How does legacy P impact losses to surface waters?

Deltares

Victoria Barcala*, Joachim Rozemeijer, Leonard Osté, Bas Van der Grift, Laurens Gerner, Thilo Behrends

Perspectives for reducing “legacy phosphorus” in agricultural soils

enabling delta life

*victoria.barcalapaolillo@deltares.nl

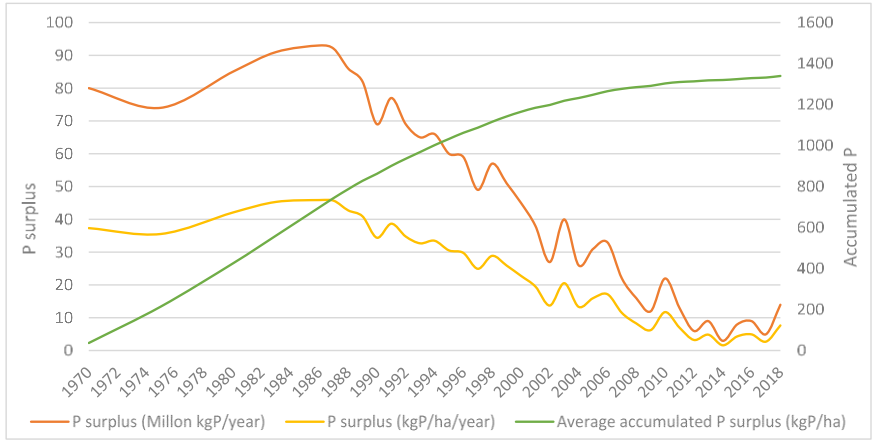
P-TRAP (EU Horizon 2020 Project **813438**)

Introduction

Problem description

Despite in recent years manure/fertilizer application has significantly decreased, and the P surplus is negative, there are still high nutrient values in agricultural catchments that cause eutrophication

The legacy P accumulated in previous decades is one of the causes for the high P values in agricultural areas



Drainage season	P surplus (kg/ha)
2016-2017	-4
2017-2018	2
2018-2019	4
2019-2020	16
2020-2021	-22
Average	-1

Objectives

1. **How is the P transported from the soil downstream?**

(sediment erosion & adsorption in iron-rich soil layers)

Methods

Site description

- Drained lowland farm
- Intensive agriculture: cattle and rotating crops
- Manure is applied as fertilizer
- Soil: sandy, non-calcareous

The farm drains to a main ditch with a calibrated V-notch in the end

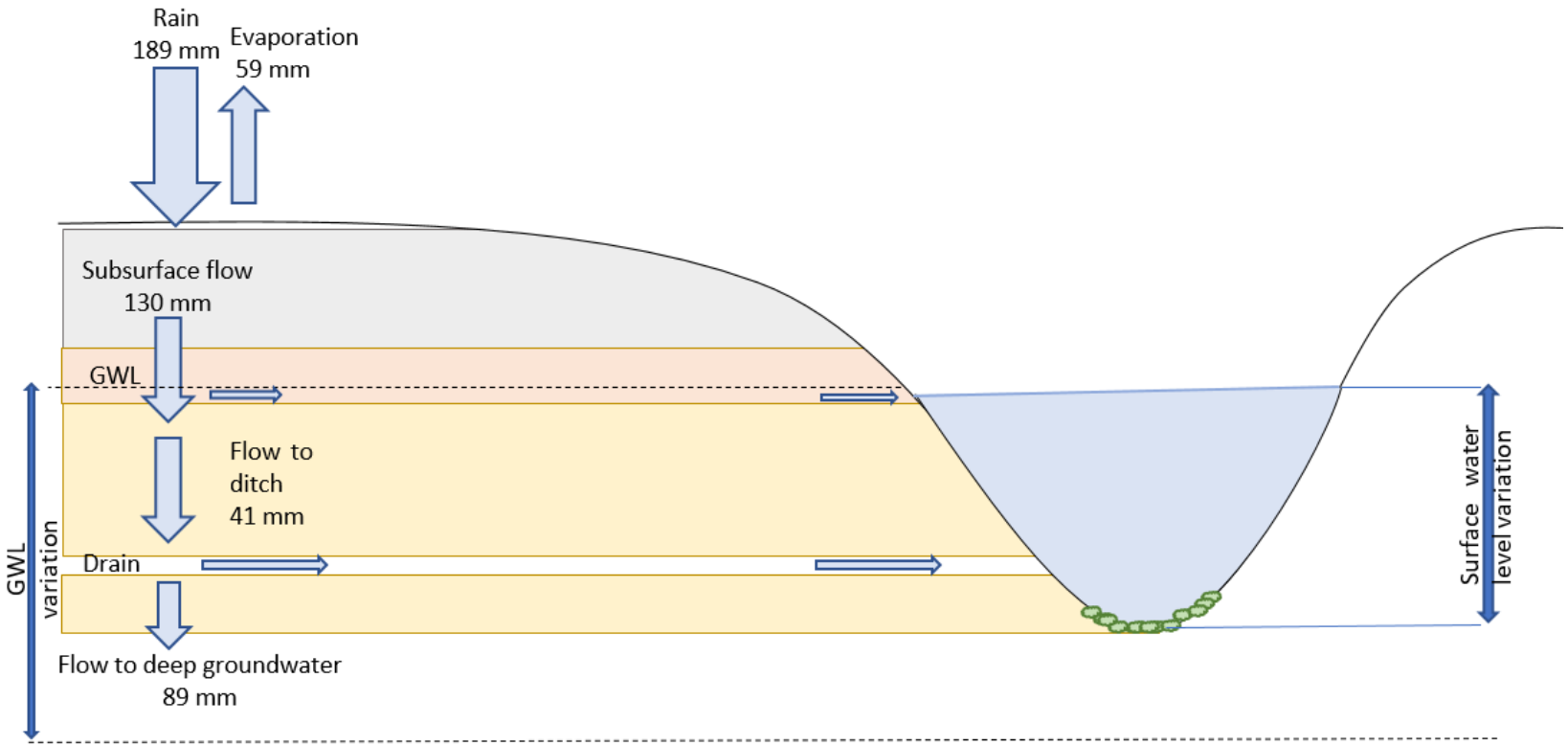
Data collected from April 2018 to 18 April 2019


Farm in Huppel, the Netherlands

A. High-frequency data: the water is pumped from before the V-notch to a monitoring station
B. Spatial distributed data: soil and ditch sediment samples, groundwater samples

Results

Water balance season 2018-2019



Transport mechanisms:

In the field:

- Infiltration and subsurface transport through soil and drains
- No overland flow
- Water transport to deep GW, field located over glacial valley

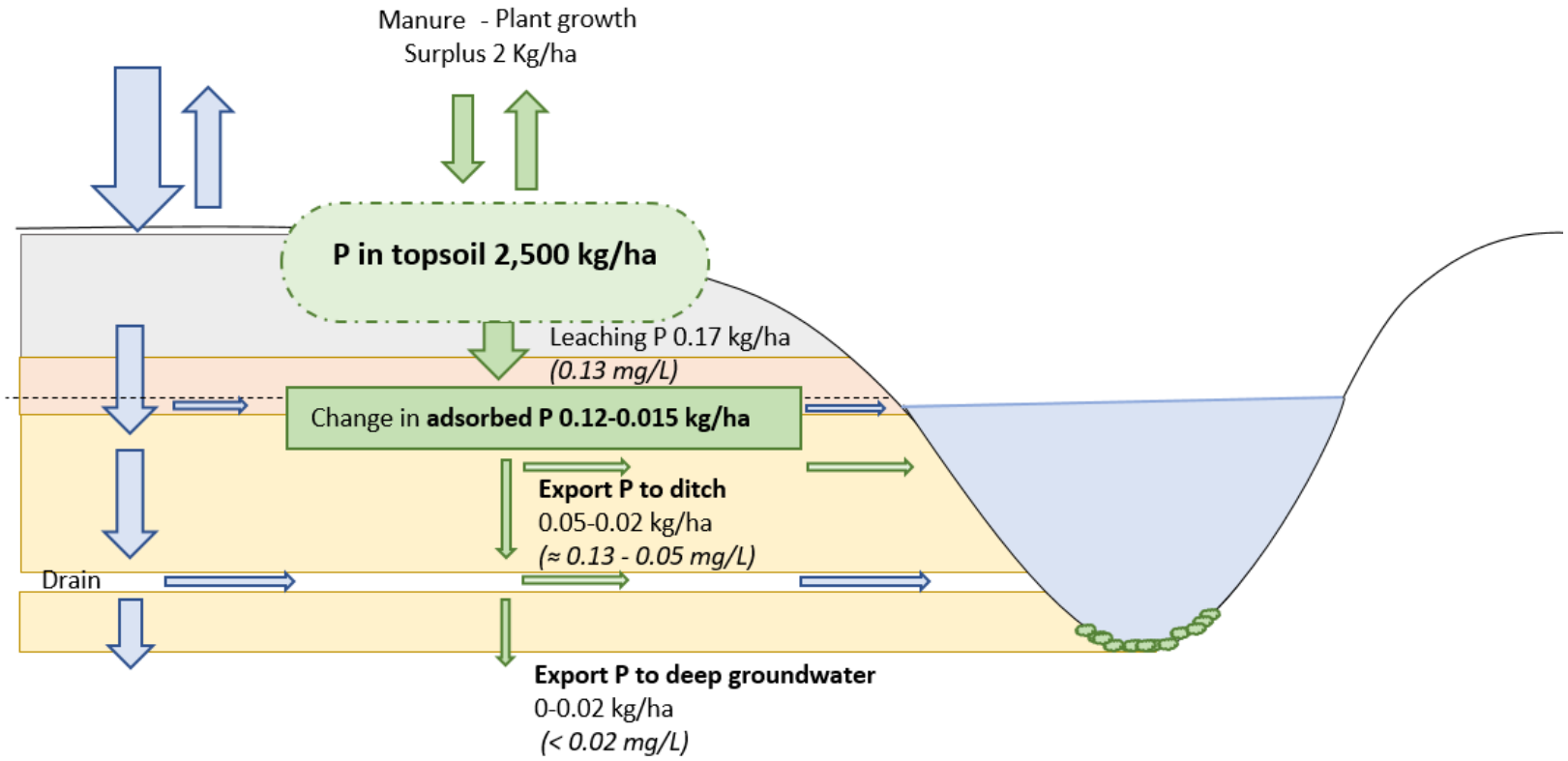
In the ditch:

- Rapid response to rain events, high hydraulic conductivity of the sandy soil
- Ditch dries when GWL decreases below 1,2 m

Water balance
Phosphorus balance
Topsoil PSD 0.26, TP 600 mg/Kg
Subsoil PSD 0.06, TP 165 mg/Kg
Subsoil PSD 0.03, TP 113 mg/Kg

Results

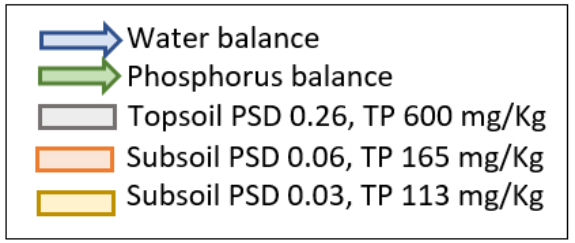
P balance and transport in the soil season 2018-2019



Transport mechanisms:

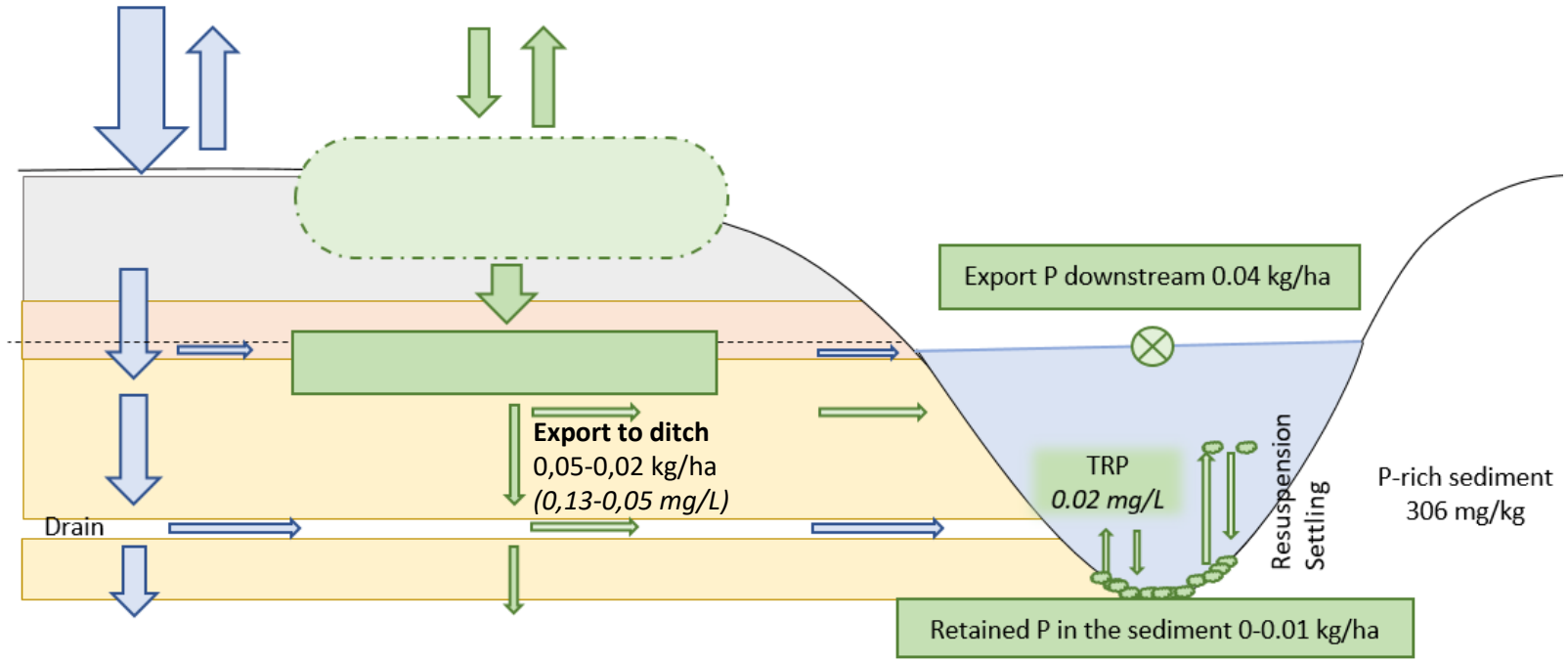
In the field:

- P surplus almost cero
- Top soil is the main source of P
- P leaches from topsoil
- Leaching P is retained by the subsoil P sorption capacity (higher Fe and Al)
- Low P values in groundwater



Results

P balance and transport in the ditch season 2018-2019



Transport mechanisms:

In the ditch:

- Authigenic particle formation, of iron oxides that adsorb or coprecipitate P
- PP settling and resuspension is the main transport mechanism
- Resuspension happens during rain events
- 78% of the P transported of of the catchment is PP
- 0,04 Kg/ha were transported in the 2018-2019 season

Water balance
Phosphorus balance
Topsoil PSD 0.26, TP 600 mg/Kg
Subsoil PSD 0.06, TP 165 mg/Kg
Subsoil PSD 0.03, TP 113 mg/Kg

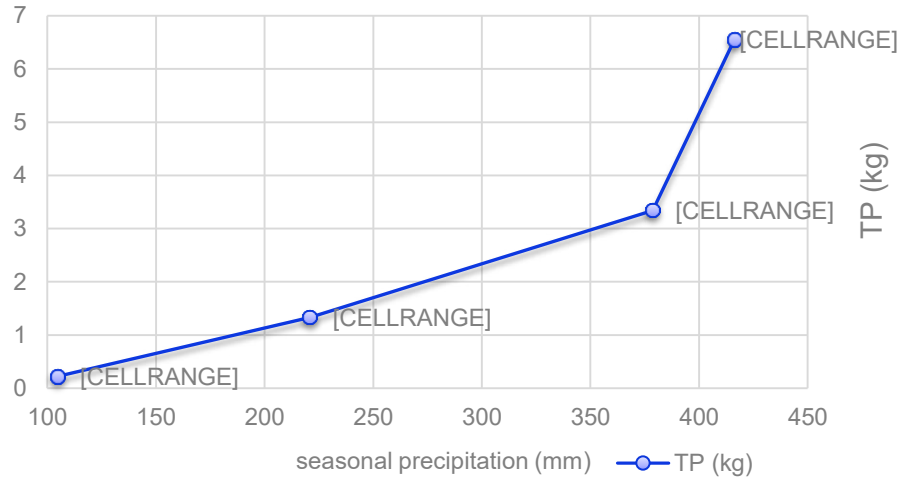
Conclusions & new data outlook

Legacy P stored in the topsoil

Iron rich subsoil retained leaching P

In the ditch P is transported as particulate P

Implementation of adjustable weirs: the farmer implemented in 2020-2021 two water retention measures. More P was transported per mm rain than before. Our preliminary results show that the groundwater level increased and was many times only 40 cm below the surface. This allowed higher P soil-water concentrations without going though the iron-rich soil layer. More P is attached in sediment particles, more P is transported with particles.



Thank you for your attention!

For more information about this research:

ENVIRONMENTAL RESEARCH
LETTERS

PAPER • OPEN ACCESS

Processes controlling the flux of legacy phosphorus to surface waters at the farm scale

Victoria Barcala[1], Joachim Rozemeijer[1], Leonard Osté[1], Bas Van der Grift[2], Laurens Gerner[3] and Thilo Behrends[4]

Published 23 December 2020 • © 2020 The Author(s). Published by IOP Publishing Ltd

Environmental Research Letters, Volume 16, Number 1

Citation Victoria Barcala *et al* 2021 *Environ. Res. Lett.* **16** 015003

Acknowledgements

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 813438.

enabling delta life

victoria.barcalapaolillo@deltares.nl