Robust and low cost options to remove nitrate and phosphate from tile drainage

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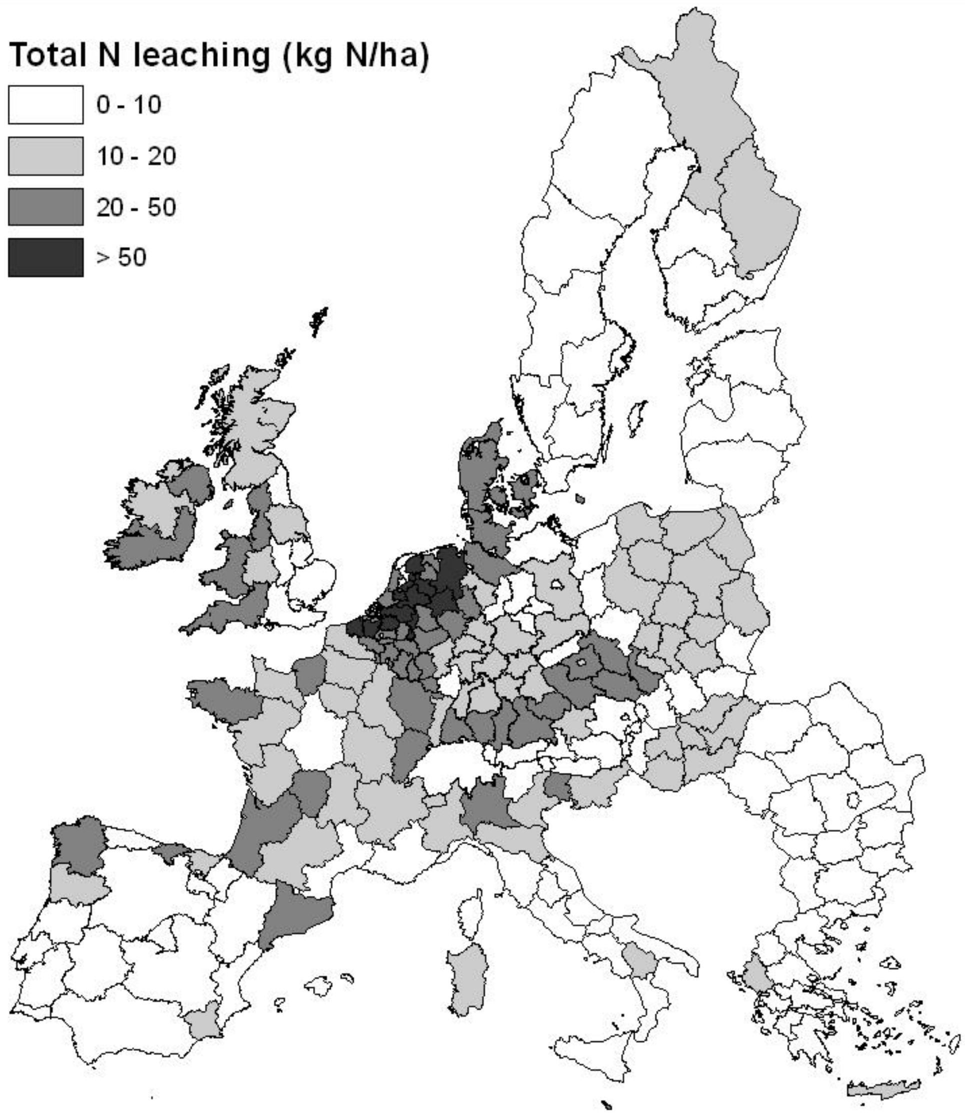
The Netherlands

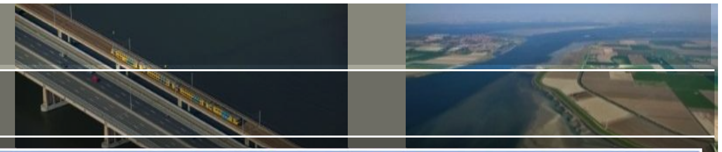
The Netherlands – intensive agriculture



Country	Agricultural export , 2012 (in billions)
United States	145 $
Netherlands	87 $
Brazil	80 $
Germany	79 $
France	70 $
Canada	44 $

Source: UN FAO

Water quality issues



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The Toxic Algae Are Not Done With Toledo. Not By a Long Stretch.

—By ***Tom Philpott*** | Wed Aug. 6, 2014 6:00 AM EDT

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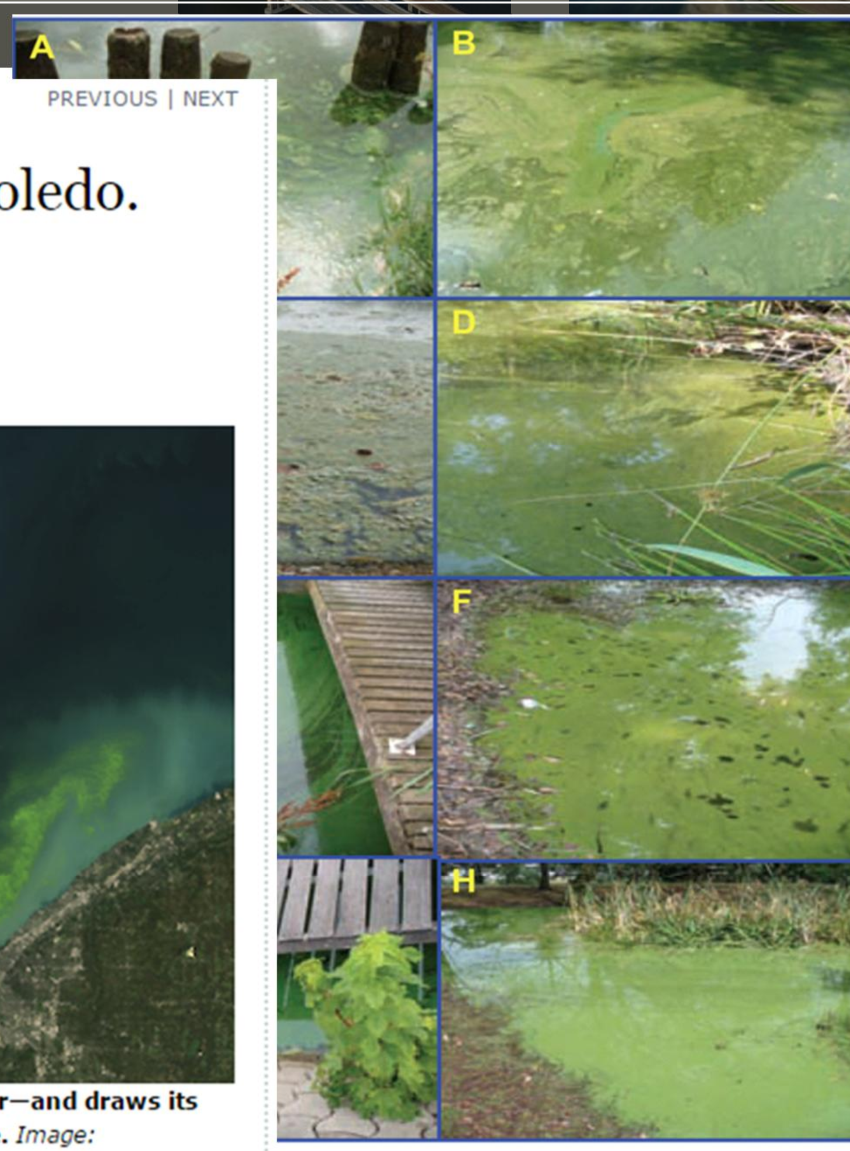
The algae bloom that swallowed parts of Lake Erie in 2011. Toledo sits near—and draws its water from—the lake's southwest region, where algae tends to accumulate. *Image: MERIS/NASA, processed by NOAA/NOS/NCCOS*

Last weekend, Toledo's 400,000 residents were sent scrambling for bottled water because the stuff from the tap had gone toxic—so toxic that city officials warned



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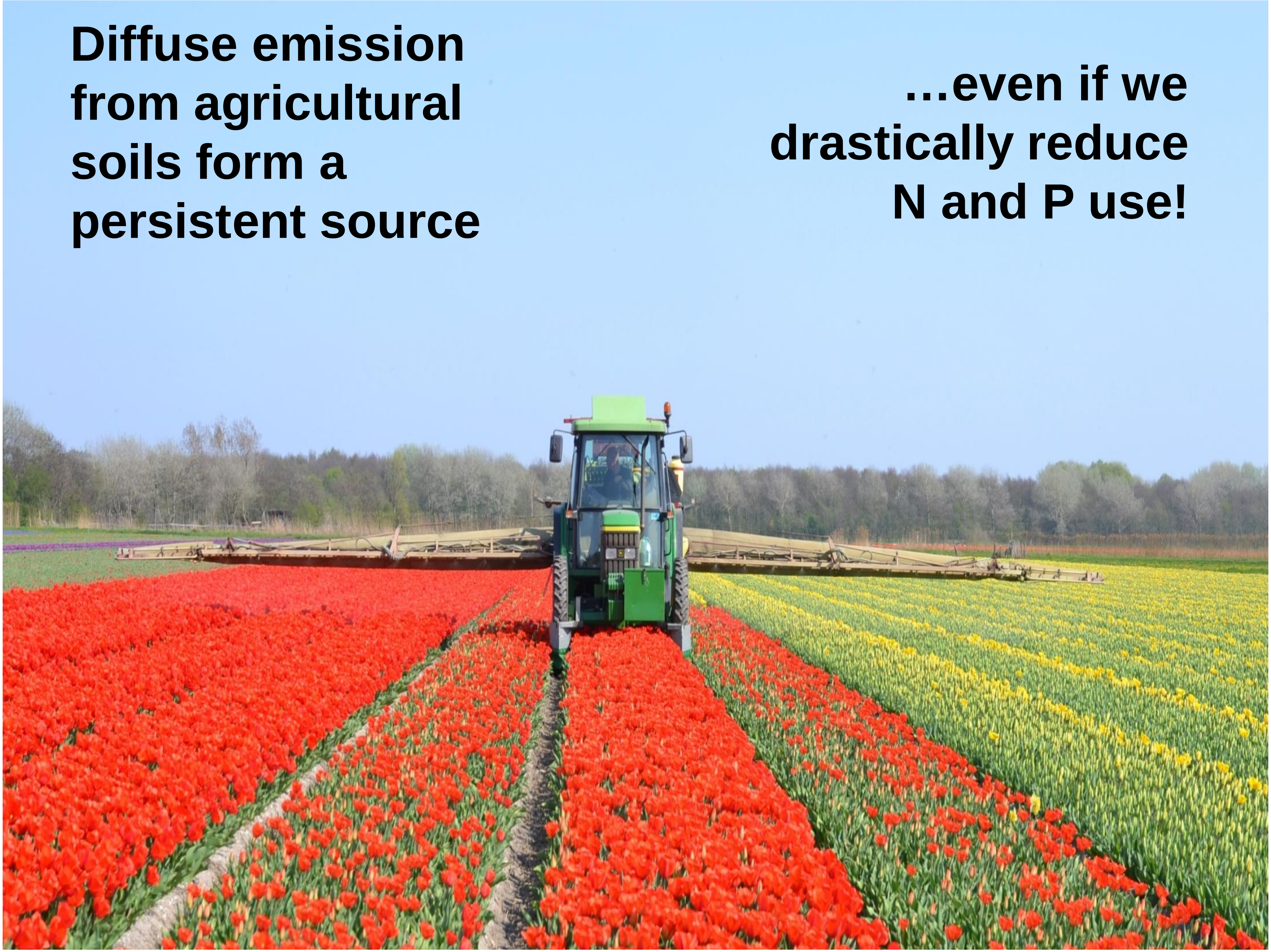
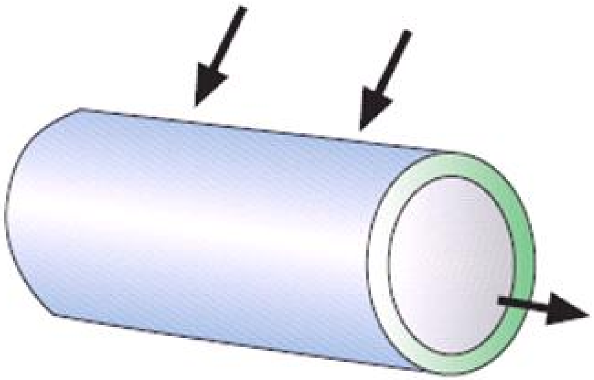
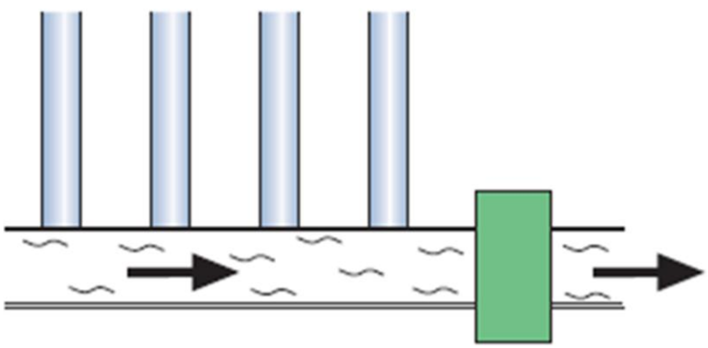

Diffuse emission from agricultural soils form a persistent source
…even if we drastically reduce N and P use!

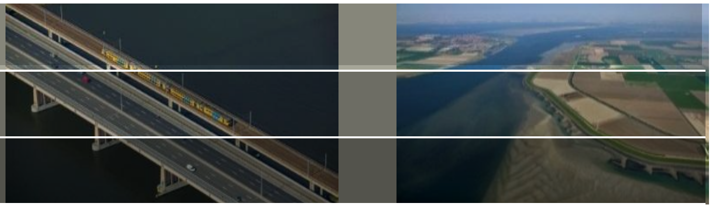
Let’s use the drainage cycle for water treatment

Half of Dutch agriculture land is drained:
plenty of opportunities…



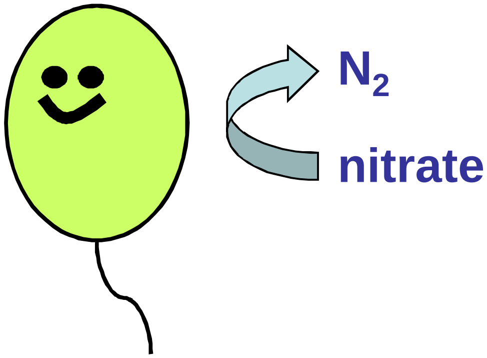


Suitable methods



Nitrate:

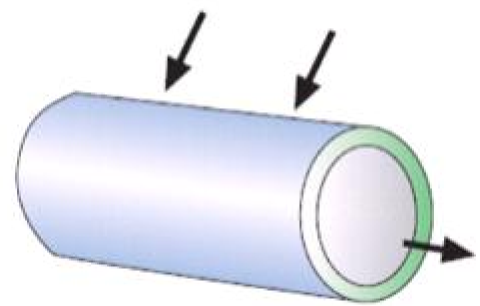
- Denitrification
- Microorganisms in soil and groundwater
- Needed:
  – Energy source: wood chips, ethanol, etc.



Phosphate:

- Chemical immobilisation
- Needed:
  - Binding material (e.g.: iron coated sand)

Nitrate removal using drains surrounded with wood chips

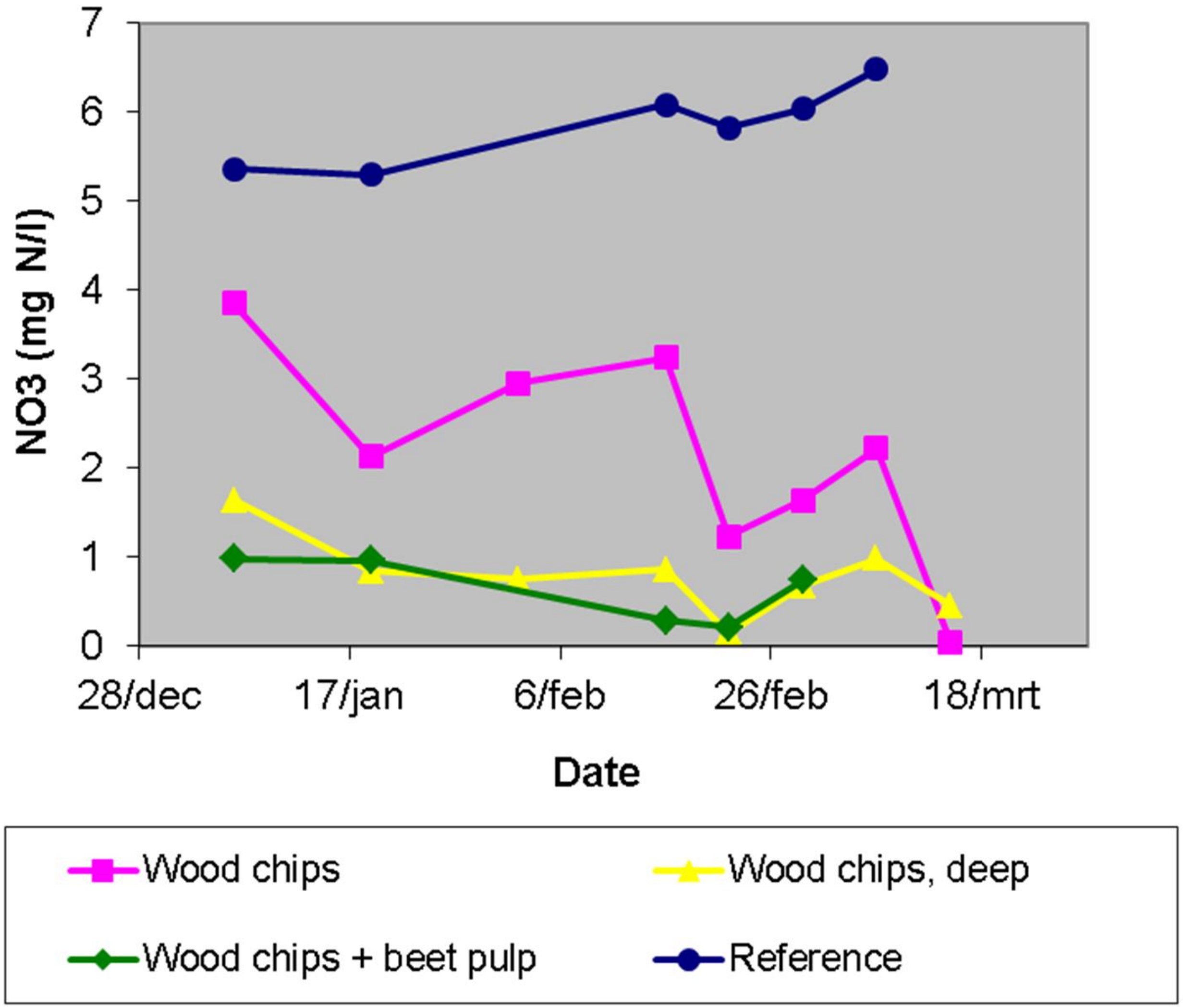


Deltares

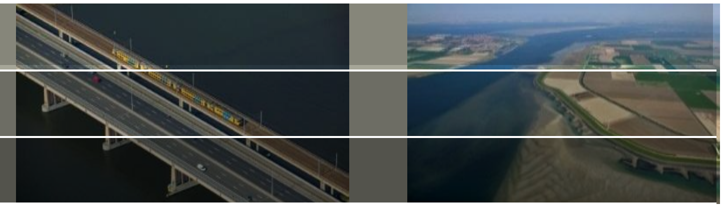
Experimental setup

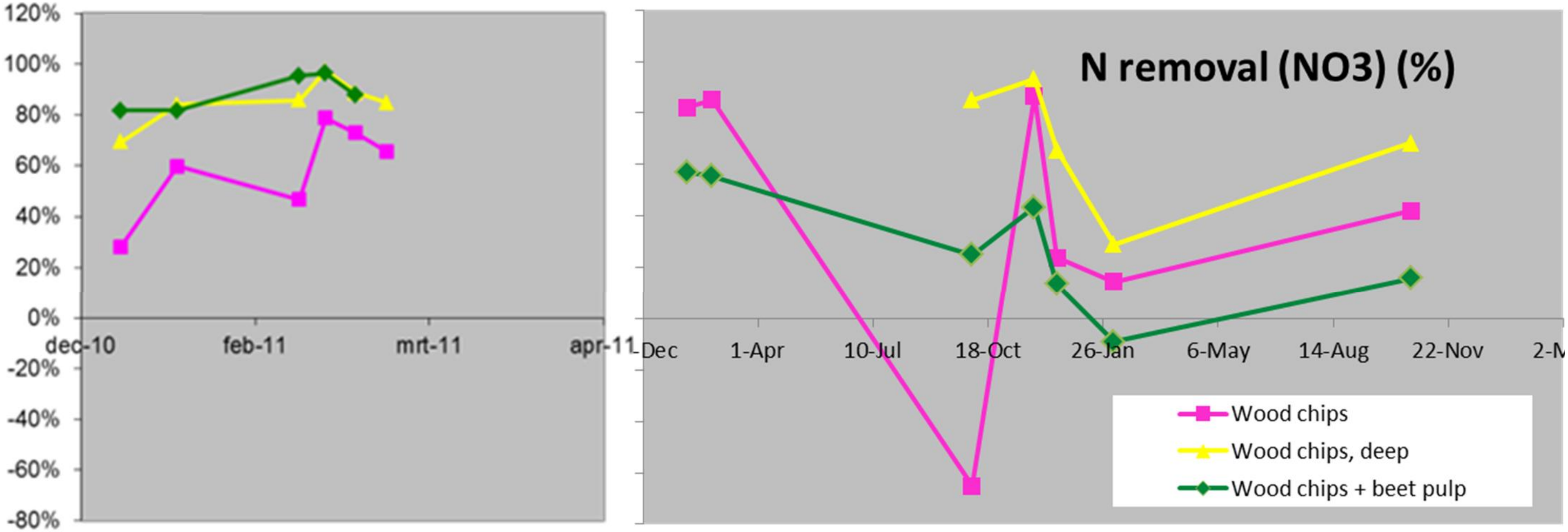
Drain nr.	Wood chips (m^3)	Sand (m^3)	Beet pulp (m^3)	Depth (m)	Description
1	11	5	0,5	1,0	Beet pulp + wood chips
2	11	5	0	1,2	Wood chips + deeper
3	11	5	0	1,0	Wood chips

Nitrate removal using drains surrounded with wood chips



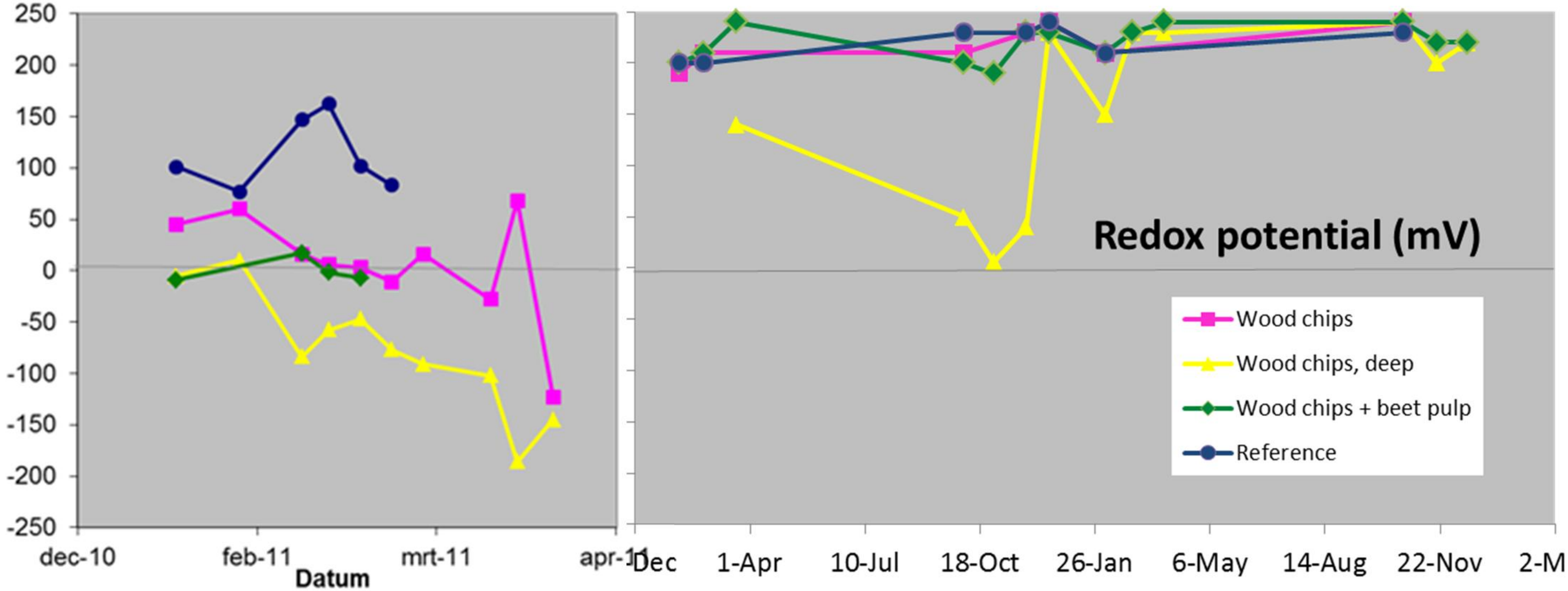
Longer term N removal efficiency





- Efficiency decreases
- Deeper drains remain most efficient

Redox potential plays a key role



Side effects (N_2O emissions)

Date	Drain	N_2O emission (µg N_2O-N per drain outlet per hour)
23 April 2013	Normal drain with woodchips	803
	Deeper drain with woodchips	Not measurable
	Woodchips with beet pulp	Not measurable
	Control	Not measurable
25 June 2013	Normal drain with woodchips	30
	Deeper drain with woodchips	86
	Woodchips with beet pulp	364
	Control	6
25 June 2013	Normal drain with woodchips	1482
	Deeper drain with woodchips	1869
	Woodchips with beet pulp	3866
	Control	400

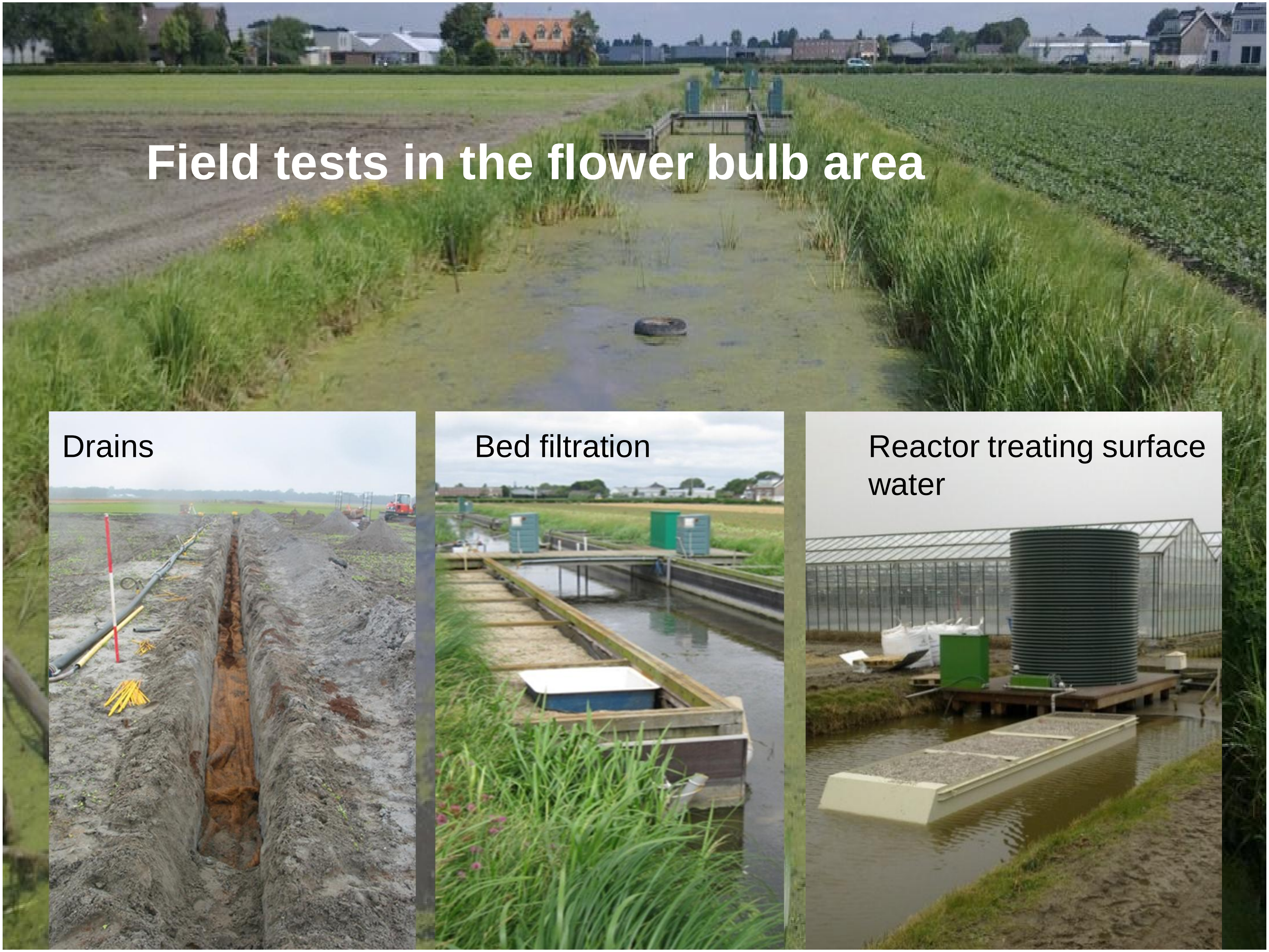
N removal - conclusions

- 60 - 80% removal is possible
- Drains at greater depth were most effective
- Wood chips loose effectiveness, probably due to exposure to oxygen
- Potential side-effects: N_2O emissions
- Control is essential to optimize efficiency and minimize side-effects

Phosphorus removal

- Chemical immobilization
- **Iron oxide coated sand**: side product from drinking water production from groundwater
  - Low cost
  - Strong phosphate binding
  - Good permeability
  - No side effects

Field tests in the flower bulb area



Drains with iron-oxide coated sand

Field tests at two locations

Results:
- 70-95% removal efficiency
- Good permeability
- No side effects

Journal of Environmental Quality

TECHNICAL REPORTS

SURFACE WATER QUALITY

Reducing Phosphorus Loading of Surface Water Using Iron-Coated Sand

Jan E. Groenenberg,* Wim J. Chardon, and Gerwin F. Koopmans

Bed filtration

Results:
- 80-95% removal
- Reasonable permeability
- No side effects

Reactor systems treating surface water

Results:
- 80-95% removal efficiency
- Limited capacity (clogging)
- No side effects

Conclusions phosphorus removal

- Various technological forms work
- Phosphorus removal rate is high 80 – 90 %
- Costs of maintenance and maximum lifetime varies
- Challenges:
  - Practical applicability
  - Permeability
  - Costs
  - Experience

Overall conclusions & outlook

- Low-cost, robust drainage technologies for removal of N and P are available
- Key challenges: optimizing stability and permeability and minimizing side-effects

- Field demonstration essential:
    - Farmers
    - Water managers
    - Constructors
- Gaining support: looking for win-win situations
- Learning from similar (international) experiences

Thank you!

All farmers, water authorities and contructors for practical assistance

Thank you for listening!

Questions?