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NuReDrain
European Regional Development Fund

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NuReDrain Webinar I:

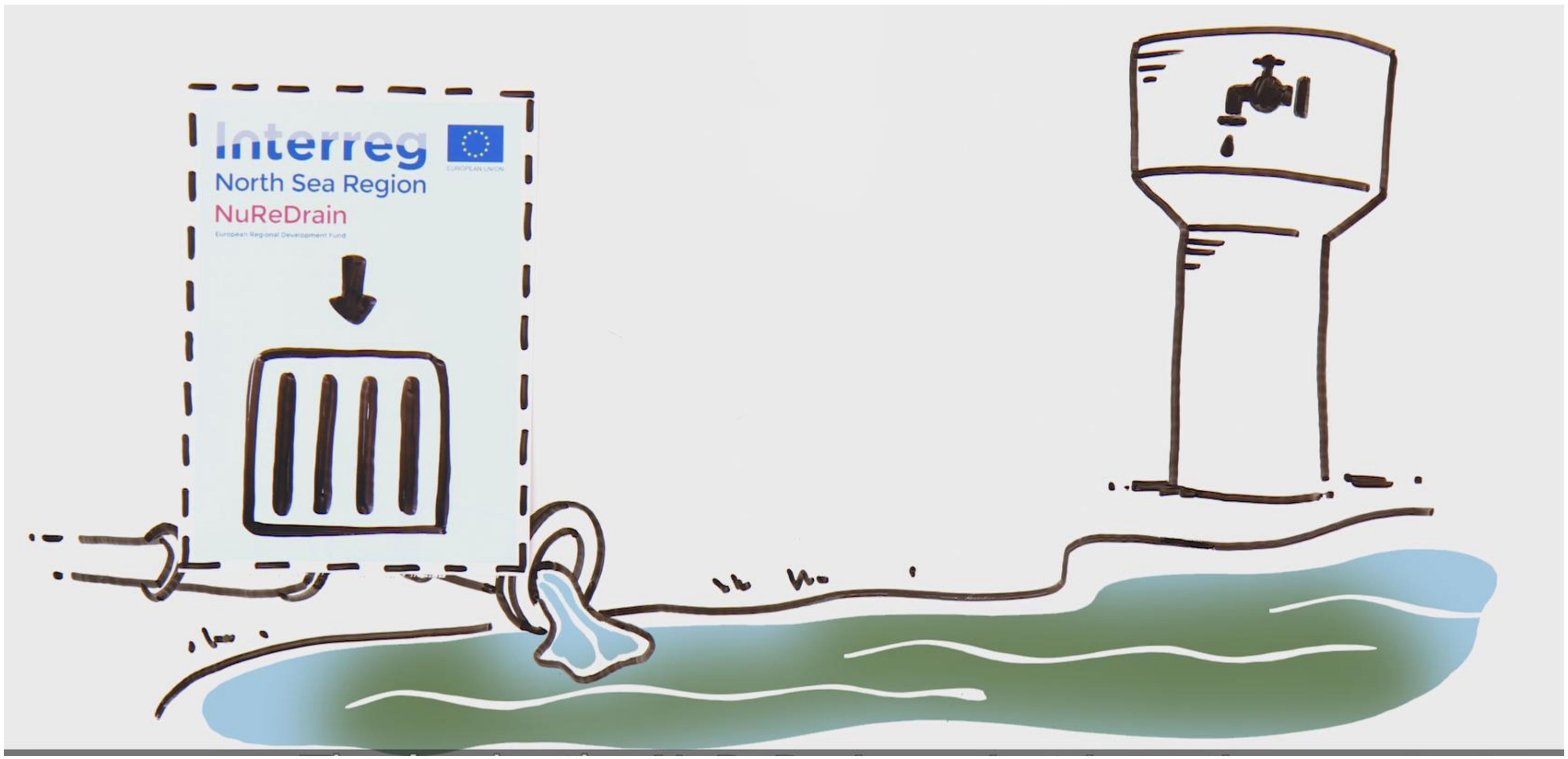
Filter technologies for P removal from drainage water

Practical issues

- Please mute yourself.
- Feel free to ask questions in the chat.
- The webinar will be recorded.
- Handouts will be put available afterwards.

- Nutrient Removal and Recovery from Drainage water
- 1/3/2017 – 30/9/2021
- Interreg North Sea Region
- Project cost: € 2 674 405 - Fund: € 1 337 203
- 11 partners in 3 countries

Project goal



Project goals

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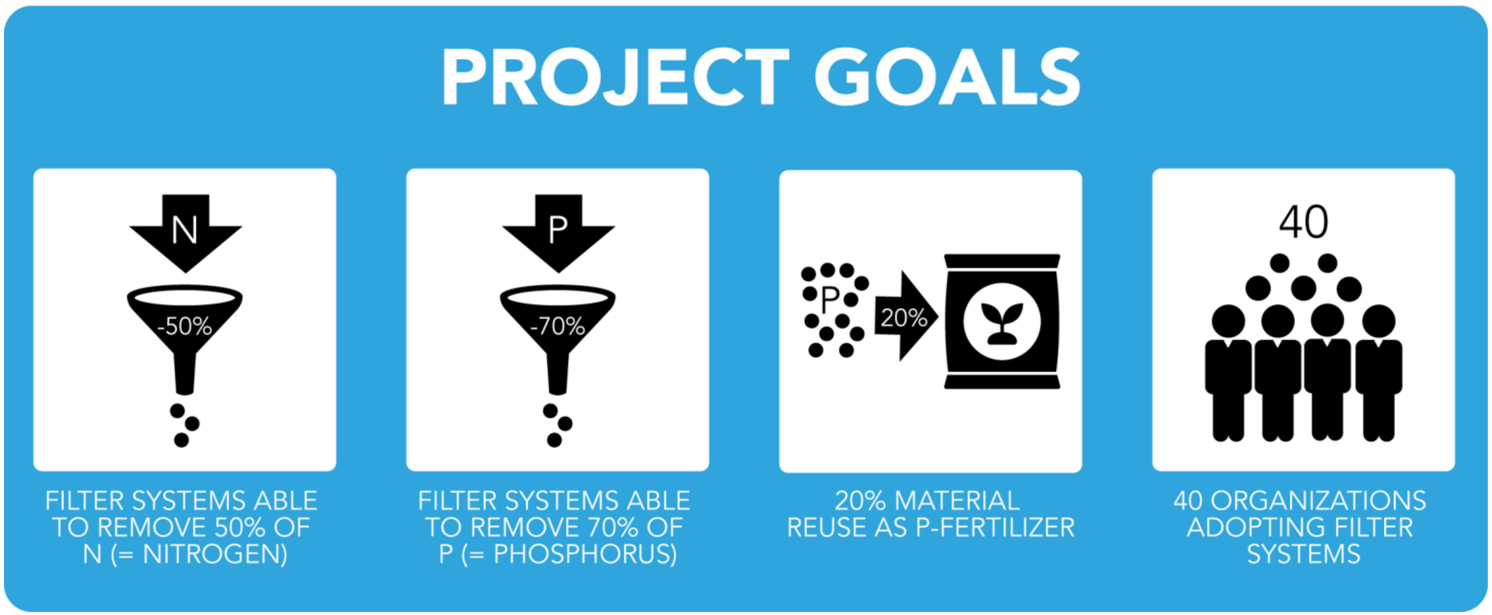

Agricultural waters

drainage water

greenhouse effluent

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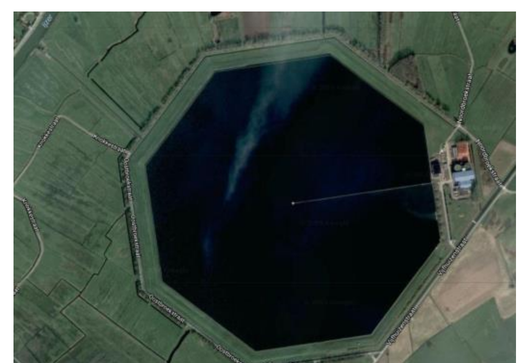
surface water

water reservoir for drinking water production



6 field cases

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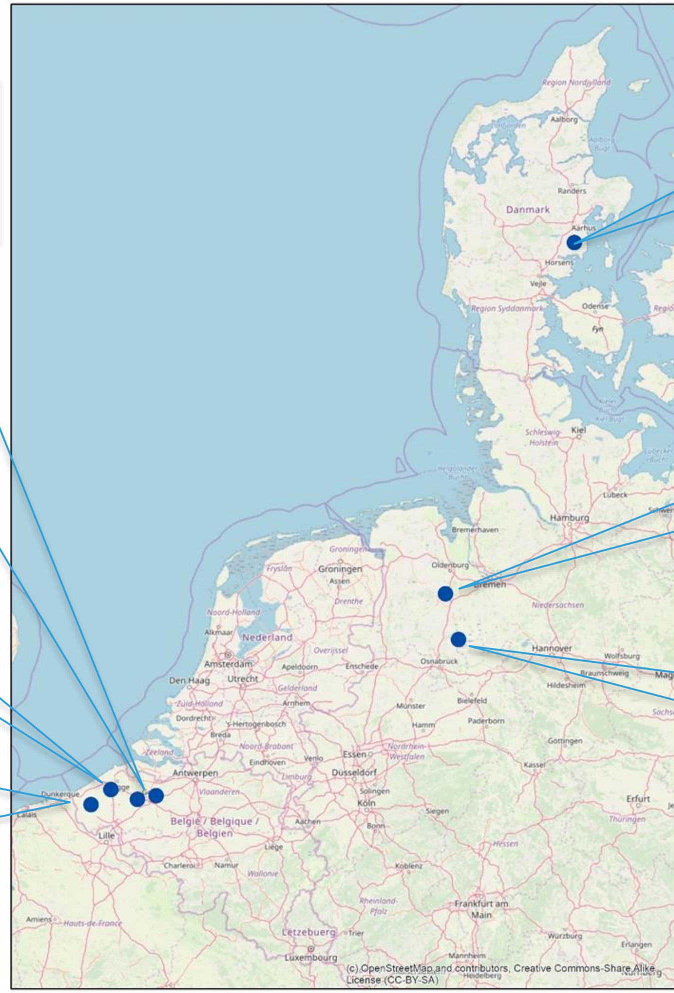
Greenhouse effluent
N + P removal

Drainage water
P removal

Water reservoir
P removal



Drainage water
N + P removal

Surface water
N removal

Drainage water
P removal

6 field cases

Greenhouse effluent
N + P removal

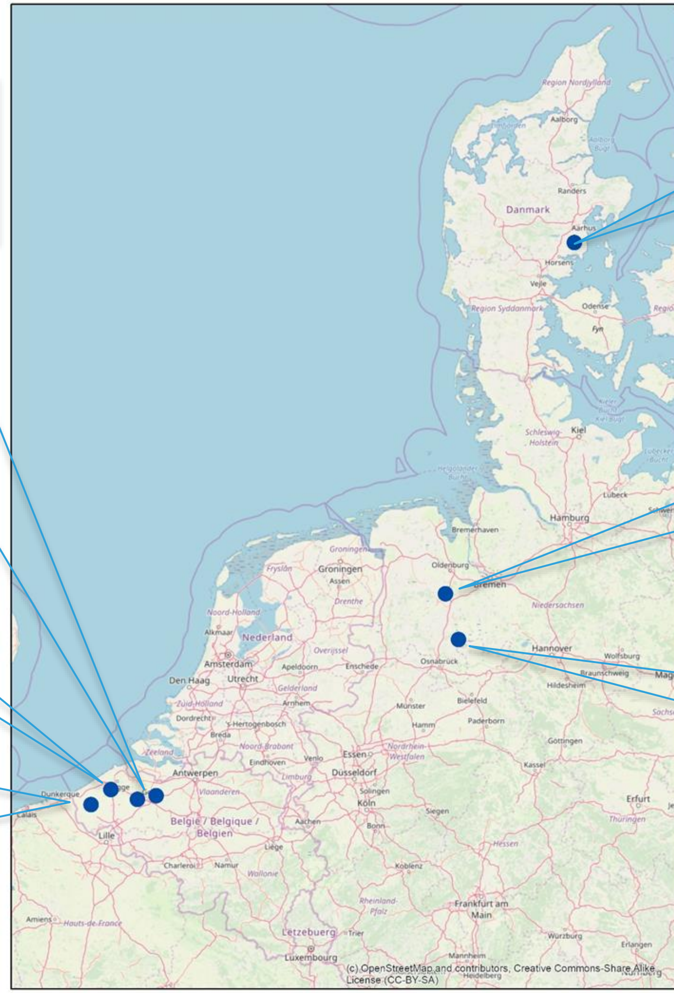
Drainage water
N + P removal

Drainage water
P removal

Surface water
N removal

Water reservoir
P removal

Drainage water
P removal



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► Phosphorus filtration in drained arable fields

results from 2nd season

High P losses in drained fields

Landwirtschaftskammer Niedersachsen
Wir bieten Lösungen – regional & praxisnah!

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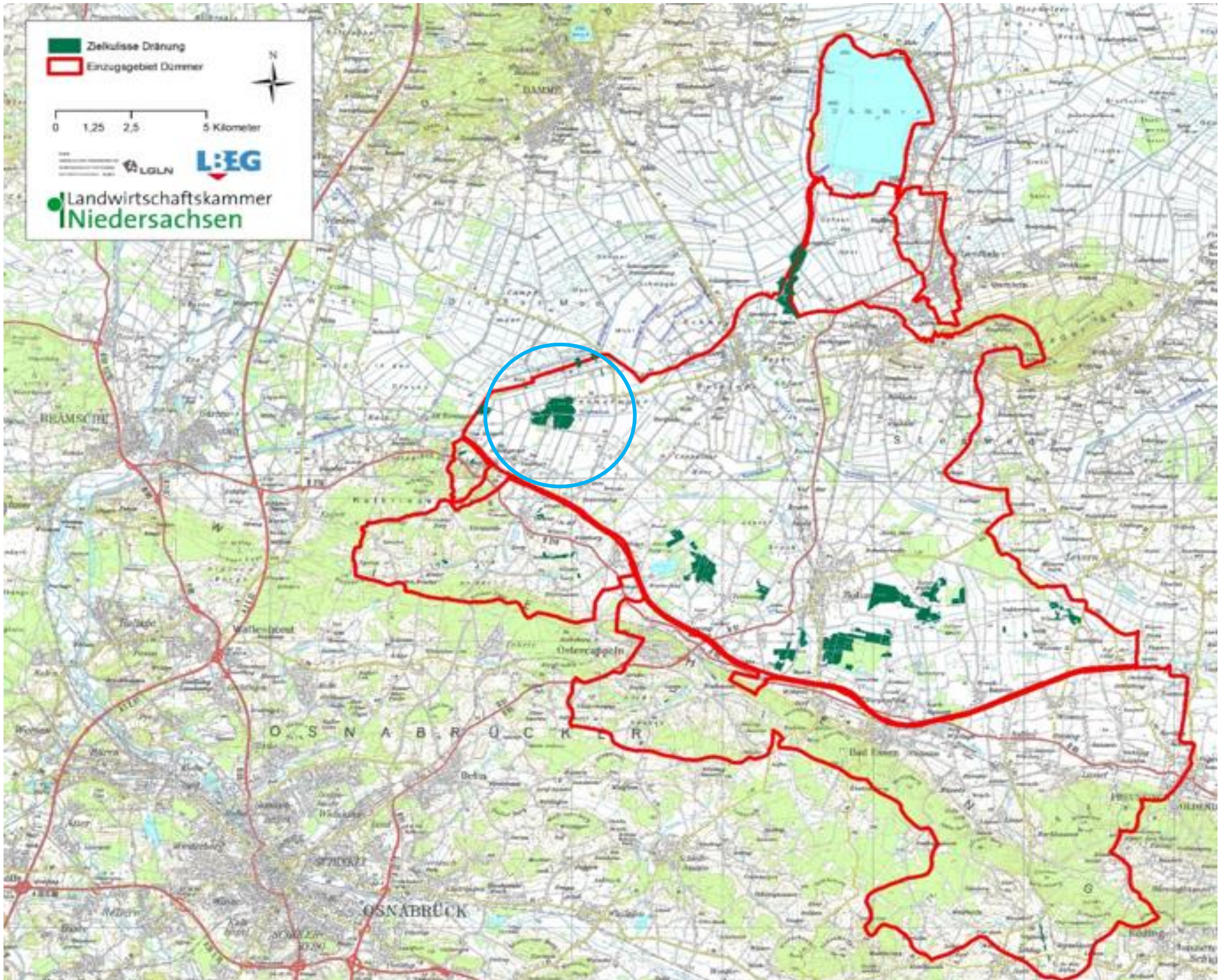

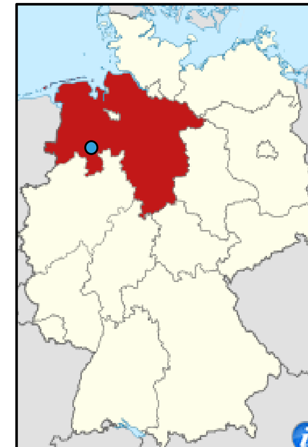

source: Wikipedia

"Hot Spots"

↑ P concentration

↑ drainage flow

Lowland and peat soils

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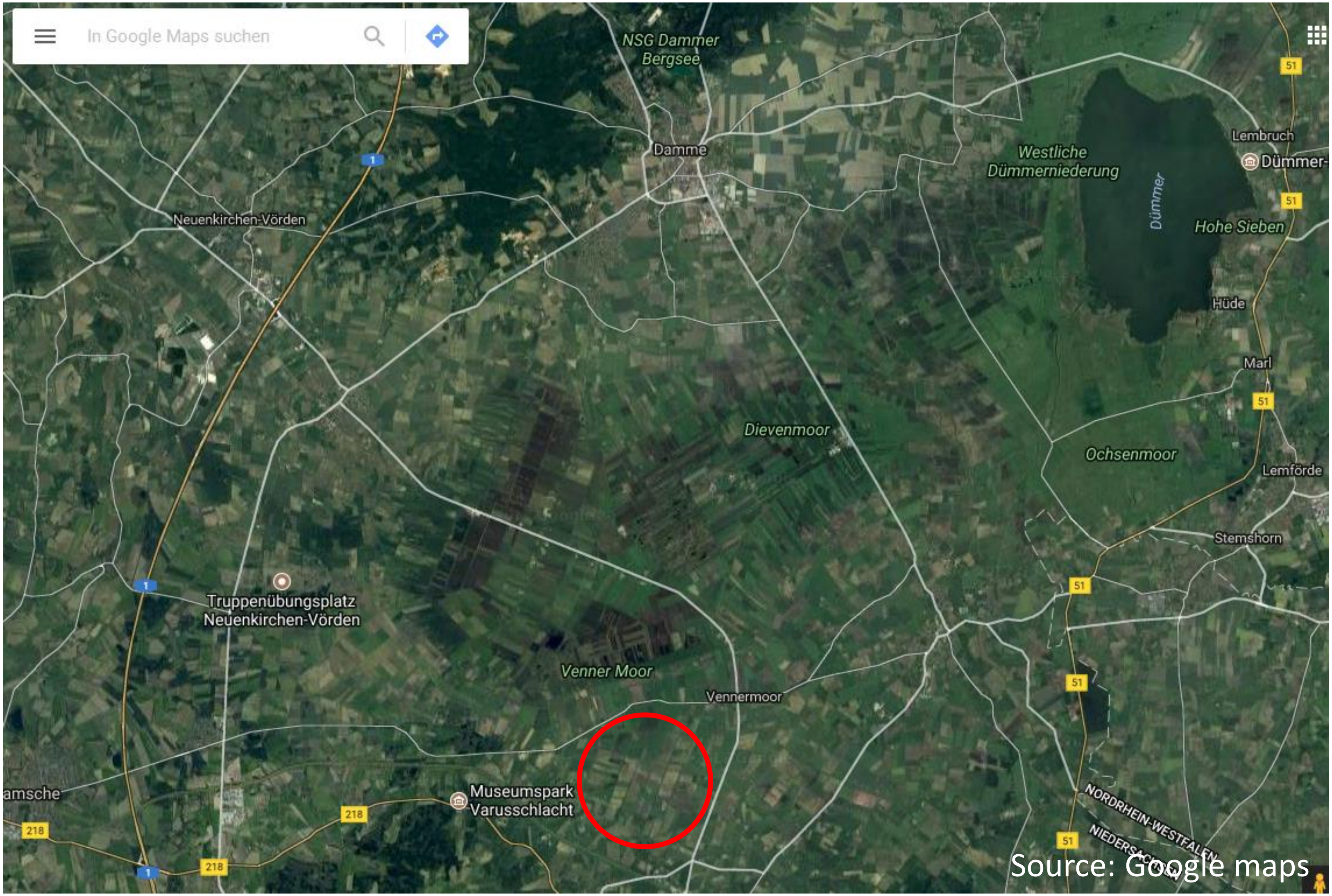


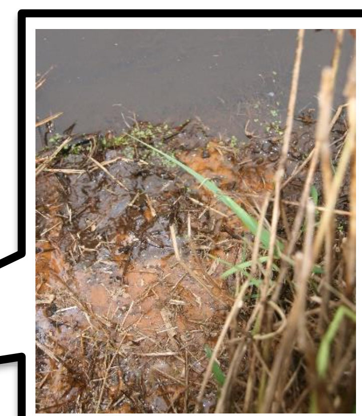
Test site specification

soil type (topsoil)

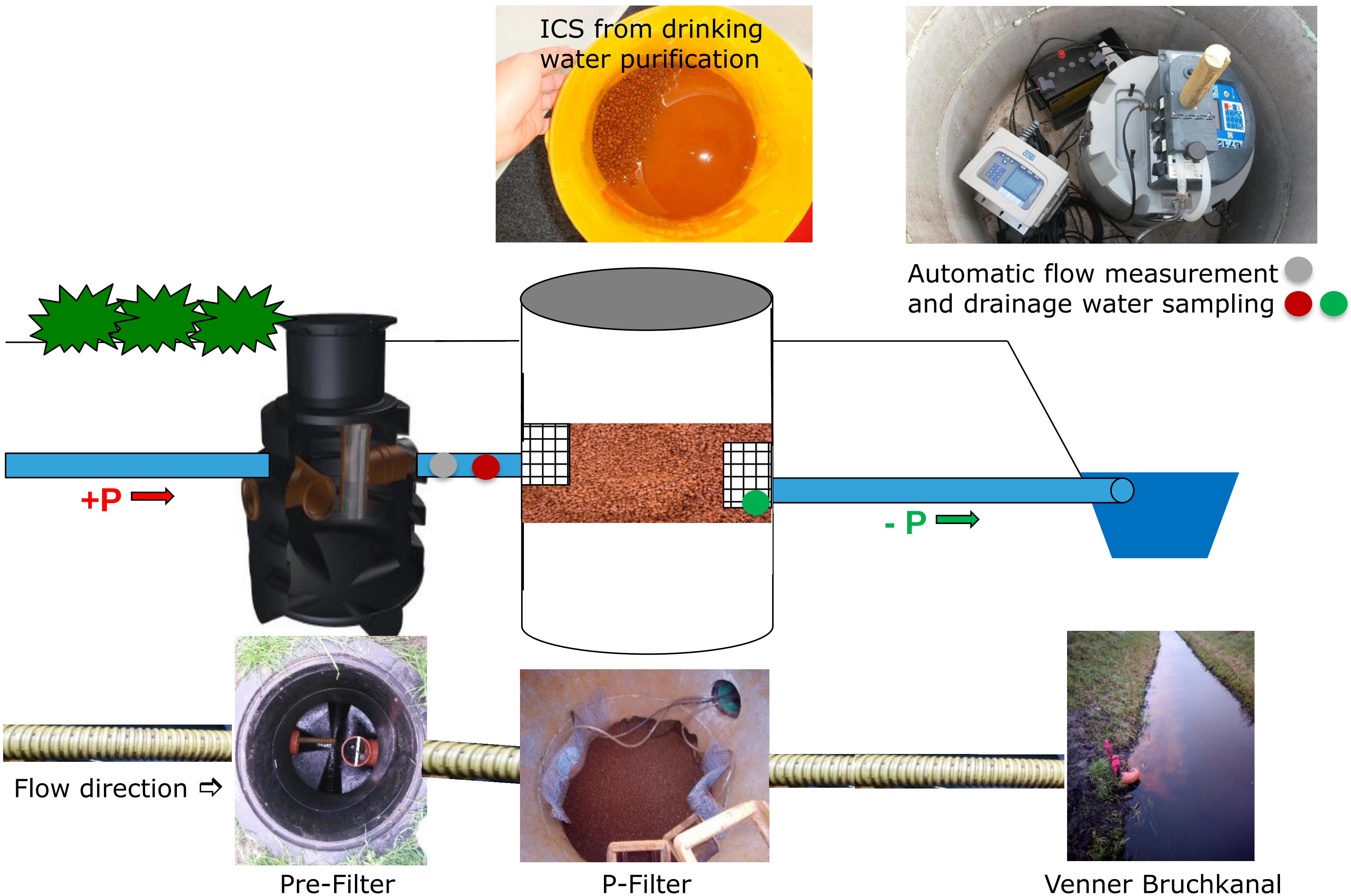
- peat soil
- loamy soil
- sandy soil, loamy, silty
- clayey soil
- silty soil
- sandy soil

Source: DTK50 der Landesvermessung + Geobasisinformation Niedersachsen, modifiziert

- Field size: 8,2 ha
- Topsoil: loamy sand, >15% organic substance
- Drainage: single tile drains (8-10 m distance)
- P expected: P_{total} ~4,0 mg/l
  $P_{soluble}$ ~0,3 mg/l
- Discharge of amorphous organic substance !!!



Setup P filter



Preliminary results...

Drainage water samples

No filter

	P tot. (mg/l)	P sol. (mg/l)
min	0,04	0,01
max	3,07	0,08

✓... below expected values

P tot. (mg/l)	P sol. (mg/l)
4,0	0,3

LBEG

✗... exceeding ecological targets

0,1-0,3mg/l OGewV2016

0,07mg/l

0,03mg/l

Filter

	P tot. (mg/l)	P sol. (mg/l)
min	0,04	0,01
max	3,19	0,02

✗... revision sampling mode & position

Preliminary results...

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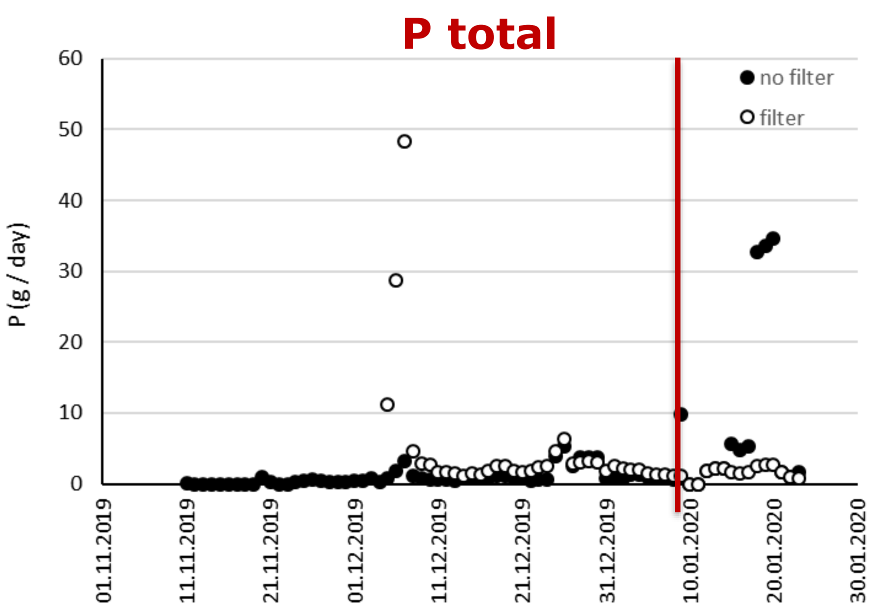
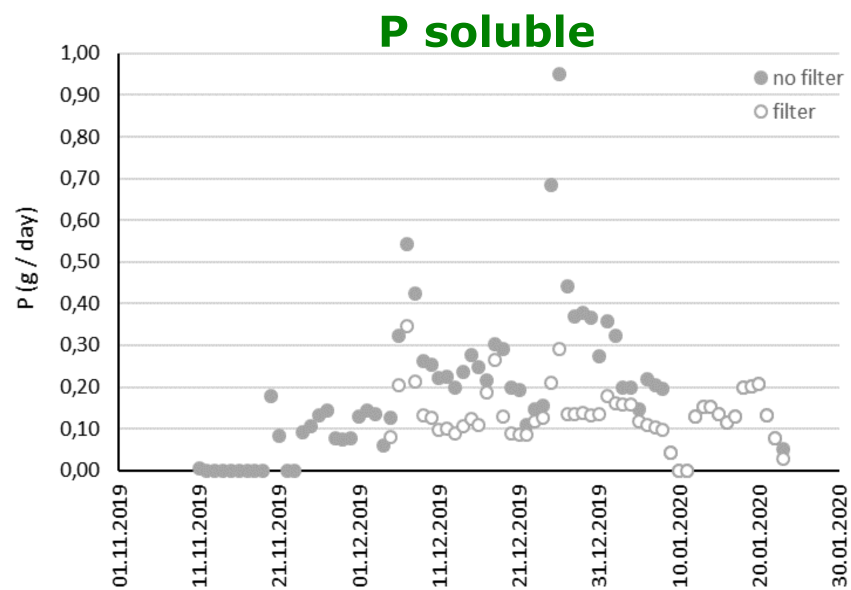
Flow-balanced nutrient discharge





- $P_{tot.}$ is retained after filter revision
- clear reduction of $P_{tot.}$ by filtering
- the total P discharge is mainly determined by particulate bound P

- $P_{sol.}$ is retained by filter
- no significant reduction of $P_{sol.}$
- 7% $P_{sol.}$ of $P_{tot.}$

Preliminary results...

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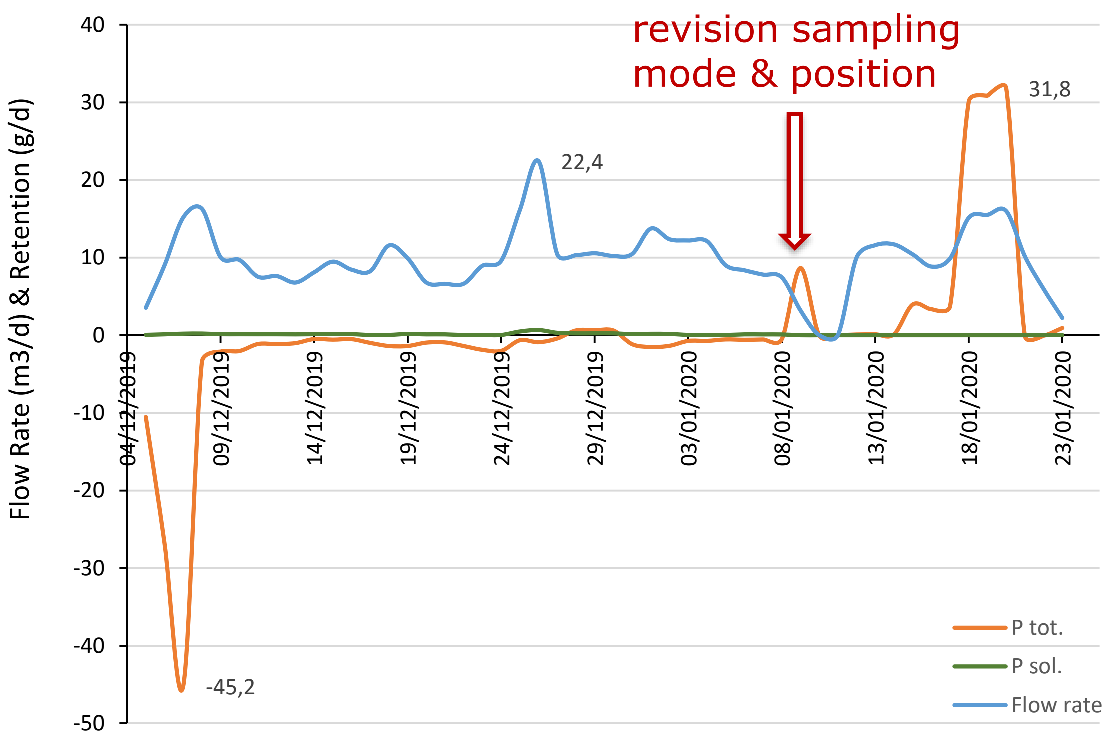
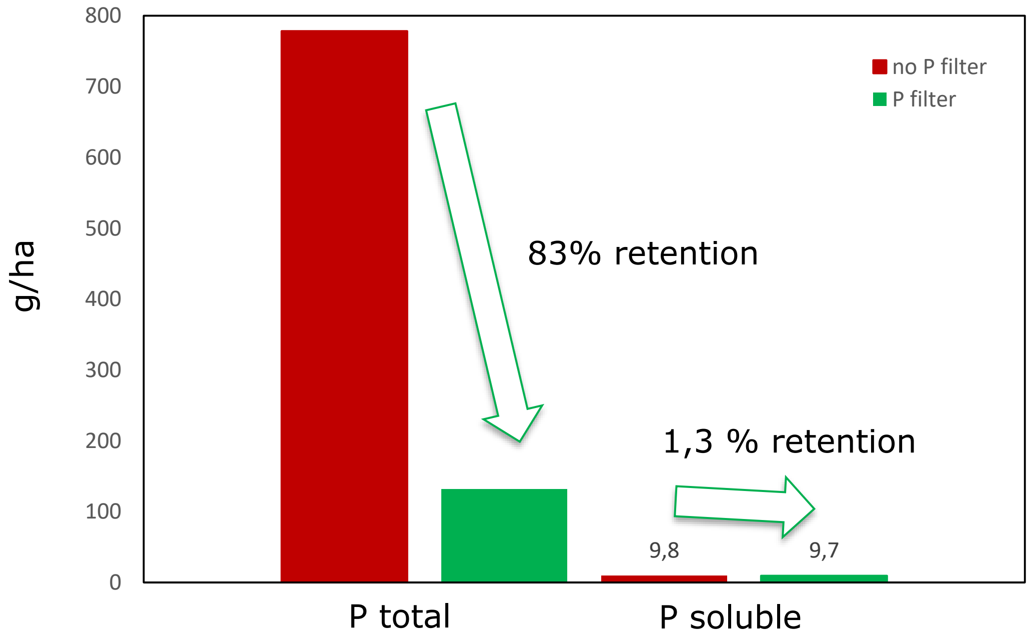
Flow rate, retention of P total and P soluble



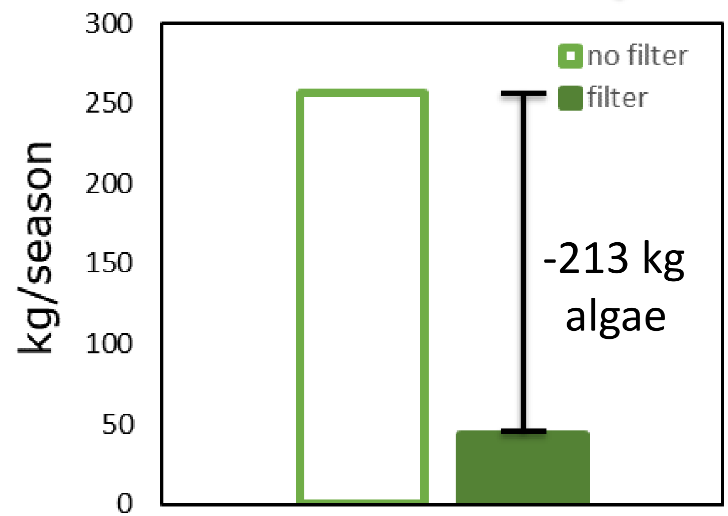
- ↑ fluctuation in flow rate
- (no) effect of flow rate on retention of $P_{sol.}$
- no clear statement about effect of flow rate on $P_{tot.}$ retention (hysteresis effect)

Preliminary results ...

Extrapolated P loss/season without & with P-filter



Assumption:
1 g P → 330 g phytoplankton



Cross-check with literature

Landwirtschaftskammer Niedersachsen – Wir bieten Lösungen – regional & praxisnah!
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… average $P_{tot.}$ export 0,29 kg ha^{-1} y^{-1} …
… P mainly in particulate form …
… 50 % of the annual $P_{tot.}$ export in 140 h, hysteresis effect …
(Ulén & Persson 1999, Hydrological Processes Vol. 13, Iss. 17)
→ more data required for statements

… tile discharge highly variable within events …
(Macrae et al. 2007, J. Agr. Wat. Man. Vol. 92, Iss. 3)
→ we can confirm that so far

… the amorphous organic substance is a carrier of P and causes a high P input into surface water …
(Zimmer et al. 2016, Agricultural Water Management 167)
→ can explain large differences in results between season 2 & 1 (not shown)

… ICS has a potential for field use due to its high hydraulic conductivity …
(Chardon et al. 2012, J. Environm. Qual., Vol. 41)
→ due to low hydraulic gradients in the field, it is important to ensure a sufficient hydraulic conductivity of the filter material

… ICS filter efficiency of >80 % in investigations of other project partners …
→ can be confirmed so far

Transfer into practice

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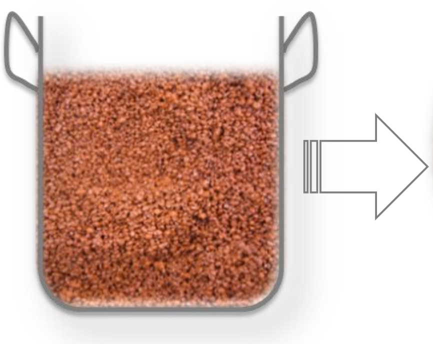
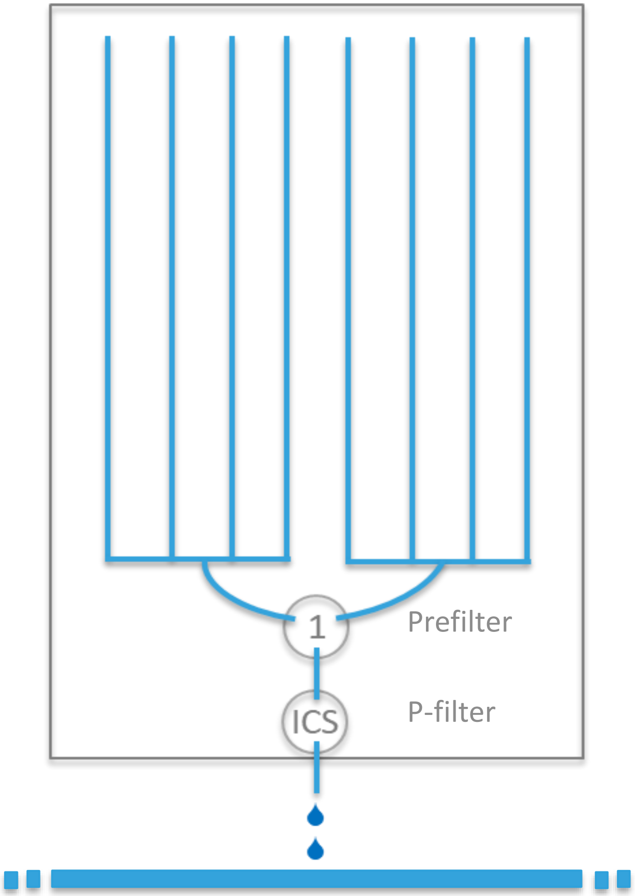
New installation
Extension of existing drainage collector systems

Benefits

- Cheap filter material ICS
- Low space consumption
- No energy supply
- Renewable (in own work)
- Long-term filter effect
- Mechanical lifting of filter material





Future perspectives

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- Have a good measuring season
  → **avoid** data loss (poor measuring conditions, damage or malfunction)
  → **avoid** erratic measurement data (backwater, clogging, pref. flow)

- Expand database → long term filter performance

- Improve P-filter → **put it into practice**

But before…

1. Farmer survey → farmers needs & wishes (**€** , **§**)
2. Develop cooperation (willingness to cooperate & practical implementation)
3. Follow-up project with an improved starting point - **thanks to all project partners!**

Q & A

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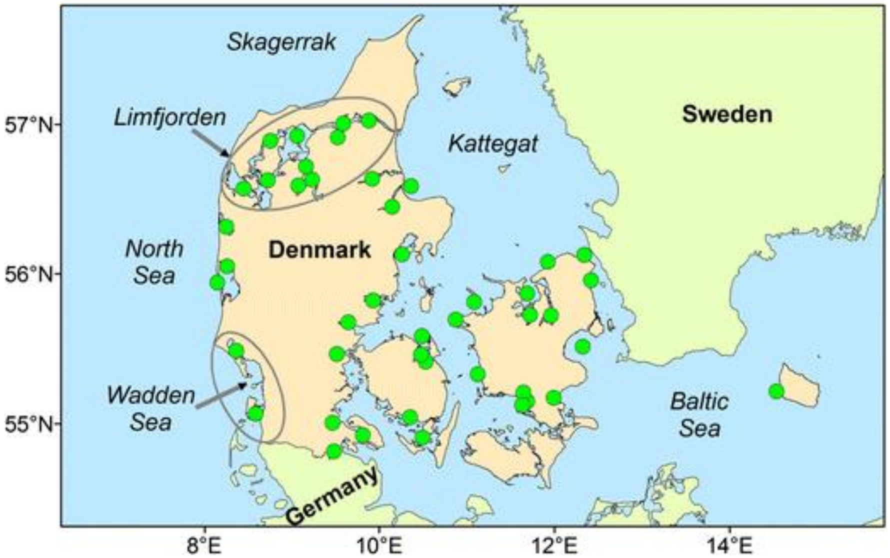
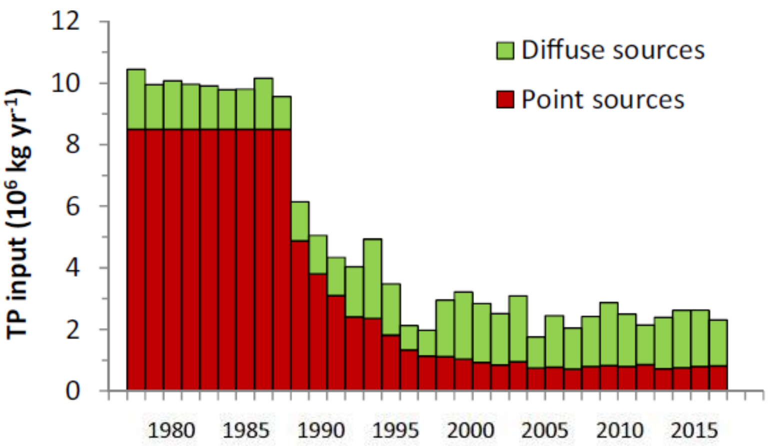
New P filter demo site at Fensholt in Denmark

Lorenzo Pugliese

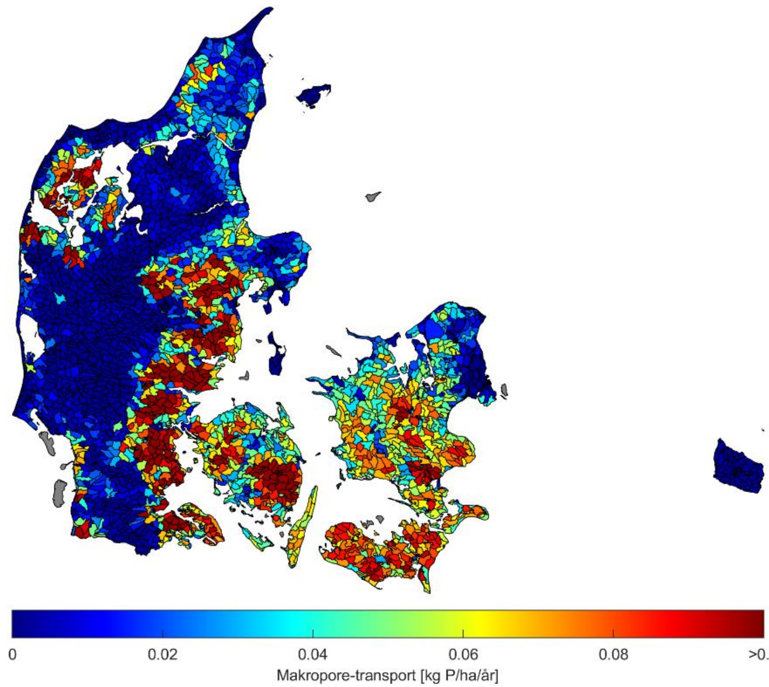
Goswin Johann Heckrath

P losses in DK



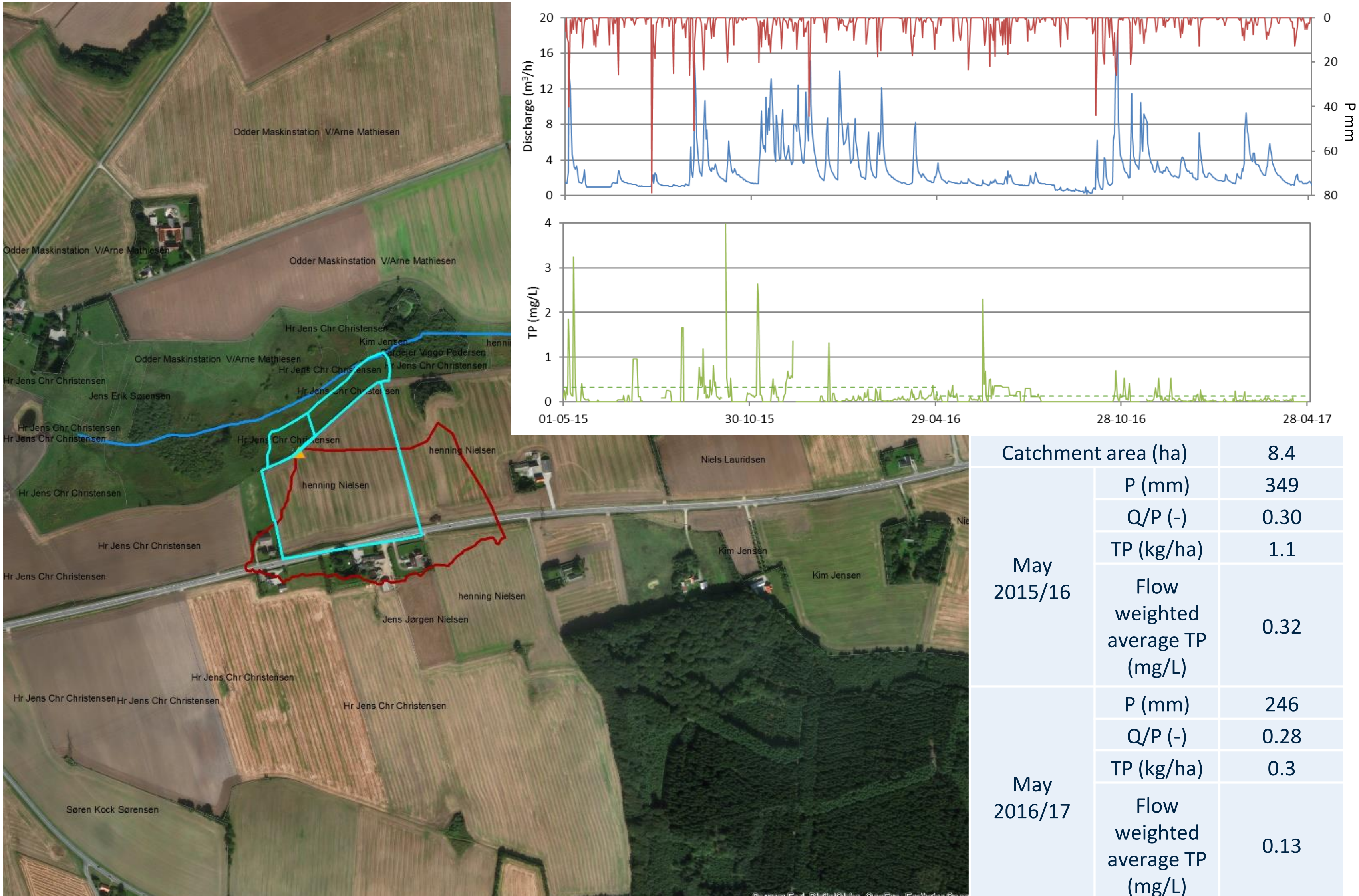


Riemann et al. (2016)



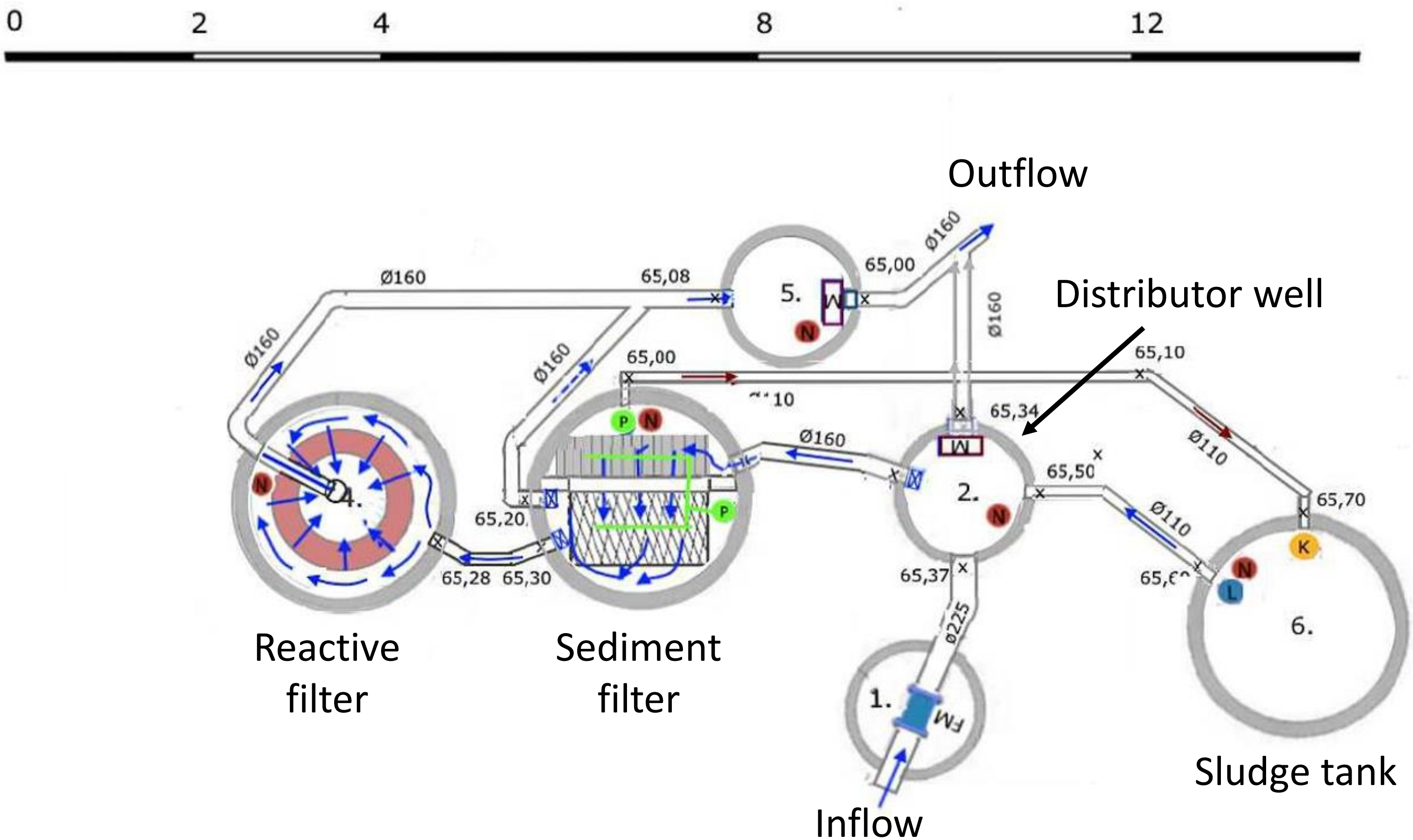
Andersen and Heckrath (2020)

Catchment area



Catchment area (ha)		8.4
May 2015/16	P (mm)	349
	Q/P (-)	0.30
	TP (kg/ha)	1.1
	Flow weighted average TP (mg/L)	0.32
May 2016/17	P (mm)	246
	Q/P (-)	0.28
	TP (kg/ha)	0.3
	Flow weighted average TP (mg/L)	0.13

System Design



Sediment filter

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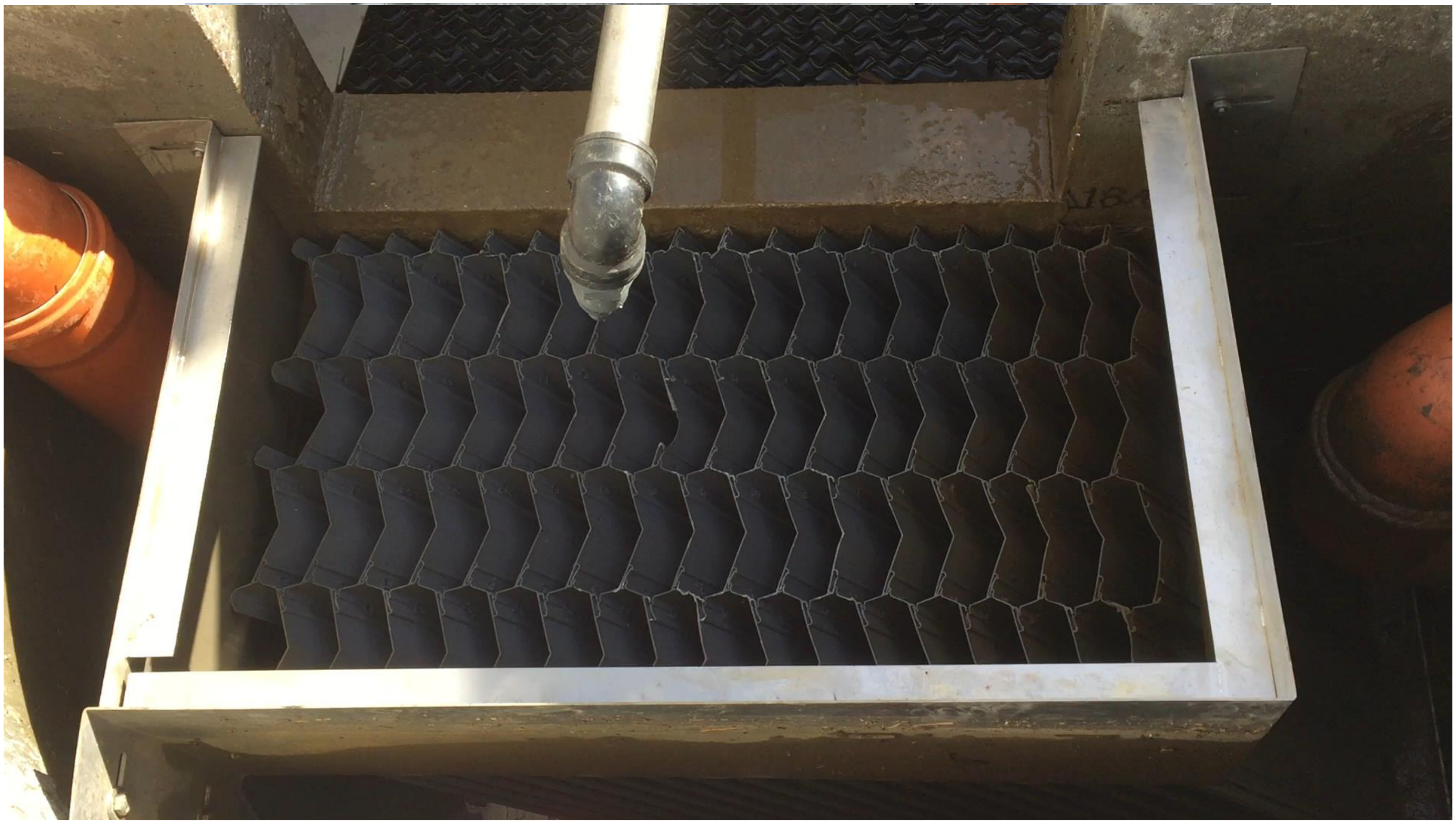

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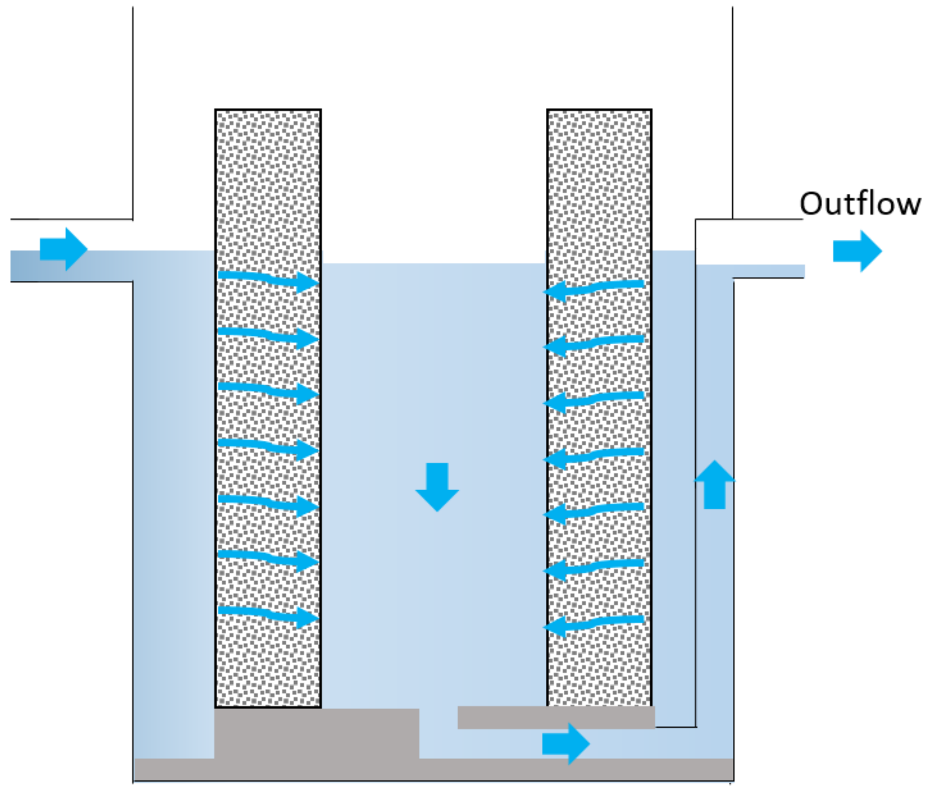
Reactive filter



Monitoring programme

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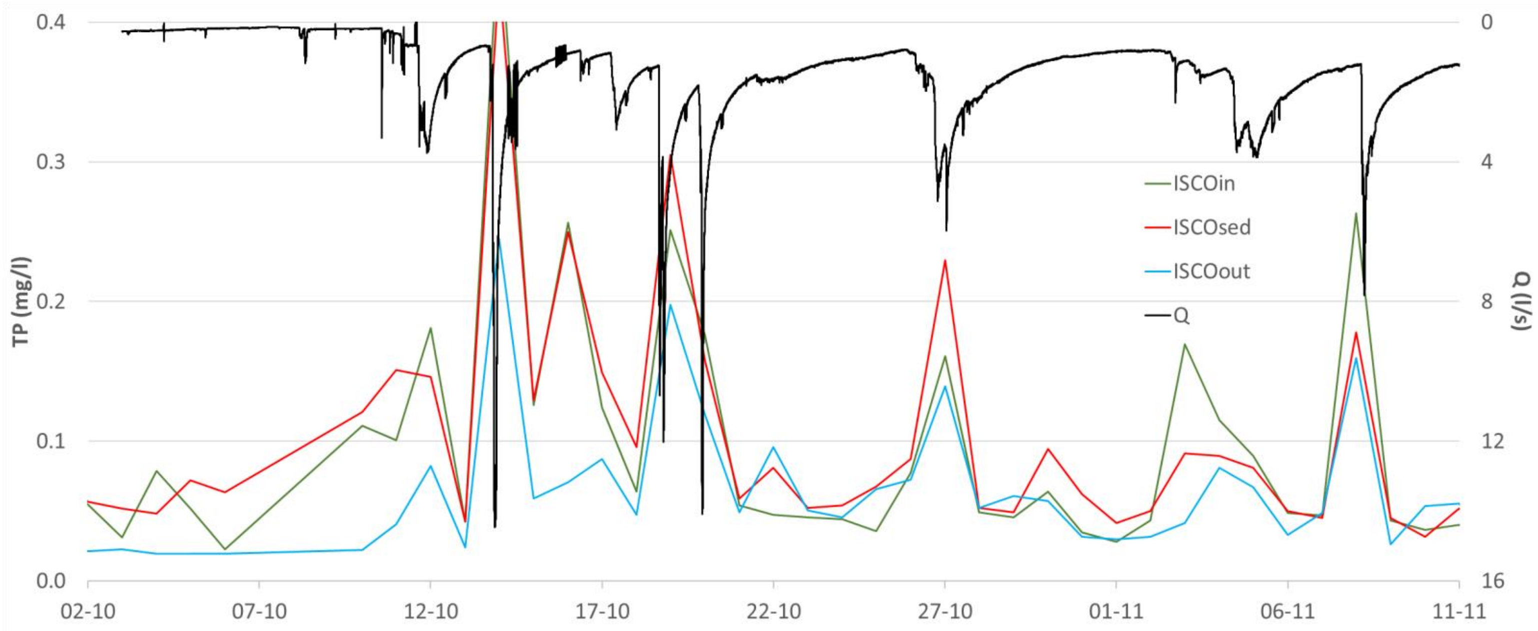
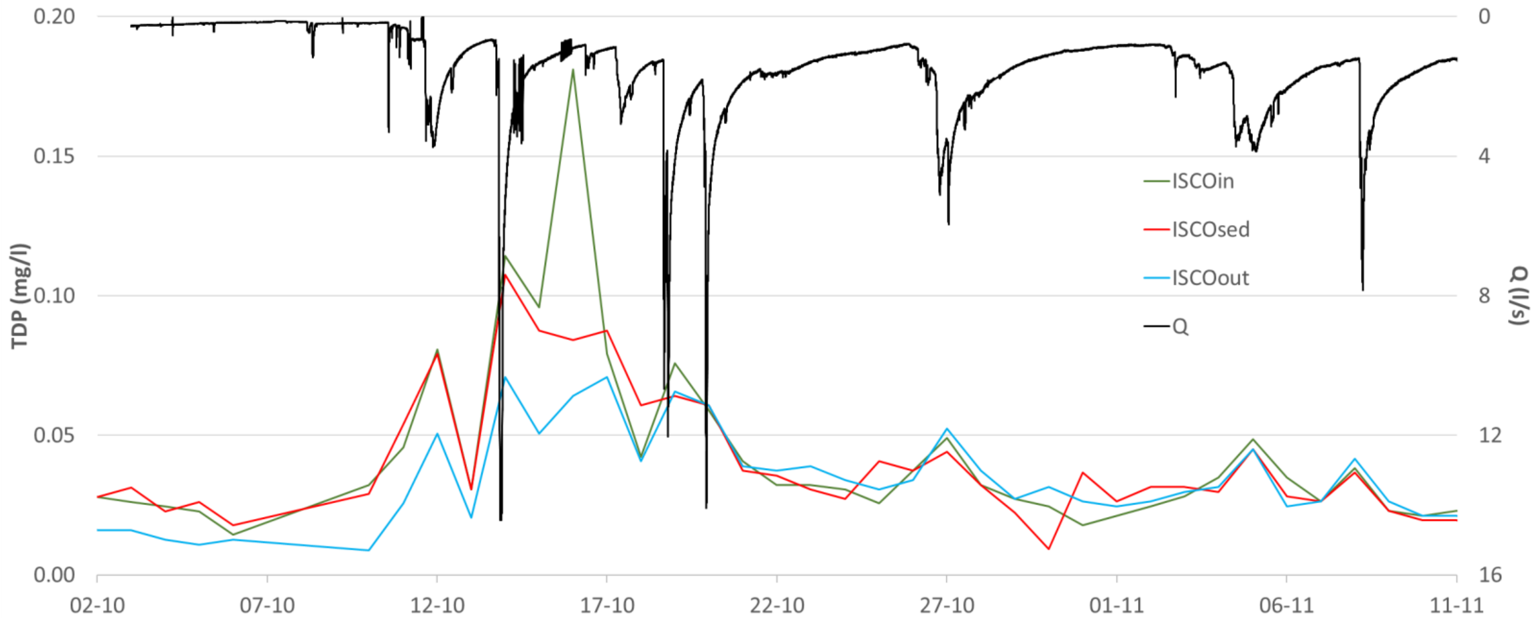
Results – Total phosphorus



Results – Dissolved reactive phosphorus



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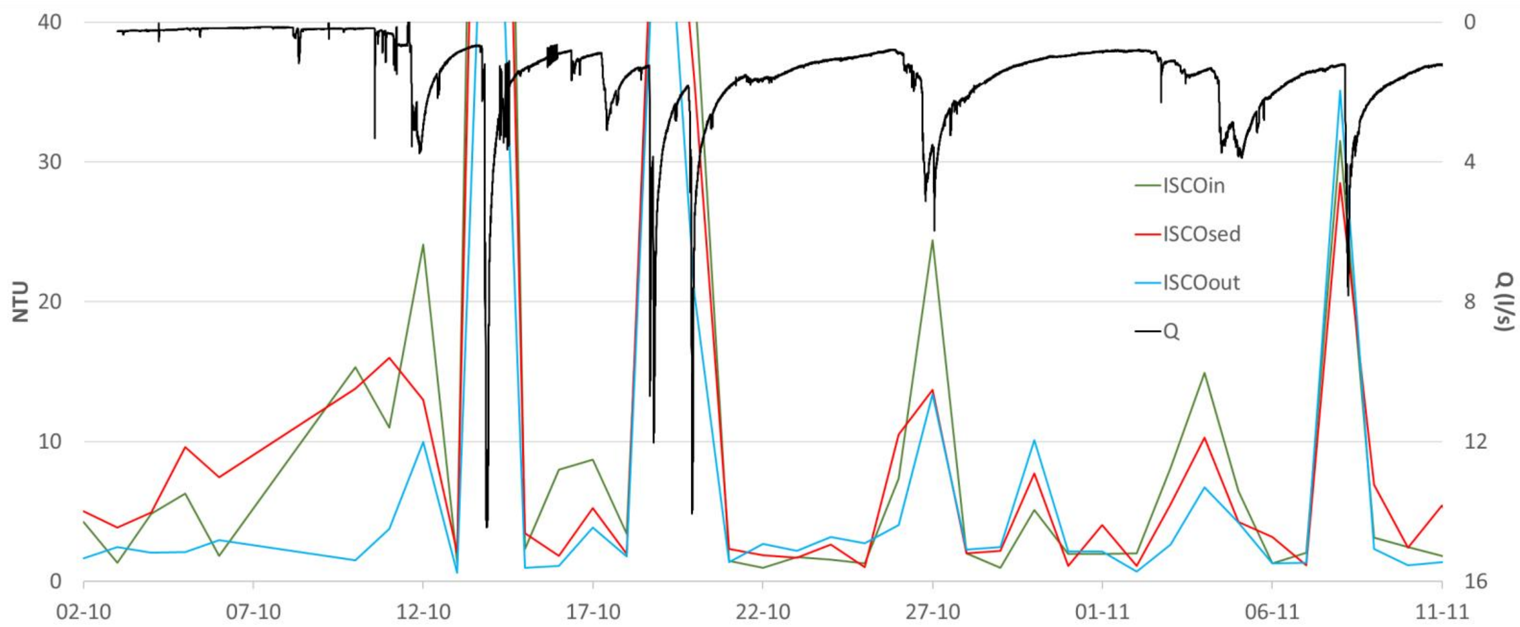
Results – Turbidity



Results

	Q (m^3)	Average removal (%)					
		ISCOin-ISCOout			ISCOsed-ISCOout		
		TP	TDP	Turb	TP	TDP	Turb
Until 18 oct	1413	51	39	44	59	40	53
After 18 oct	3538	1	-6	-8	15	-13	5
feb-20	6346	19	-1	13	18	-5	17

Future perspectives

Challanges

- ***Sediment retention***

- *Replacement of reactive filter material*

Possible improvements

- Alternative physical removal of sediments (?)
- Flocculation with aluminium and iron

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Q & A

Lorenzo.Pugliese@agro.au.dk

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Reducing phosphorus (P) losses from drained agricultural fields with iron coated sand (ICS) filters

Hui Xu, Stany Vandermoere, Stefaan De Neve
Department of Environment
Ghent University

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Why is it important?

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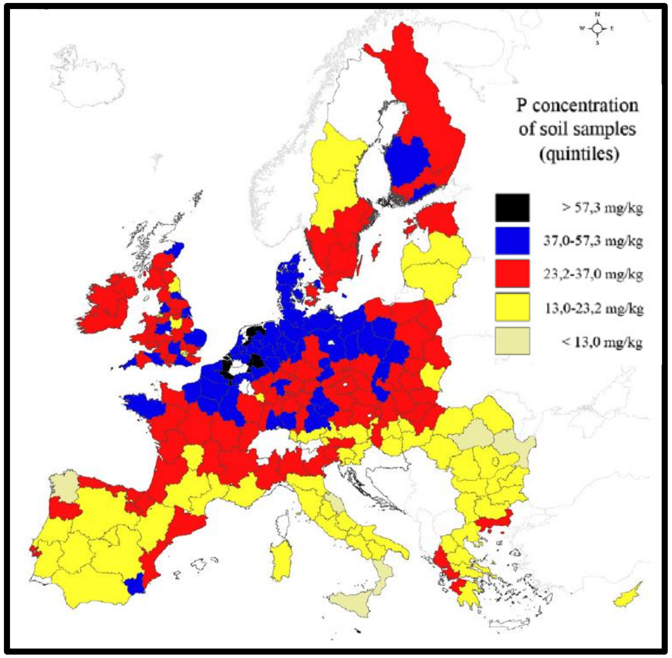
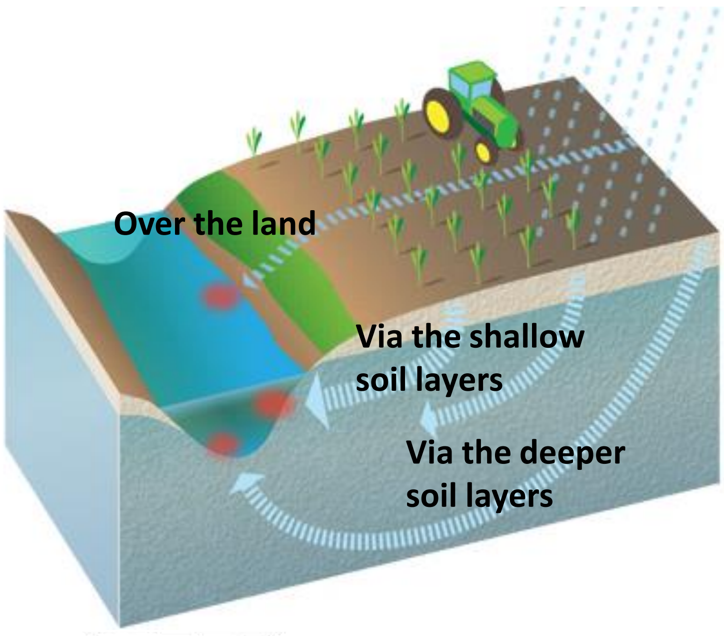
In Northwest Europe, agricultural P losses

→ eutrophication problems in surface water

High to very high soil P test values



17—40 % is drained in NW Europe



What do farmers need?

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- Reduce P loads as much as possible

  (< 0.1 ppm, Water Framework Directive)
- For individual drainage pipe with water flow of 6-8 m^3 per day
- Process discontinuous flows
- Low cost and easy to install

Phosphorus Filter Development

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- Phosphorus sorbing materials (PSM) & Principle
- Lab-scale evaluation
- Field-scale evaluation
- Development of prototype
- Performance of prototype

PSM: Phosphorus Sorbing Materials

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Iron coated sand (ICS)

By-product from drinking-water industry

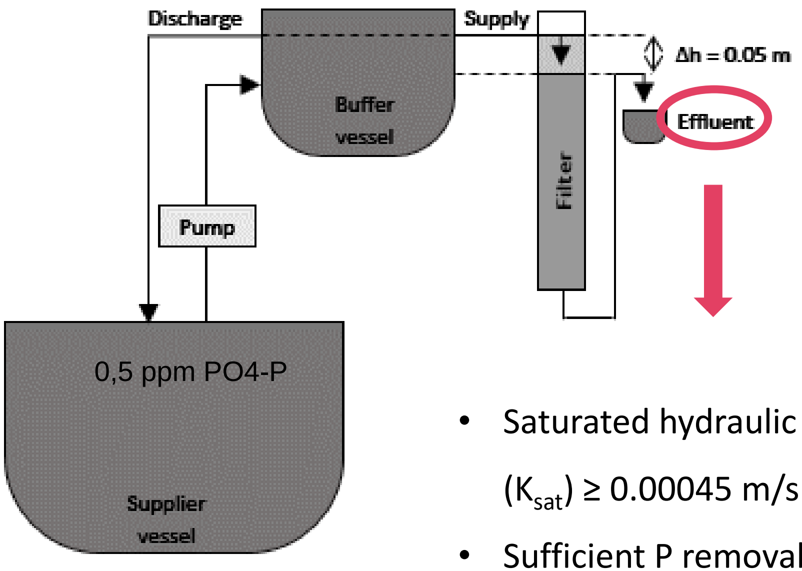
Ball-milled and acid pretreated glauconite

Abundantly available natural mineral

Vandermoere S., Ralaizafisoloarivony N., Van Ranst E., De Neve S. (2018). Reducing phosphorus (P) losses from drained agricultural fields with iron coated sand (- glauconite) filters. Water Research, 141, 329–339. https://doi.org/10.1016/j.watres.2018.05.022

Principle: P is removed from water by absorbing into iron coated sand (ICS)

Prepare and test filters at lab scale



- Saturated hydraulic conductivity (K_{sat}) ≥ 0.00045 m/s
- Sufficient P removal

Vandermoere S., Ralaizafisoloarivony N., Van Ranst E., De Neve S. (2018). Reducing phosphorus (P) losses from drained agricultural fields with iron coated sand (- glauconite) filters. Water Research, 141, 329–339. https://doi.org/10.1016/j.watres.2018.05.022

At field scale

Three experimental sites

Zedelgem
-three individual drains
-max water flow 8 m^3/day

Simple bucket filter

flow

tlet

Prototype development

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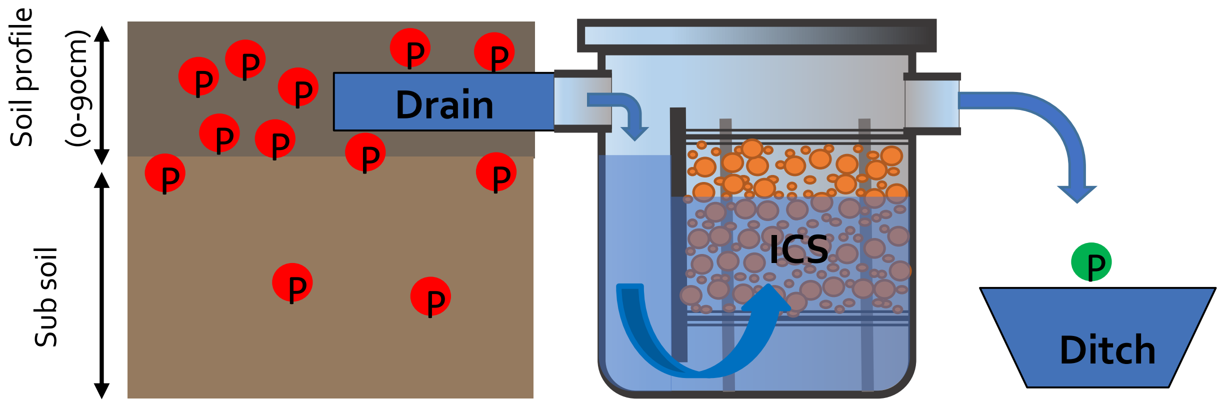

Key features:

upward-oriented outlet

mesh netting at bottom & top

Prototype performance

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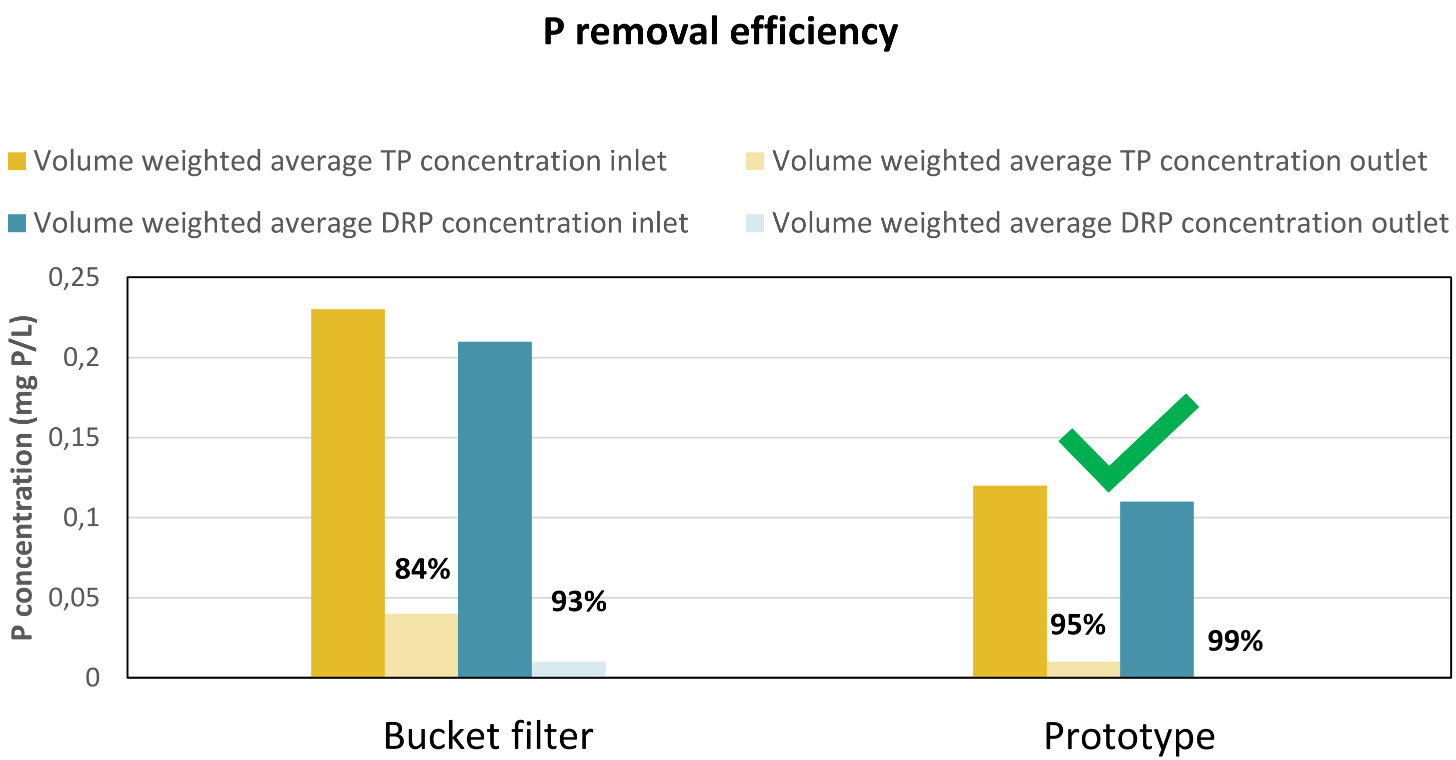
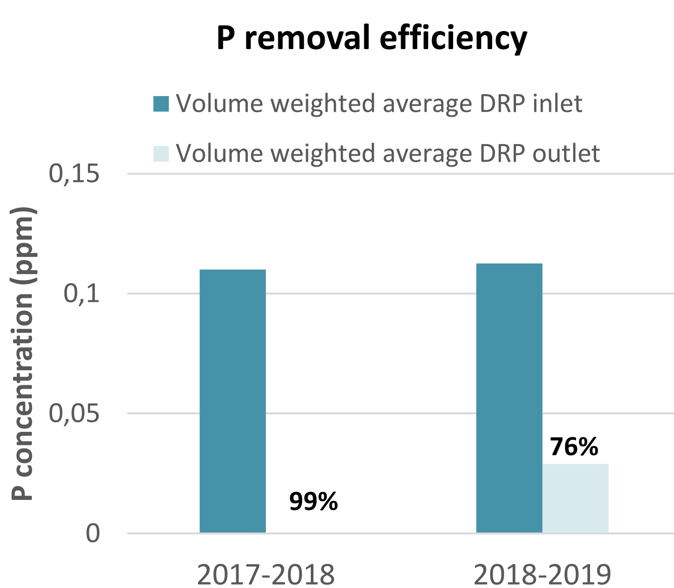


Water flow: **0.04-4.3 m³/day** **0.04-3.6 m³/day**

TP: total phosphorus
DRP: dissolved reactive phosphorus

Prototype performance

-Seasonal variation



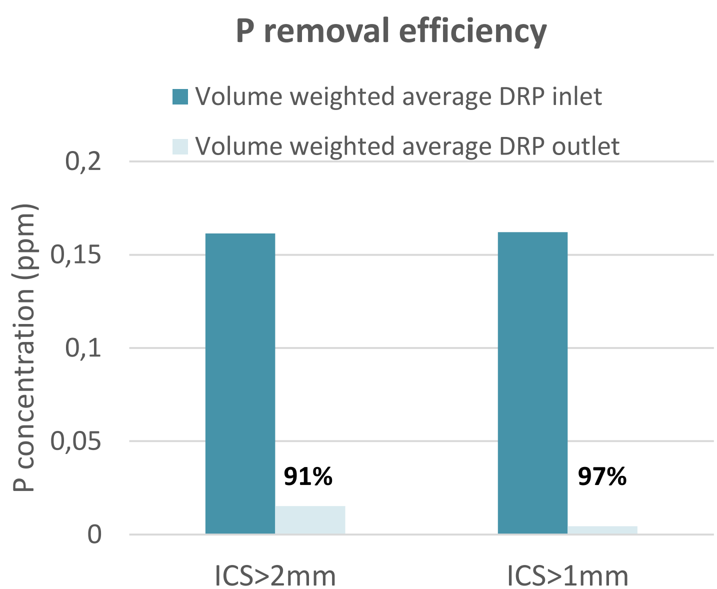
Water flow: **0.04-3.6 m³/day** **0.1-7.2 m³/day**

2017-2018

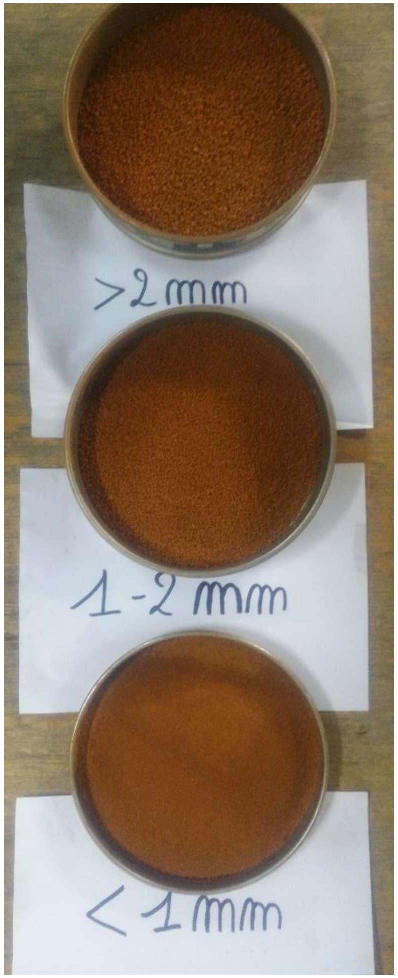
2018-2019

Prototype performance

-Effect of particle size



Water flow: **0.1-2.2 m3/day** **0.4-3.1 m3/day**



Evaluation of the filter

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- Only applicable for individual drains
- Mostly remove dissolved reactive P

+ Low-tech solution: easy installation and operation
+ High P removal efficiency
+ Low cost of filter materials: ICS is industrial by-product
+ Causes no other contaminations
+ No impact on accessability and landscape

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Q & A

Next seminars

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- Friday 25/9 – 10h -11h30:

P recovery and P removal modelling

- Friday 2/10 – 10h – 11h30:

Filter technologies for N removal from agricultural waters

https://northsearegion.eu/nuredrain/

Acknowledgements

Vlakwa
VLAAMS KENNISCENTRUM WATER
FLANDERS KNOWLEDGE CENTER WATER
empowered by vito

vito

OOWV

KU LEUVEN

inagro

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De Watergroep
WATER. VANDAAG EN MORGEN.

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DEPARTMENT OF AGROECOLOGY

UNIVERSITY OF COPENHAGEN

Universität Rostock
Traditio et Innovatio

PCS
proefcentrum voor sierteelt

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Provincie Antwerpen

Provincie Oost-Vlaanderen
Voor ieder van ons

west-vlaanderen
de gedreven provincie