

Human nutrient over-enrichment in coastal waterways and deltas; There's a long history



Salomon van Ruysdael 1648



Nutrient-eutrophication dynamics along the freshwatermarine continuum representing coastal deltas

- Dogma: Primary production controlled by P availability in freshwater, N in marine ecosystems.
 - However: Accelerating anthropogenic N & P loading has altered nutrient limitation and eutrophication dynamics
 - Results: Human-impacted systems reveal a complex picture and a challenge to nutrient management









Nutrient limitation dynamics in the Chesapeake Bay





Human Impacts on Nutrient Limitation along the FW to Marine Continuum The Mississippi R./Delta/Gulf of Mexico

DIN:P ratios on the shelf are very high, compared with Redfield values (16 N:1 P)

Spring 01 bioassay: Only treatments containing P led to increases in Chl a.



Conclusions

Excessive anthropogenic N loading has led to P limited conditions in spring. Spring bloom is controlled by P supplies. N limitation persisted in summer.

Management option: Reduce BOTH N and P inputs to control eutrophication and hypoxia

Sylvan et al. 2006; EPA SAB 2009

Managing nutrient loads and phytoplankton growth responses in Himmerfjärden, Sweden

Courtesy: Ulf Larsson & Ragnar Elmgren Stockholm University











Lowering nitrogen discharge below 400 tonnes/yr clearly reduced local phytoplankton biomass.

Source: Ulf Larsson, pers.comm.

Yangtze River Delta System, China The contemporaneous effects of damming and nutrient enrichment



4. N:P ratio in the Yangtze River Estuary and the adjacent ECS in 2002-2006.



Chai et al., Sci. Total Environ. 2009









Effects of nutrient (N & P) additions on phytoplankton production (Chl a) in Lake Taihu, China: Both N & P inputs matter!!

Xu et al. 2010; Paerl et al. 2011



The 2000 kg gorillal Confounding impacts of tropical cyclones on coastal nutrient-eutrophication dynamics







Major hurricanes/tropical storms & phytoplankton bioom (Chl a) responses

Freshwater Discharge affects location of algal production & blooms (Chl a)



Flow: high \uparrow , low \downarrow , moderate \leftrightarrow

no data



Conclusions/Implications

- Primary production controlled by P availability in many freshwater systems. However, some are N & P co-limited or N limited.
- In Estuarine/Coastal systems N limitation prevails. However, heavily N impacted systems can be P limited or N & P co-limited.
 - Expanding human water- and airshed activities have greatly increased N & P loading and altered nutrient limitation.
- Interactions of nutrient loads and FW discharge flushing/residence time, salinity regime) determine eutrophication potential.

• Controlling eutrophication along the entire freshwater-marine continuum in deltaic systems requires a dual nutrient (N&P) reductions.





Has Freshwater P Reduction w/o Parallel N Reduction Exacerbated Estuarine Eutrophication?

What's the mechanism?



Estuary Location