Restoration measures in shallow lakes

Water quality improvement also reduce greenhouse gas emissions

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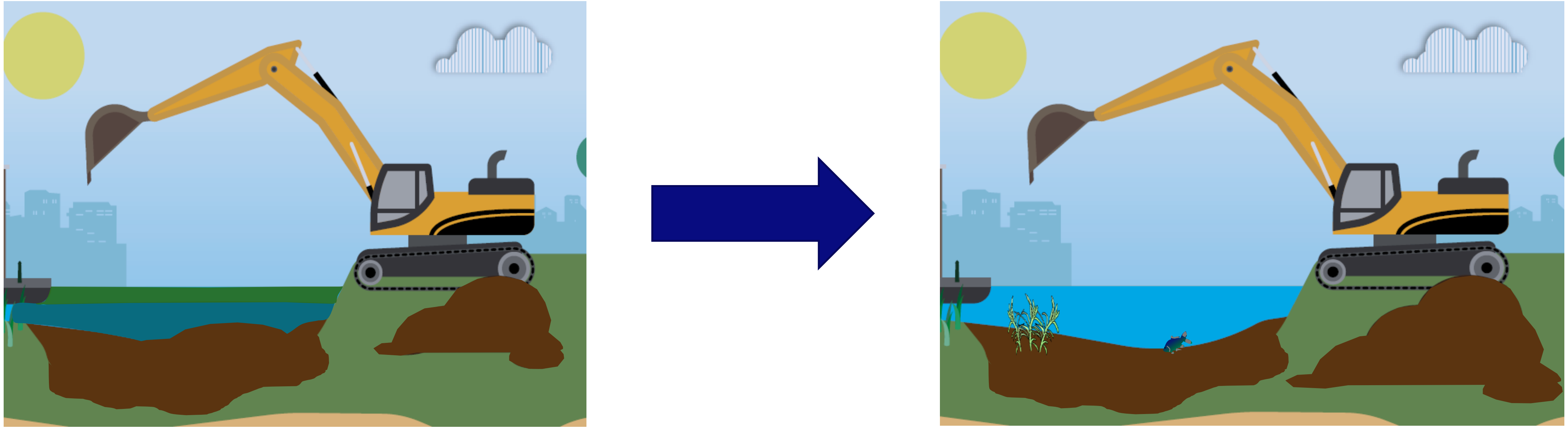
enabling delta life

Dredging to improve water quality

Water quality improvement has many benefits:

- Reduction of Algal blooms
- Improvement of ecological quality (plants, fish, etc)
- Improvement for recreational purposes



…Also reduction of greenhouse gases

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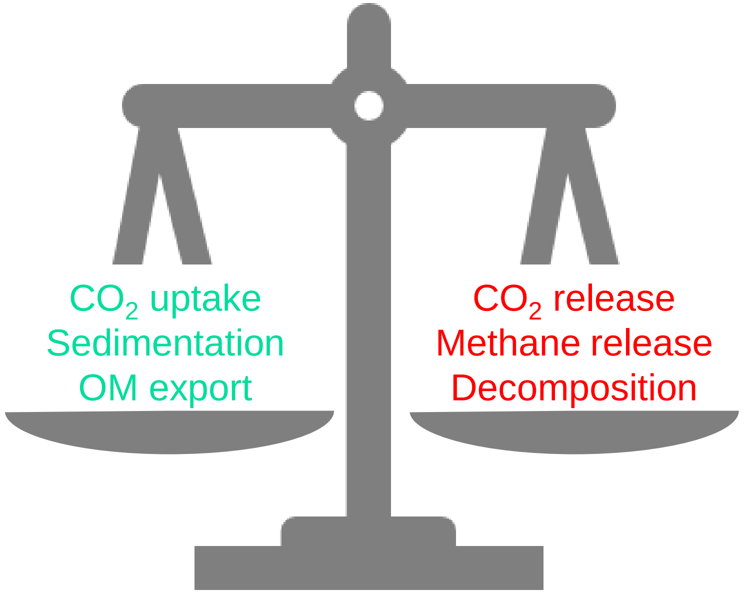
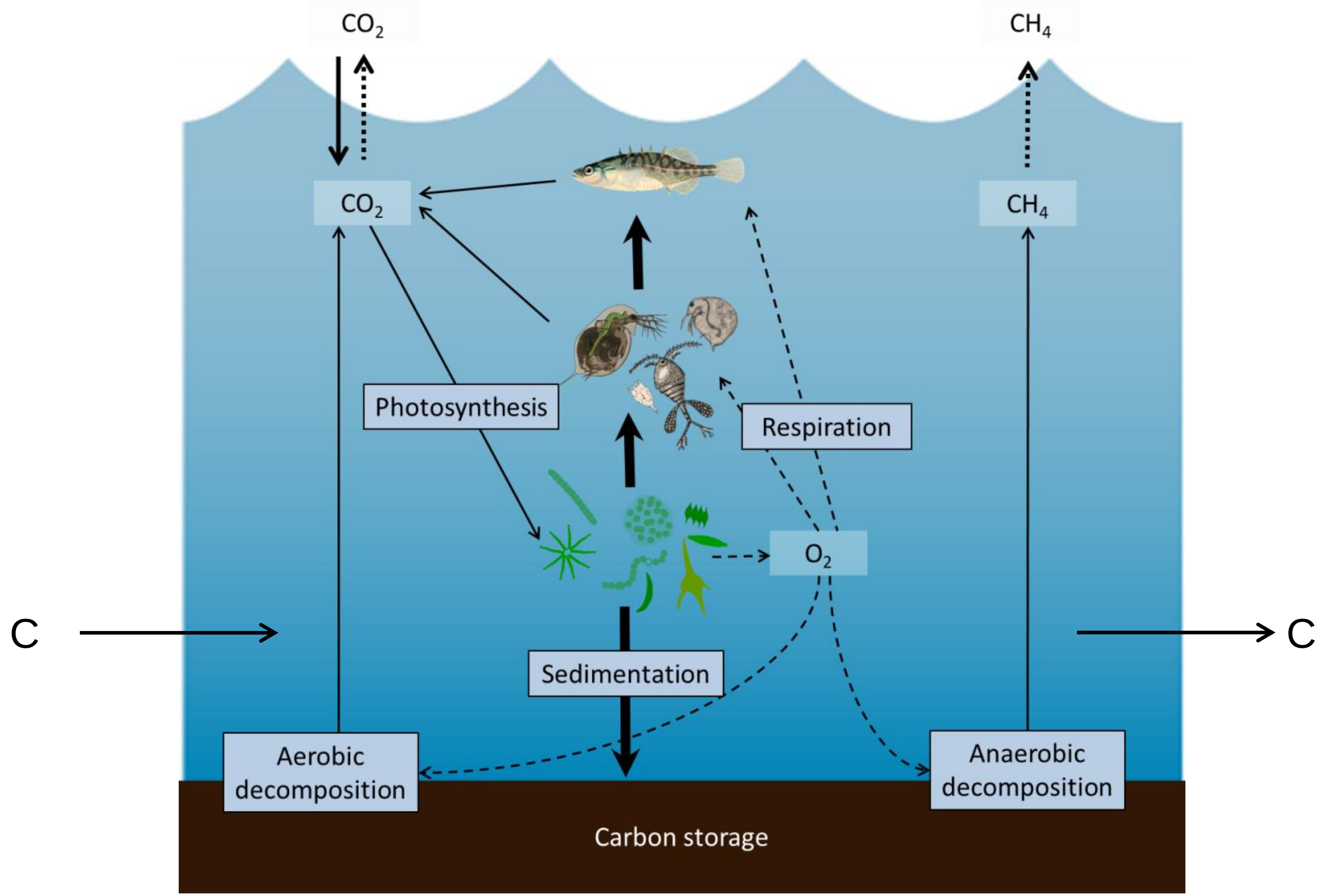
Greenhouse gas balance



CO_2 uptake
Sedimentation
OM export

CO_2 release
Methane release
Decomposition



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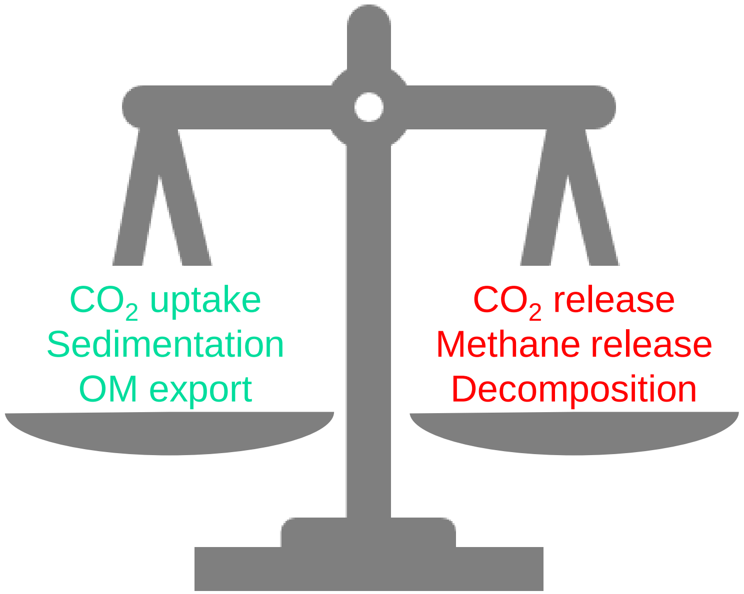
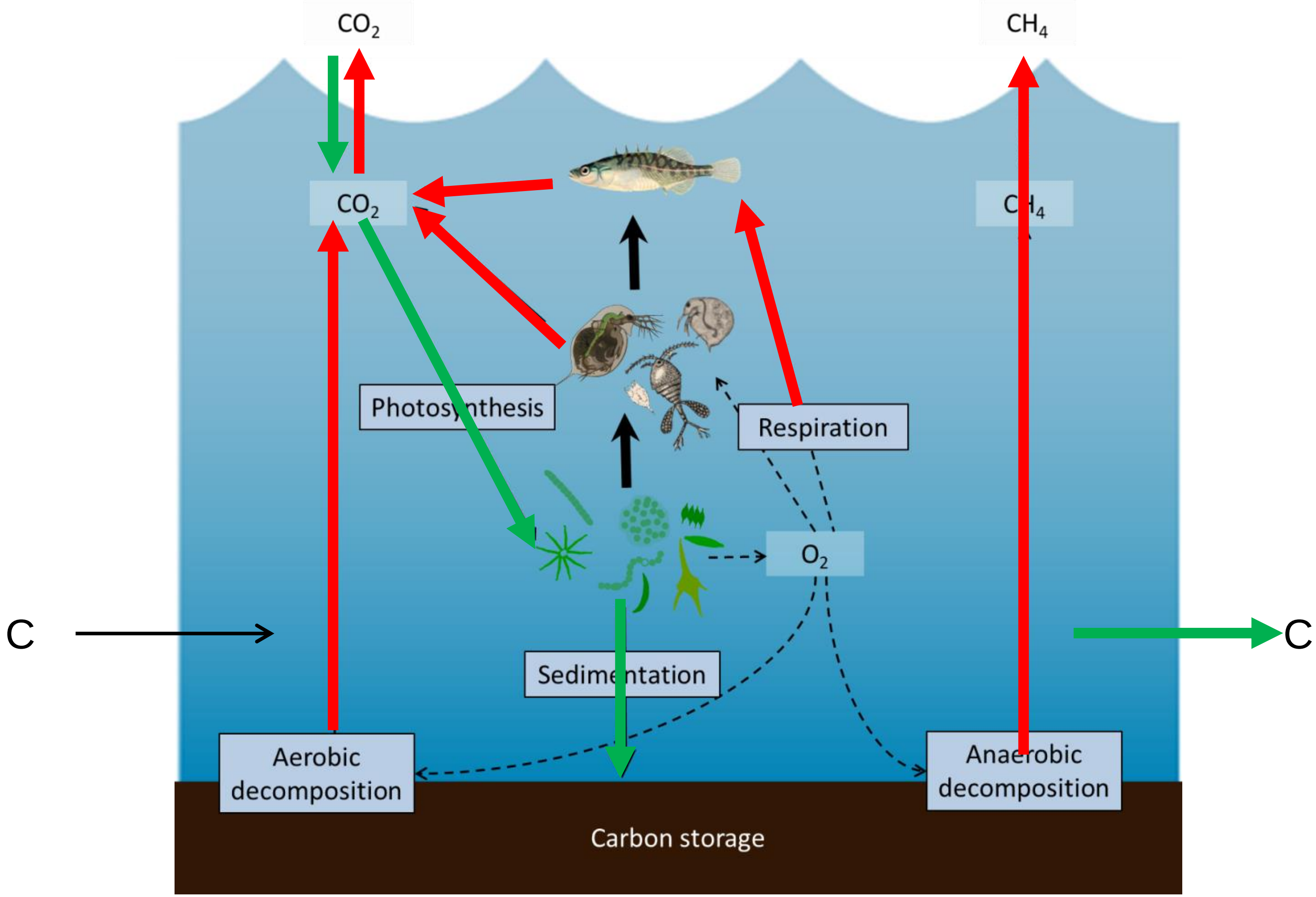
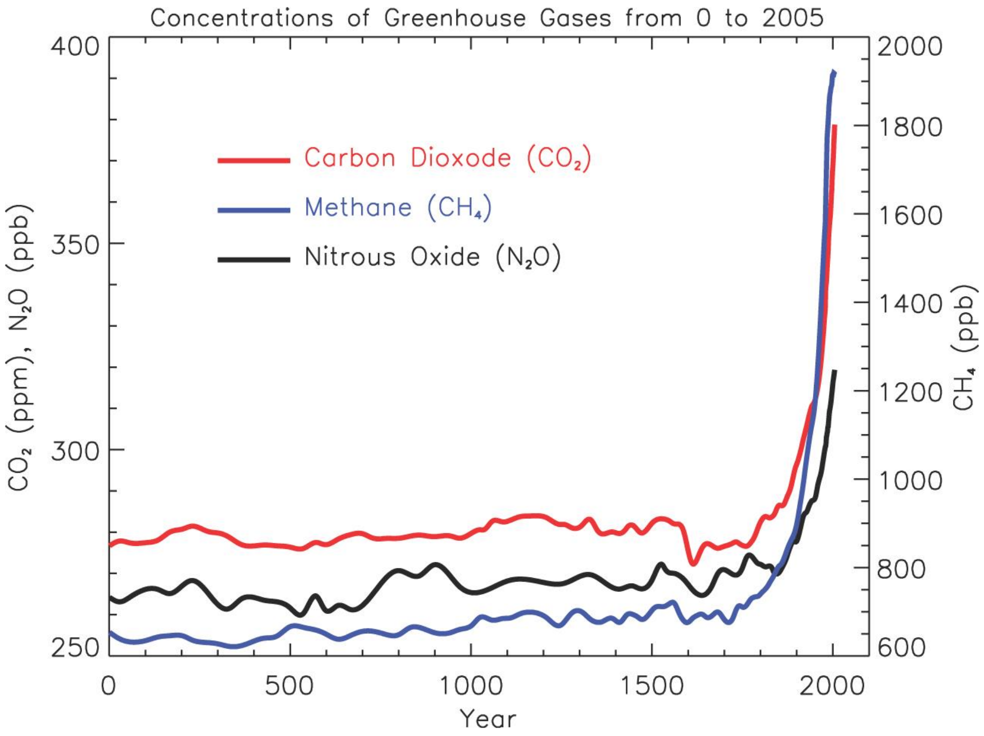
Greenhouse gas balance

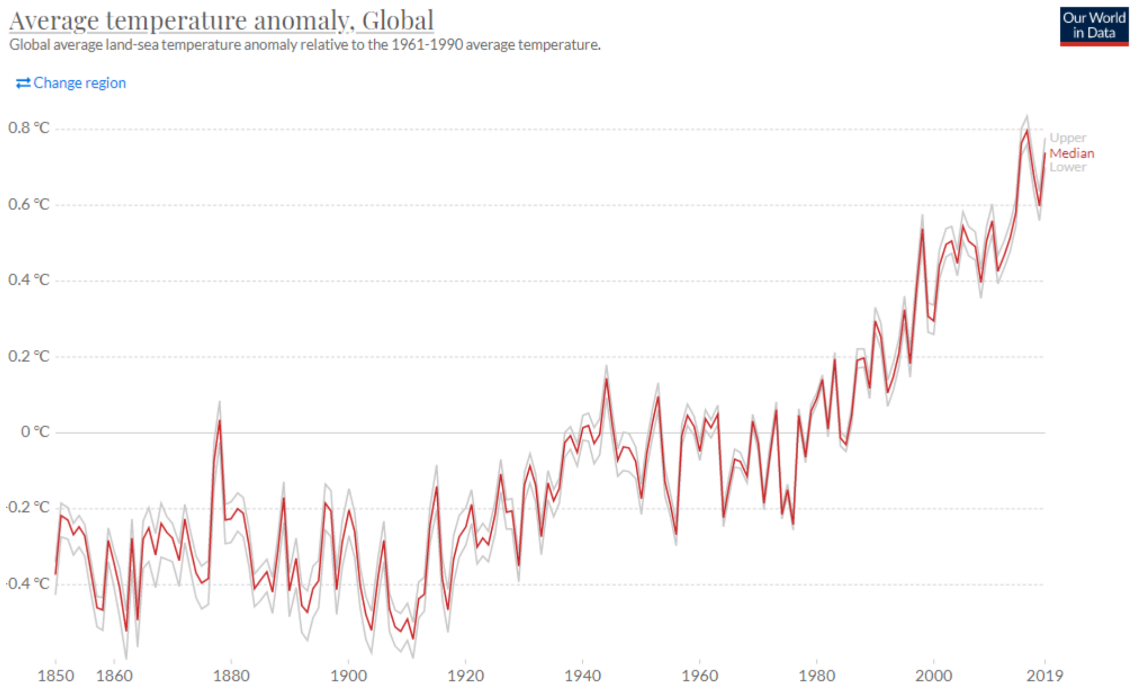




Relevant greenhouse gases

Greenhouse gas		CO_2 equivalent
Carbon dioxide	CO_2	1 x
Methane	CH_4	>25 x
Nitrous oxide	N_2O	298 x





Relevance of GHG from shallow waters

- National and international climate goals and agreements
  - 2030 55% reduction of GHG emissions (relative to 1990)
  - 2050 neutral-emissions

- Shallow water systems can cause high emissions
  - Shallow ditches alone: 16% of methane emission in NL

→ Need for understanding GHG emissions from shallow waters

BlueCAN project

Goals:

- Quantify GHG emissions from shallow surface waters
- Reveal dominant processes
- Develop tool/method to assess GHG emission

Status

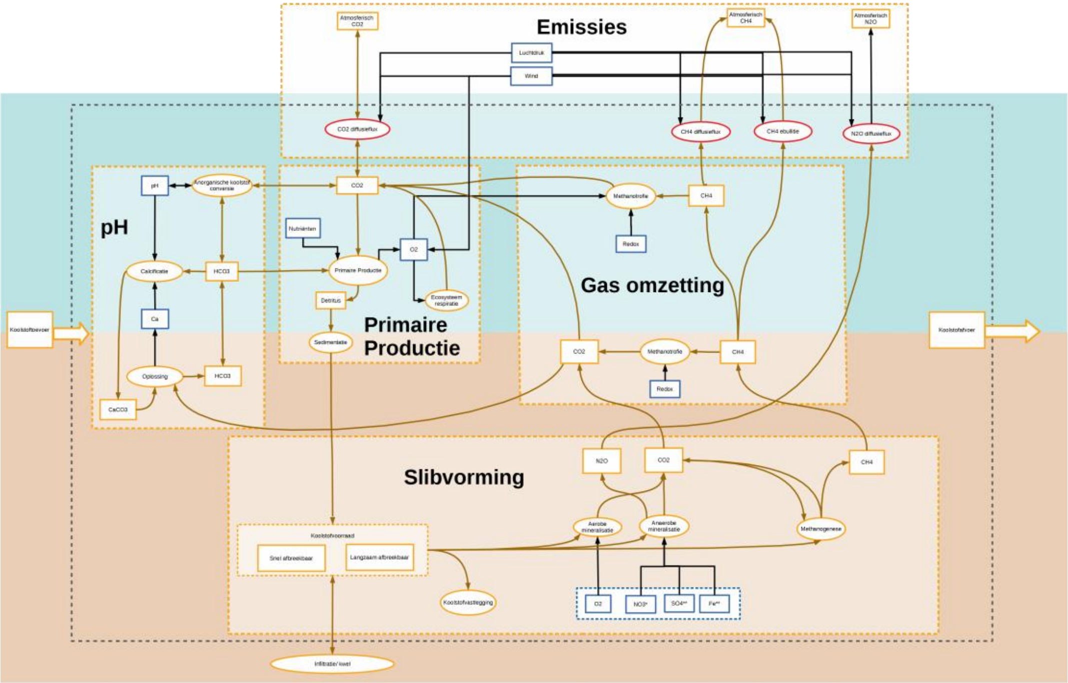
Fase 1: measured and modelled based on 4 shallow lakes in NL

Fase 2: (currently ongoing): expansion in locations and surface water types (ditches, small streams)

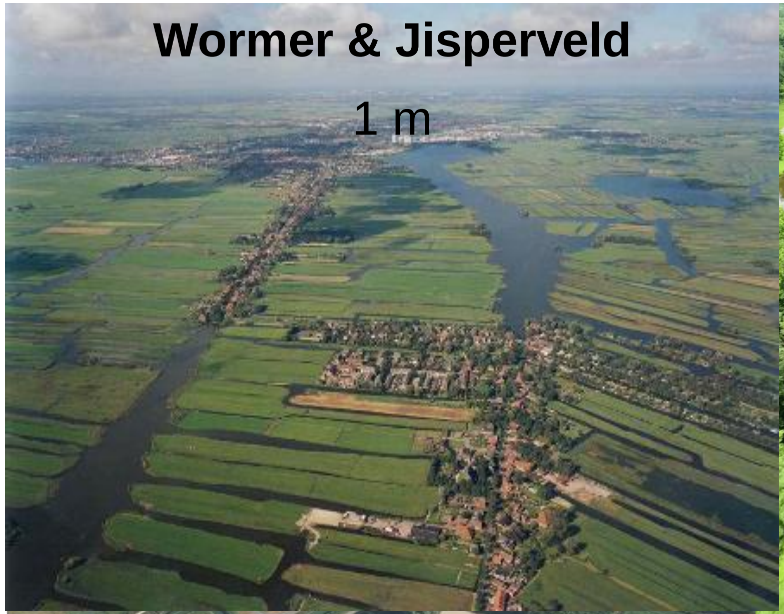
BlueCan study approach

Experimental

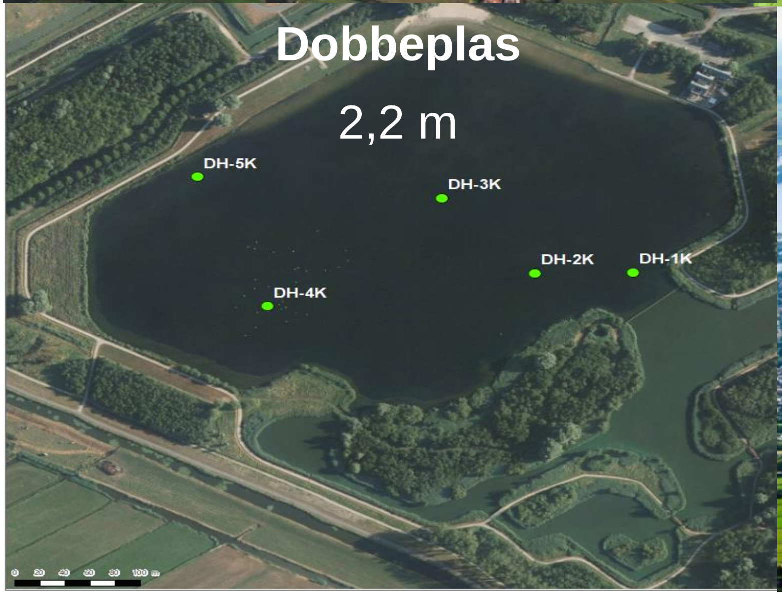
Mathematical modelling

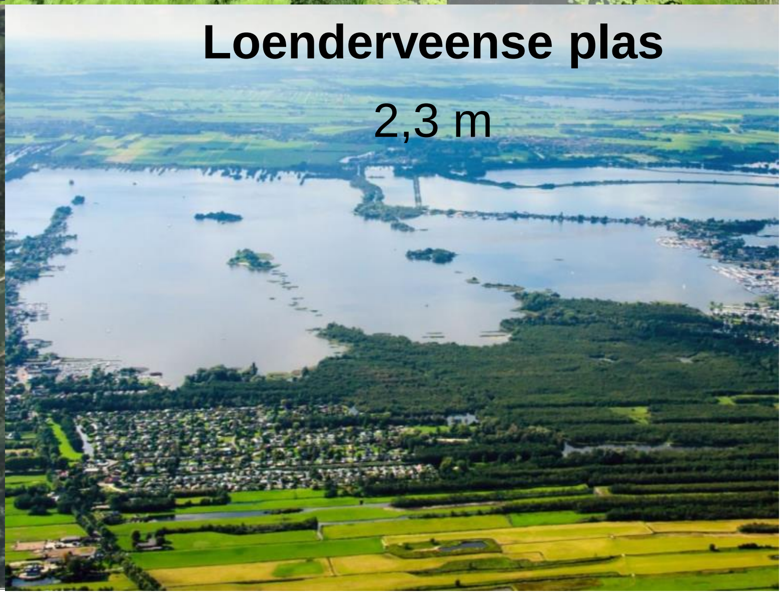


Fase 1: cases


Wormer & Jisperveld
1 m

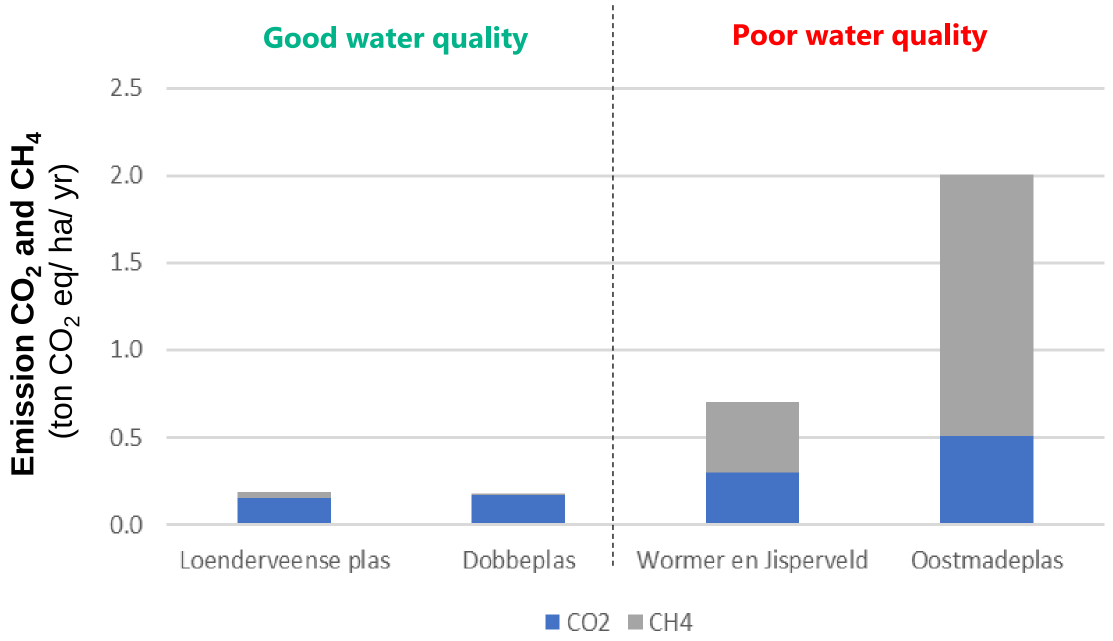

Oostmadeplas
3,5 m


Dobbeplas
2,2 m
DH-5K
DH-3K
DH-2K
DH-1K
DH-4K


Loenderveense plas
2,3 m

Results

Location	TOC (%)	DOC (mg/L)	P pw (mg/L)	P sw (mg/L)	Water quality
Loenderveense Plas	35	10	0,03	0,03	Good
Dobbeplas	2-5	13-24	0,05-0,18	0,01-0,05	Good
Wormer-Jisperveld	30	27	0,2-2	0 – 0,06	Poor
Oostmadeplas	2	25	3-4	1	Poor



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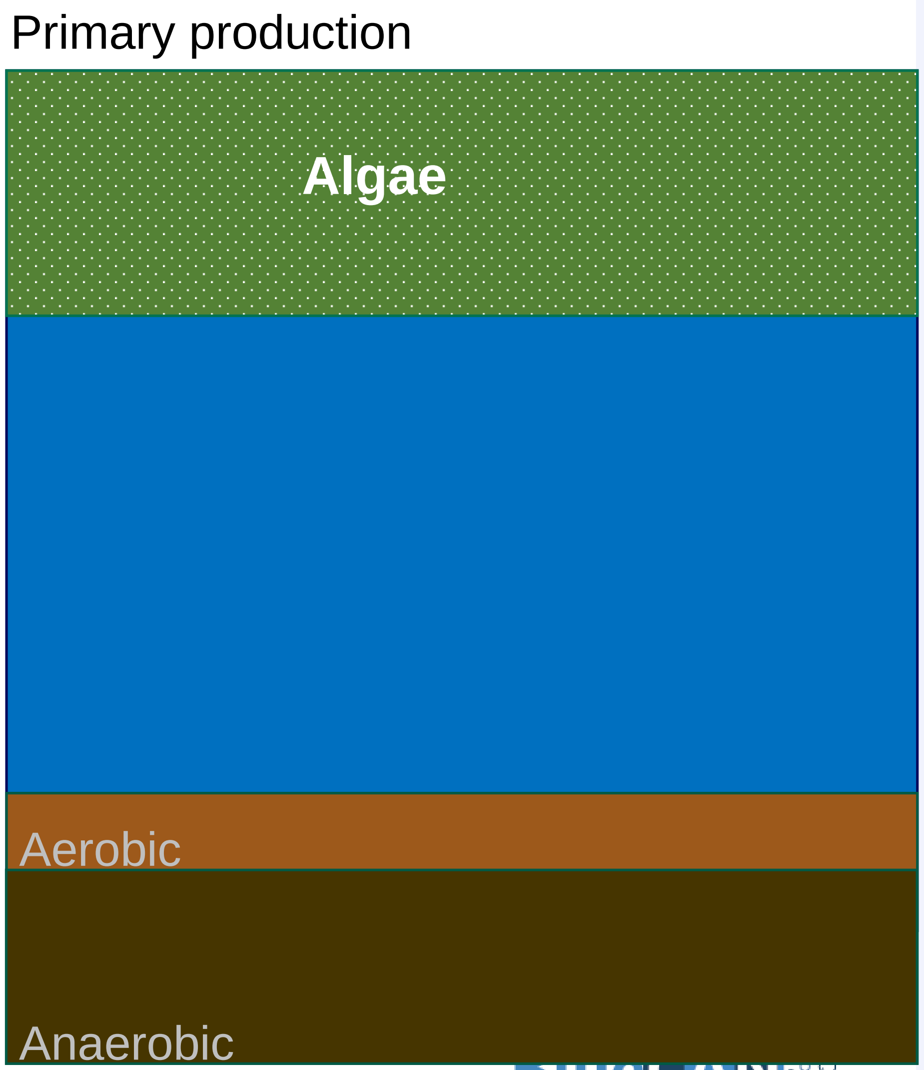
Why is water quality important for GHG?

Poor water quality (eutrofication):

- High algae content (yearly blooms) in eutrophic conditions



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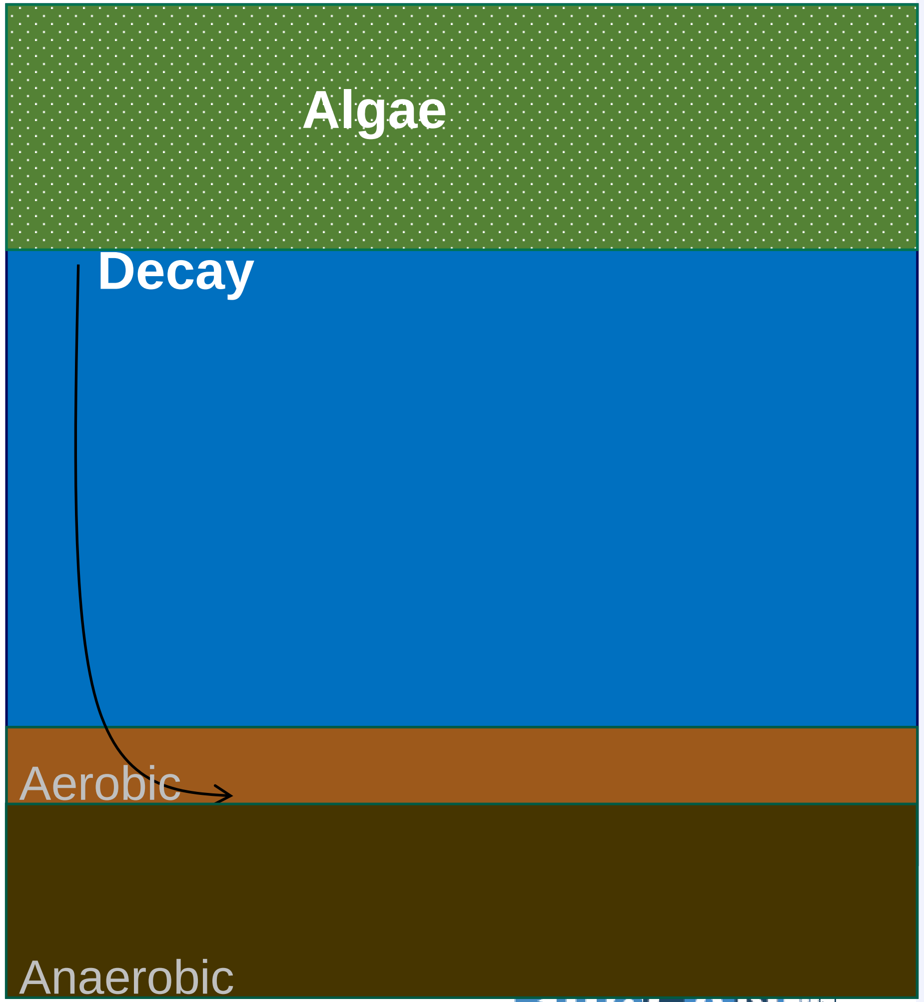
Primary production



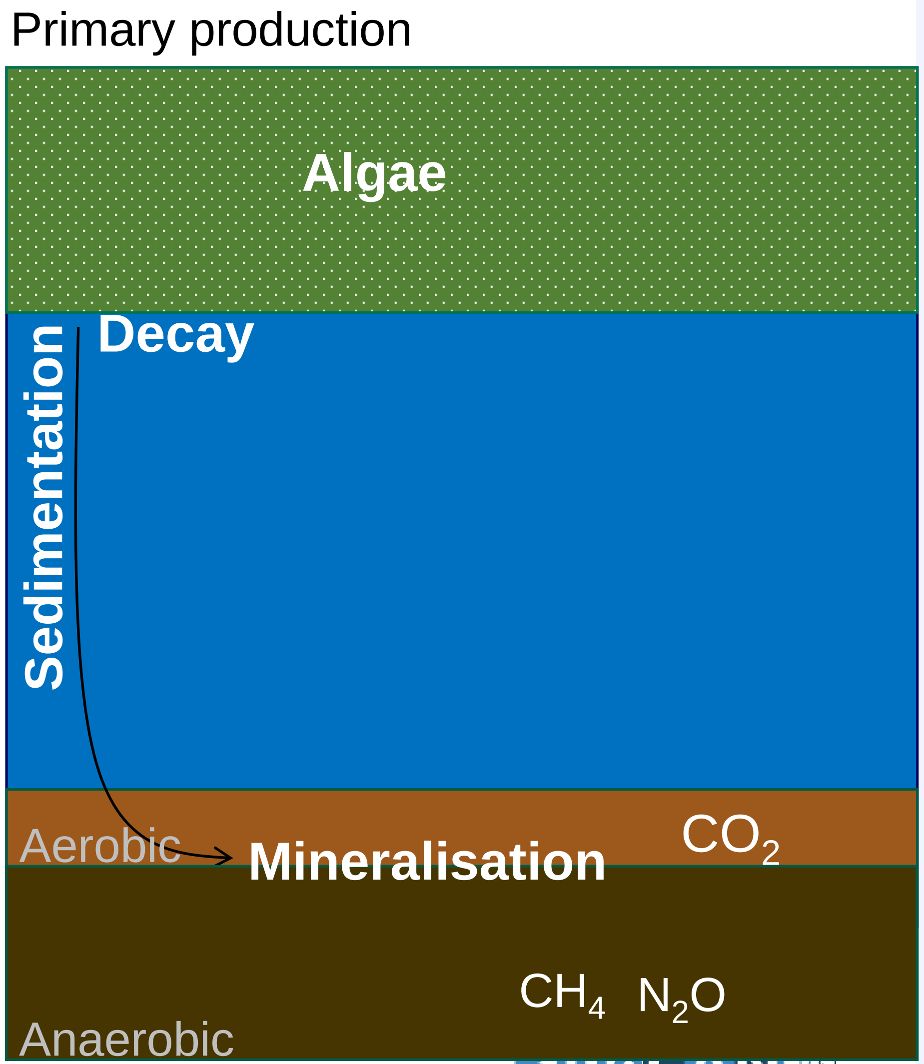
Why is water quality important for GHG?

Poor water quality (eutrofication):

- High algae content (yearly blooms) in eutrophic conditions

→ high sedimentation

→ high mineralization rate



Why is water quality important for GHG?

Poor water quality (eutrofication):

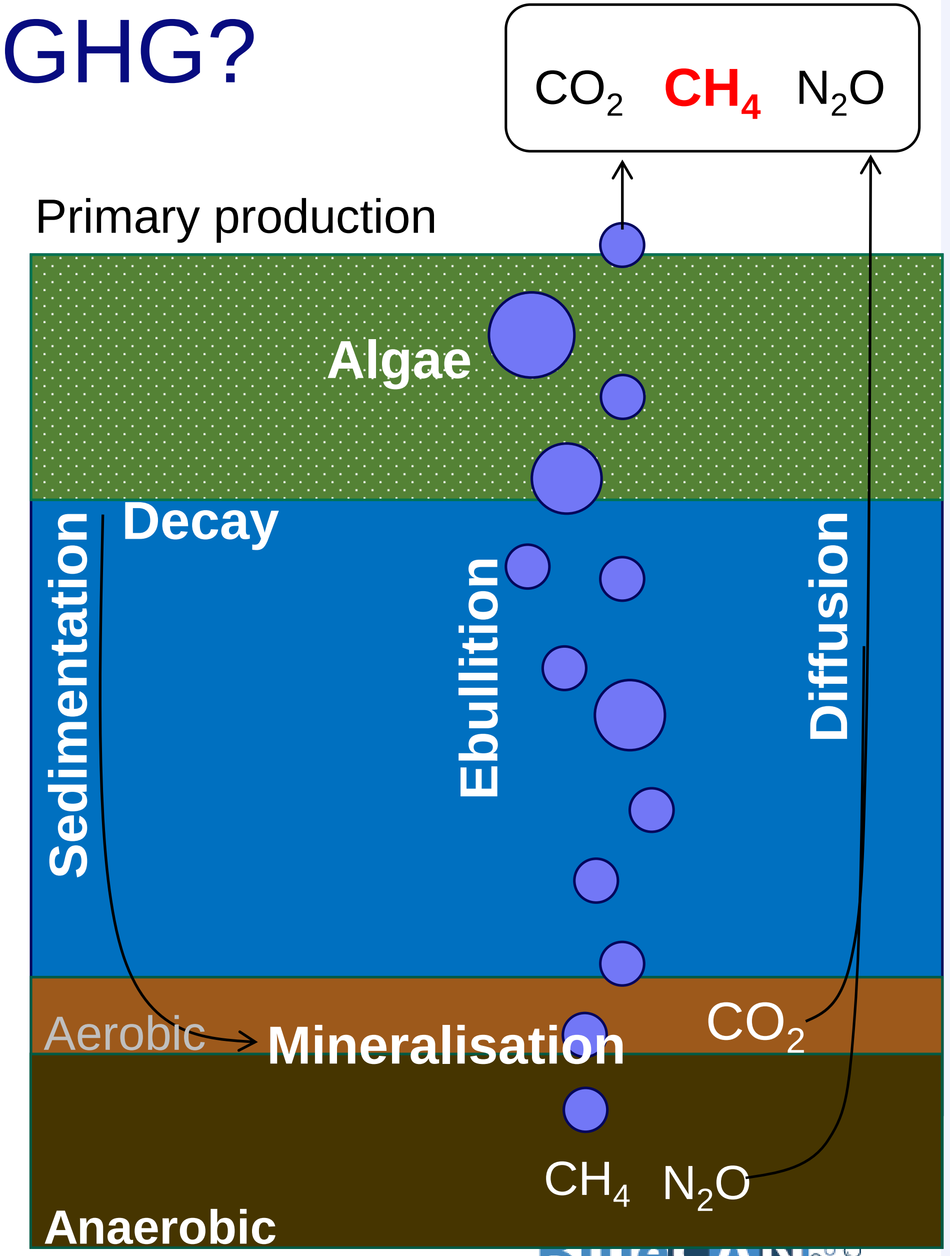
High algae content (yearly blooms) in eutrophic conditions

→ high sedimentation rate

→ high mineralization rate

Sediment becomes anaerobic

→ high **methane emission**



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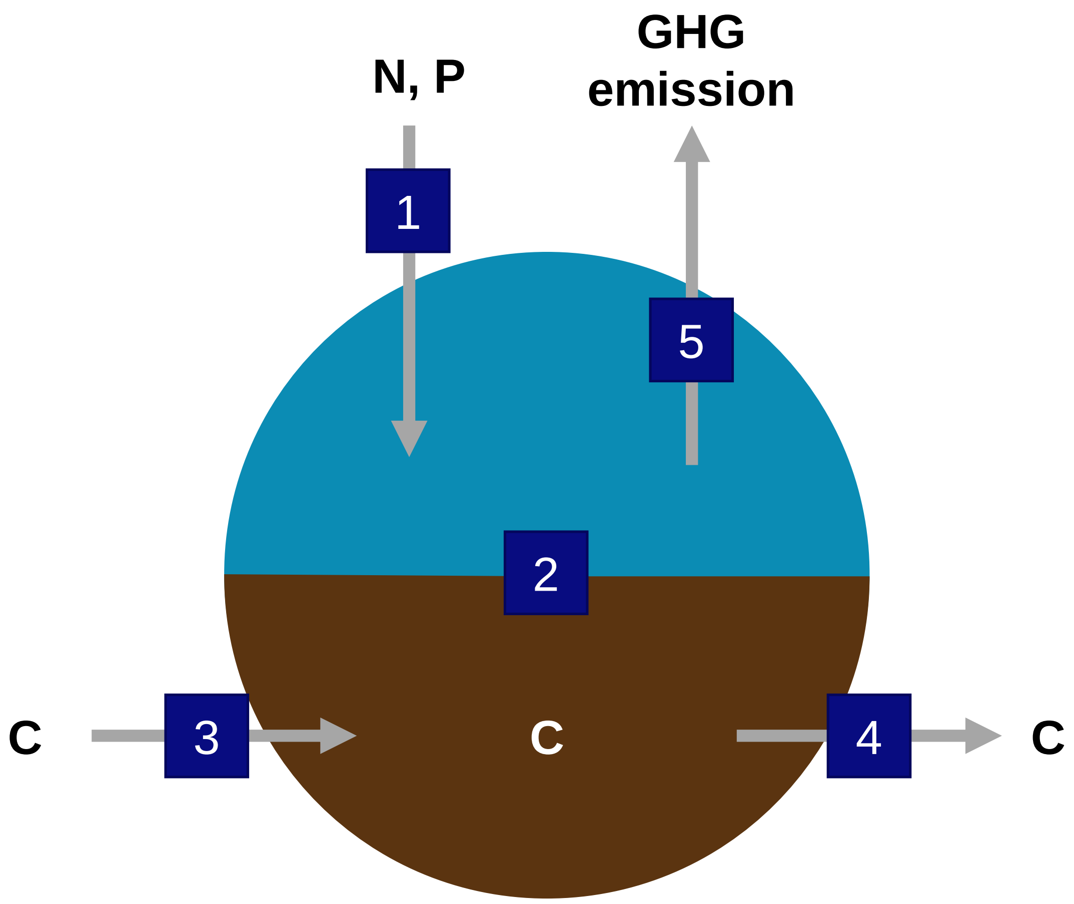
Toop development BlueScan
Conceptual approach



Insight in GHG emission required based on:

1. N and P loads (in equilibrium)
   Blue scan tool (see next)
2. Mud depth and composition
   Measurements
3. Input carbon (org), direct
4. Management and measures
   Dredging
5. Net emissions CO_2, CH_4, N_2O

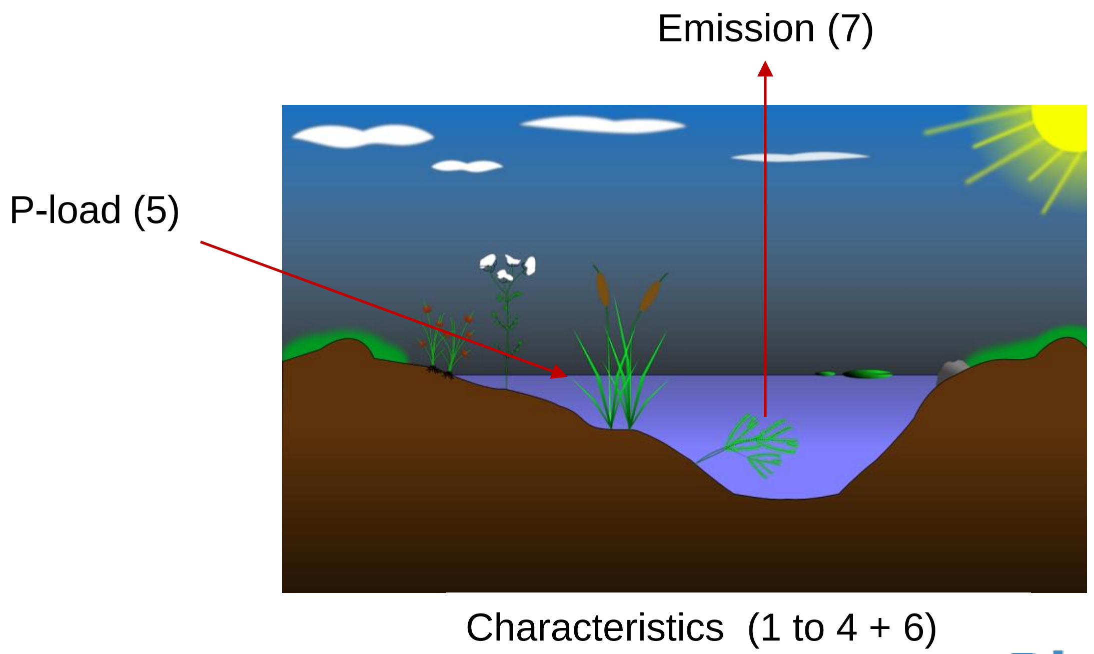
BlueScan tool system characteristics

Input

1. Sediment type (Clay, peat, sand)
2. Fetch (m)
3. Waterdepth (m)
4. Flow rate(mm/d)
5. P-load (mg/m^2/d)
6. Surface area(ha)

Output

Emission: CO_2, CH_4, N_2O (in ton CO_2 eq/ha/jaar)



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Behind the BlueScan tool
mathmetical models

- Waterquality models Delwaq & PCLake → Best of both!
- Expanded with Carbon cycle

	Delwaq	PCLake
Proxy for emissions	Yes	Yes
CO_2/CH_4	Yes	No
Hysteresis	No	Yes

- PCLake with correction ratio CO_2/CH_4 from Delwaq
- Delwaq with correction algae/plant ratio from PCLake

Conclusions

- Significant emissions from sediments -in shallow lakes-
- Water quality is an important determinant

Water quality improvement & greenhouse gas emission reduction go hand in hand

- Measurements and tool can give a good order of magnitude indication of emissions

Next steps

- Emission measurements over a wider range of cases
- Emissions in ditches/larger lakes
- Emissions of nitrous oxide
- Emissions from dredging

Recent developments

- 2019 ***Refinement*** to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Emissions from human-controlled waters are taken into account

- Default for fresh/brackish lakes:
  4.6 ton/ha CO_2-eq per yr

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2 biggest climate-related challenges and opportunities for sediment management

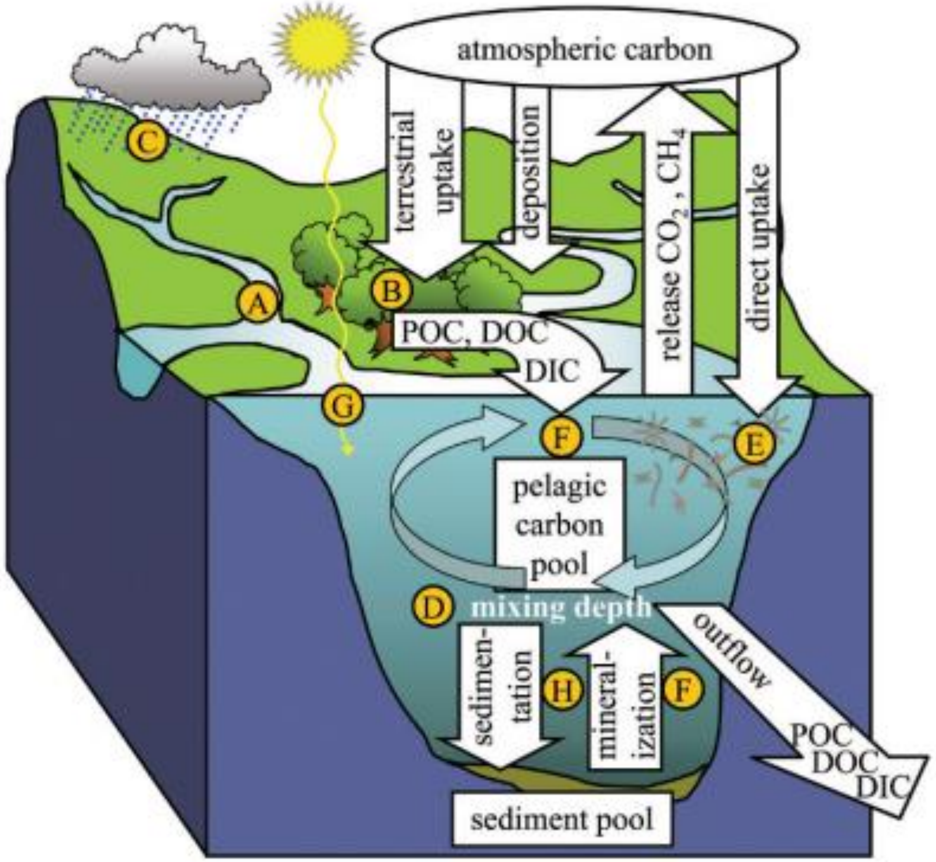
Challenges:

- Fulfilling European and national CO_2-emission goals (zero emission in 2050) without cost and reliability effects
- Manage soft sediment in such a way that emissions from sediments are minimized (strategies)

Opportunities

- Water quality measures and reduction of GHG go hand in hand, which makes it possible to pool funding for both activities.
- Emission reductions are calculated compared to a base year (often 1990). As emissions from soft sediment have never been minimized, actions do have effect.

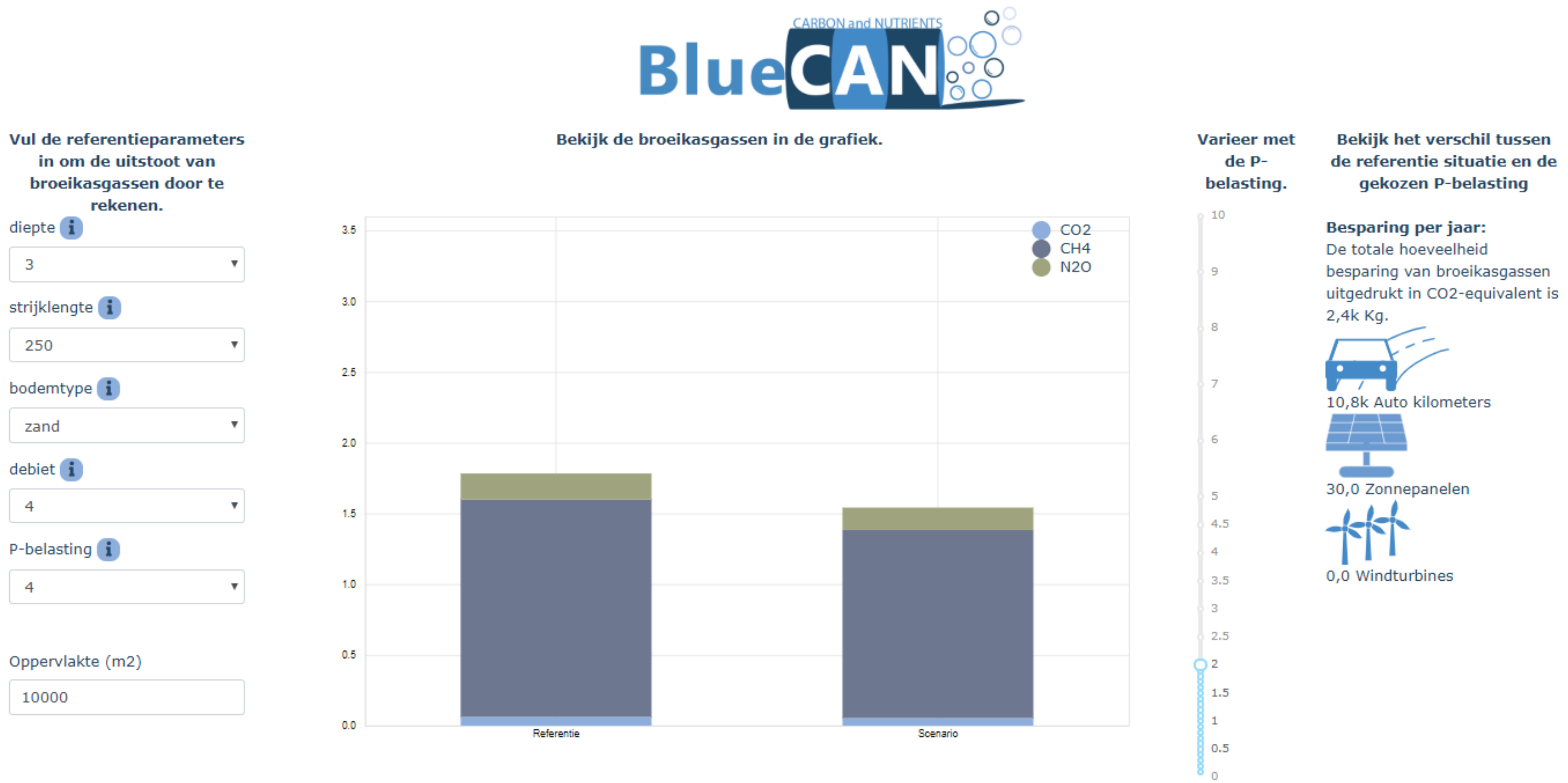

Thank you for your attention
Questions?

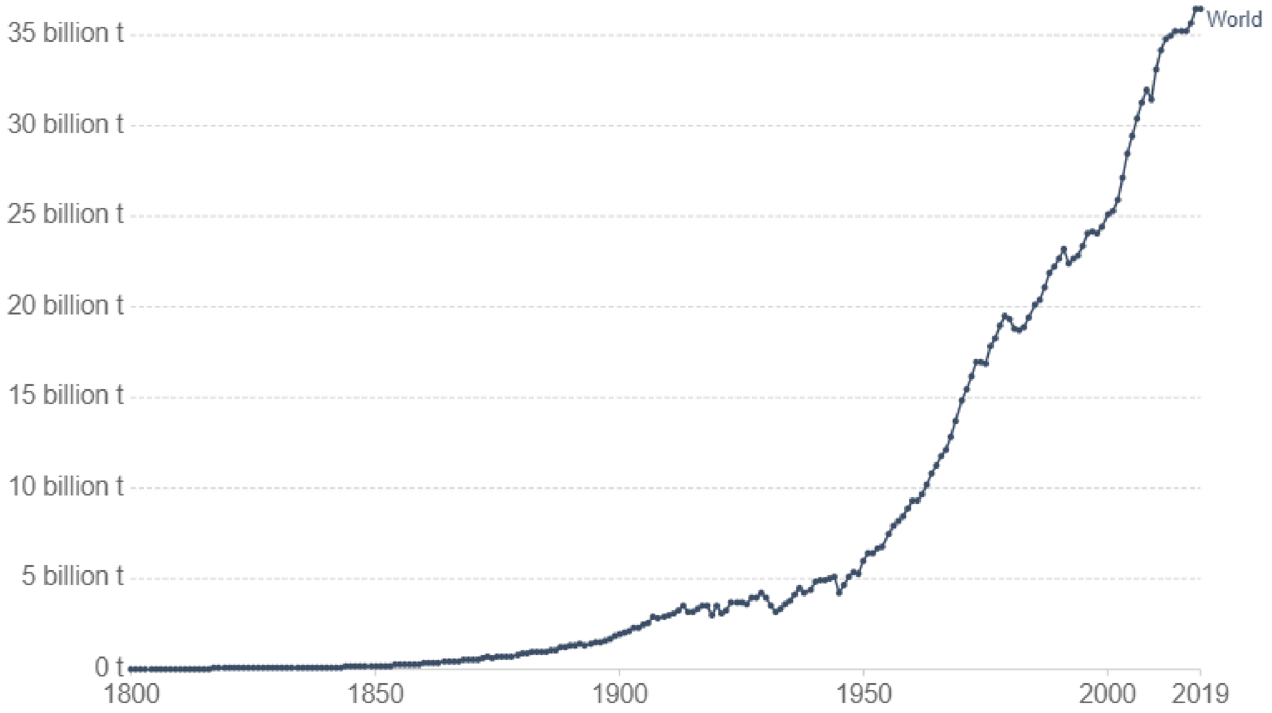


Carbon cycle

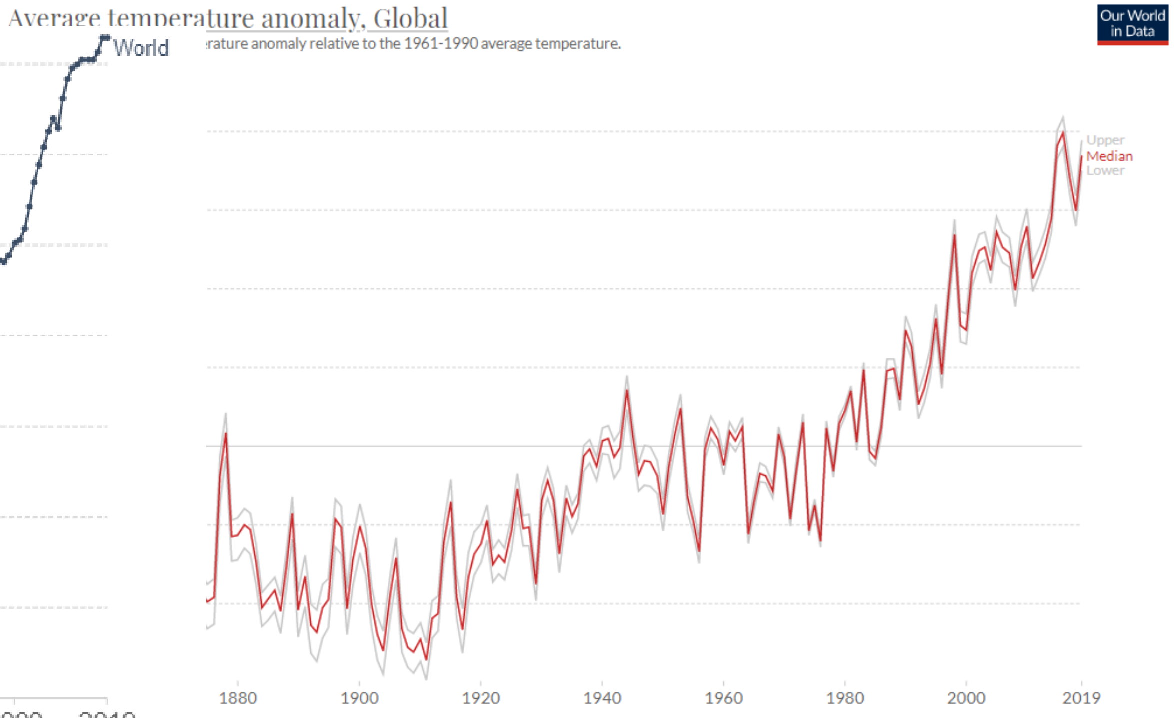
https://aslopubs.onlinelibrary.wiley.com/doi/pdf/10.4319/lo.2009.54.6_part_2.2298

Tool (preliminary version)





Source: Global Carbon Project; Carbon Dioxide Information Analysis Centre (CDIAC)
Note: CO_2 emissions are measured on a production basis, meaning they do not correct for emissions embedded in traded goods.
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY



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