A SATURATED BUFFER ZONE AS COST-EFFECTIVE NATURE-BASED SOLUTION TO MITIGATE THE AGRICULTURAL NUTRIENT POLLUTION OF STREAMS IN DENMARK

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STØTTET AF
Promilleafgiftsfonden for landbrug

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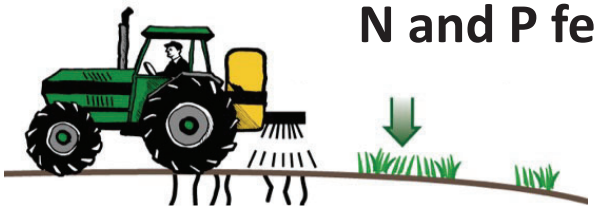
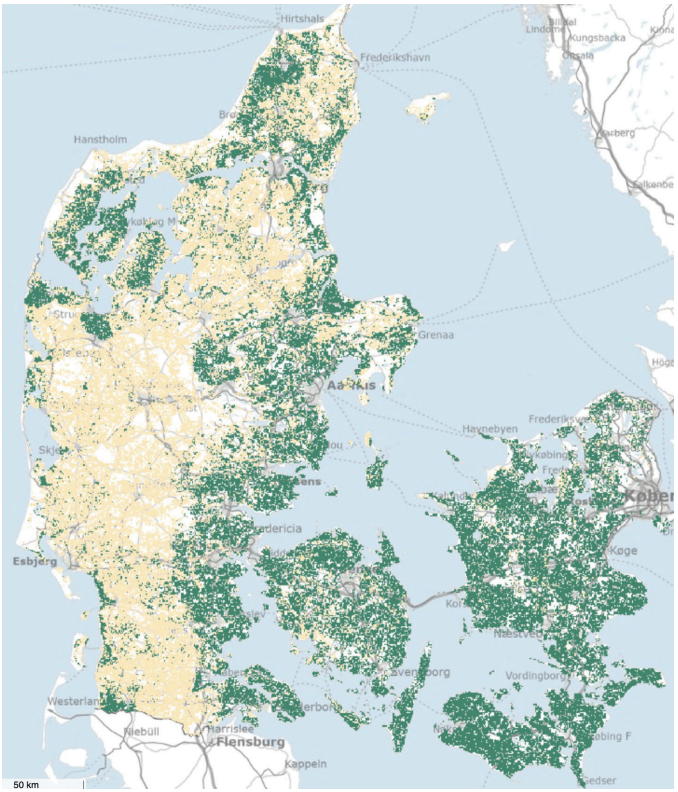
BACKGROUND



N and P fertilizer

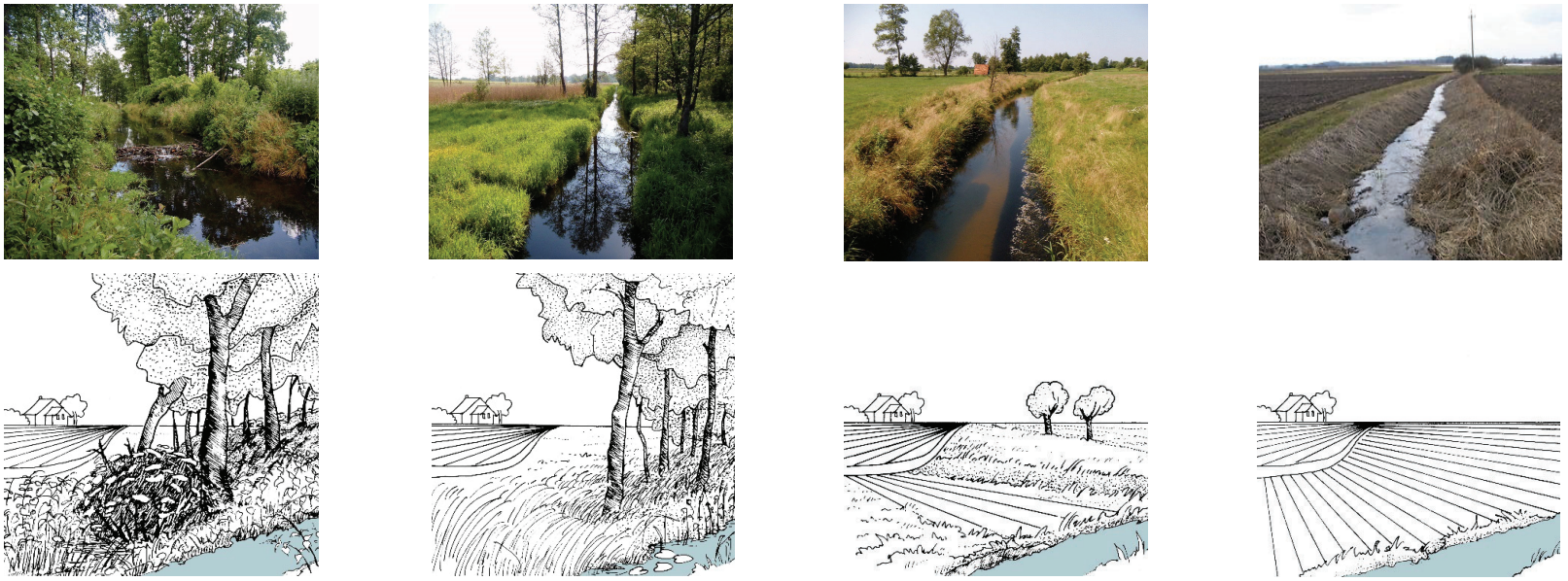
N and P leaching



Drain map of DK

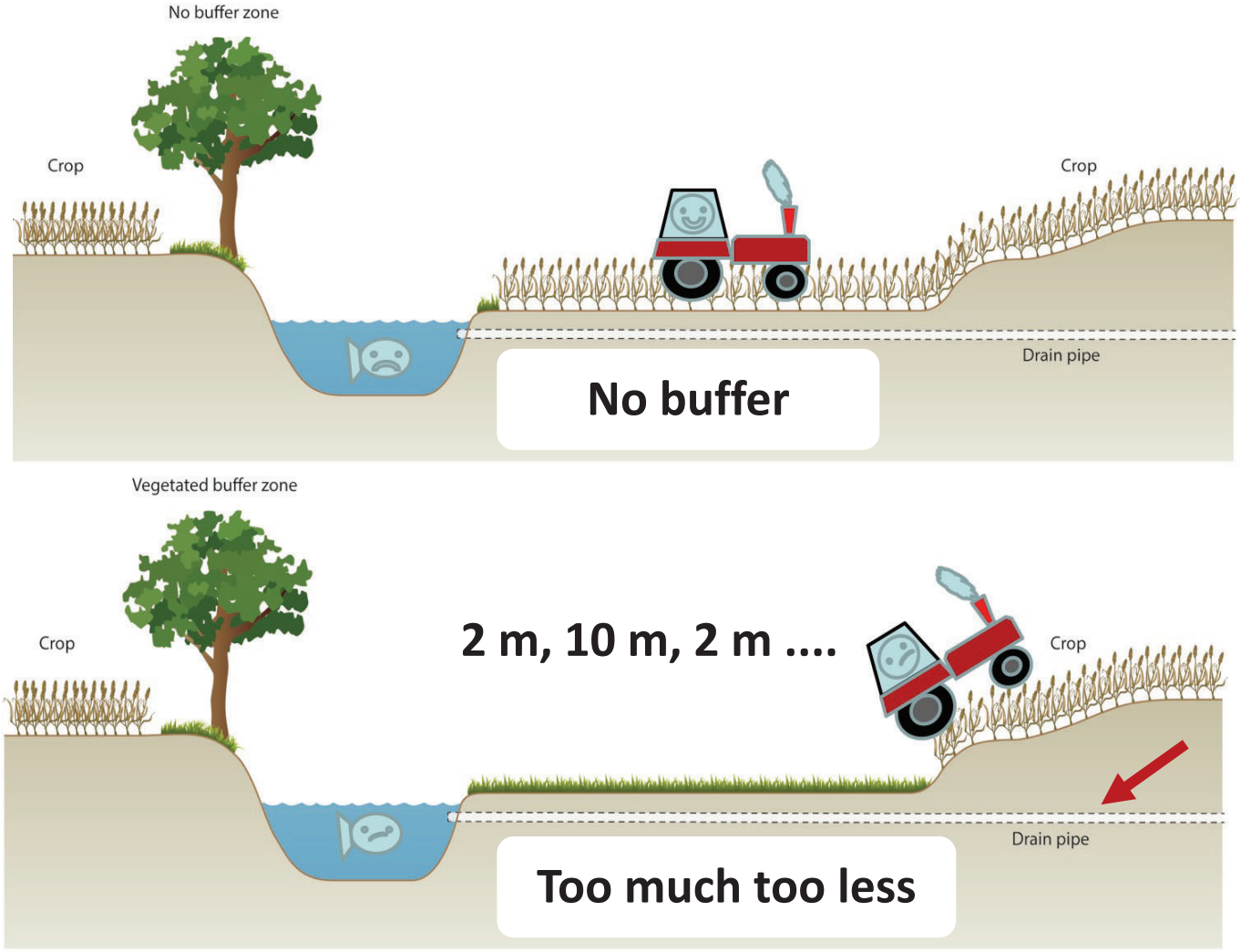
Baltic Sea Polluted

BUFFERZONE DEGRADATION

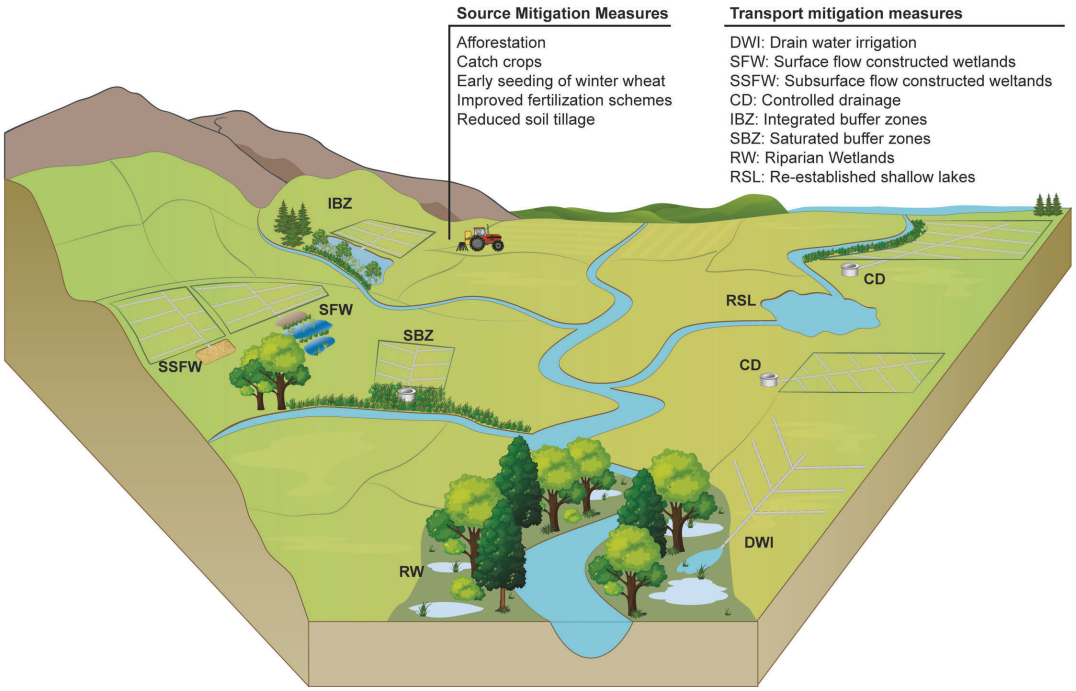


Images by Halina Galera (Clearance 2017-2020)

BUFFERZONE DEBATE

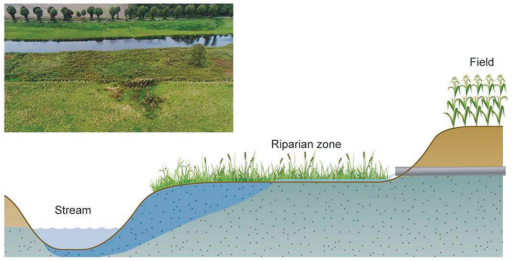


BUFFERZONE (R)EVOLUTION

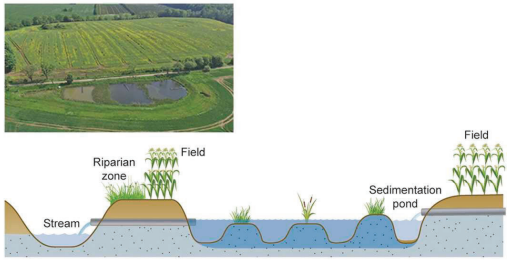


Hoffmann et al. 2020

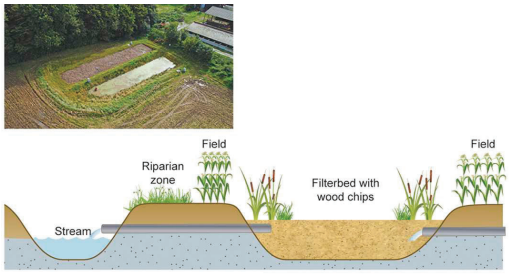
A) Drain water irrigation



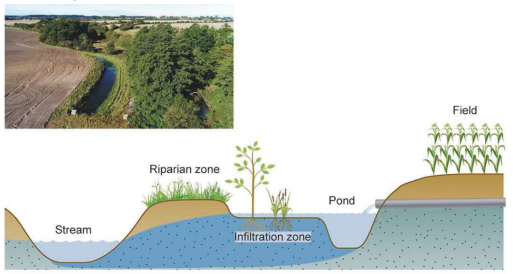
B) Surface flow constructed wetland



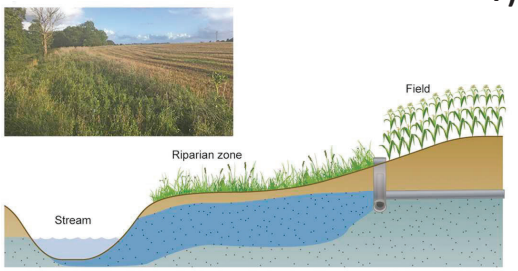
C) Subsurface flow constructed wetland



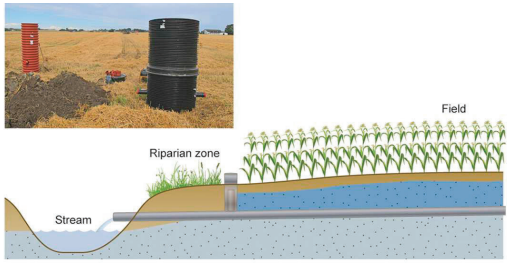
D) Integrated buffer zone



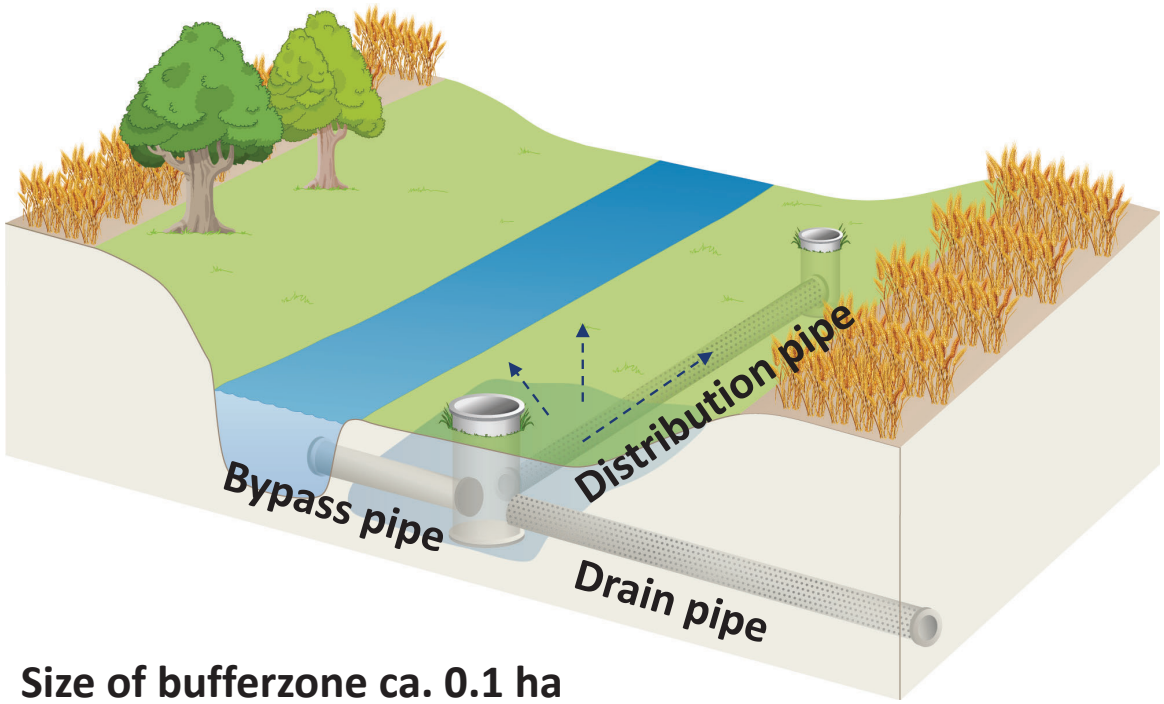
E) Saturated buffer zone



F) Controlled drainage



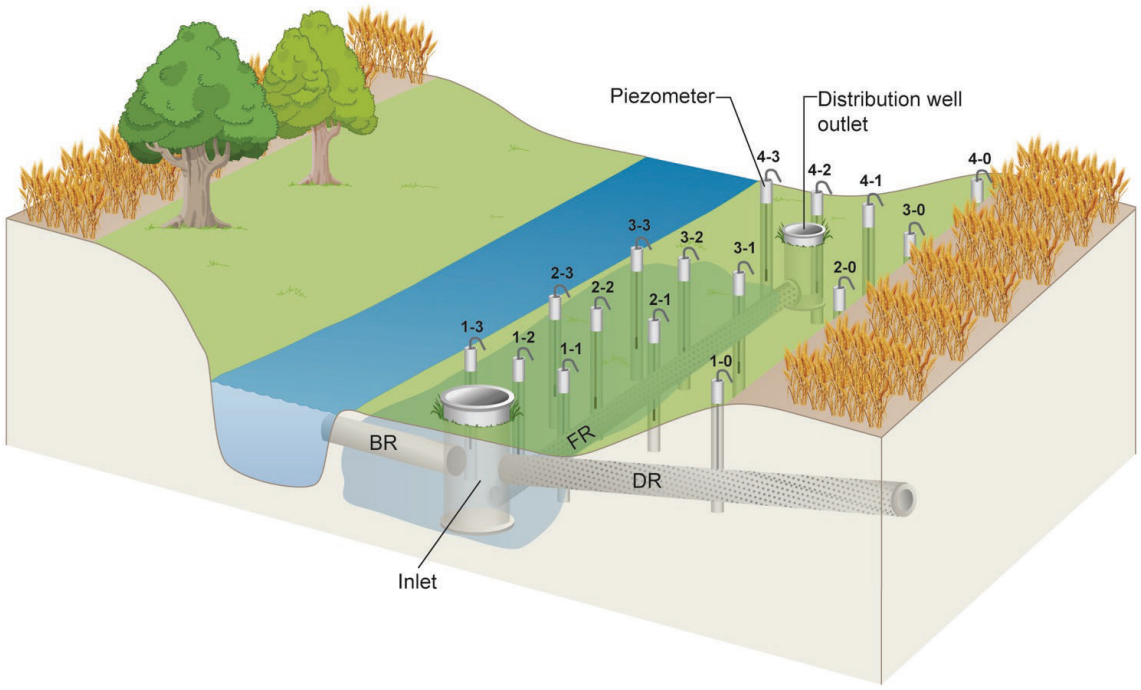
THE CHOICE AND THE CHALLENGE



Size of bufferzone ca. 0.1 ha
Catchment size ca. 4.5 ha

Where is the water flowing???

THE COMPREHENSIVE APPROACH



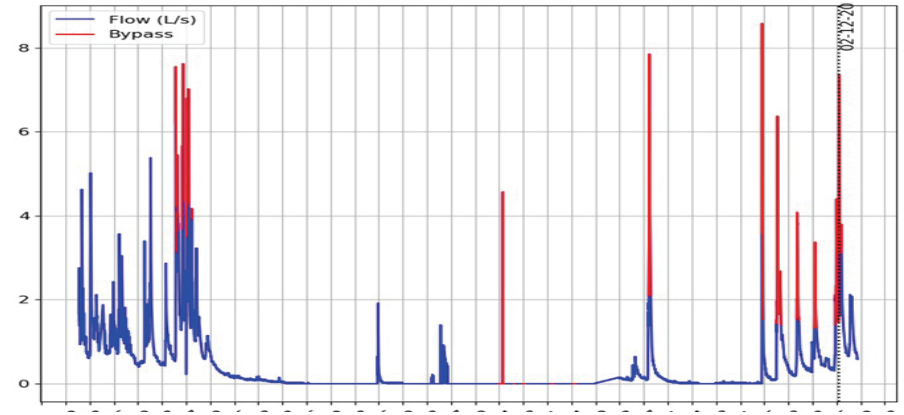
(Maagaard et al. 2022)

Done –List (2019-2021 …2023)

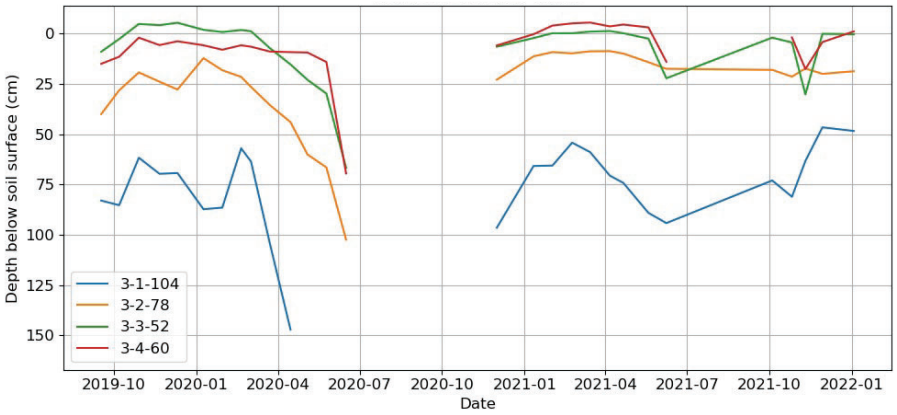
1) Water inflow (continously)
2) Water quality inflow (3-hourly)
3) Water quality buffer zone (3-weekly)
4) Water table changes (hourly to 3-weekly)
5) Soil water flow pattern (tracer experiment)
6) Saturated hydraulic conductivity (slug test)
7) Soil quality (Fe, P, N, C, P saturation)
8) Nutrient uptake plants (N, P)

RESULTS

Water inflow



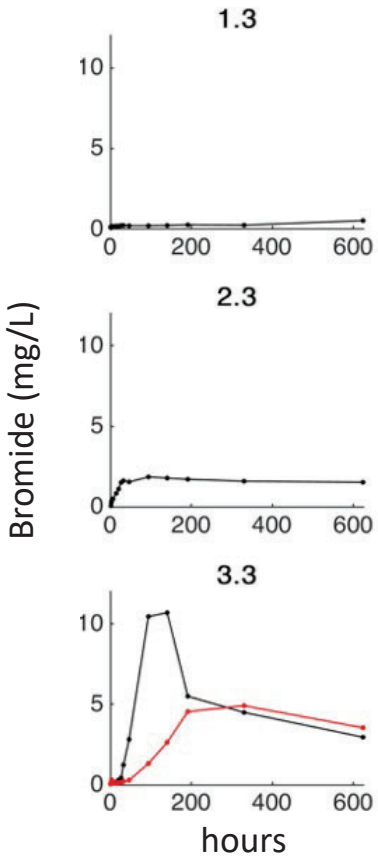
Water table



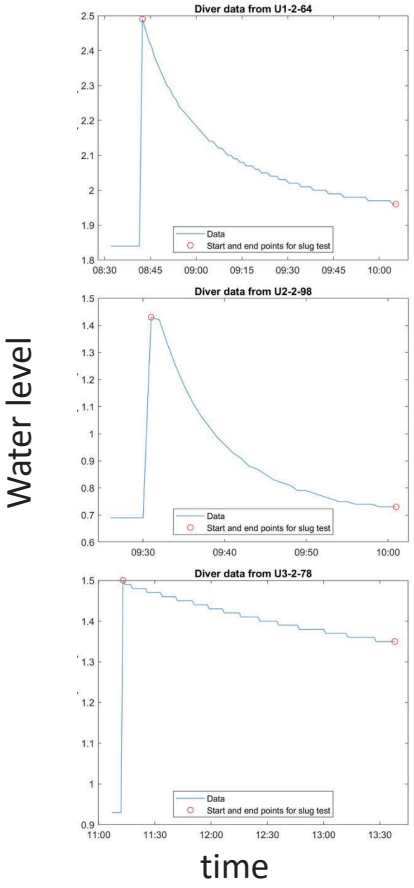
High temporal variation of water inflow (0-8 L/s) with (mostly) no water flow in the summer months; only about 30% of the buffezone was water saturated during the „drain season“.

RESULTS

Trace soil water flow



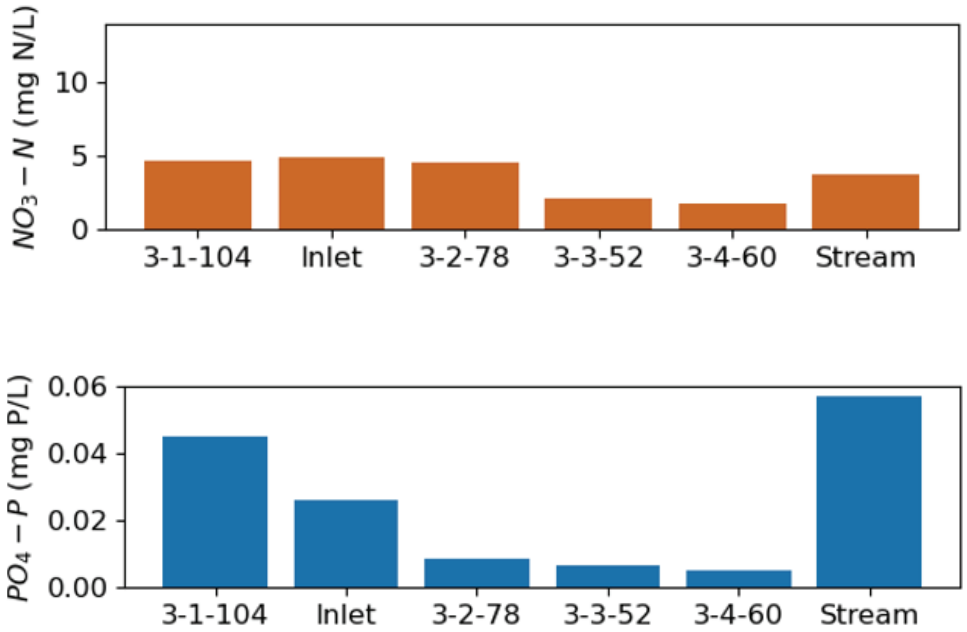
Quantify soil water flow



Saturated hydraulic conductivity varied by factor 50 corresponding with high spatial differences of soil water flow with distinct preferential flow pattern.

NUTRIENT REMOVAL

Transect 3: concentration changes



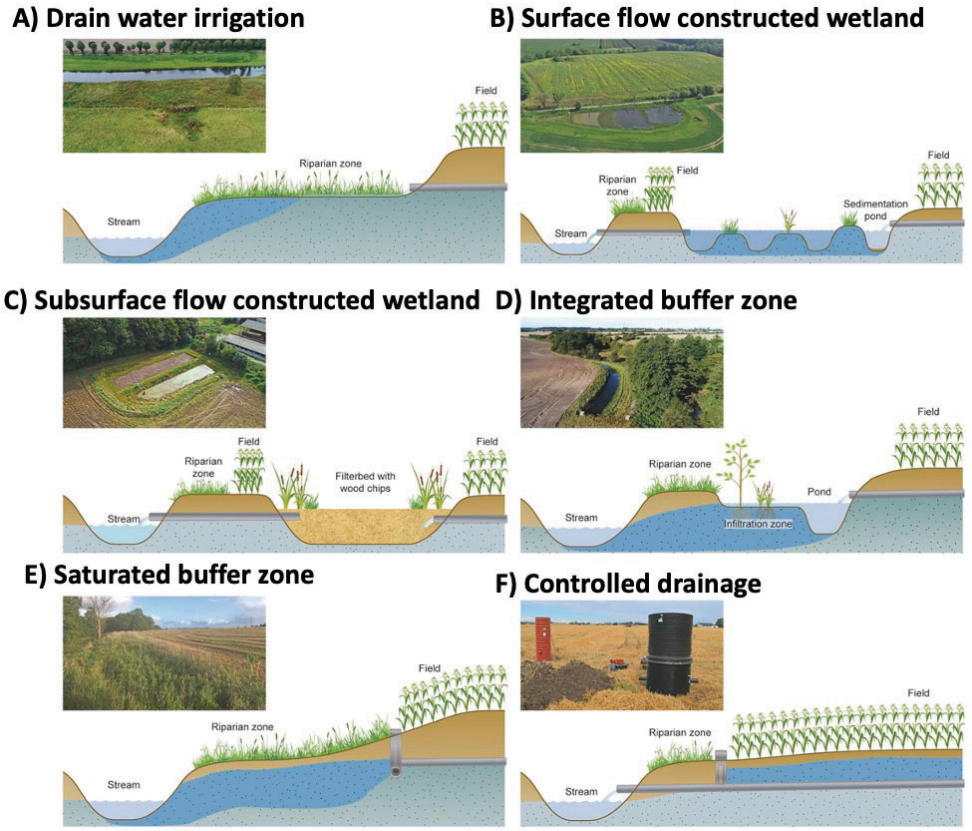
The TN import over about 2 years was 130 kg and for phosphate it was 0,9 kg P. During this time 105 kg nitrate-N and 0.7 kg phosphate-P was removed equating to removal efficiencies of 87% and 76%, respectively.

NUTRIENT REMOVAL BY PLANTS

The nutrient uptake by plants was in average 14.9 g N/m² and 1.6 g P/m² , i.e. about 30% of the N removal and even all of the P removal could be explained just by plant uptake.

THE WINNER IS (SO FAR):

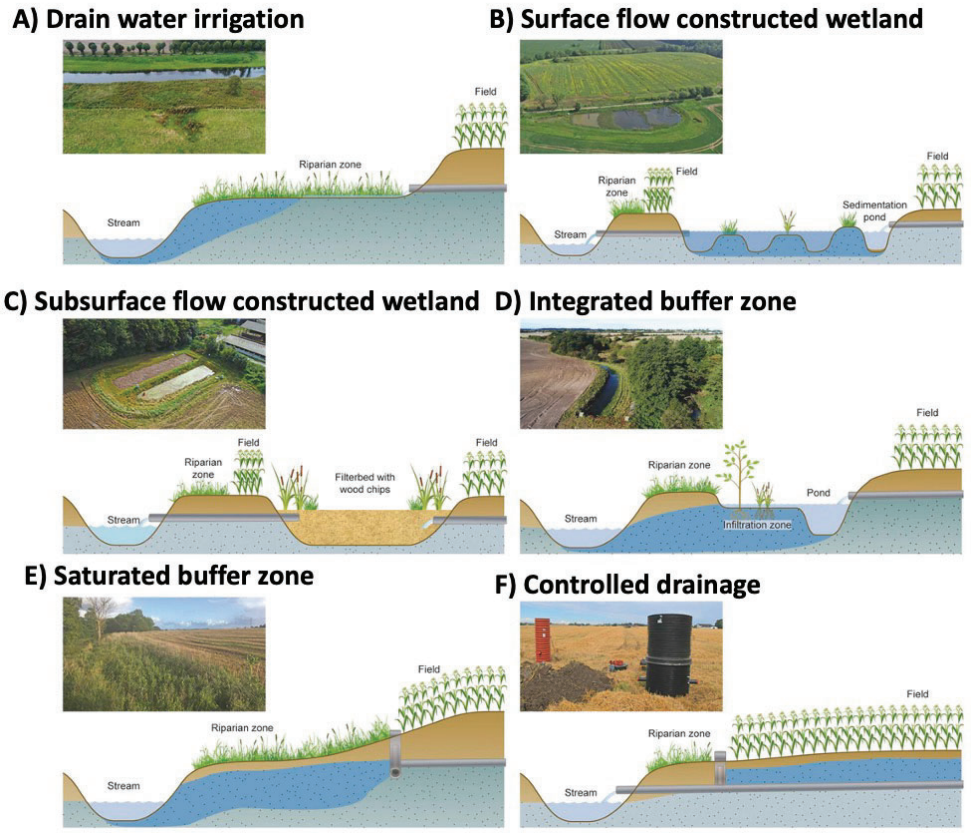
Mitigation Measures	Removal efficiency (%)	
	TN	TP
A) Drain water irrigation	45 ± 22	-51 ± 49
B) Surface flow constructed wetland	23 ± 10	45 ± 20
C) Subsurface flow constructed wetland	50 ± 13	12 ± 4
D) Integrated buffer zones	45 ± 12	29 ± 60
F) Controlled drainage	33 ± 13	5 ± 29
E) Saturated buffer zones (one site!)	*87*	*76*



BUT WHAT IS THE COST-EFFICIENCY ?

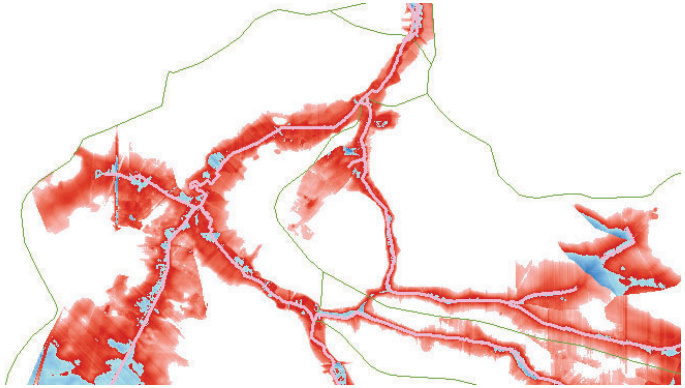
Mitigation Measures	€/kg N (0.1 ha, 20 yrs)
A) Drain water irrigation	0 ?
B) Surface flow constructed wetland	20
C) Subsurface flow constructed wetland	?
D) Integrated buffer zones	10
F) Controlled drainage	0 ?
E) Saturated buffer zones (one site!)	*2*

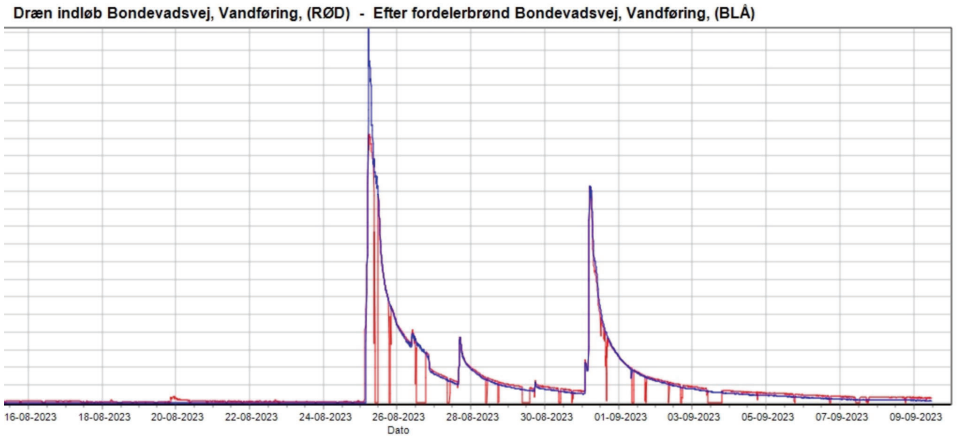
Needs approavel!



NEXT STEPS

1. New test sites
2. Long-term performance
3. Wider benefits and side effects
4. Optimization
5. National Mapping





JUST TEAMWORK :-)!!!

Thank you!