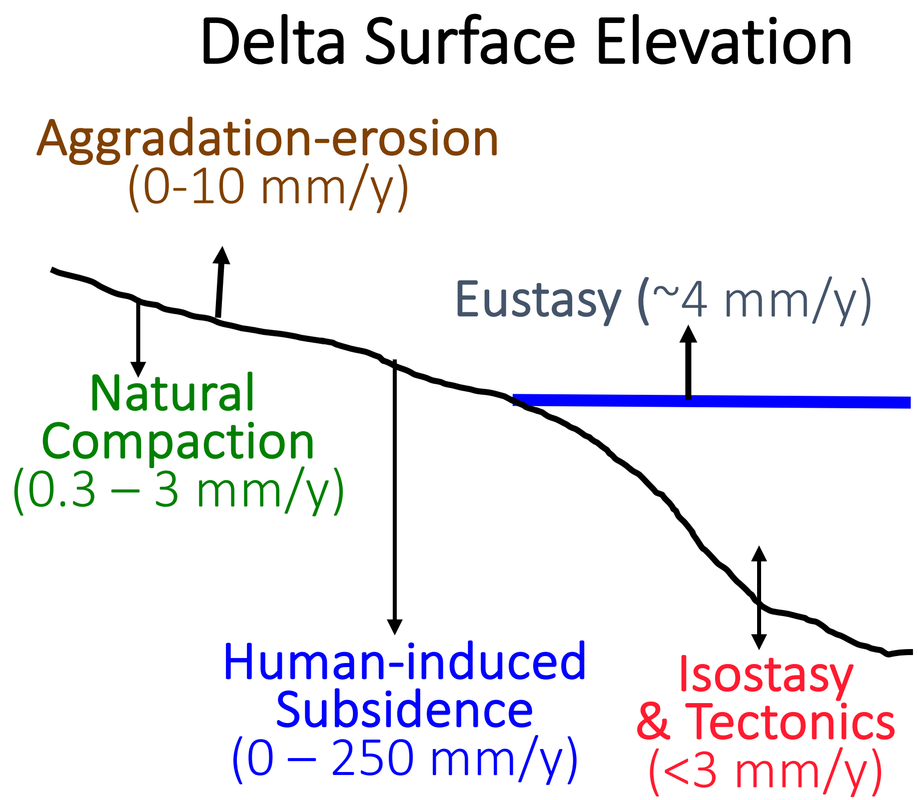
marine process that remove sediment to a delta:
tidal flat erosion, tidal channel widening, sediment failures, hypopycnal plumes, hyperpycnal flows, wave-assisted erosion, delta drowning (relative sea level rise)

Syvitski & Farrow 1983, SG









$$\partial\eta/\partial xy = (A\text{-}Er) - \Delta E - C_n - C_A \pm M$$

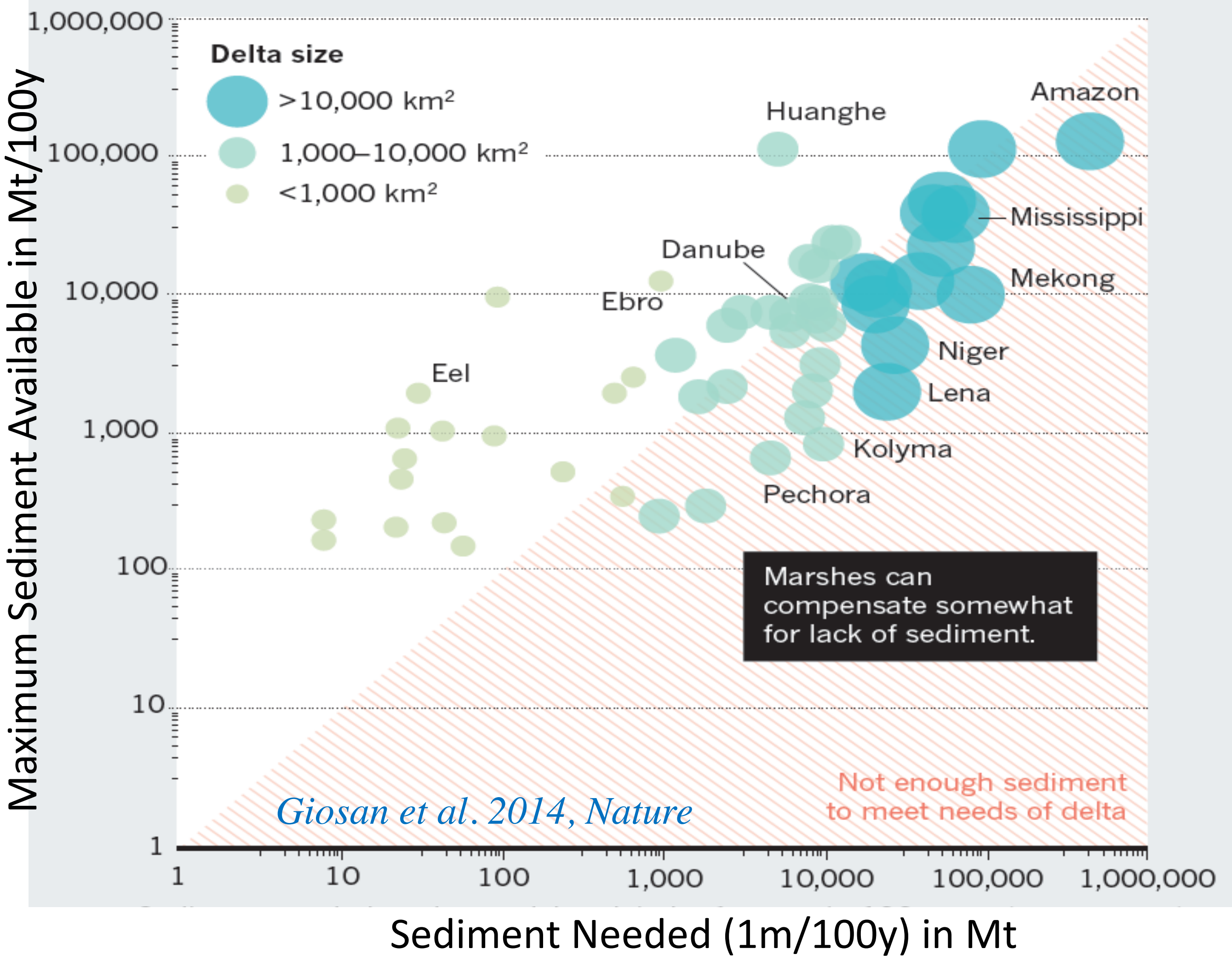
Late Holocene: $1.9 = 5 - 0.1 - 2 - 0 - 1$

Anthropocene: $-13 = 1 - 4 - 2 - 7 - 1$

in mm/y

Small marine deltas: small reservoirs trap less sediment allowing a delta to better keep up with sea level rise; their coarser-grained sediment compacts less; less likely to have human induced-subsidence (with exception: ex. Tokyo, Osaka, Nagoya, Jakarta); do not have a geological mass large enough to induce isostatic subsidence

Large marine deltas: Numerous and larger dams trap more sediment; sediment deficit is likely; finer-grained sediment compact more; more likely to have accelerated compaction (subsidence); geological mass likely large enough to induce its own isostatic subsidence



$$\partial \eta / \partial xy = (A\text{-}Er) - \Delta E - C_n - C_A \pm M$$

Large Deltas: $-12 = 2 - 4 - 2 - 7 - 1$

Small Deltas: $-3 = 4 - 4 - 1 - 2 - 0$

in mm/y

GLOBAL IGBP CHANGE

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Small delta (marine) characteristics	**Large delta (marine) characteristics**
Distributary channel formation (years) Avulsions (decades)	Distributary channels (decades) Avulsions (century)
Valley flooding (decades) Topset: Sand & Gravel	Overbank flooding or storm surge (years) Topset: Silt and Clay
Delta gradient (Qs, tidal range) Number of channels (fluvial dynamics)	Delta gradient (Qs, shelf depth) Number of channels ($Q_{mx}/(Ti^2+Wa^2)$)
Limited Human Footprint (bridges for many but for high population coasts the entire delta is occupied & engineered)	**Enormous Human Footprint** (1) engineered changes to distributary channels; (2) accelerated subsidence; (3) engineered coastal barriers; (4) land reclamation & polder creation; (5) Megacities; 6) Agri- & Aquaculture

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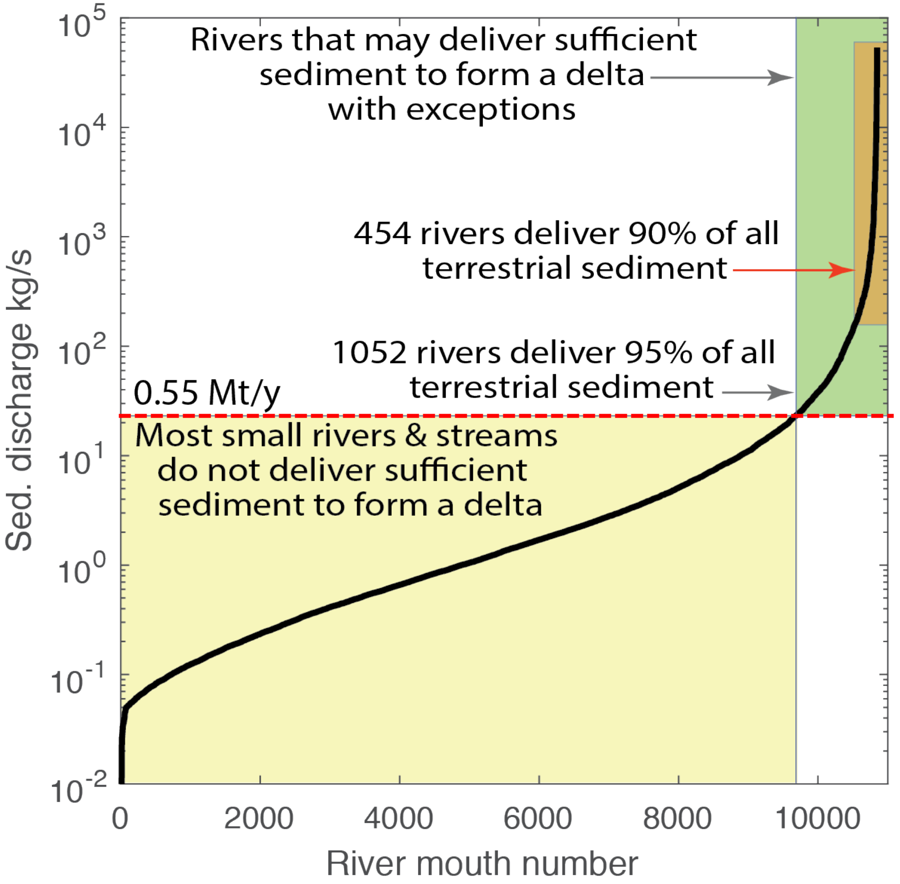
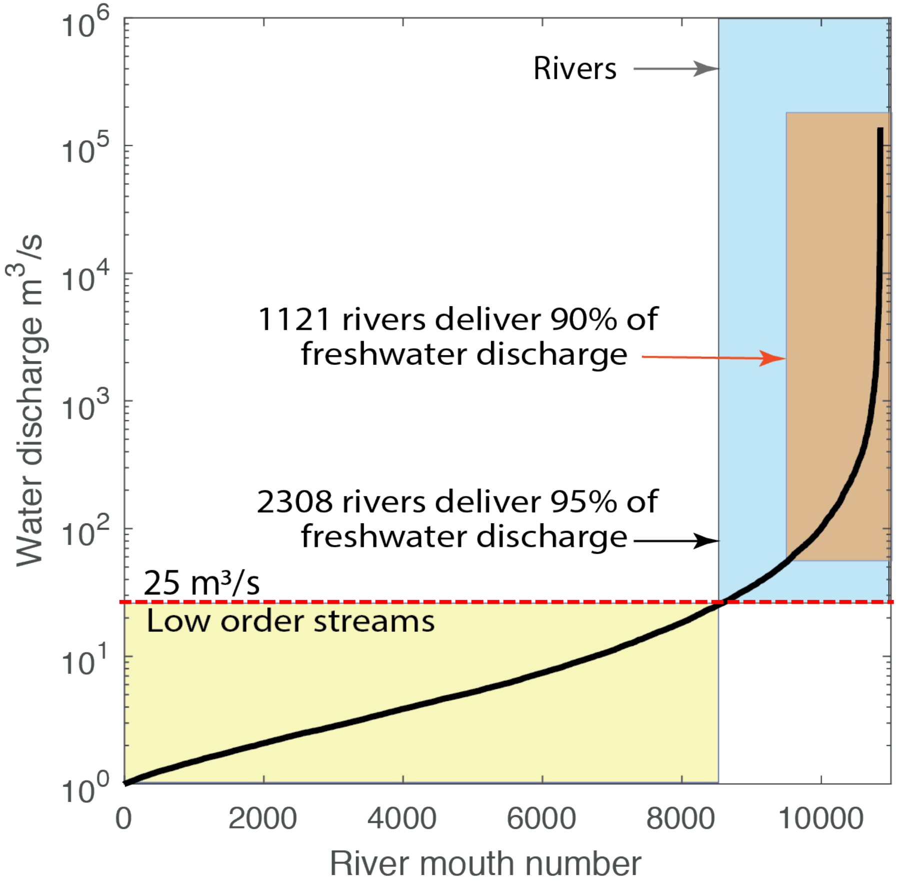
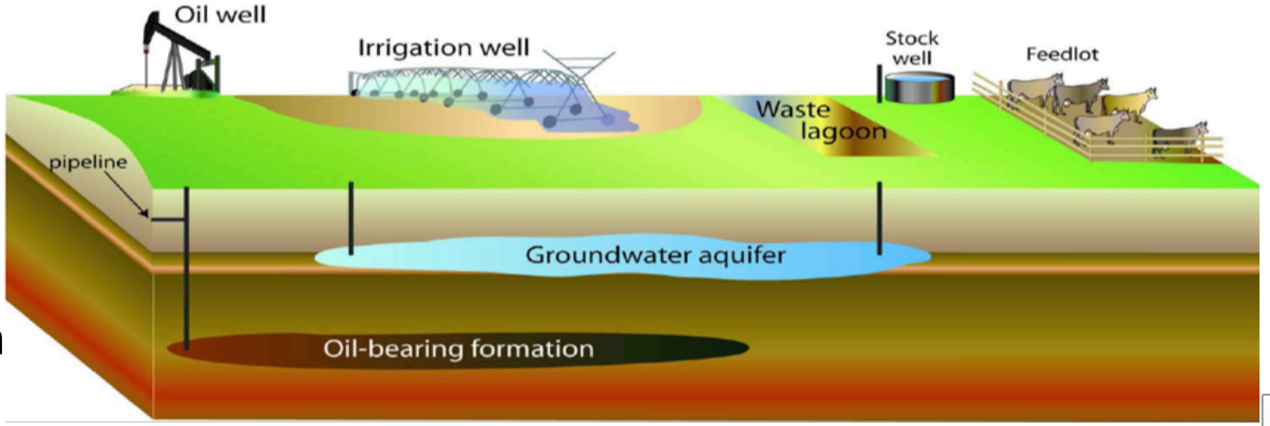




Summary:

Many *large deltas* suffer from accelerated subsidence and depend on engineering to withstand the forces of nature.

Small deltas suffer less from human impacts (with exceptions) and are better able to withstand climate change. Small deltas are understudied.



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