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Future Deltas

Ecosystem services in deltas: carbon sequestration and protection against flooding

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Deltas: Ecosystem Services

- primary production and agriculture
- environmental filtering and water quality improvement
- flood abatement, coastal protection and safety
- nature, biodiversity and recreation
- greenhouse gas reductions & carbon sequestration

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Deltas: Ecosystem Services

- Decomposition in peat lands

  impacts of warming, drying and oxygen
  impact of nutrient loads

- Restoration biology

  interaction with physical properties
  competing agendas/ building with nature

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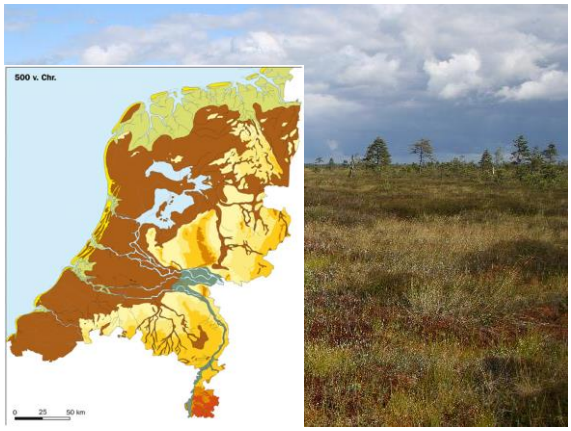
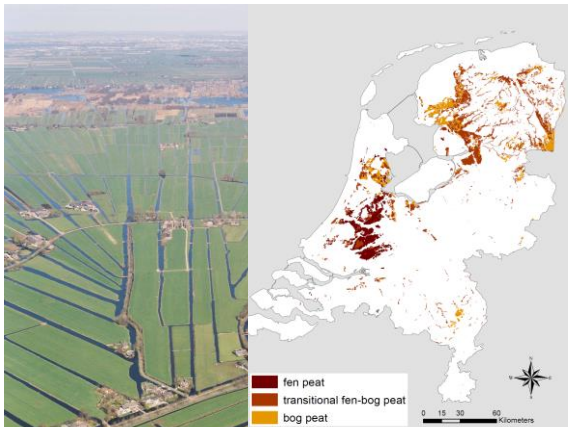
Peat meadows in the Netherlands

- Peat meadows on drained peat lands have been in agricultural use for centuries
- Peat oxidation has created long-term **soil subsidence**
- Intensive land use with deep **drainage** and heavy **fertilizer use** threatens environmental health and increases subsidence/ flood risks
- Water quality has deteriorated

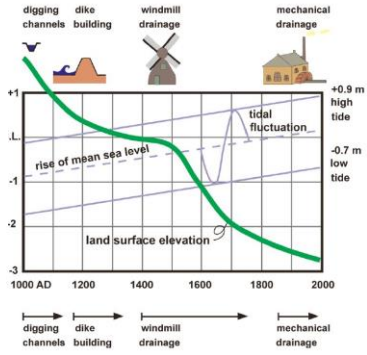




Dutch peat areas…

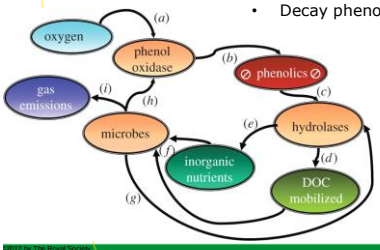
… subsidence causing damage to buildings and infrastructure

… is costly



Peat decomposition

- Aerobic decomposition (O_2) faster than anaerobic decomposition (NO_3, Fe^{3+}, SO_4)
- Phenolics block hydrolytic enzymes
- Decay phenolics only with O_2



Causes

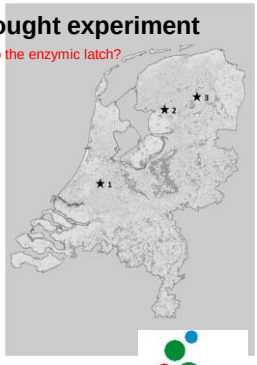
Poor water quality leaching of nutrients and Dissolved Organic Carbon (DOC)

Subsidence and greenhouse gas emissions

Summer drought experiment

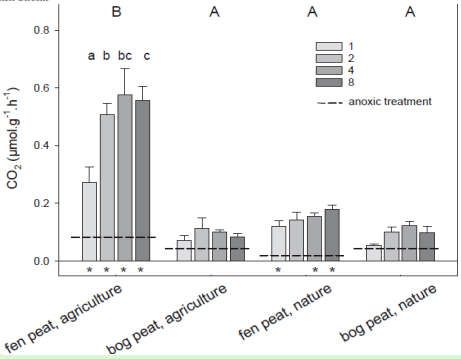
Can short term drought events open up the enzymic latch?

- Peat samples from well below groundwater level
- Anoxic incubation for 14 weeks, 1-8 weeks oxygenation
- Analysis: CO_2 and CH_4 production, phenolic compounds, pH, nutrients



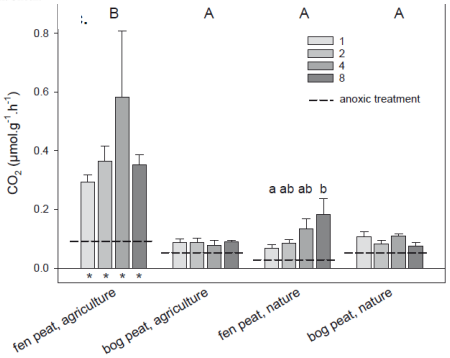
Knowledge for Climate

CO_2 production during dry period: ↑



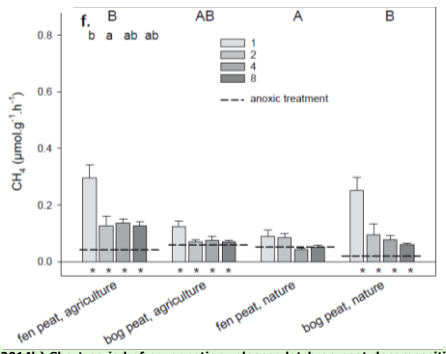
Brouns et al (2014b) Short period of oxygenation releases latch on peat decomposition. Sci Total Environ 481:61-68.

CO_2 production after dry period: ↑



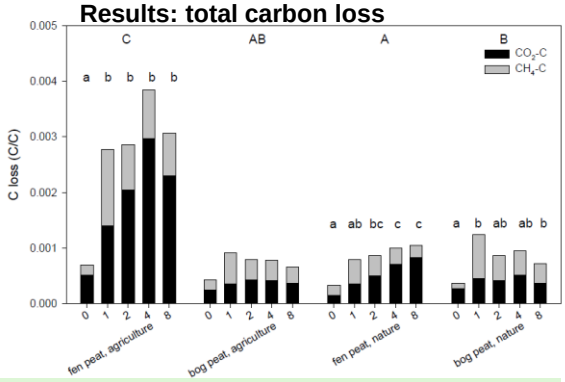
Brouns et al (2014b) Short period of oxygenation releases latch on peat decomposition. Sci Total Environ 481:61-68.

CH_4 production after dry period: ↑



Brouns et al (2014b) Short period of oxygenation releases latch on peat decomposition. Sci Total Environ 481:61-68.

Results: total carbon loss



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Conclusions (Dutch peat meadows)

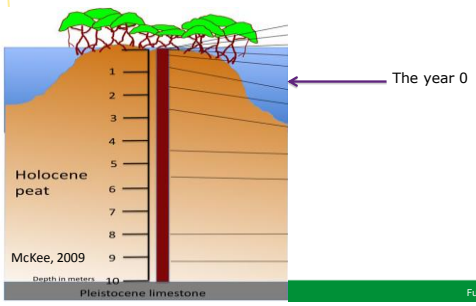
Short (1 week) summer droughts will stimulate peat decomposition during and after this dry period. Current estimates of the effects of drier summers should therefore be re-evaluated.

Currently working on risk assessments of peat oxidation and compaction of different botanical peat types in collaboration with Physical Geography

Mangrove ecosystems

- Coastal Protection
- Habitat
- Nutrient buffer zone
- Carbon sink

Mangroves rise through peat formation



Mangrove carbon burial

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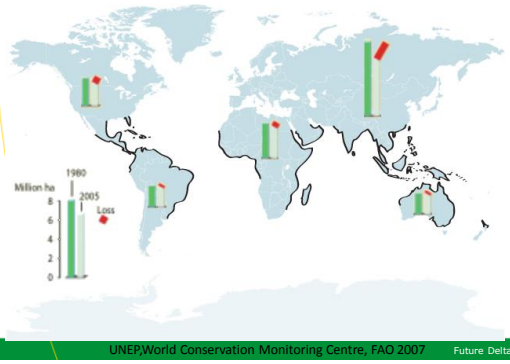
Mangroves are disappearing



UNEP,World Conservation Monitoring Centre, FAO 2007

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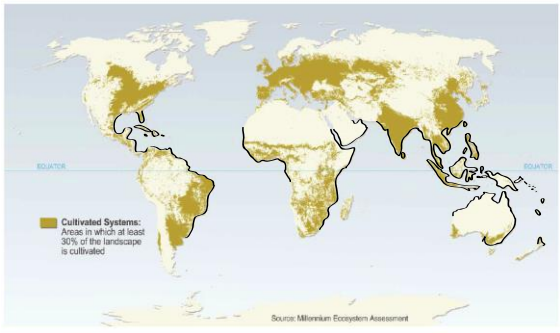
And receive increasing amounts of fertiliser



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Effects of nutrient loads on soil carbon budget unclear

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Mangrove soil functioning

Nitrogen
Phosphorus

Fertiliser

Primary production

SOC pool

Decomposition

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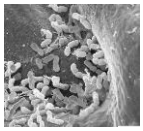
Mangrove soil functioning

Nitrogen
Phosphorus



?

Primary production

SOC pool

Fertiliser

Decomposition

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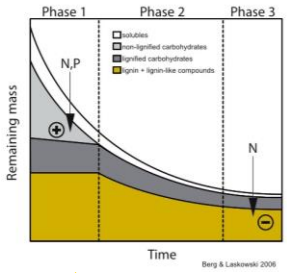
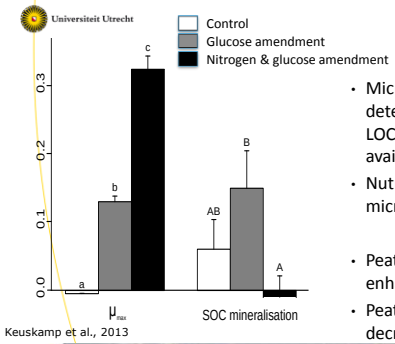


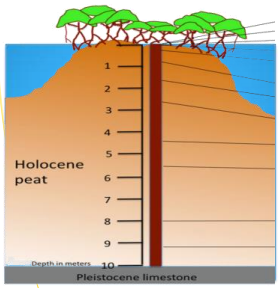
- Nutrient input enhances initial decomposition rate
- But inhibit decay in later stages



Keuskamp et al., 2013

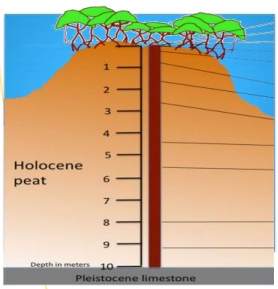
- Microbial biomass determined by LOC/glucose availability.
- Nutrients increase microbial growth rate
- Peat decomposition is enhanced by glucose.
- Peat decomposition is decreased by glucose + nitrogen

Conclusions Mangroves



Do we expect carbon loss due to coastal nutrient enrichment?

Conclusions Mangroves



No we don't. Nitrogen increases primary production but decreases decomposition of SOC

N-limited mangroves may even be suitable for wastewater polishing.

Restoration of riparian zones for nature and safety

- Reduction of river/stream floodplains
- Less water retention capacity
- Reduced biodiversity
- Habitat fragmentation

Laborers straightening the Baakse Beek, 1927, archive picture, Spaarnestad Photo

Hagmolenbeek, 2010

Water plants and plans:

Integration of vegetation in improved models for sustainable water safety and biodiversity management

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Restoration of riparian zones for nature and safety

- Importance of plant dispersion and establishment capabilities
- Interaction between vegetation and flow dynamics (and sediment retention)
- Need to consider tradeoffs between nature and other demands (not always a conflict)

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Future Deltas, Ecosystems and their Services

- Predicting future system impacts and restoration trajectories from a basis in mechanistic understanding
- Need to integrate biology with physical impacts, changing infrastructure and land-use change

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www.uu.nl/futuredeltas