Deltares
Enabling Delta Life

Flowcap: continuous 'passive' registration of loads from drainage tubes

HRWQ-monitoring workshop Magdeburg

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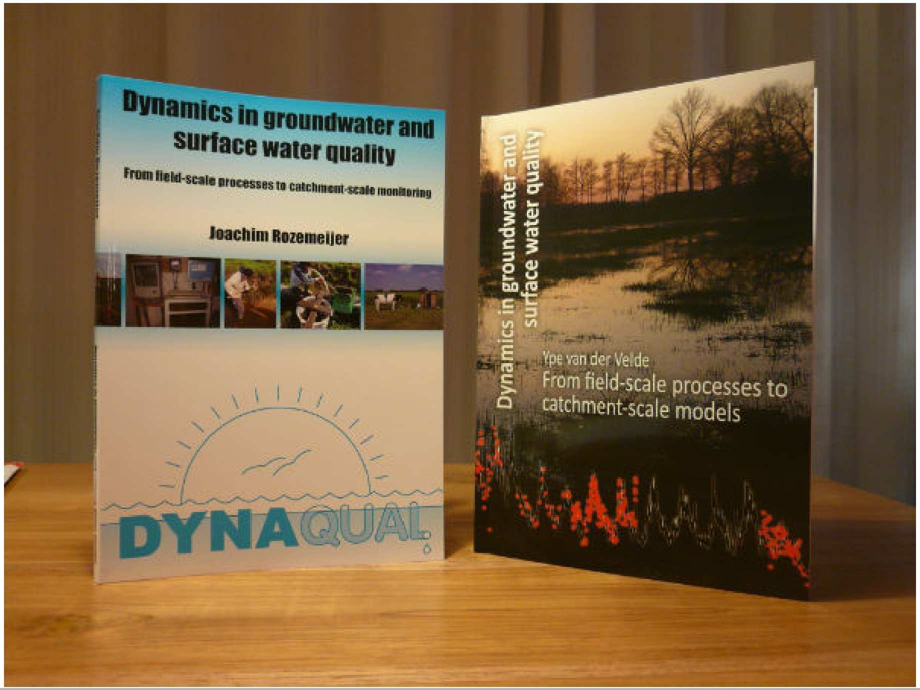
2006-2010: DYNAQUAL

Papers with focus on water and solute transport modeling:
Van der Velde et al, 2010a-c, 2011a,b (Vadose Zone J., HESS, WRR)

Papers with focus on water quality monitoring:
Rozemeijer et al., 2007, 2009, 2010a-d (Env Poll., J. Hydrol., WRR, ES&T)



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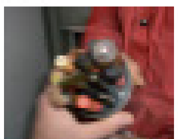
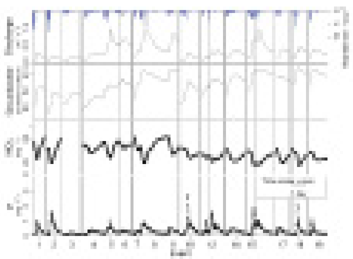
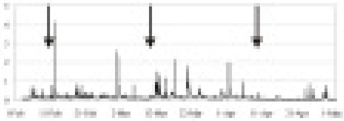
Applications of continuous water quality monitoring techniques for more efficient water quality research and water resources management

Water quality management can benefit from continuous water quality measurements. We applied 15 minute interval P and NO_3 concentration measurements (1) to improve understanding of nutrient transport processes, (2) to test innovative sampling techniques, and (3) to improve load estimates (also before and after the continuous measurements).

We applied equipment for continuous concentration measurements to a discharge measurement flume at the outlet of a lowland agricultural catchment.
A Phosphax Sigma auto-analyser measured P-tot and PO_4 concentrations and NO_3 was measured by a Hydrolab-10 multiparameter probe.



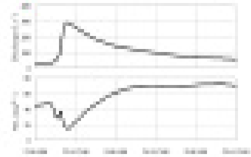


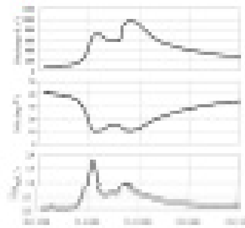


The results show the response of the nutrient concentrations to rainfall events. The common monthly measurement frequency of many surface water quality monitoring networks (arrows) are too low to capture the short-term dynamic behavior of the solute concentrations.

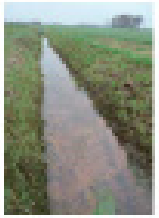
Nutrient transport process understanding

NO_3 concentrations repetitively decreased in response to rainfall events due to dilution with rainwater. After this initial dilution, higher NO_3 concentrations were measured due to higher groundwater levels.



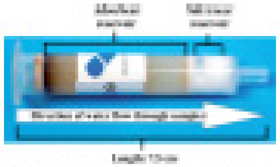


P concentrations repetitively peaked in response to rainfall events due to the flushing of P-rich sediments from the catchment. A double discharge event showed that the available P supply needs time to replenish after each event.



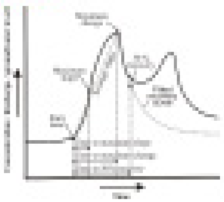
Testing new sampling techniques

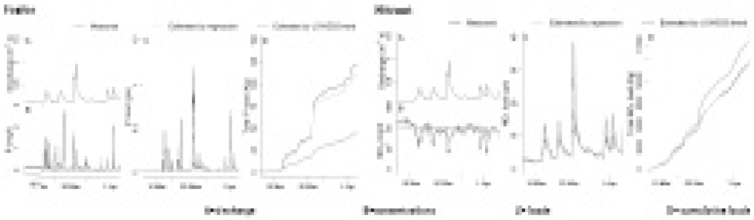
Average concentration measurements may be a cost-efficient alternative for common snapshot grab sampling. We tested the SorbiCell passive sampler. The SorbiCell results matched with the results from continuous monitoring and weekly grab sampling.



Improve load estimates

For periods with low concentration measurement frequencies, load estimates can be improved by characterizing the concentration response to precipitation events. Using a short period of continuous measurements, we improved the load estimates from a 20% to a 1% bias for NO_3, and from a 63% bias to a 5% bias for P.





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Introduction

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Temporal variability in groundwater and surface water quality in humid agricultural catchments; driving processes and consequences for regional water quality monitoring

Joachim Rozemeijer[1, *] and Ype van der Velde[2]

With 10 figures and 1 table

Abstract: Considering the large temporal variability in surface water quality is essential for adequate water quality policy and management. Neglecting these dynamics may easily lead to decreased effectiveness of measures to improve water quality and to inefficient water quality monitoring. The objective of this paper is to summarise our understanding of temporal variability in surface water and upper groundwater quality and to discuss the consequences and opportunities for regional water quality monitoring. In regional monitoring networks, measurement frequencies are typically too low to capture the short-term temporal variations in solute concentrations. This causes large uncertainty in the assessment of (trends in) average concentrations and contaminant loads. The most important driver for short-term variations in water quality in most catchments is the variability in meteorological conditions, which induces changes in the relative discharge contributions of water from different flow routes and different chemical compositions. Various options exist for dealing with the transient behavior of water quality in regional water quality monitoring. Estimates of average concentrations and loads from low-frequency concentration data can be improved by using the explanatory strength of commonly available measurements of quantitative hydrological data like precipitation, discharge, and groundwater levels. This paper provides examples of the relationship between water quality and explanatory variables in conceptual, statistical, or process-based models. Another strategy for dealing with short-term variability in water quality monitoring is to measure long-term average solute concentrations using passive samplers. Similarly, on-site auto analyzers and ion specific electrodes provide opportunities for continuous water quality measurements.

Key words: Water quality, monitoring, surface water, groundwater, nutrients.

Introduction

Terrestrial and aquatic ecosystems, including people, would not survive without sufficient fresh water of good quality. Due to the increasing human population, the global fresh water resources are increasingly scarce and polluted. Surface water and groundwater resources are particularly threatened in areas with dense population and intensive agriculture. The loss of agrochemicals (nutrients, heavy metals, and pesticides) from agricultural fields contaminates groundwater and surface water bodies. This threatens the ecological, industrial, and recreational functioning of these water systems. For example, the enrichment of ecosystems with nutrients (eutrophication) results in a general loss of biodiversity (e.g. Weijters et al. 2009)

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Introduction

Variations in flow route contributions are the main driver for dynamics in surface water quality

Groundwater:

Long travel times

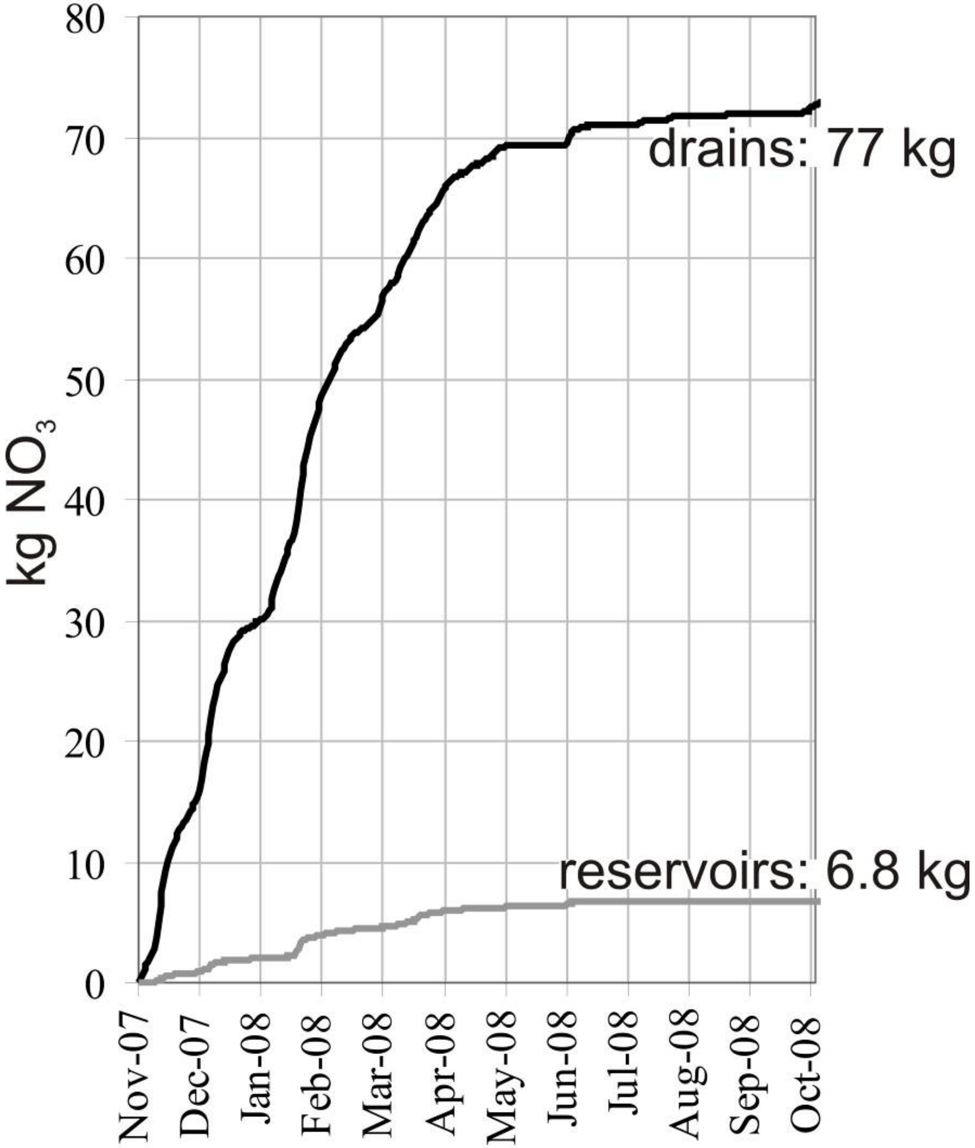
Tube drains:

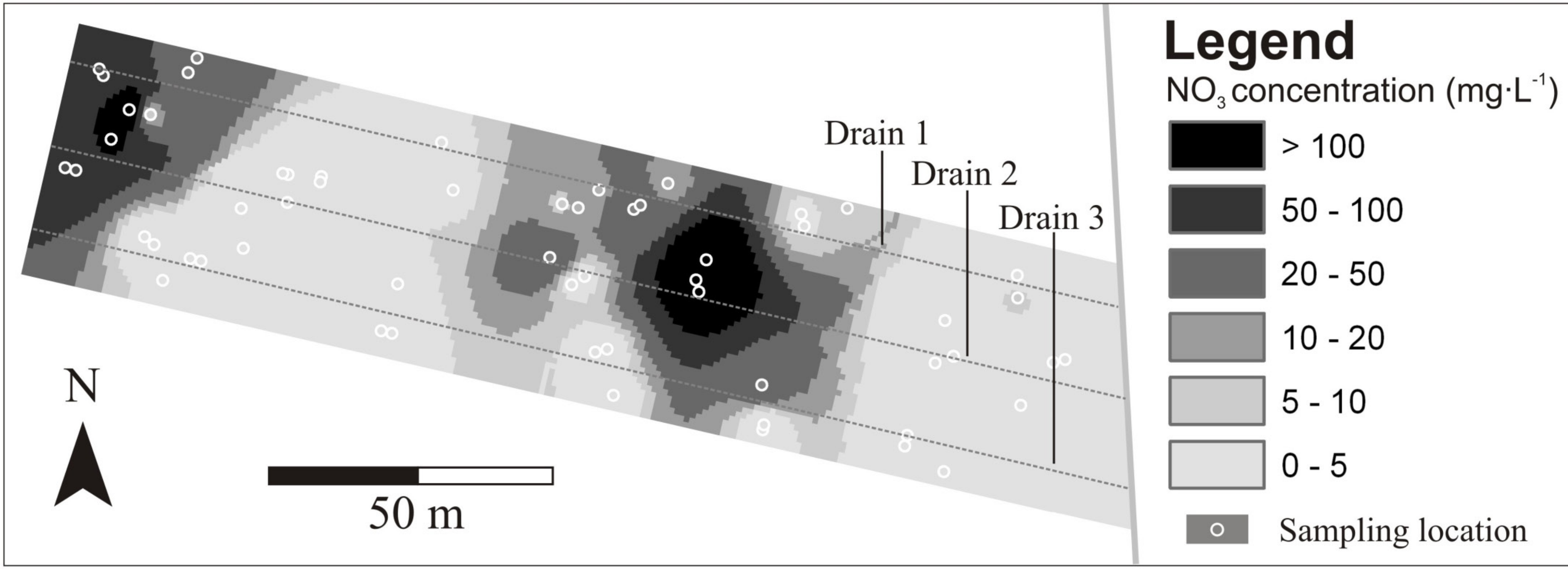
Medium travel times

Overland flow:

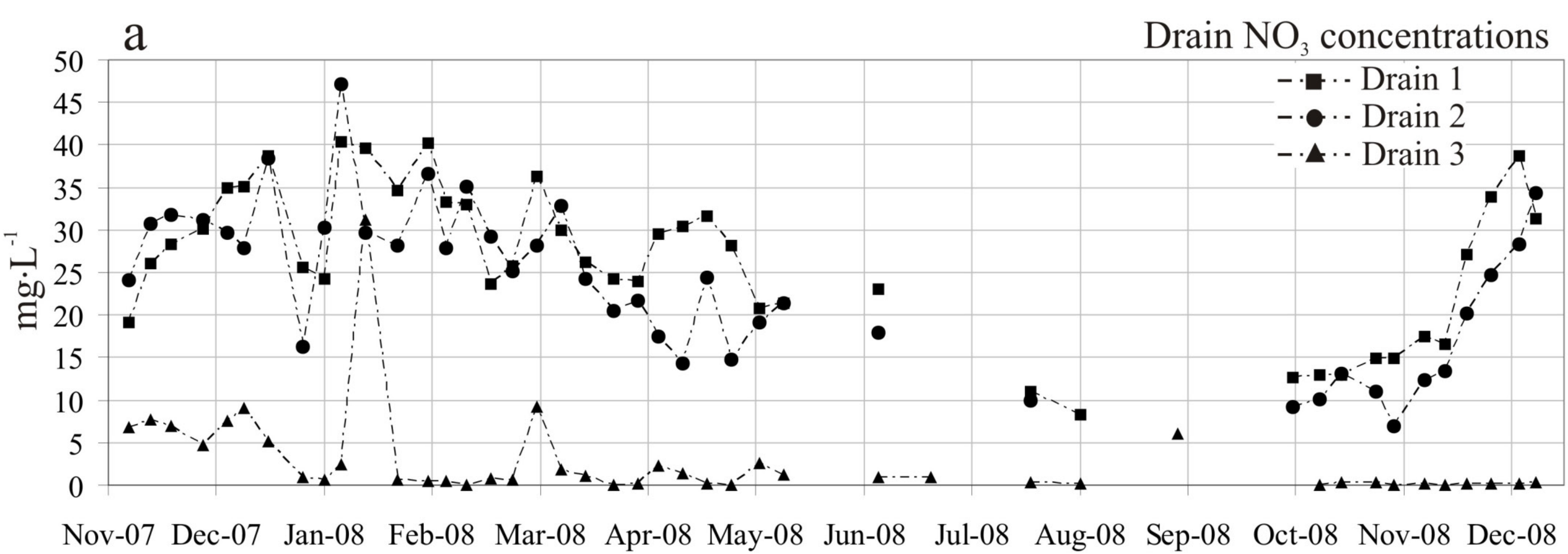
Short travel times

Rozemeijer et al, 2011, Environmental Pollution

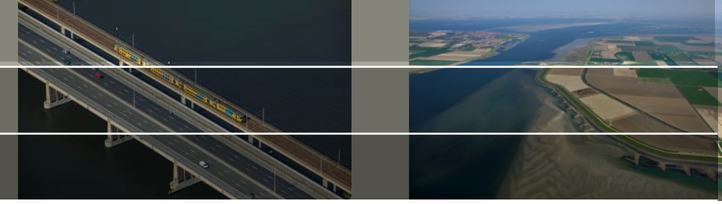




Legend
NO3 concentration (mg·L-1)
> 100
50 - 100
20 - 50
10 - 20
5 - 10
0 - 5
Sampling location
Drain 1
Drain 2
Drain 3
N
50 m

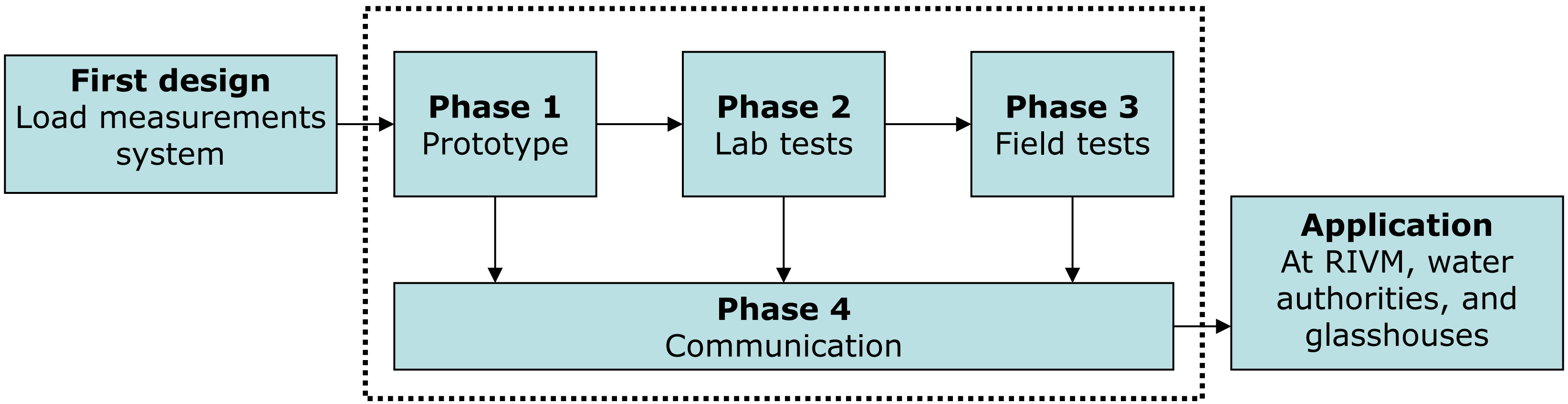


a
Drain NO3 concentrations
Drain 1
Drain 2
Drain 3
mg·L-1
50
45
40
35
30
25
20
15
10
5
0
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08

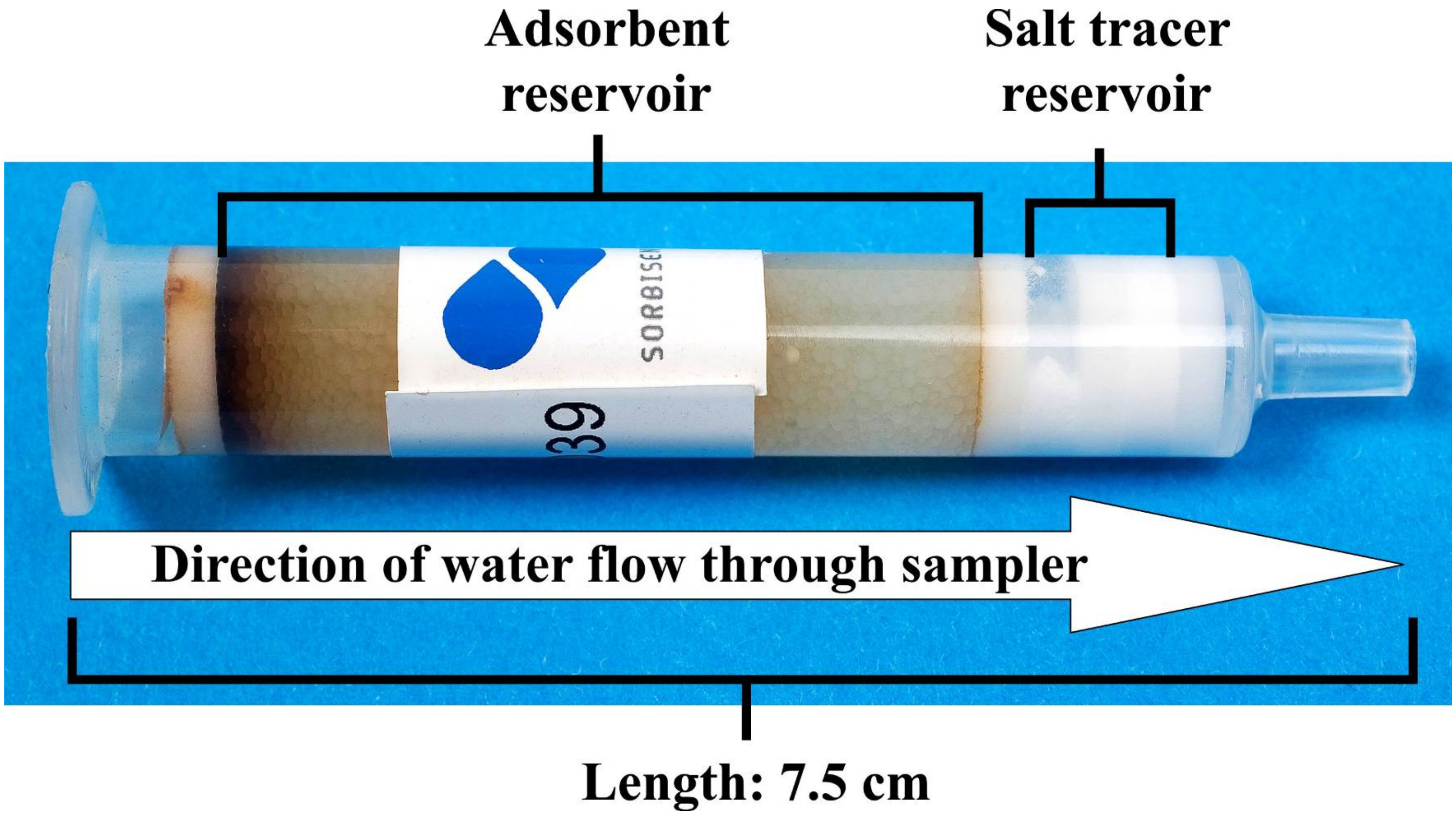


Goal DiVeLOp-project:

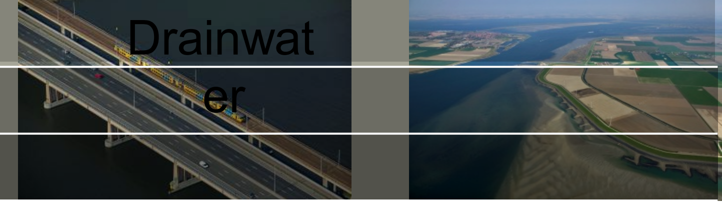
To design a cheap, robust, and broadly applicable measurement system for loads from subsurface tile drains and drainage from glasshouses

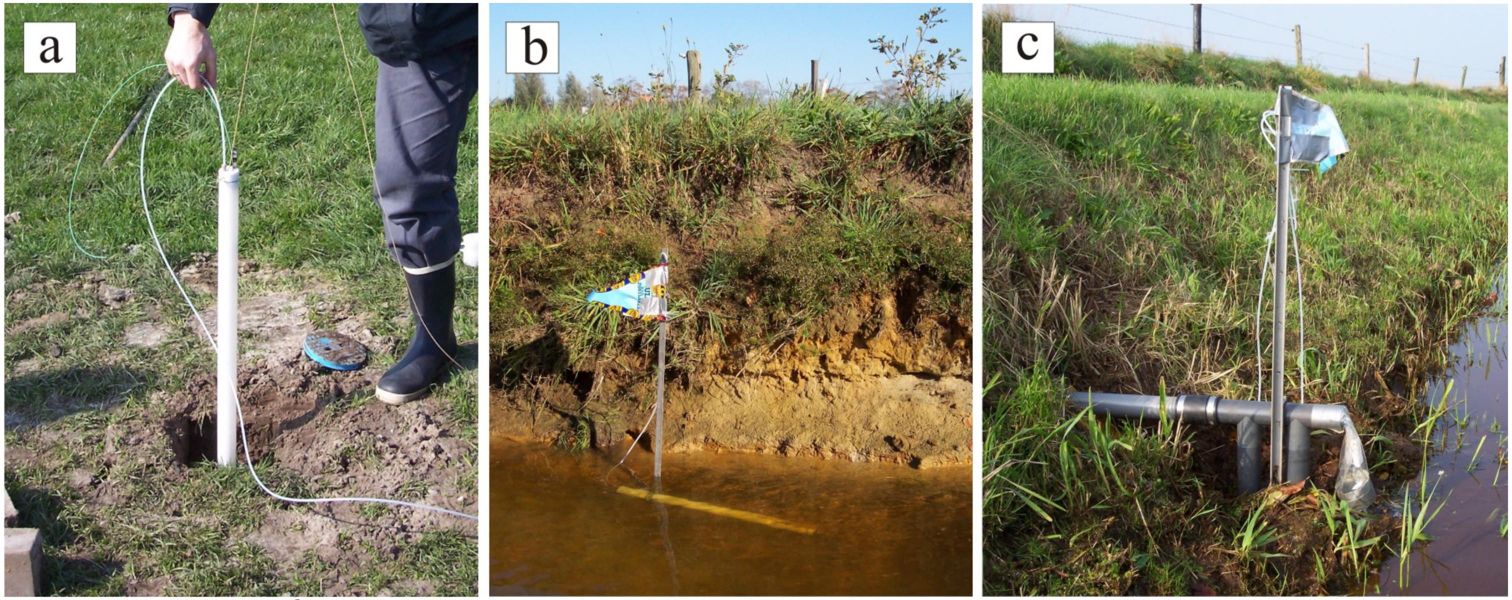


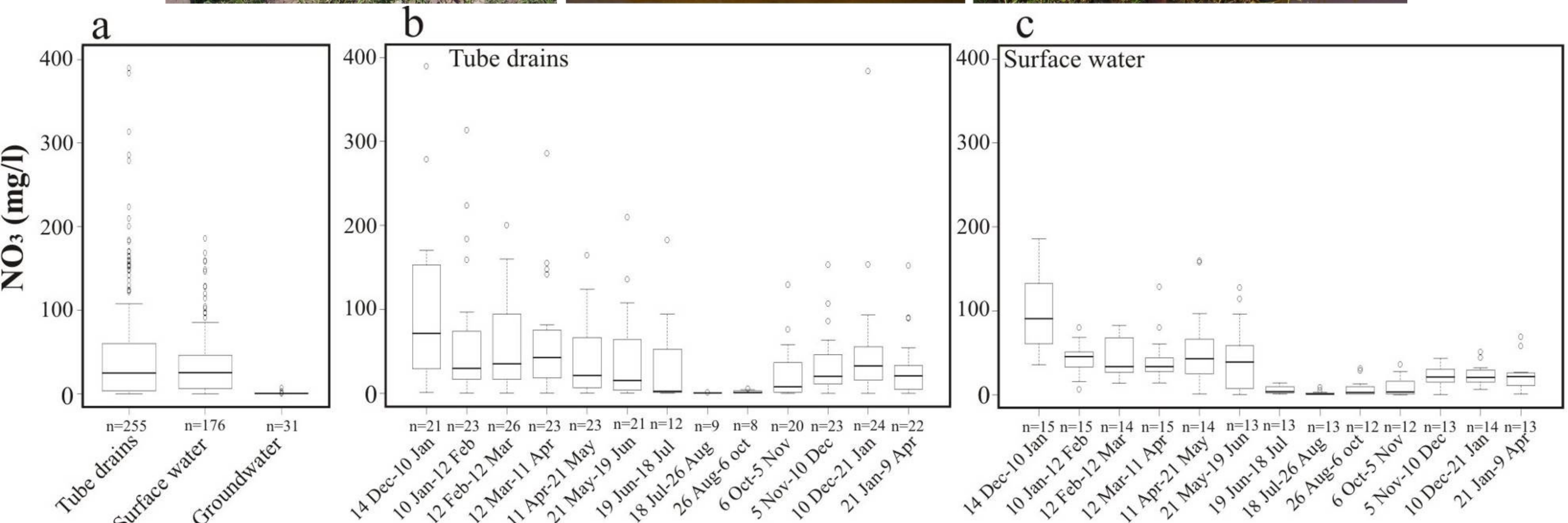
Flowcap development



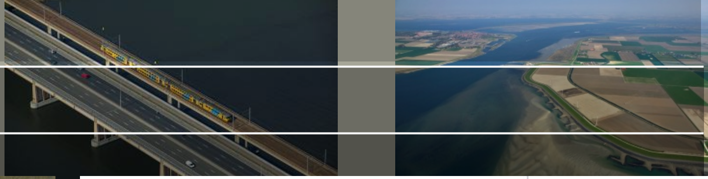
Flowcap development

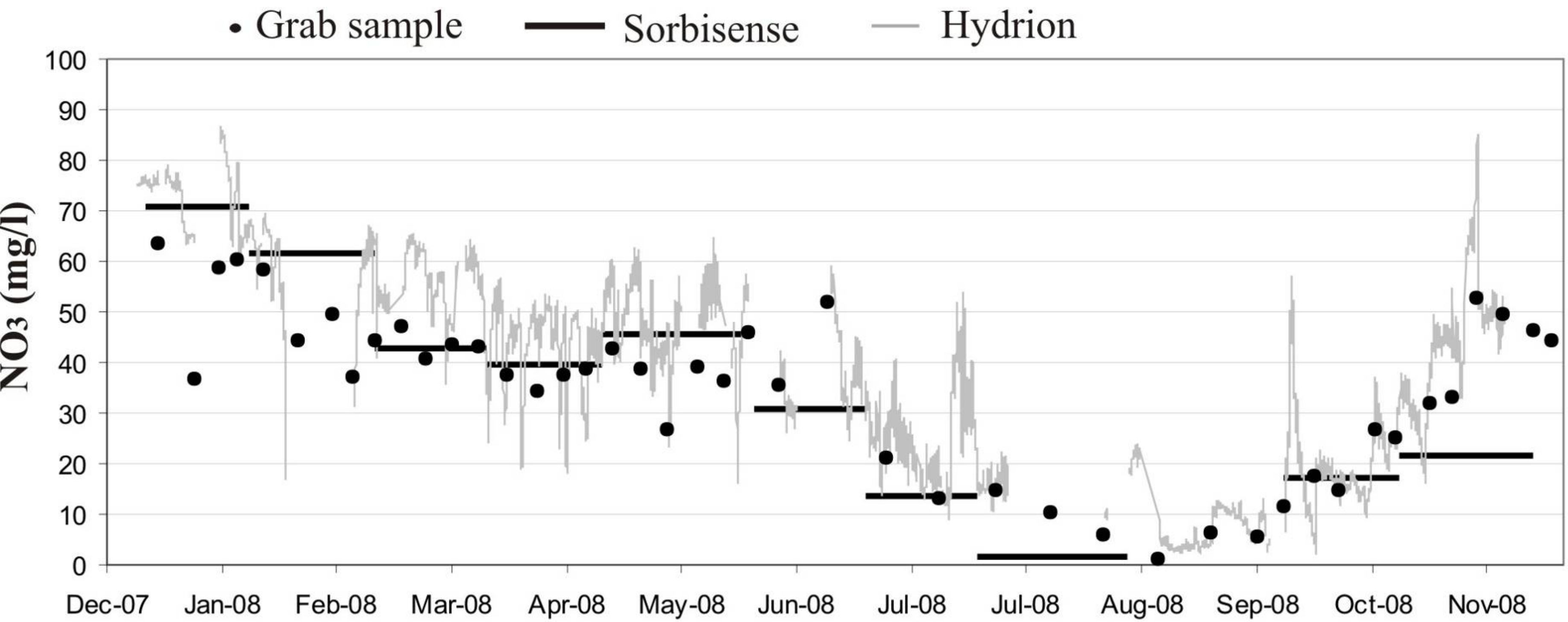






Flowcap development





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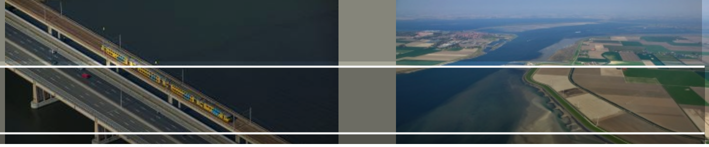
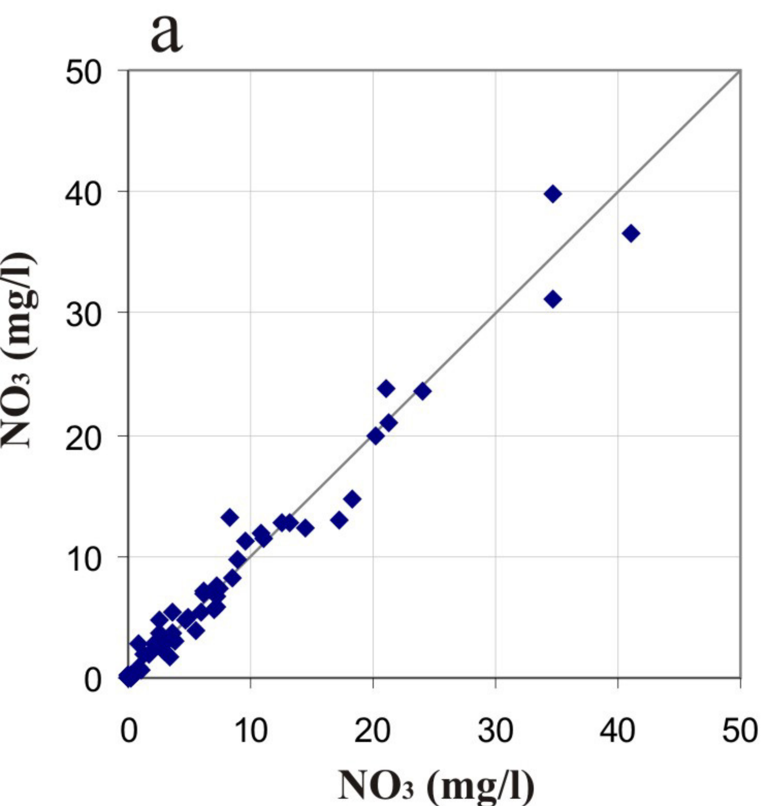
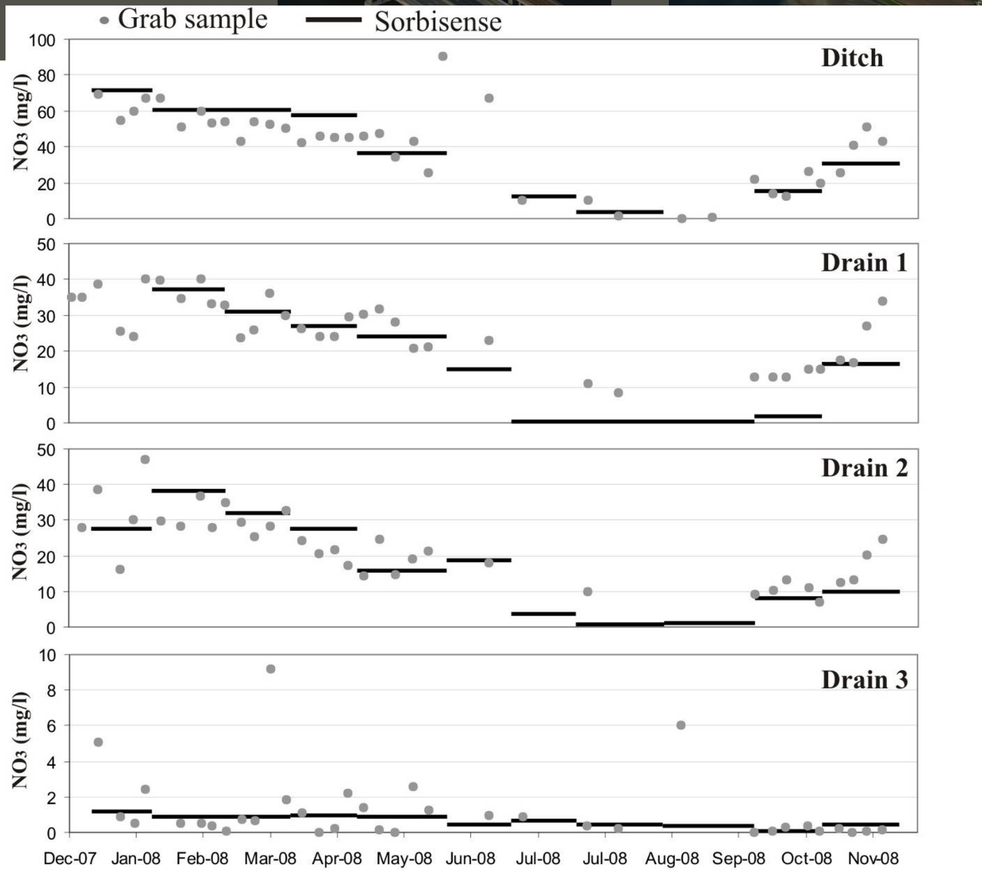






Flowcap development

Conclusion from DYNAQUAL regarding SorbiCells:

- Good results for NO3 after start up problems and adjustments
- Average concentration measurements preferable over snapshots for better load and average concentration estimates

But:

- SorbiCells give time averaged concentrations and not flow averaged concentrations

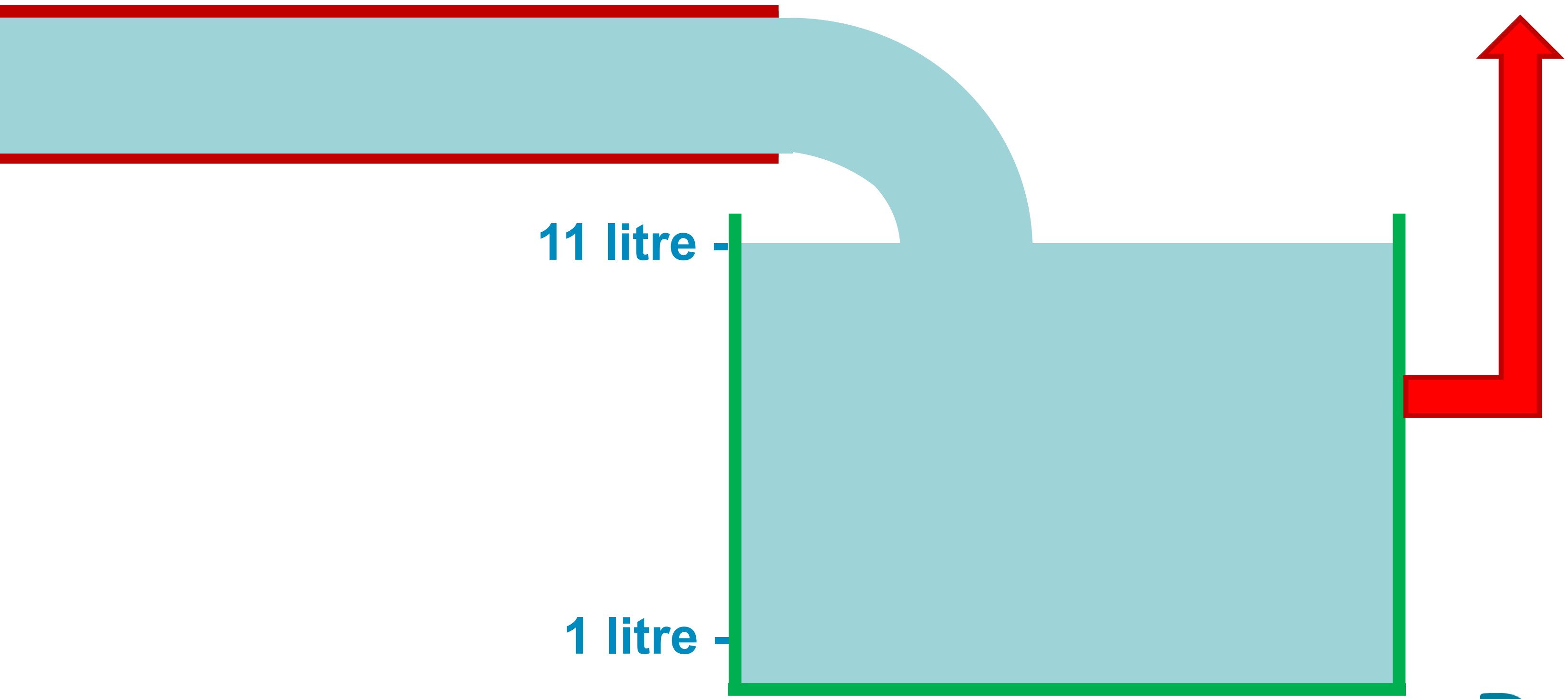
Flowcap development

Day 1-10: 1 liter containing 1 g (1 g/l)

Day 11: 10 liter containing 100 g (10 g/l)

Time average concentration: 1.82 mg/l

Flow average concentration: 9.2 mg/l



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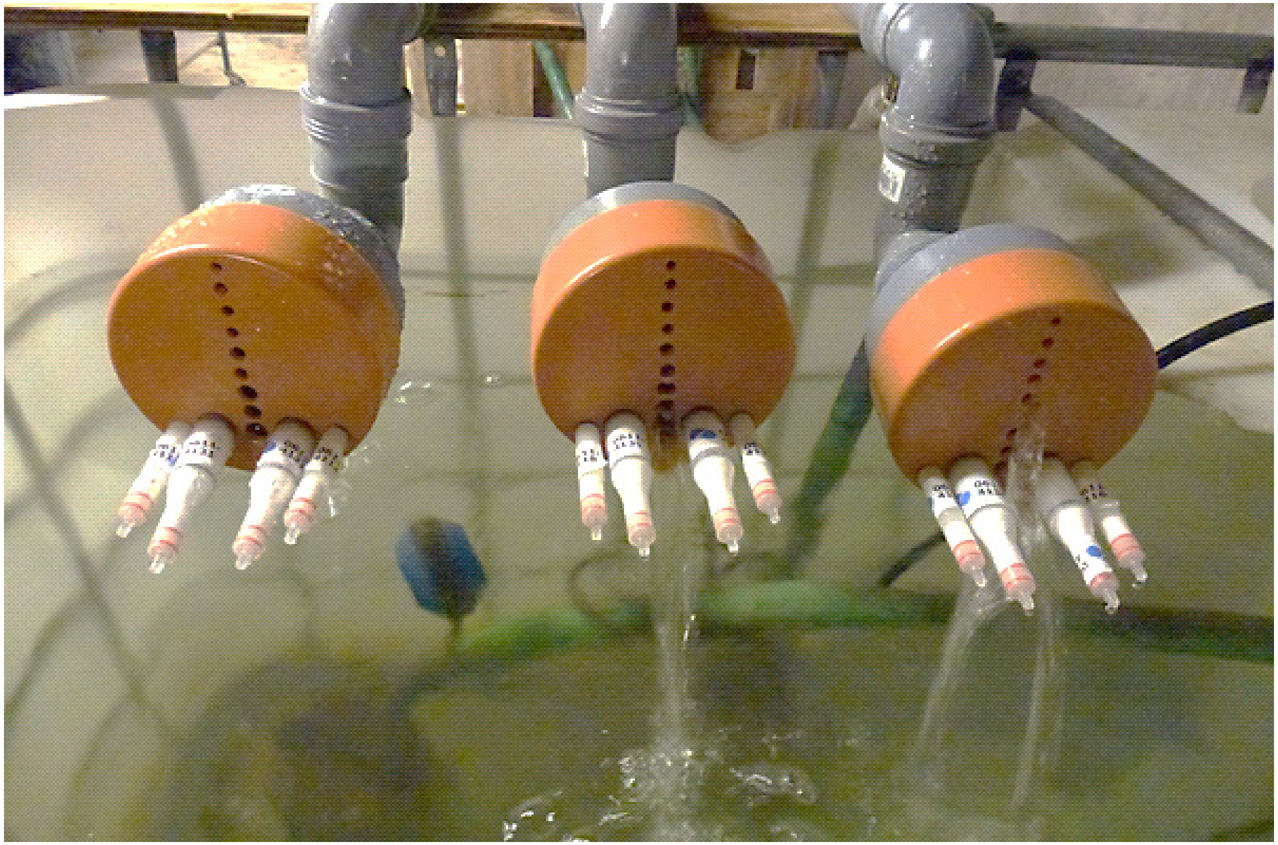
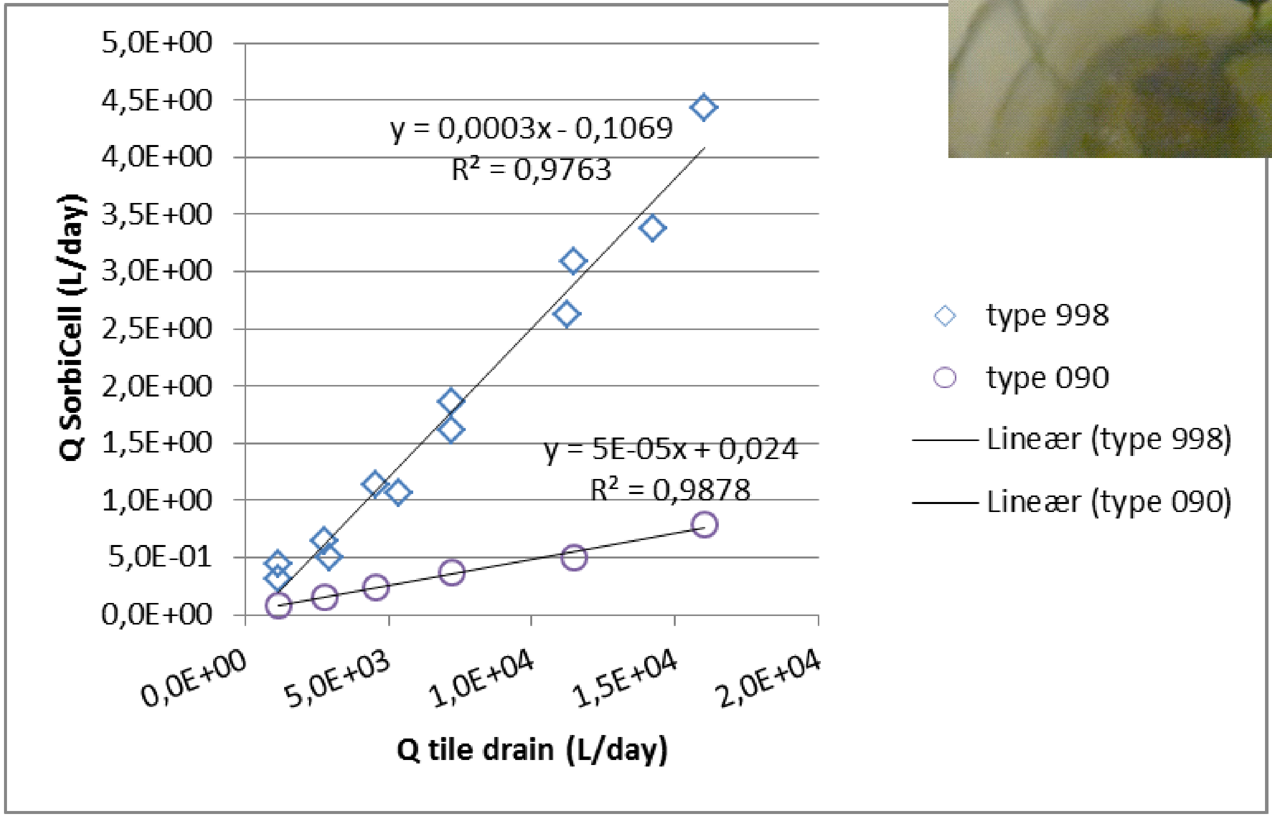
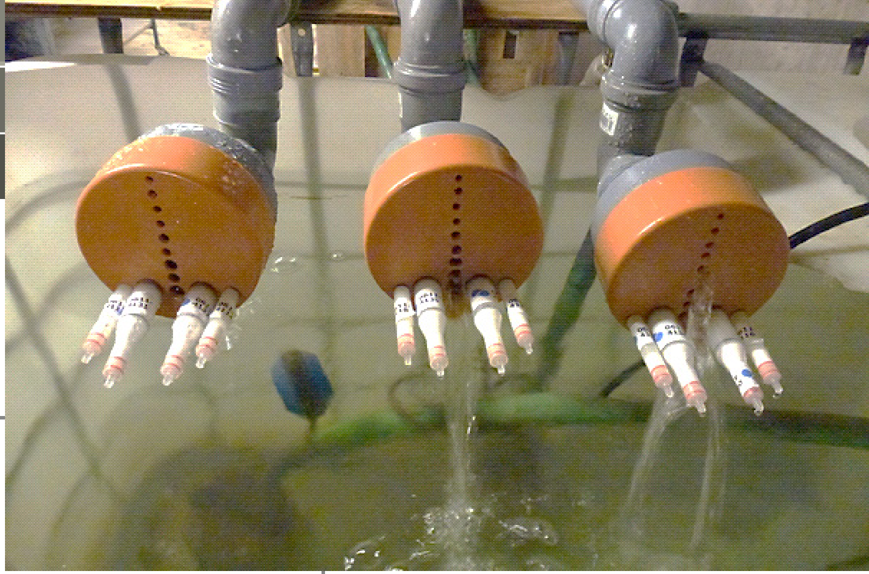
Flowcap development



Flowcap development





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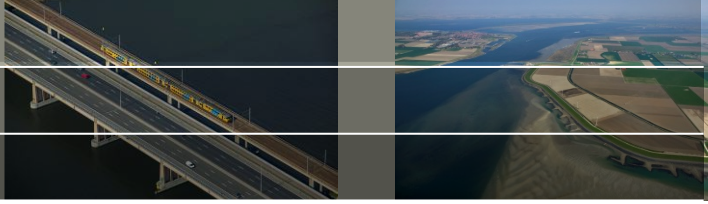
Flowcap development

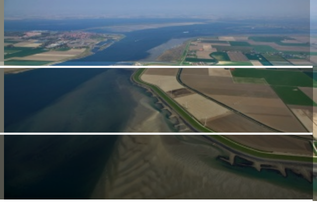
Zeewolde-RIVM



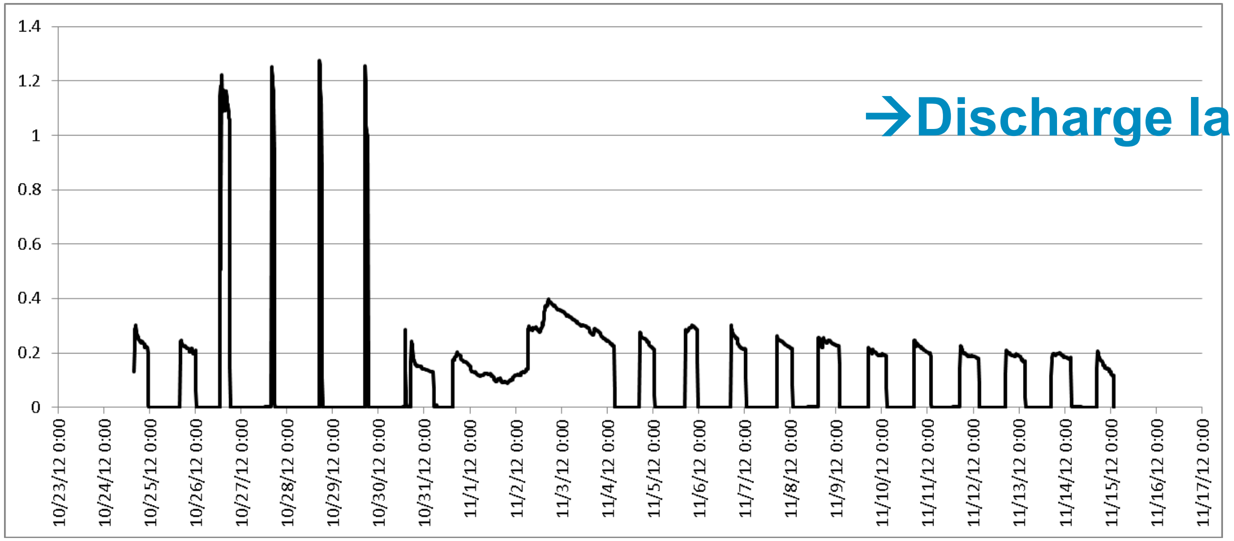
Bleiswijk-Glasshouse


LANGE
450.0

Flowcap development

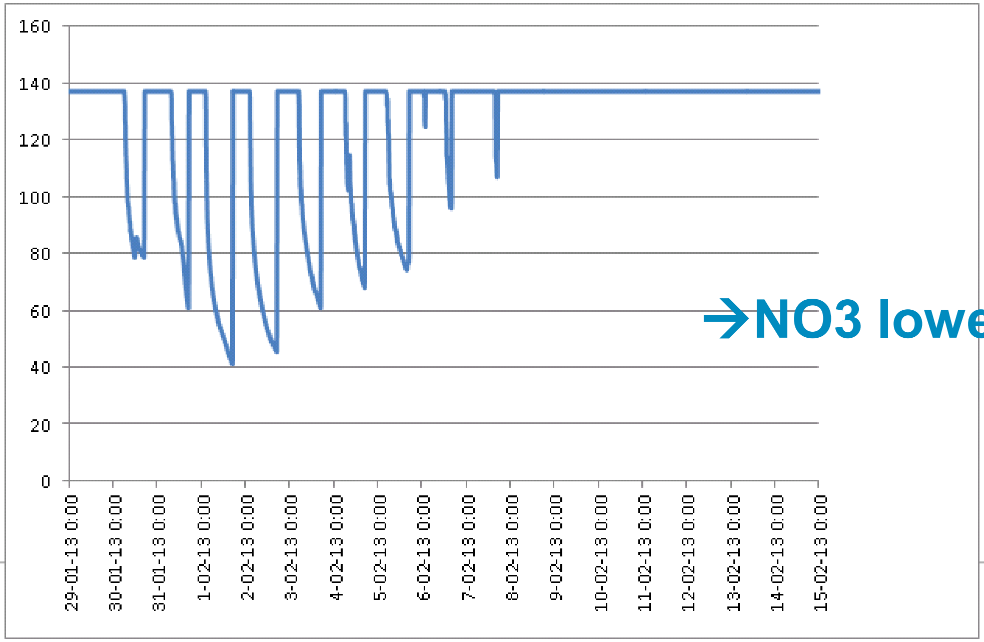


Dscharge



→Discharge largely during the night

NO3-N (mg/l)



→NO3 lower during discharge ‘events’

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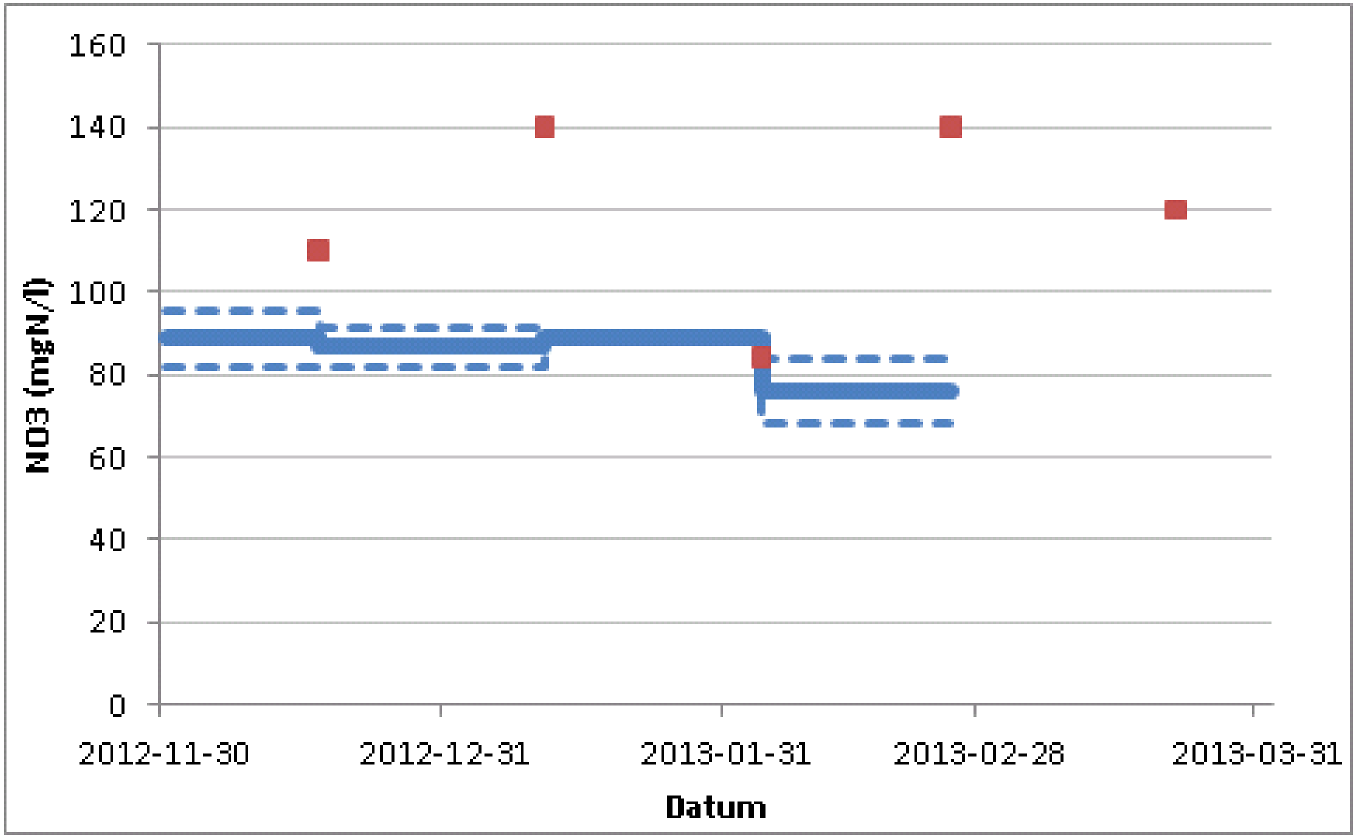
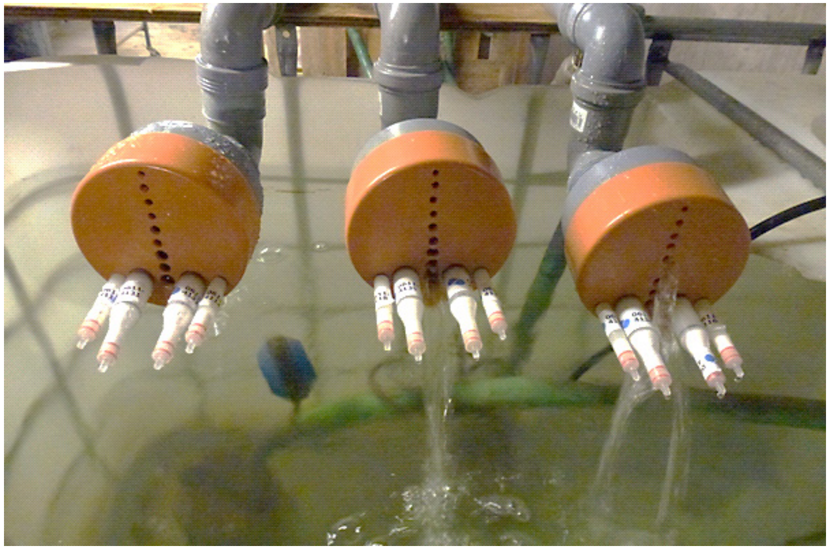
Flowcap development



Flowcap development

Conclusions

- Flowcap produced good results in laboratory conditions
- Flowcap and SorbiCells need some ‘babysitting’ during first field applications
- Flowcap design is being improved based on field experience
- Flowcap may also be applicable for load measurements of other solutes and other types of drainage tubes (industrial/medical spills?)



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