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NuReDrain

► Phosphorus filtration in drained arable fields

results from 2nd season

High P losses in drained fields

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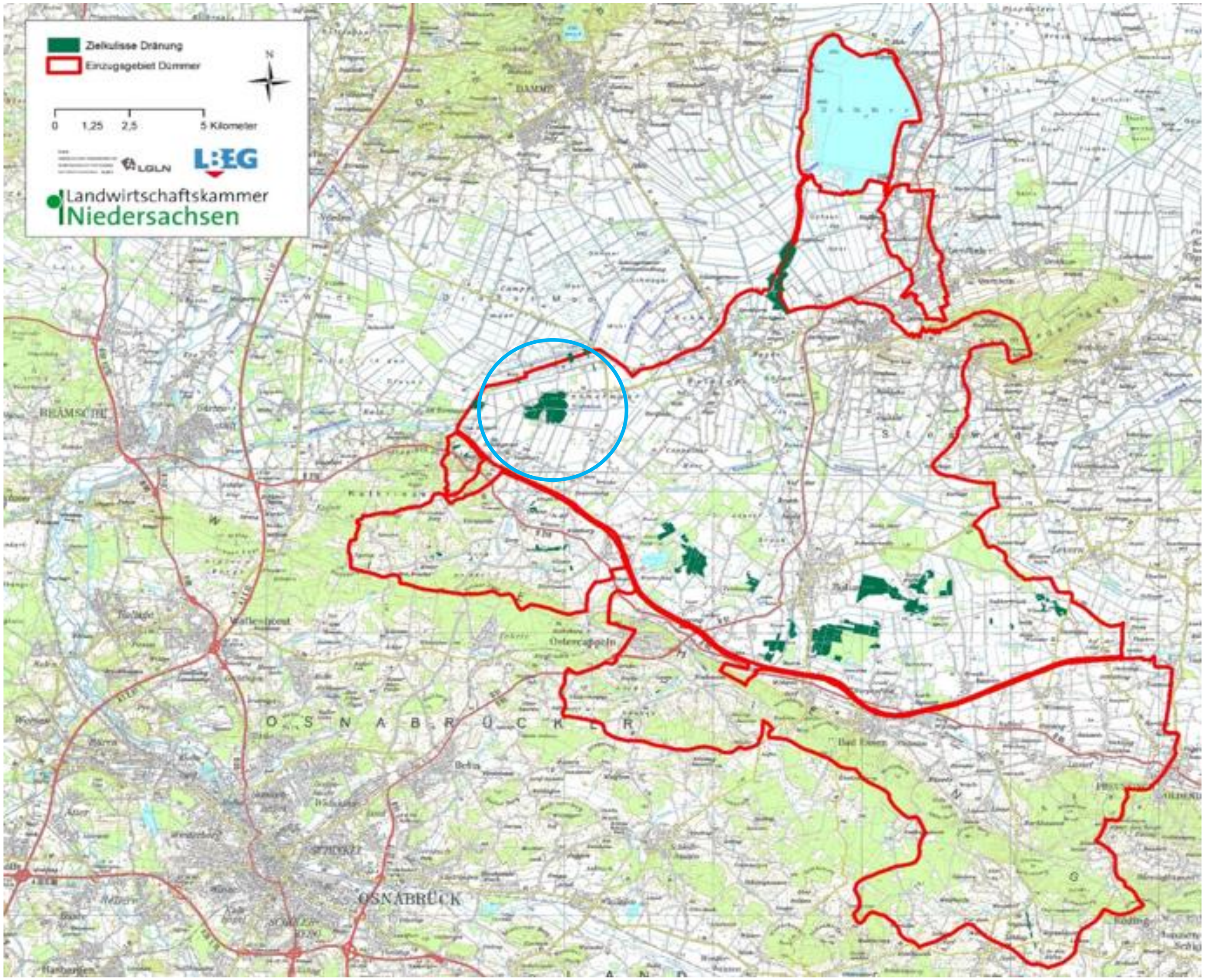

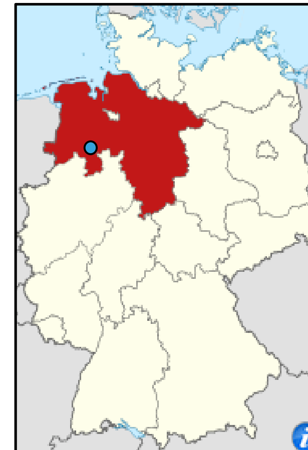
source: Wikipedia

"Hot Spots"

↑ P concentration

↑ drainage flow

Lowland and peat soils

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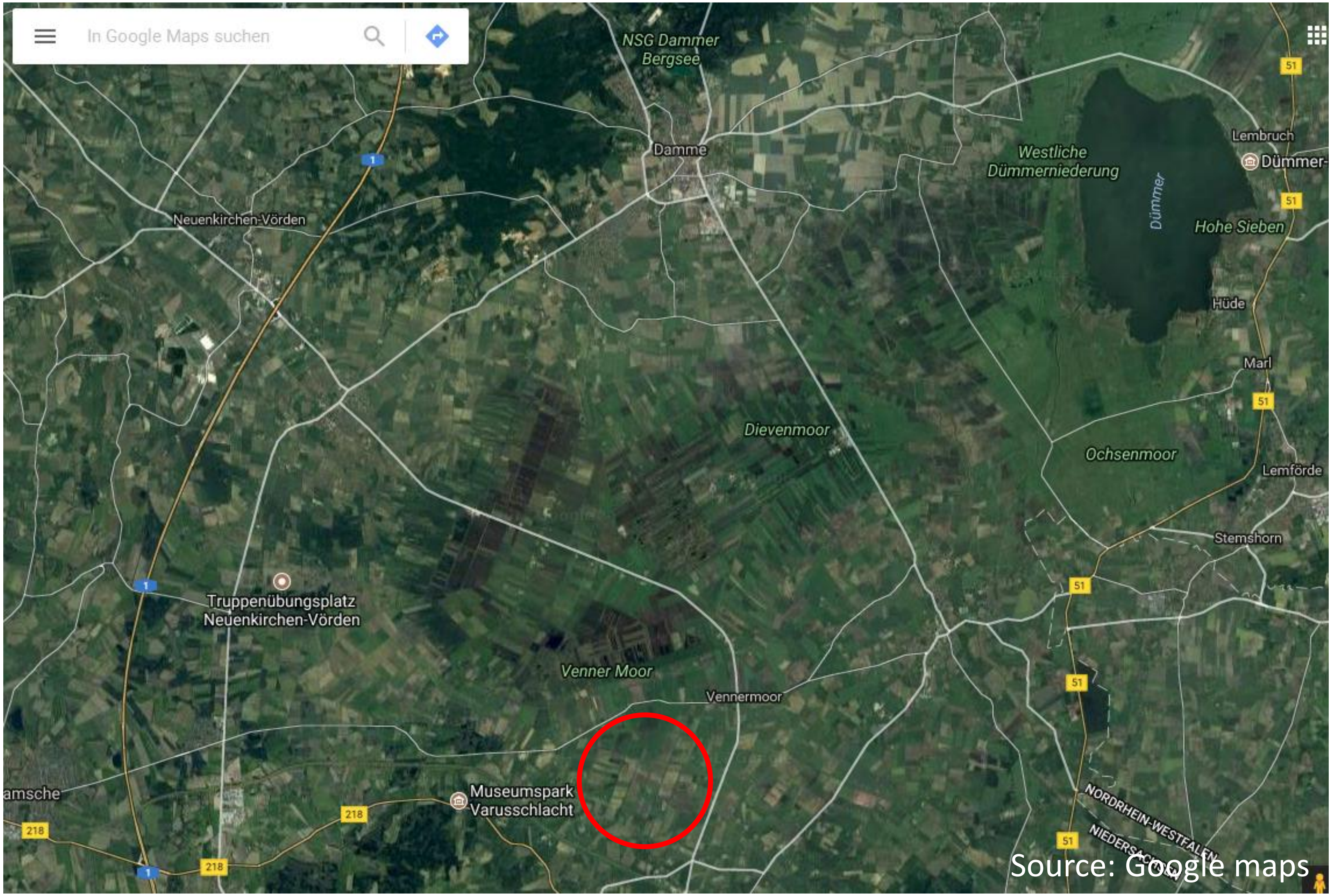


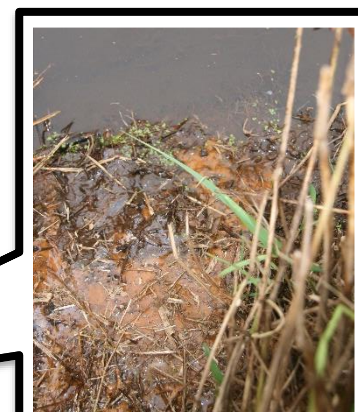
Test site specification

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

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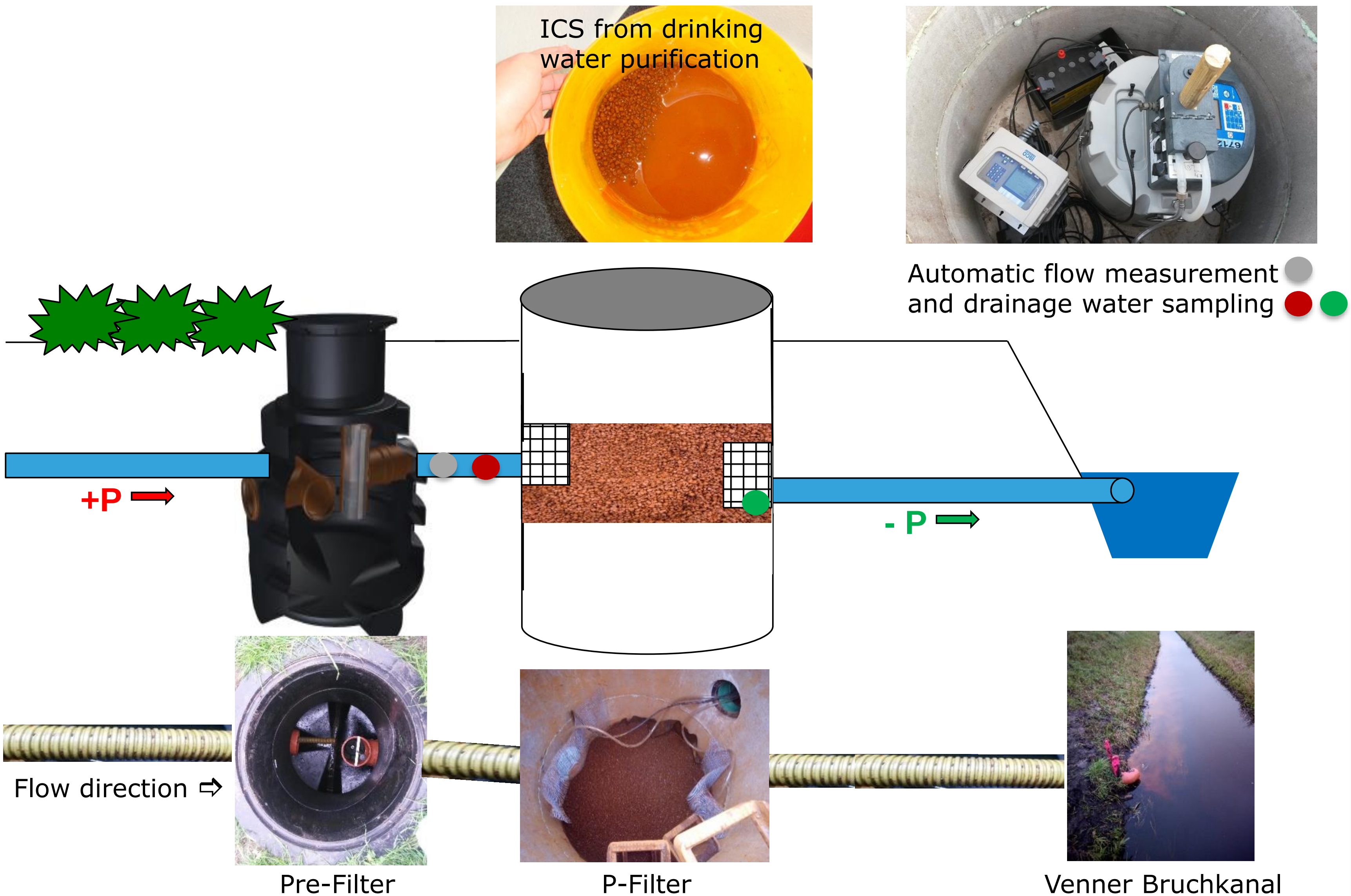

Preliminary results...

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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	$\boxed{3,19}$	0,02

✘... revision sampling mode & position

Preliminary results...

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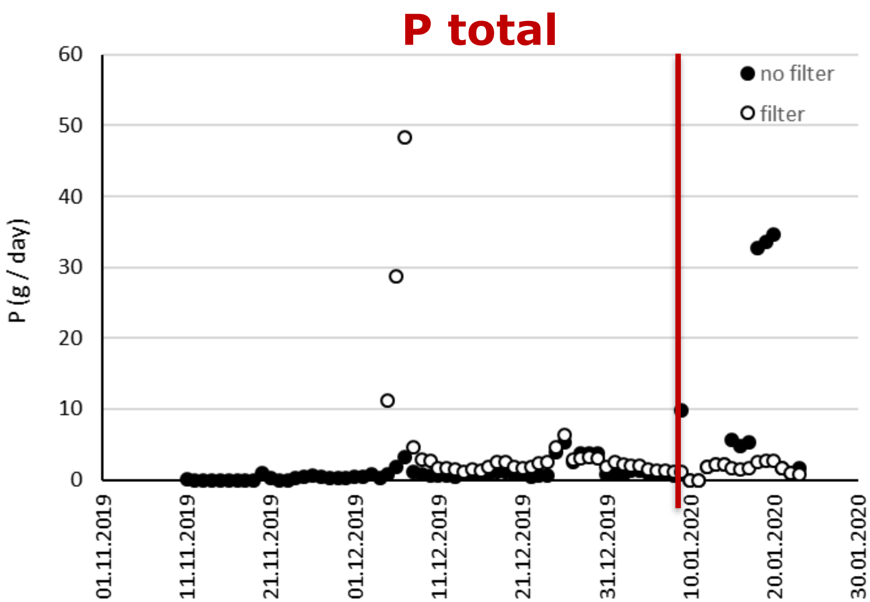
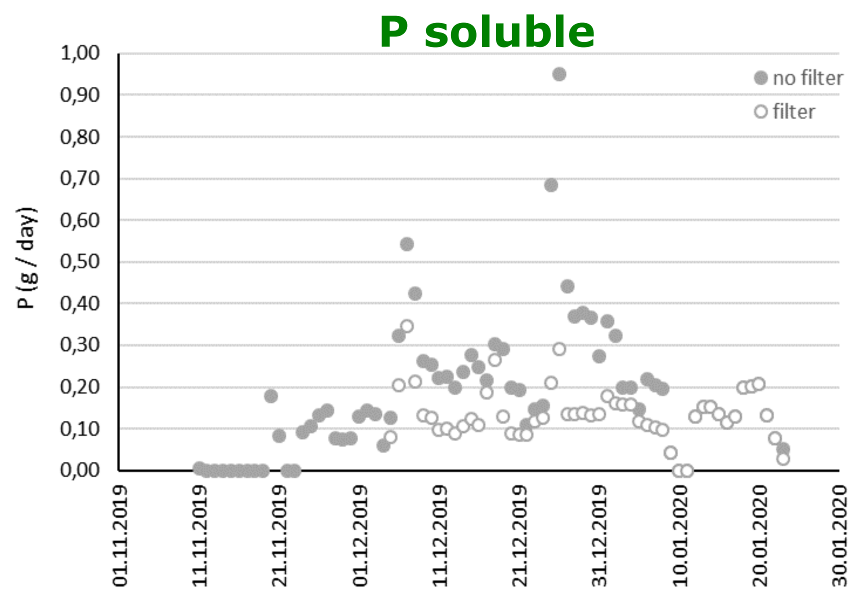
Flow-balanced nutrient discharge





- $P_{tot.}$ 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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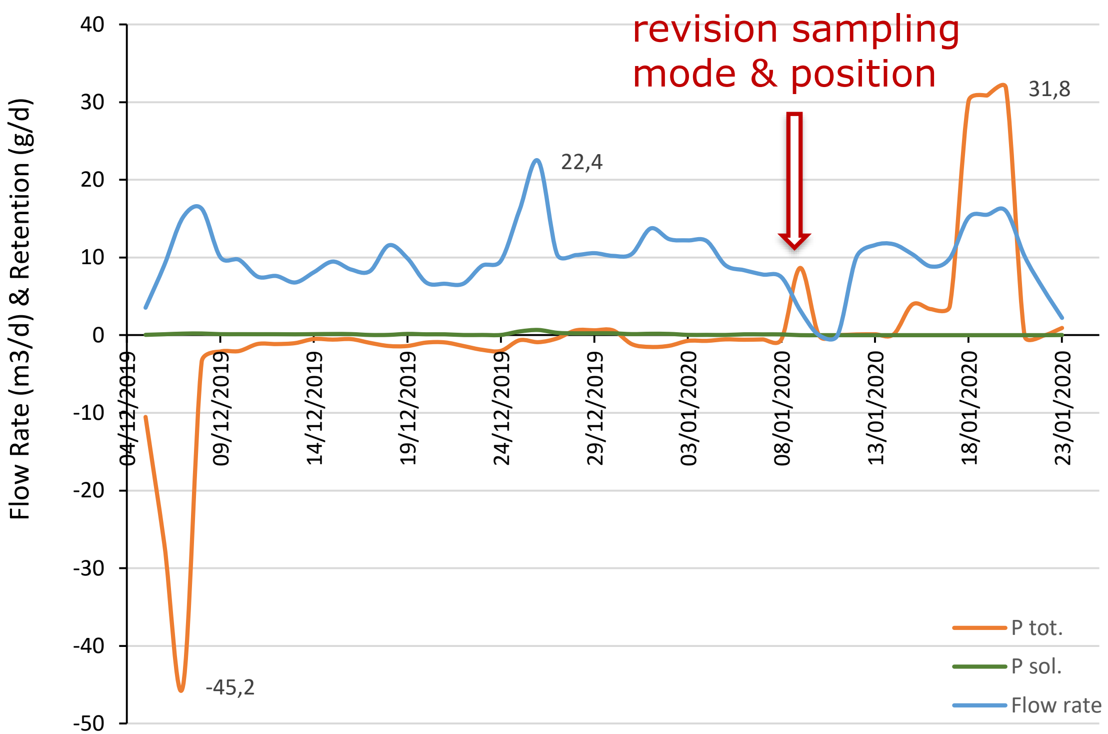
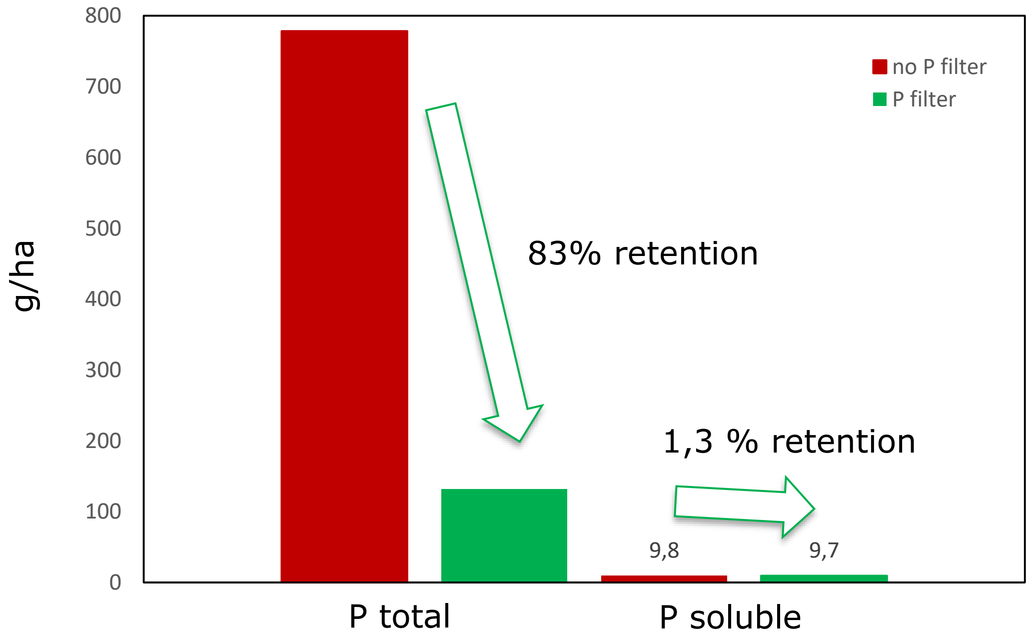
Flow rate, retention of P total and P soluble



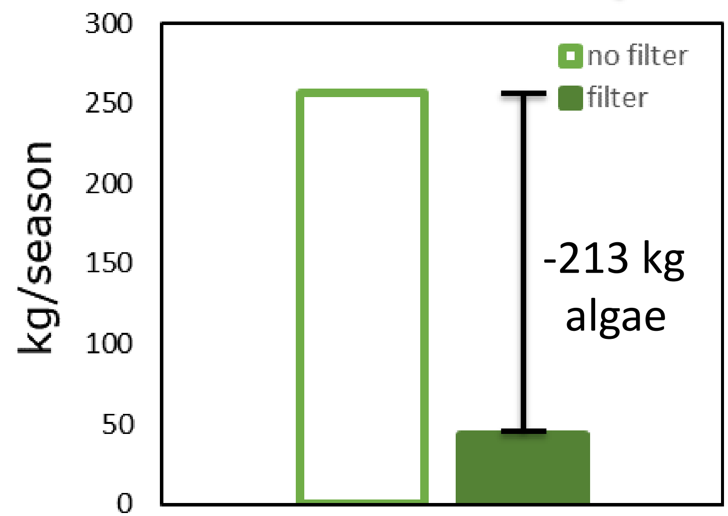
- ↑ fluctuation in flow rate
- (no) effect of flow rate on retention of $P_{sol.}$
- no clear statement about effect of flow rate on $P_{tot.}$ retention (hysteresis effect)

Preliminary results …

Extrapolated P loss/season without & with P-filter



Assumption:
1 g P → 330 g phytoplankton



Cross-check with literature

… *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

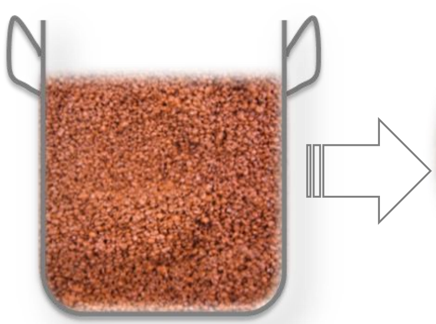
… ICS filter efficiency of >80 % in investigations of other project partners …
→ can be confirmed so far

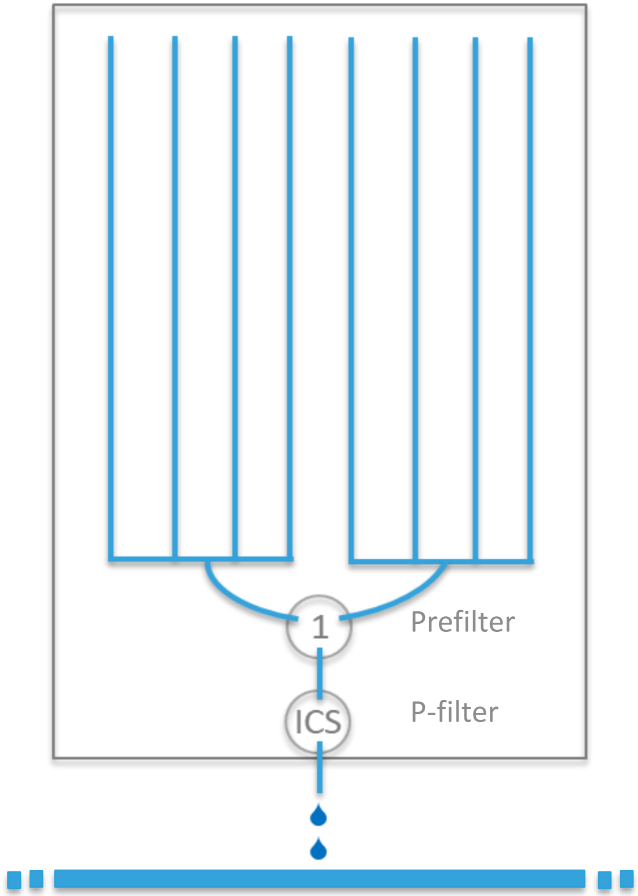
Transfer into practice

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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