Building towards a conceptual model for phosphorus transport in lowland catchments

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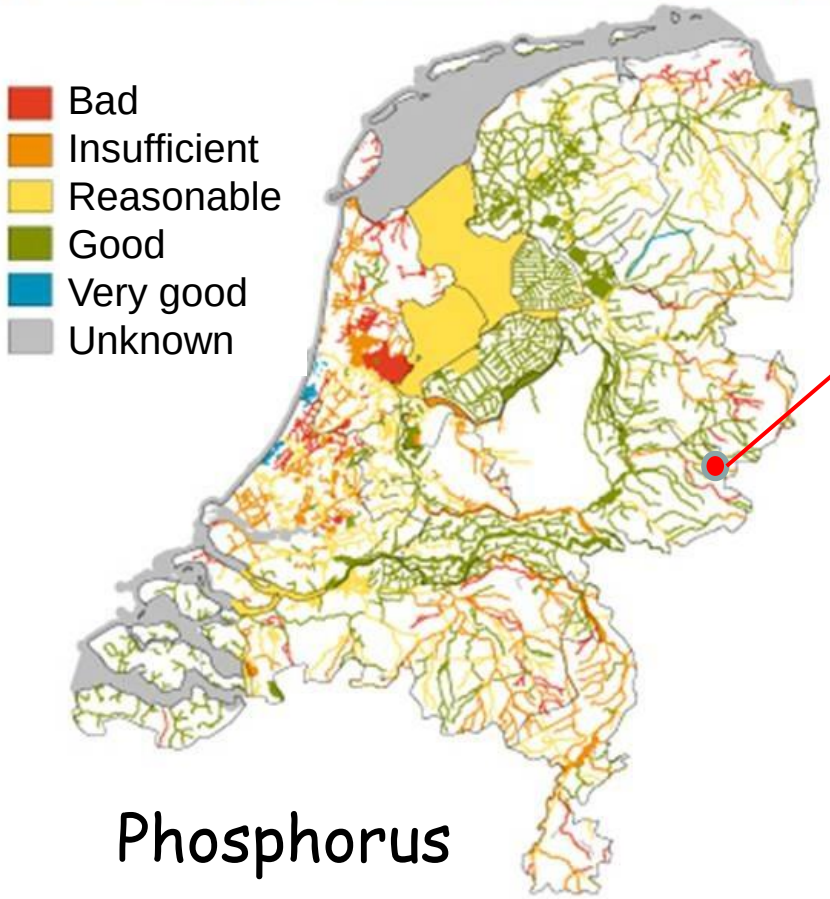
Netherlands water en phosphorus

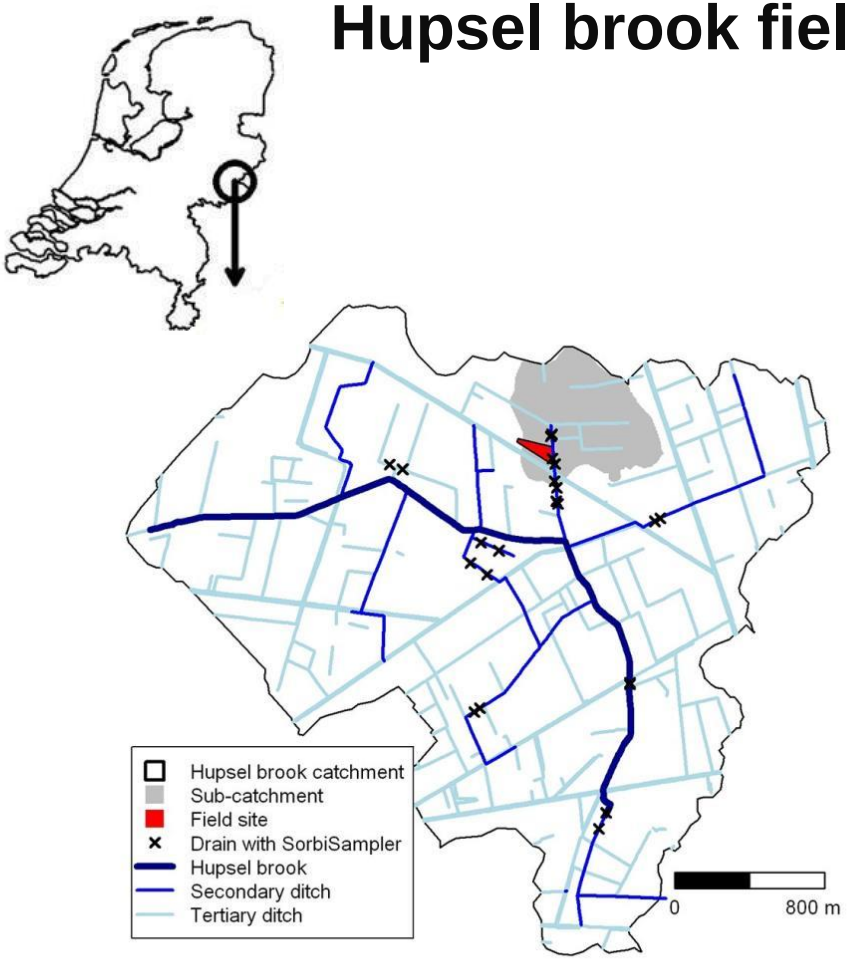
Assessment phosphorus concentration, Water Framework directive 2009

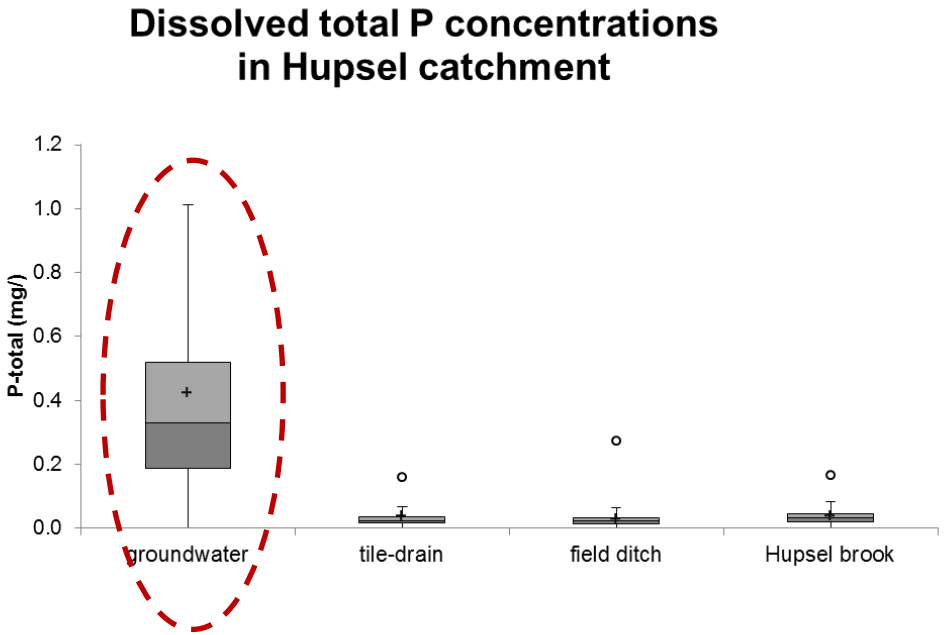


Phosphorus

//www.compendiumvoordeleefomgeving.nl/

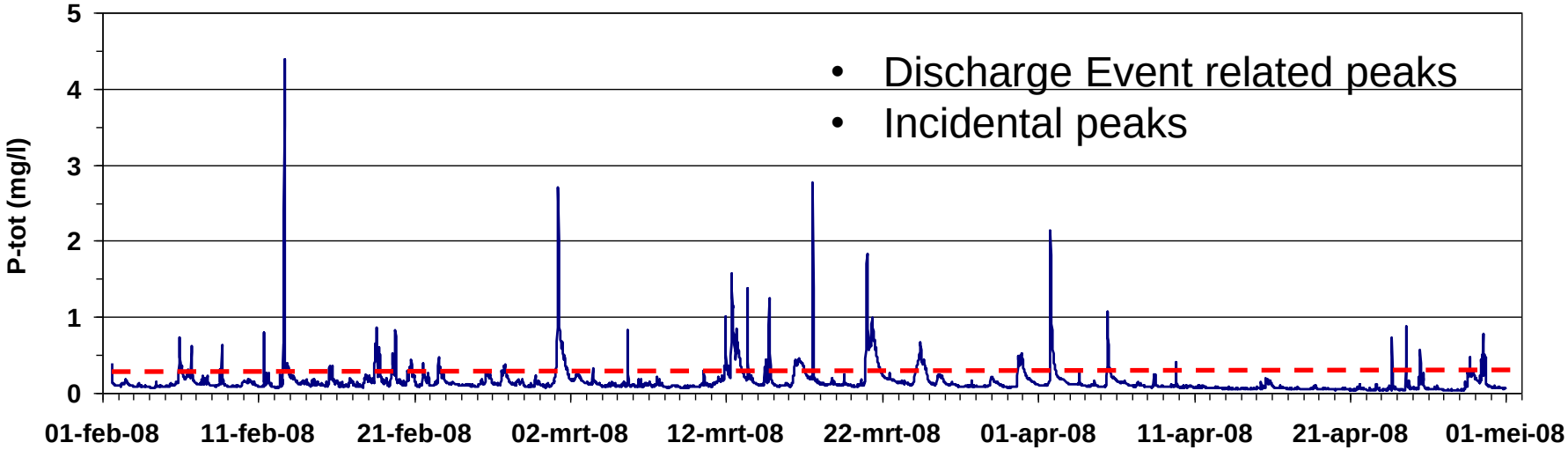
Hupsel brook field experiment



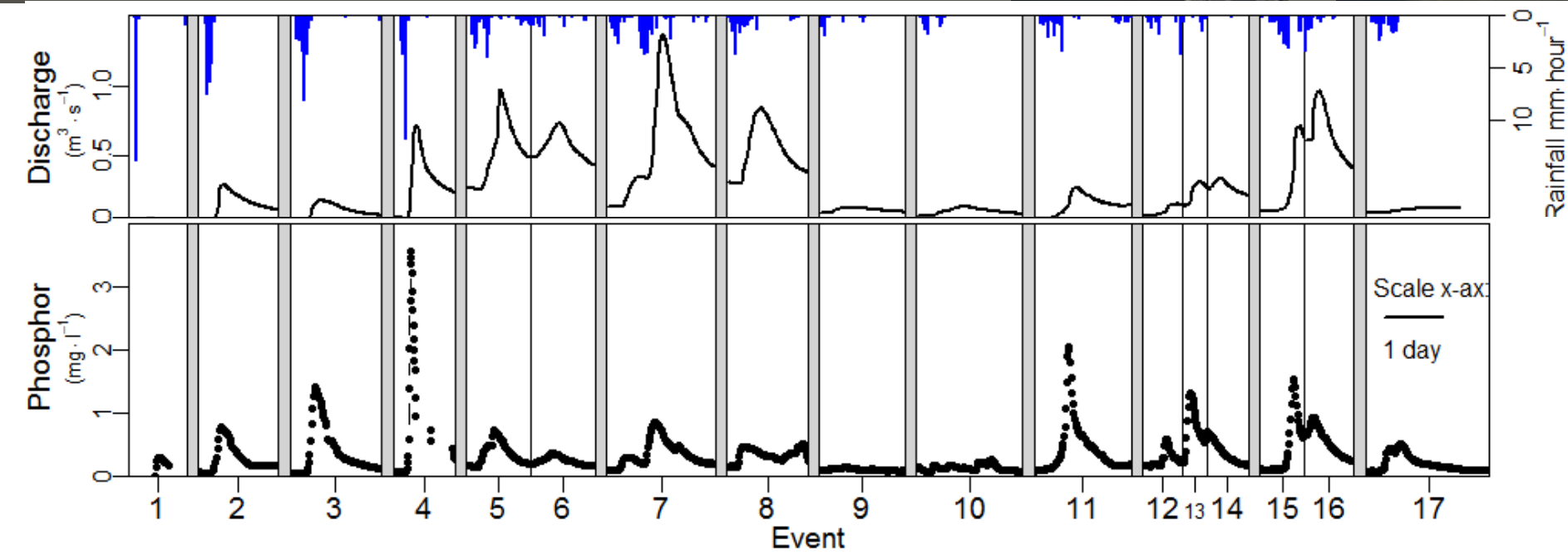


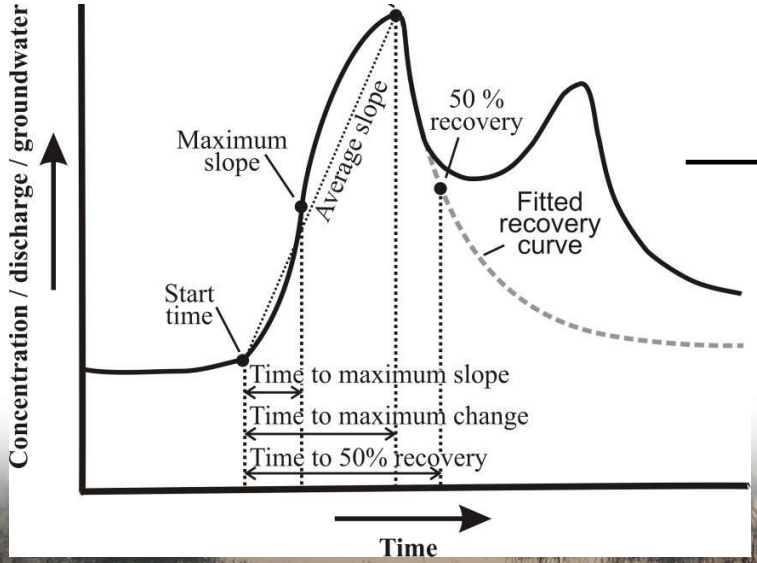
Van der Velde et al., 2010; Vadose Zone J.

Phosfax: Continuous total phosphorus



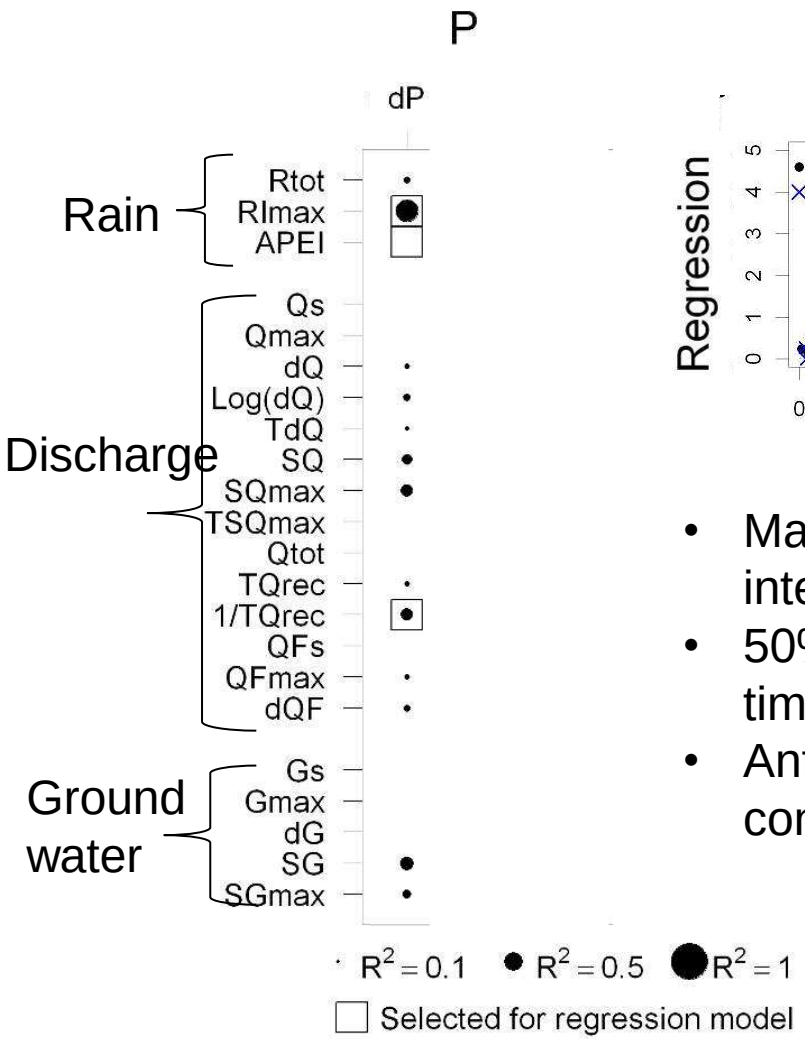
Discharge event respons



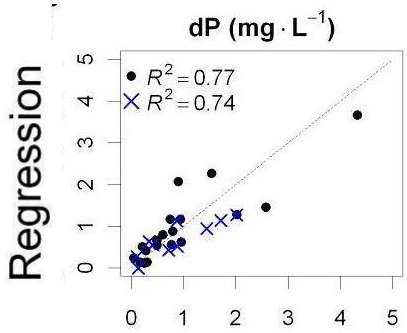


- **Maximum concentration**
- **Time to maximum concentration**
- **50% recovery time**

Regression



P-peak



- Max Rain intensity
- 50% recovery time discharge
- Antecedent conditions.

Rozemeijer et al, 2011

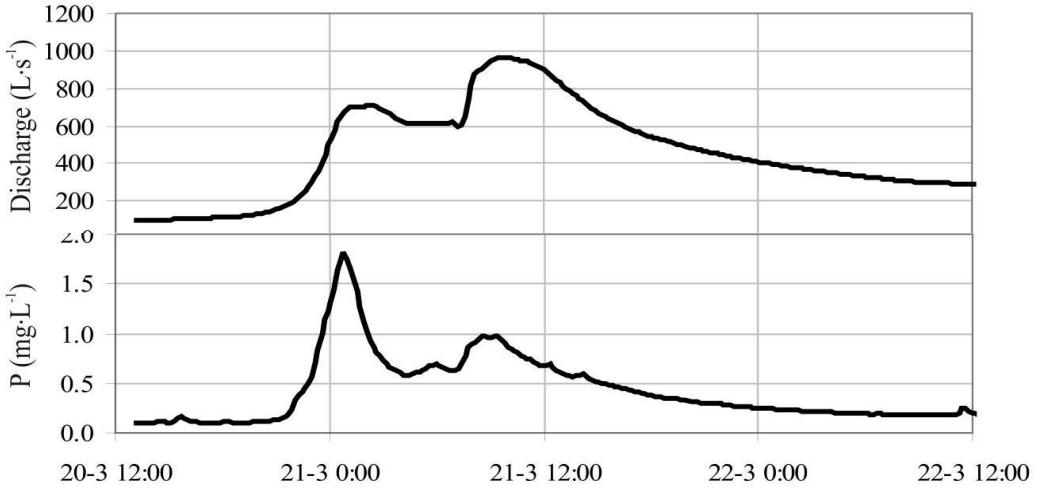
Summary

Phosphorus transport in lowland streams.

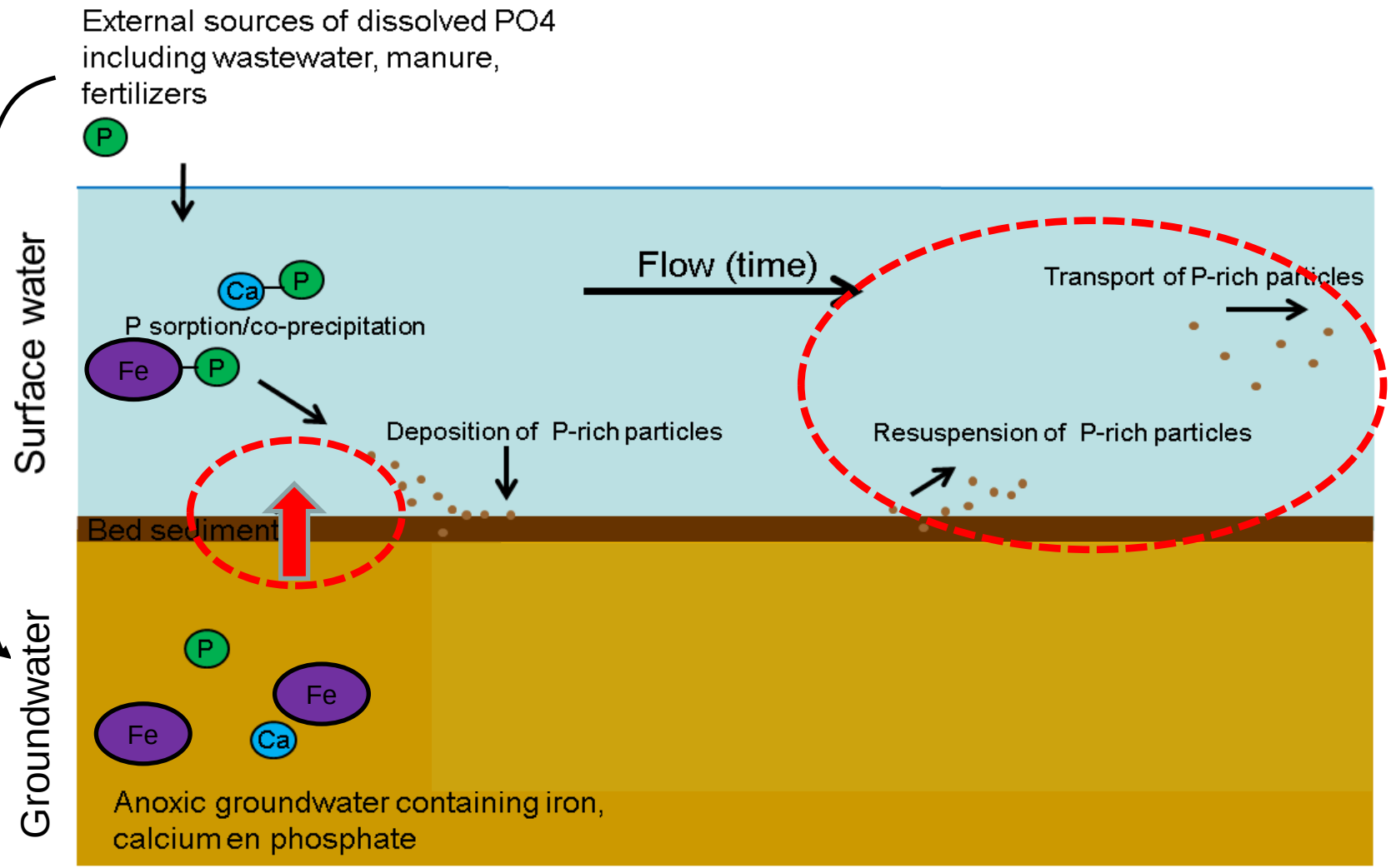
- Both streambed resuspension and surface erosion

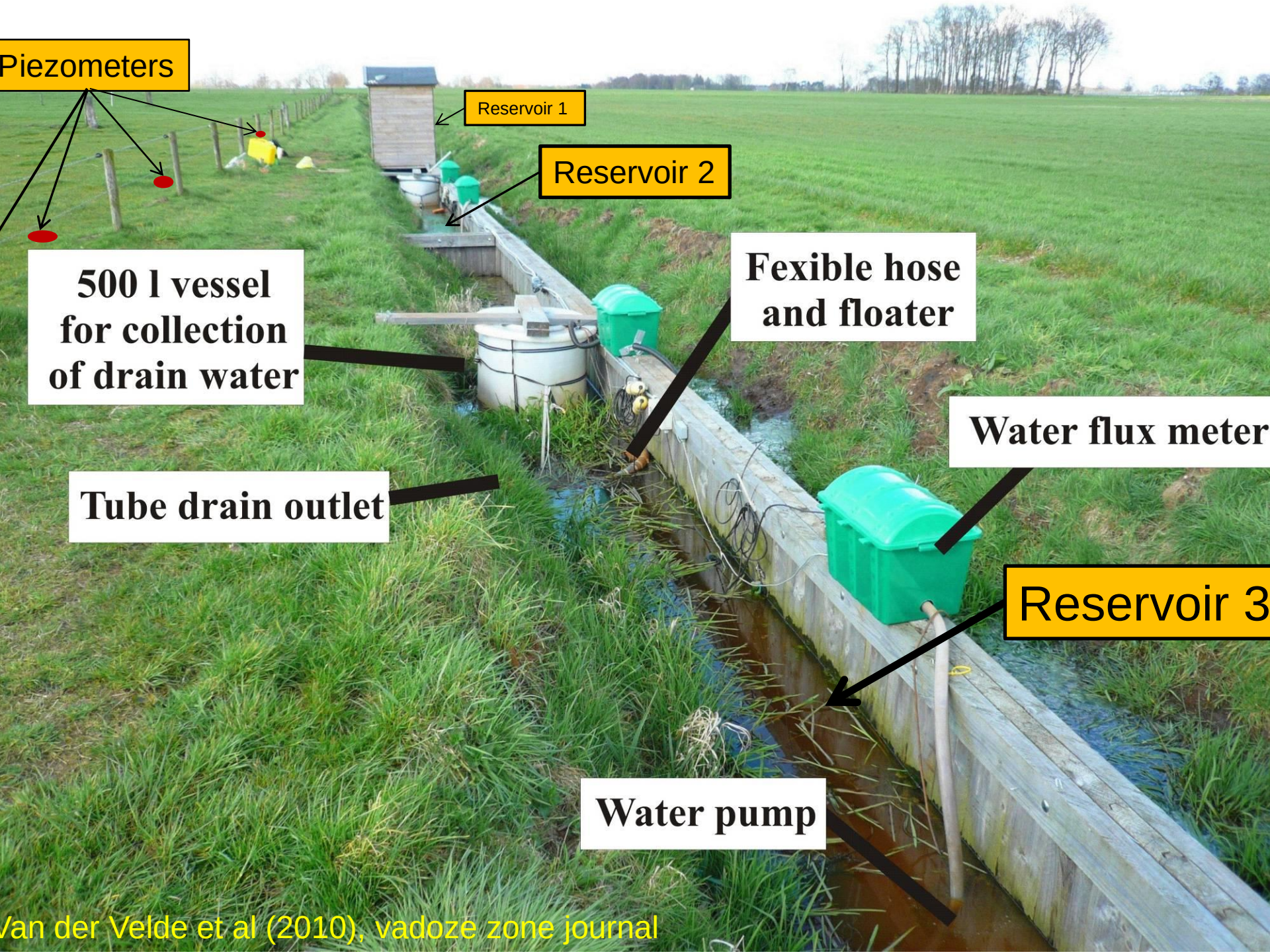
→ The correlation with rainfall intensity suggests surface erosion

→ The correlation of antecedent conditions suggests streambed resuspension (flushing).



Conceptual model in-stream processes

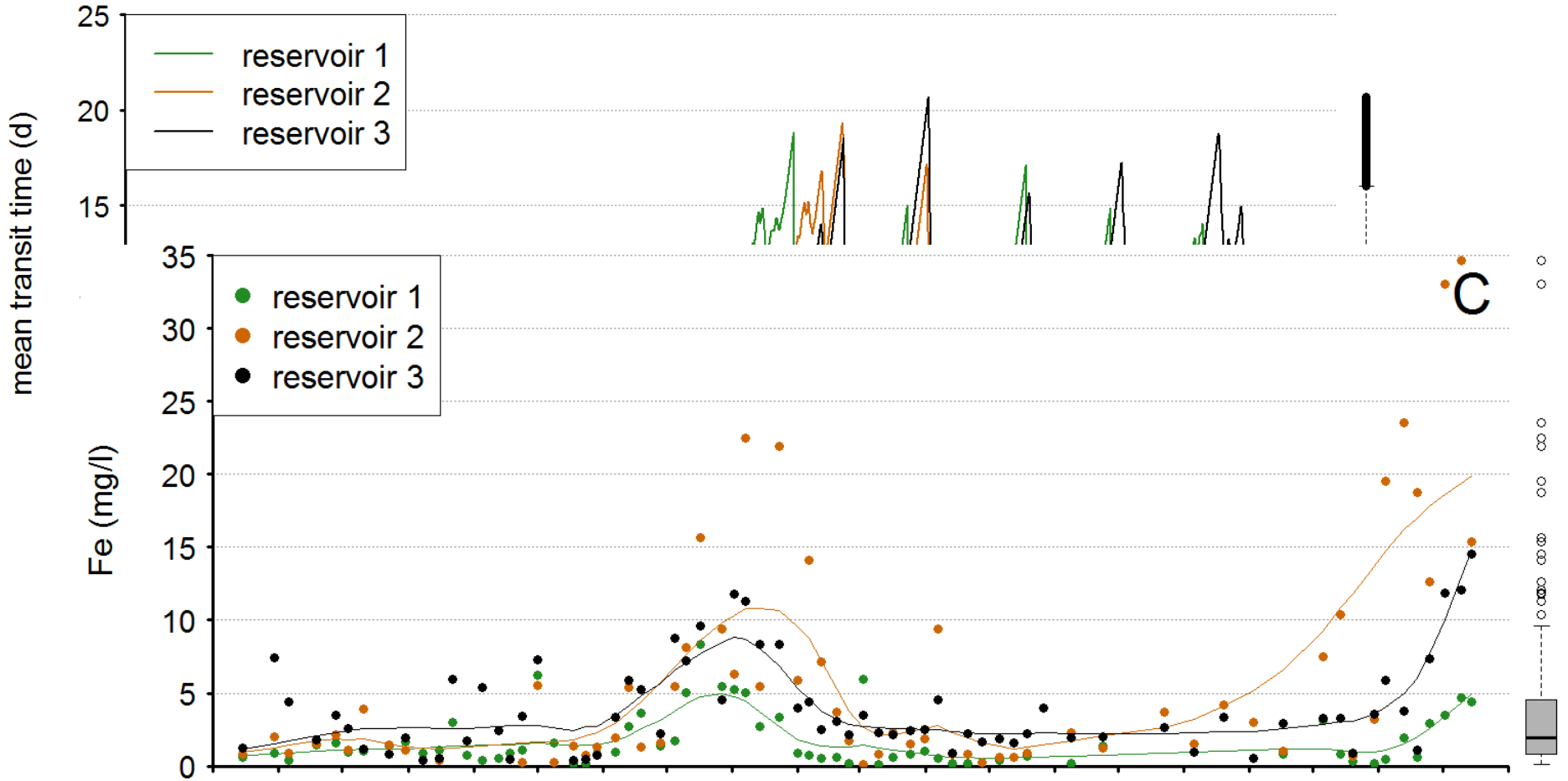




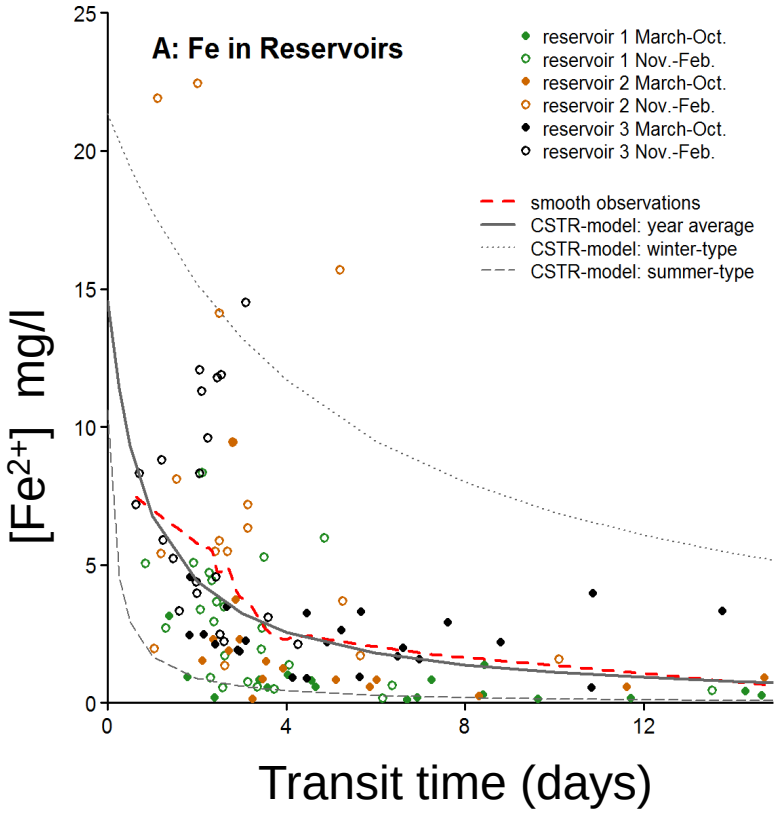
Van der Velde et al (2010), vadoze zone journal

Reservoir transit time

Fluxes to reservoir mean transit time.



Measured and modeled P concentration vs transit time

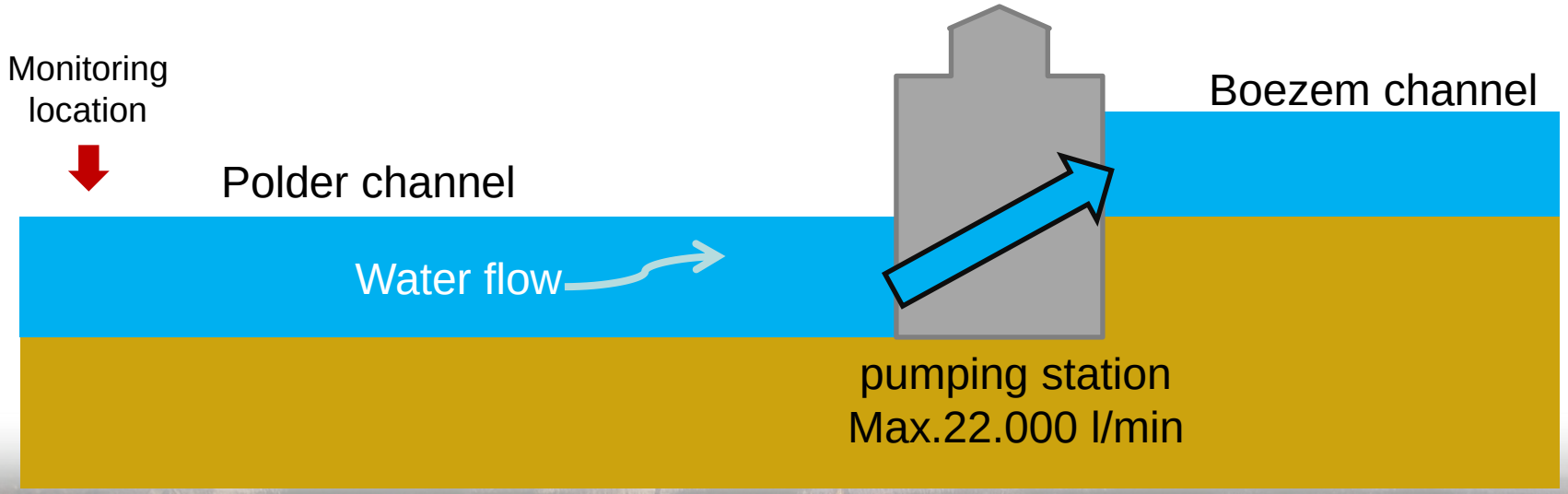


- Fast binding of PO_4 in presence of Fe^{2+}:
  No time for dissolved transport
- Much less iron is needed to bind all P
  (2:1 instead of 18:1)

Streambed sediment and particulate P transport

Effect of flow velocities on re-suspension and sedimentation streambed sediment

- Pumping station controls flow velocities and changes in suspended sediment in polder channel

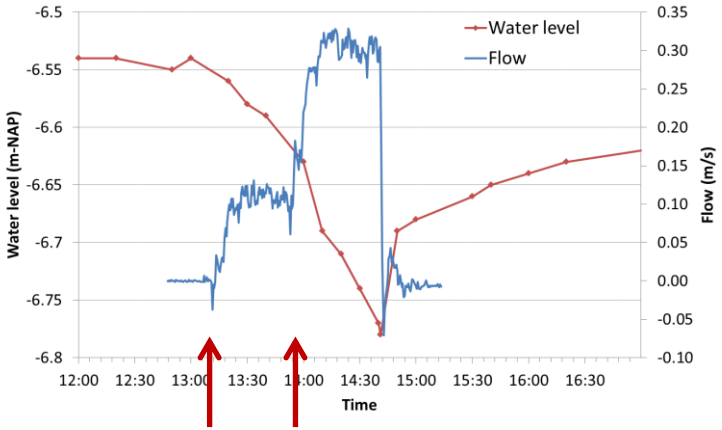


Continuous monitoring of dynamics in suspended sediments

LISST-100 – **L**azer **I**n-**S**itu **S**cattering and **T**ransmissometry

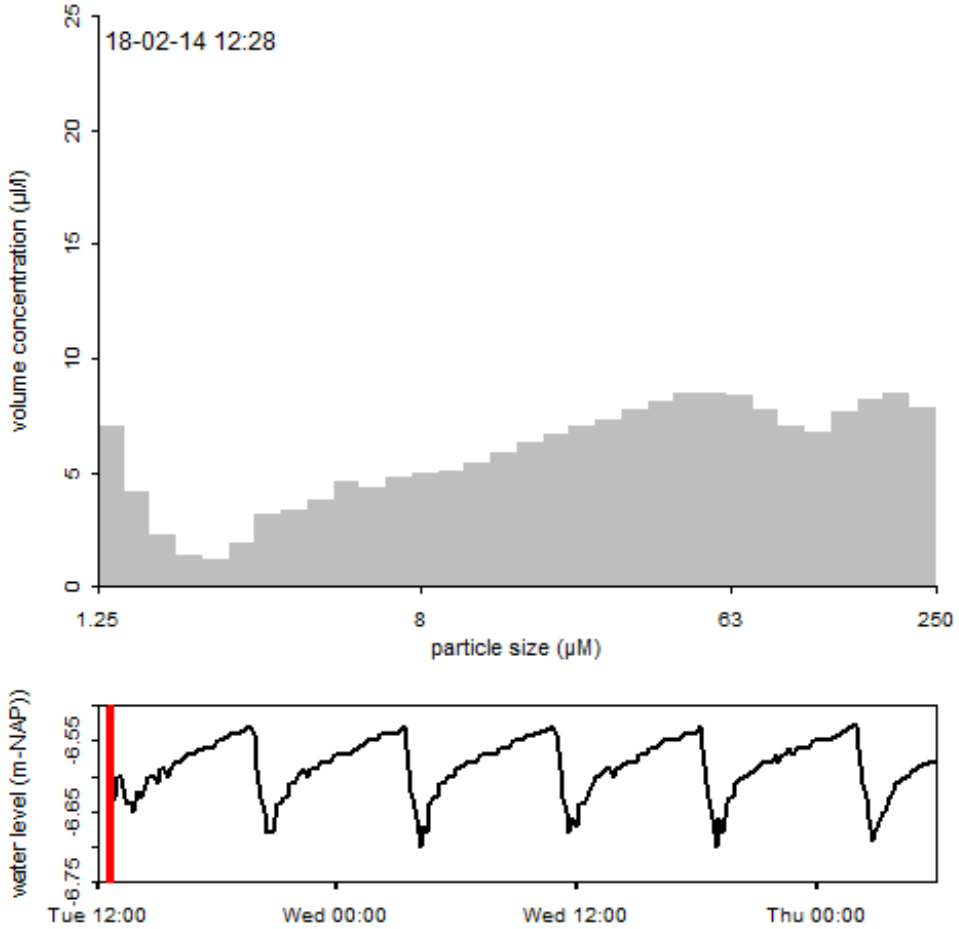
- multi-parameter system for in-situ observations of particle size distribution and volume concentration.

Particle size distribution & volume concentration

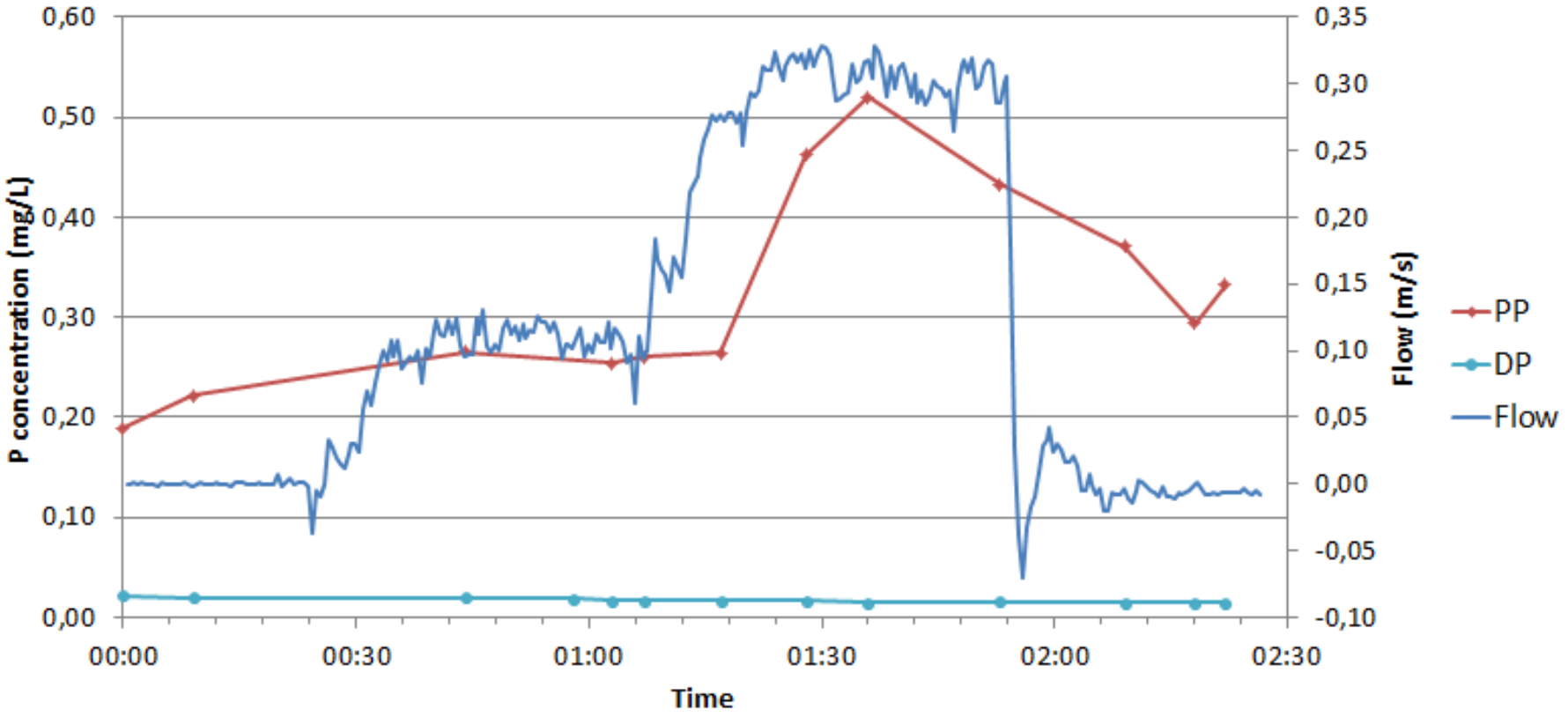


Start 1st pump

Start 2nd pump

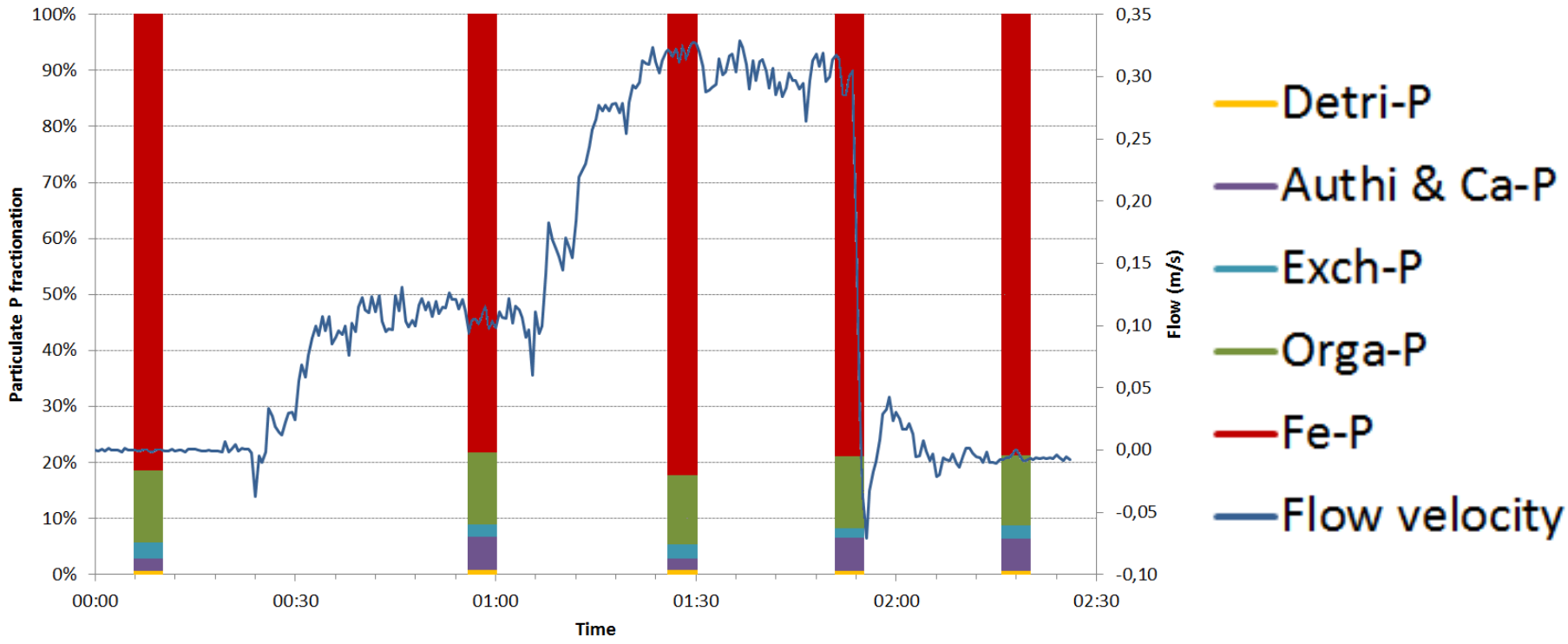


Flow, Particulate P and Dissolved P

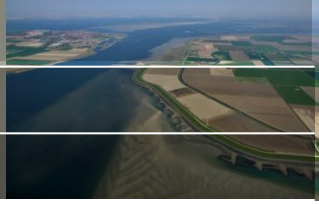


Speciation of Particulate P

Determined by Sequential Chemical extraction of Suspended Sediment



Conclusions & questions left



- P-mobilization through surface erosion and streambed resuspension
- Groundwater important P-source
  Fast immobilization of P during oxidation process of Fe(II)
  - Precipitation of $Fe_2PO_4(OH)_3$ (lab-studies)
  - How stable are these precipitates?
- Resuspension of streambed sediment during high flows.
  - No composition change of particulate P-species during high flows.
- P from surface erosion? Effect of a moving redox interface around streams? P-buildup at the redox-interface?
- Inspiration from Continuous water quality / sediment measurements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Thank you!