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Restoring Seagrass/algal Beds as A Measure to Abate Climate Change

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Climate change and CO_2 emission

- Increasingly agreed upon
  - Our global climate is Getting Warmer and Warmer
  - Associated with more frequent climate disasters (floods, droughts, ice sheets melt and sea level rise, etc.)
- Increasing consensus
  - The global climate warming results from elevated atmospheric levels of green-house gases, esp. CO_2 (from ca. 280 ppm 10K years ago ~ pre-industrial evolution to present ca. 385 ppm) largely due to fossil fuels burning by the human being
  - Even with strenuous efforts to limit emissions, [CO_2] will rise > 450 ppm before mid-century, beyond the level where the risk of dangerous climate change becomes unacceptably high
  - Uncertainty implies a small risk of catastrophic impacts even at current concentration, and that risk grows monotonically as emissions continue to drive up the atmospheric CO_2 burden

  - Science 325 (2009)
- Our choice: try to reduce [CO_2] by every means

Carbon cycle: sinks and sources

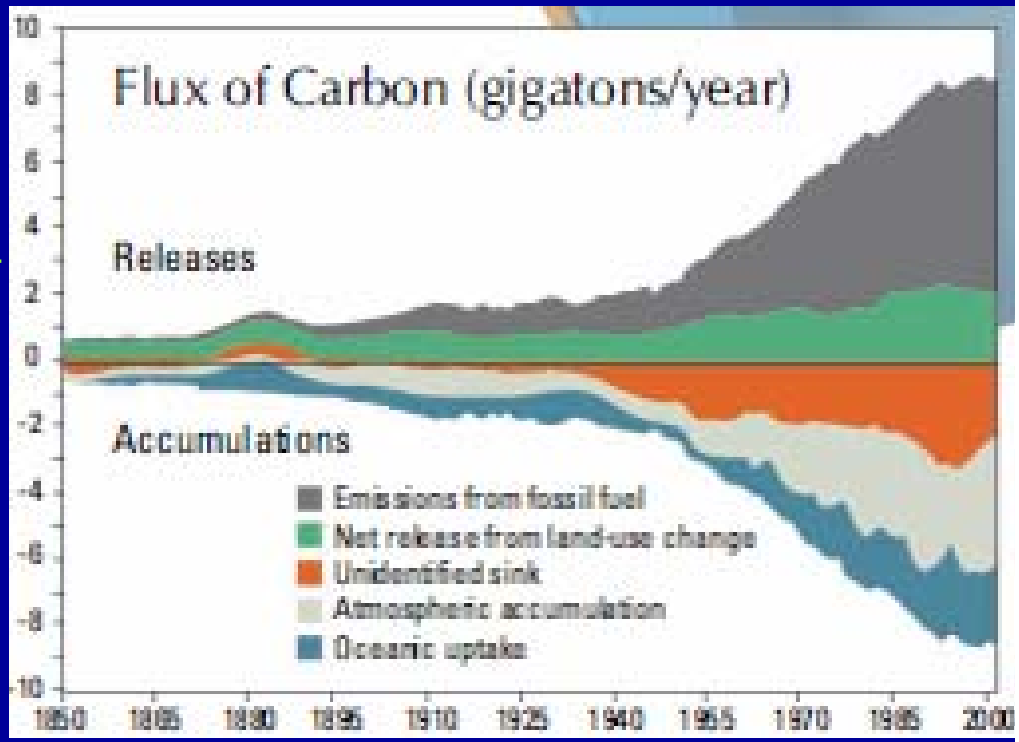
Sources (G tons/yr)

- Vegetation respiration: + 55.5
- Ocean outgassing: 90.5
- Fossil fuel & cement emissions: +6.4
- Changes in land use: +1.2

Sinks (G tons/yr)

- Vegetation net production: -57
- Ocean water absorption: -92.2
- Land sinks: -2.3

Gap: ca. + 3.1 mainly with uncertainty of emission due to deforestation and losses of aquatic plant habitats?



- Science 325 (2009)

Contribution to CO_2 sinking by seagrass/kelp beds

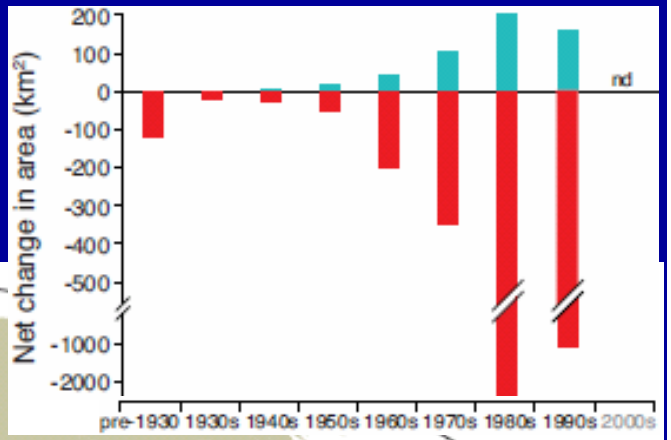
- Seagrass beds: 12% of marine production of organic carbon (Duarte & Chiscano 1999) with only 1% of total biomass of marine plants
- Marine kelps (macroalgae): estimated ~ that of seagrass beds
- Added up ~ ¼ of marine production of organic carbon
- Also help mitigate climate change by hosting high biodiversity

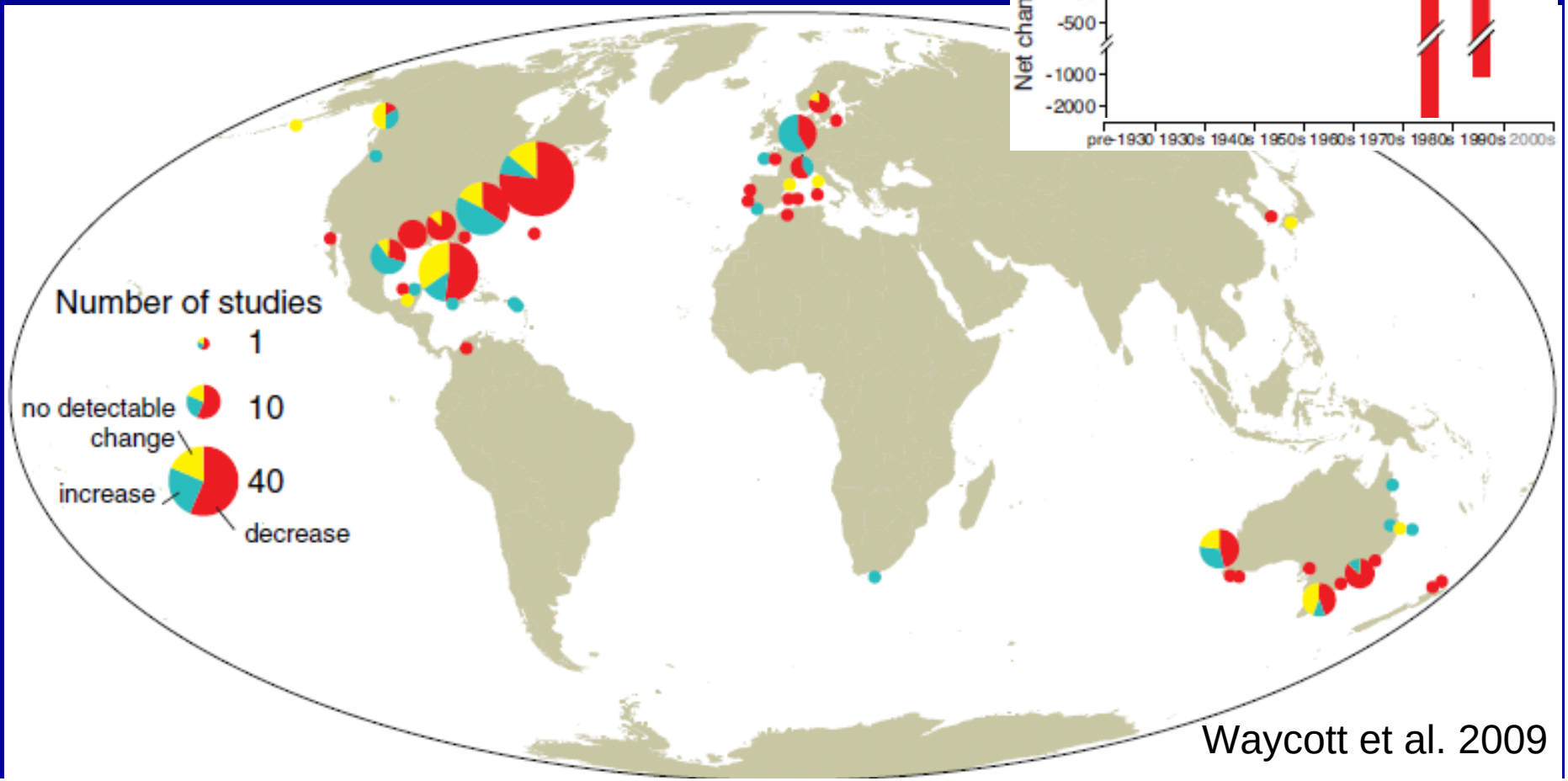
- Merits of seagrass over kelps:
  - Higher carbon storage capacity
  - Little risk of causing environmental problems
  - Help protect the coastal bank from storm's (linking to climate change) erosion

- Merits of kelps over seagrass:
  - Higher growth rate
  - More adapted to eutrophicated waters (higher nutrient levels)
  - Wider range of light adaptation
  - More readily for direct uses by the human

Globally many seagrass/kelp beds have been lost

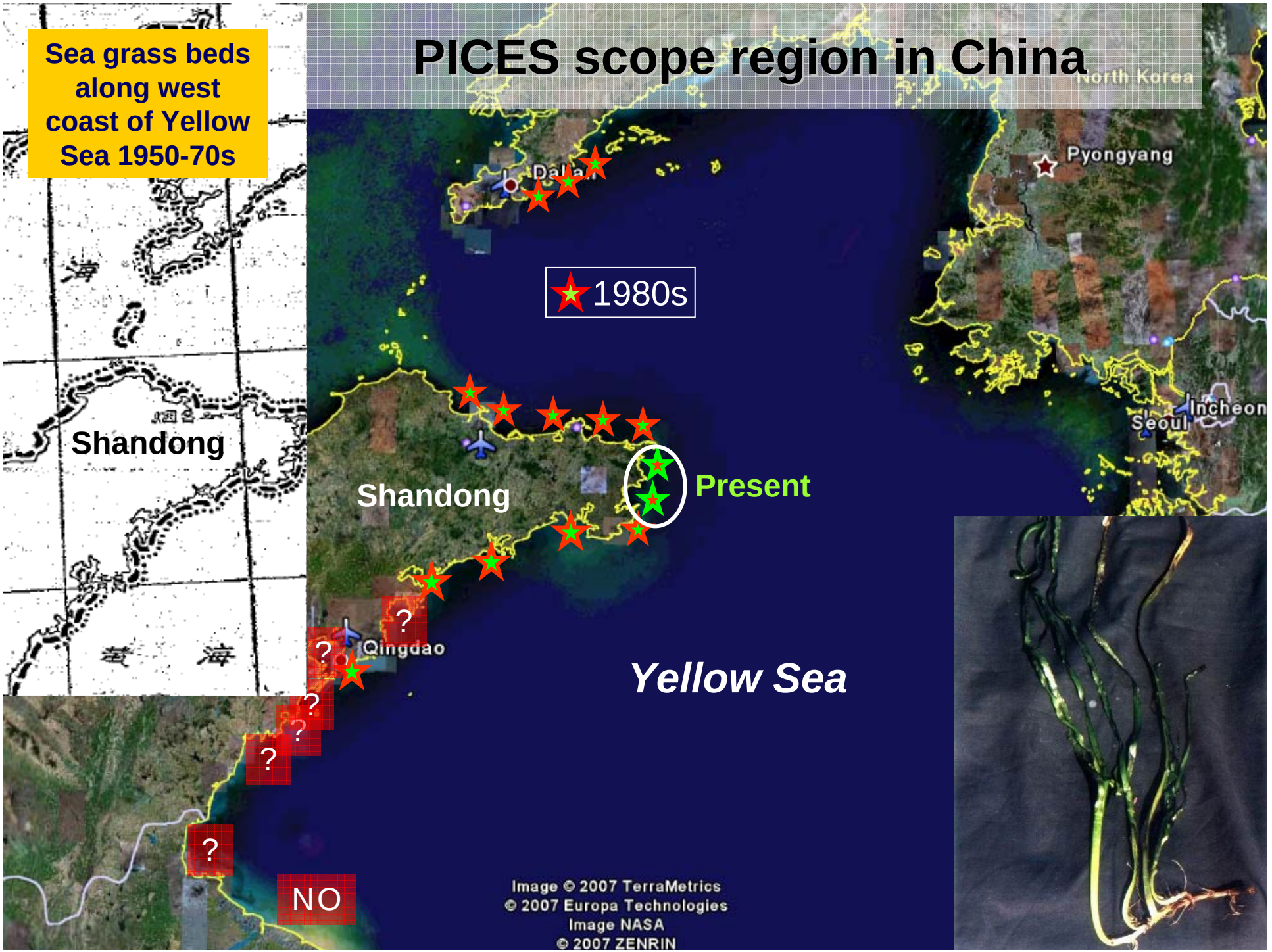
- Seagrass: at a rate of 110 km^2/yr since 1980 & 29% of the known areal extent in 1879





Waycott et al. 2009

PICES scope region in China



Seagrass on the west coast of Yellow Sea

1950-70s

- *Phyllospadix iwalensis* Makino, *Zoster marina* L., *Z. caespitosa* Miki
- biomass 920-1480 g/m^2 (Shandong coast)

1980s

- *Zostera marina* 200-500 g/m^2
- *Phyllospadix iwatensis, Ruppia maritima* L.

Now

- *Zostera* sp. 750 g/m^2 (yet with limited area)

Suggested reasons of the dramatic decline/recent recovering

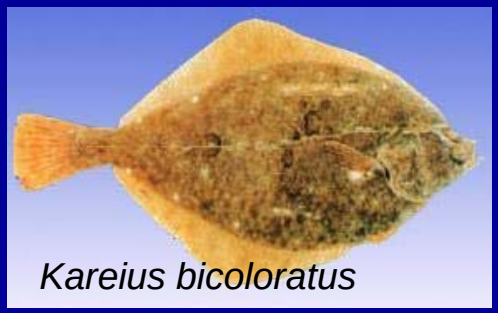
Declines:

- Reclamation
- Environmental degradation
- Climate change – land/water uses change
- Poor awareness

Recovery:

- Improved awareness
- Lessen environmental stress

Commercial species in the sea grass bed



Other contributions of seagrass beds to CO_2 reduction

- For fisheries
  - provide spawning/nursery ground
  - enhance fish resources
  - reduce fishing efforts (less CO_2 emission)

- Material for house building – seagrass thatched folk houses
  - Lower energy input and less CO_2 emission, naturally $cool_{summer}$ & $warm_{winter}$
  - Durable (replacement >every 40-50 years), therefore lower management effort input and less CO_2 emission, and ensures long-term storage of carbon

Actions of demand

Restore the seagrass/kelp beds

- Mapping
- Artificial seeding and planting
- Facilitation (kelp reefs, seagrass rafts?)
- Monitoring
- Some commercial demand (kelp: biofuel, etc; seagrass: fisheries, construction) in place

Summary

- Seagrass/kelp beds play critical role in CO_2 sinking and reduction of its emission
- However they have been facing large global losses
- Actions are needed & ready to implement restoration

Thank you

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