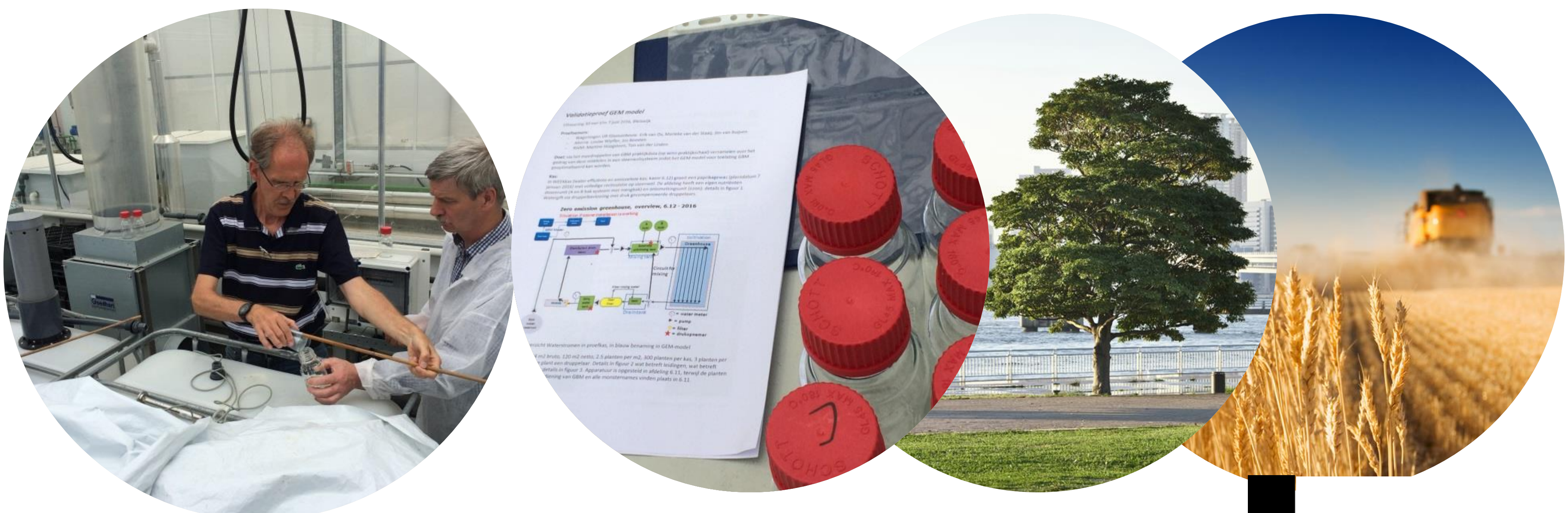
Testing of the Greenhouse Emission Model for a Dutch soilless growing system

1 September 2017, Louise Wipfler



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Presentation of work by working group

- Wageningen UR: Louise Wipfler, Jos Boesten, Erik van Os, Marieke van der Staaij
- RIVM: Ton van der Linden, Martine Hoogsteen

Background

- Important economic sector for the Netherlands
- Since 2016: Greenhouse Emission Model is use in registration
- GEM is instrument to calculate concentrations in surface water and groundwater due to pesticide use in greenhouses in NL
    - Soilless cultivation
    - Soil bound cultivation
- Predicted Environmental Concentrations for soilless are much higher than in the former assessments

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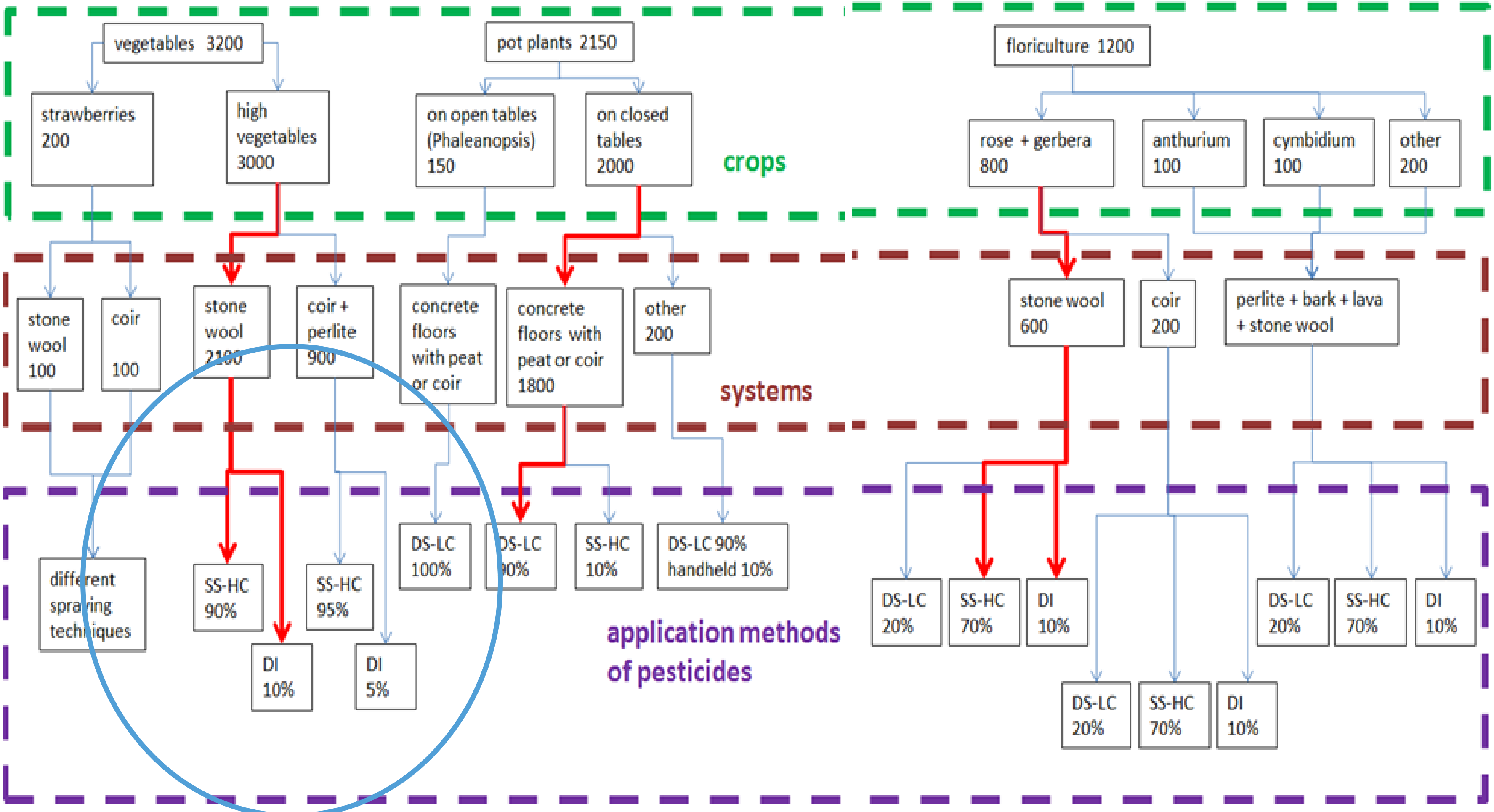
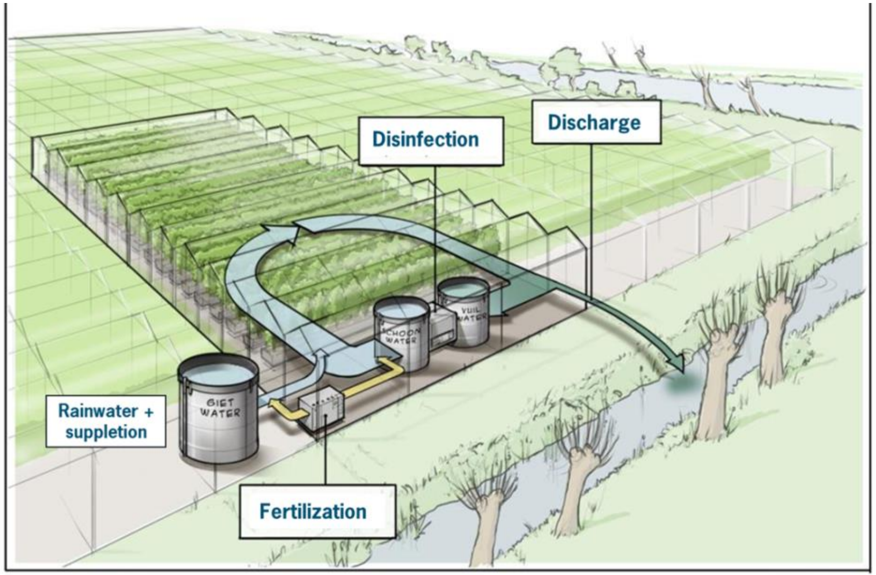
Testing of the model

- Request by stakeholders
- Aim: to compare the Predicted Environmental Concentration (PEC) calculated by GEM with concentration measured under real conditions
- But: What are the ‘real’ conditions?

Soilless cultivation (ha) in NL → which system?



Model concepts (1)



- WATERSTROMEN MODEL predicts:
  - water needs based on greenhouse climate conditions
  - drainage flows and discharge (filter rinsing water & discharge of deteriorated water)
- Water volumes are input to substance emission model

Model concepts (2)

- Substance Emission Model: PPP fate
  - Number of connected ideally mixed tanks
  - Degradation via first order kinetics, formation of metabolites
  - Plant uptake assumed to depend on Kow of PPP (Briggs)
  - Differentiation between slabs and ebb/flow systems (pot plants)
  - Input to TOXSWA

Model concepts (3)

- Substance Emission Model: PPP fate continuation
  - Application via nutrient solution (dripping) or via spraying, fogging or low volume mister
  - Spraying: pesticides in condensation water (glass) collected and added to recirculation water

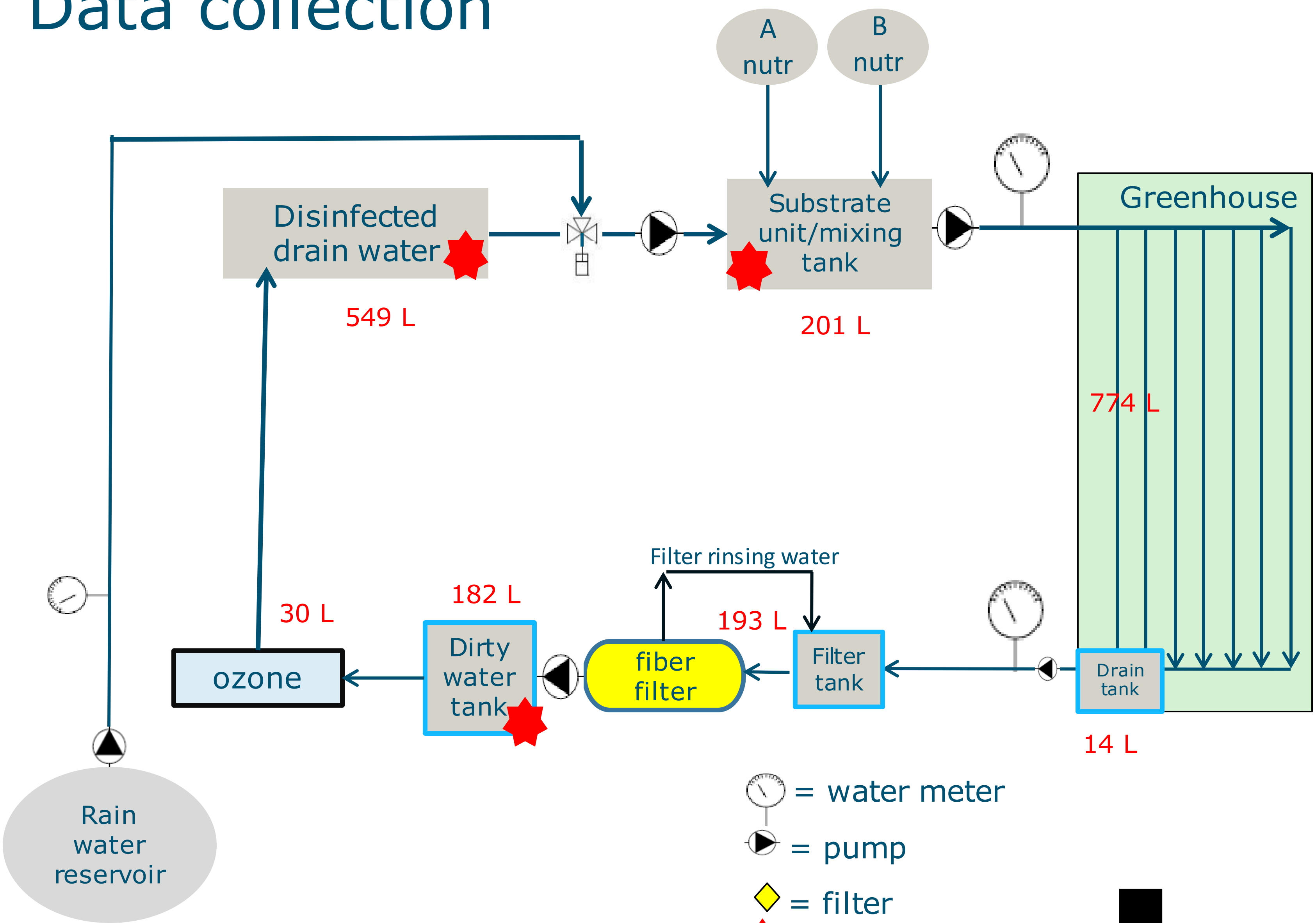
Experimental set up

- Experimental site in Bleiswijk, 120 m^2 net greenhouse
- Drainwater is recirculated and passes ozone installation for disinfection
- No discharge of recirculation water during experiment
- Sweet pepper, planted 7/1/2016,
    - 2.5 pl/m^2, 300 pl/greenhouse, 3 pl/stone wool slab
- Start experiment at 31/5 and end at 7/6.
- Pesticide applied via dripping application according to label on 31/5 at 10 am:
    - pymetrozine (Plenum), 15 g/1000pl, 50% a.i.
    - imidacloprid (Admire), 14 g/1000 pl, 70% a.i.


January 2016


31 May 2016

Data collection



Data collection

At start of experiment
Initial volume in each tank

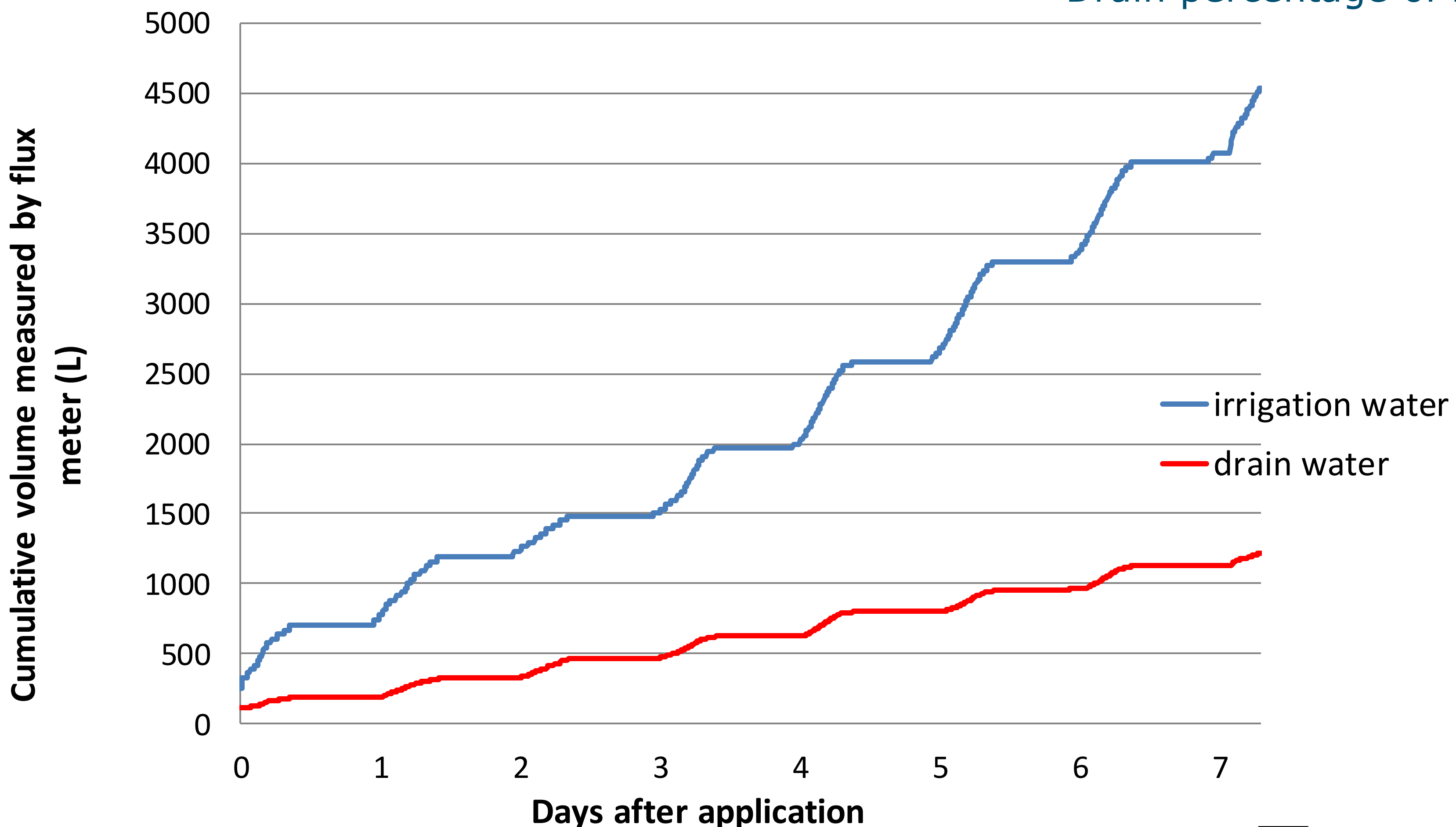
Measurement type	frequency
Pressure sensors in 3 tanks	5 min
3 Water meters	5 min
Lets-grow database Irrigation timing, radiation, temperature, humidity	5 min
PPP sampling in duplicate -- between 8-17 hr	Day 1+2: 2 hours Day 3+4: 3 times Day 5-7: daily
water content in slabs	3 min

(Tank) volumes commercial systems

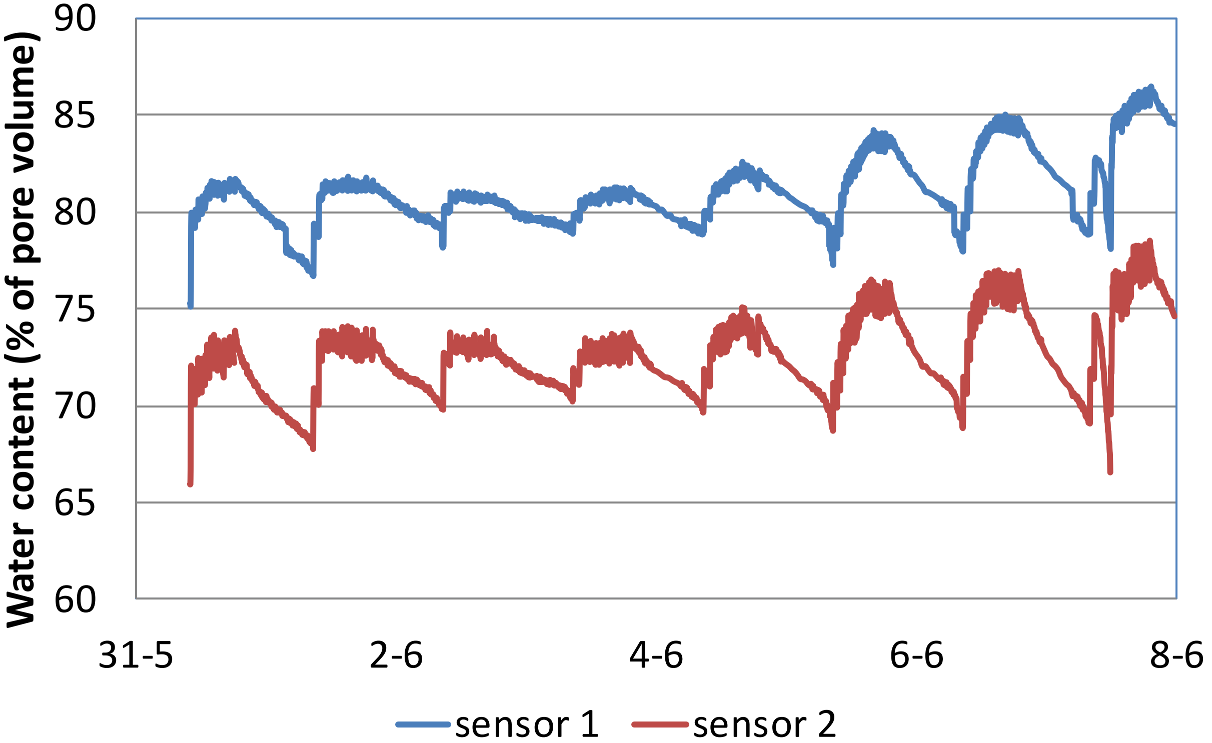
(m^3/ha)	Experiment	GEM	Minimum (commercial)	Maximum (commercial)
Cultivation part	80	125	79	108
Dirty drain tank	15	50	20	70
Clean water tank	15	50	20	70
other/ mixing tank	17+18	10	2	143
total	145	235	121	391

Drain water flux (cumulative)

- Drain percentage of 27%



Slabs



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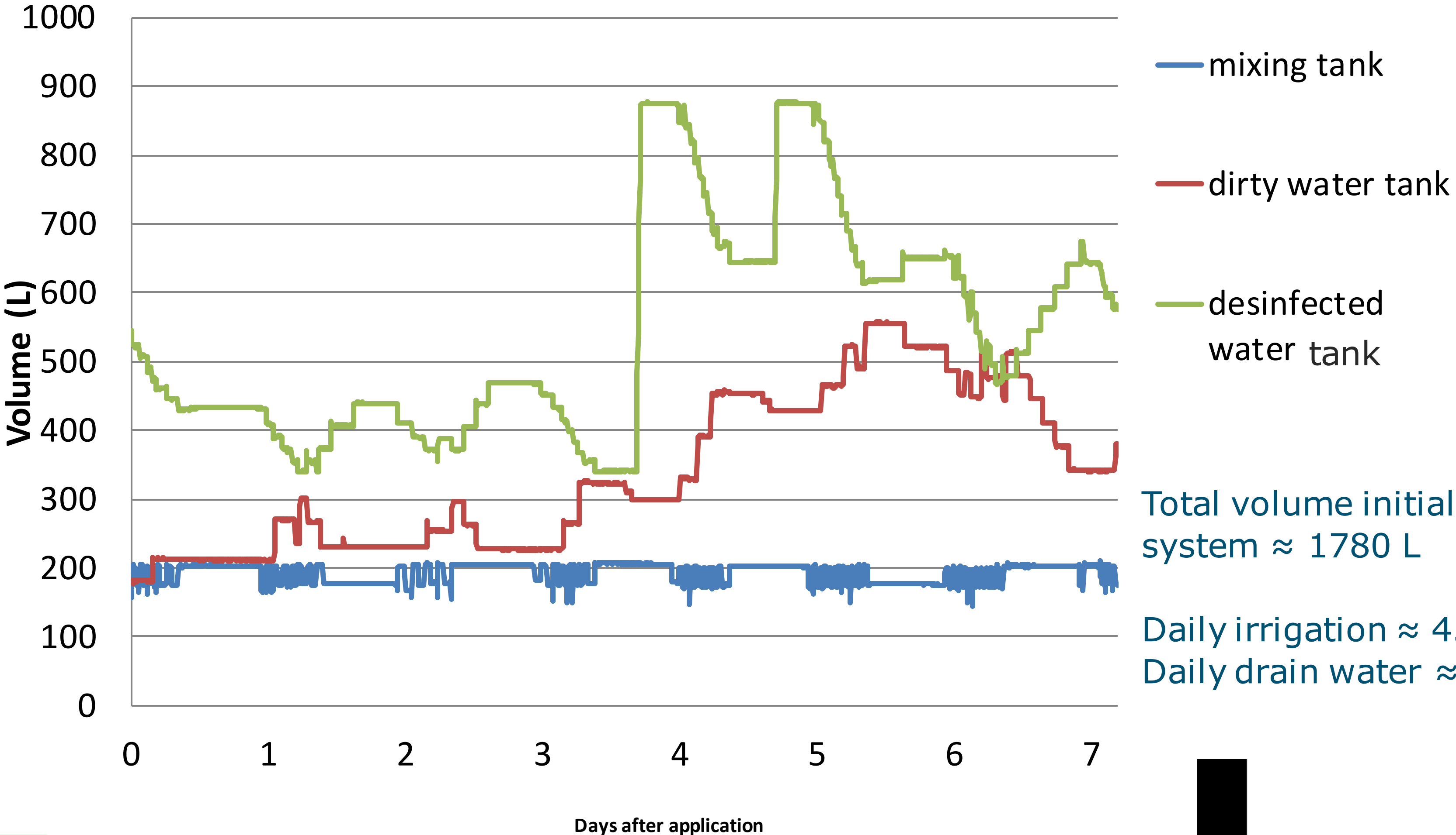
Water in tanks (pressure sensors)



Total volume initially in system ≈ 1780 L

Daily irrigation ≈ 450 L
Daily drain water ≈ 120 L

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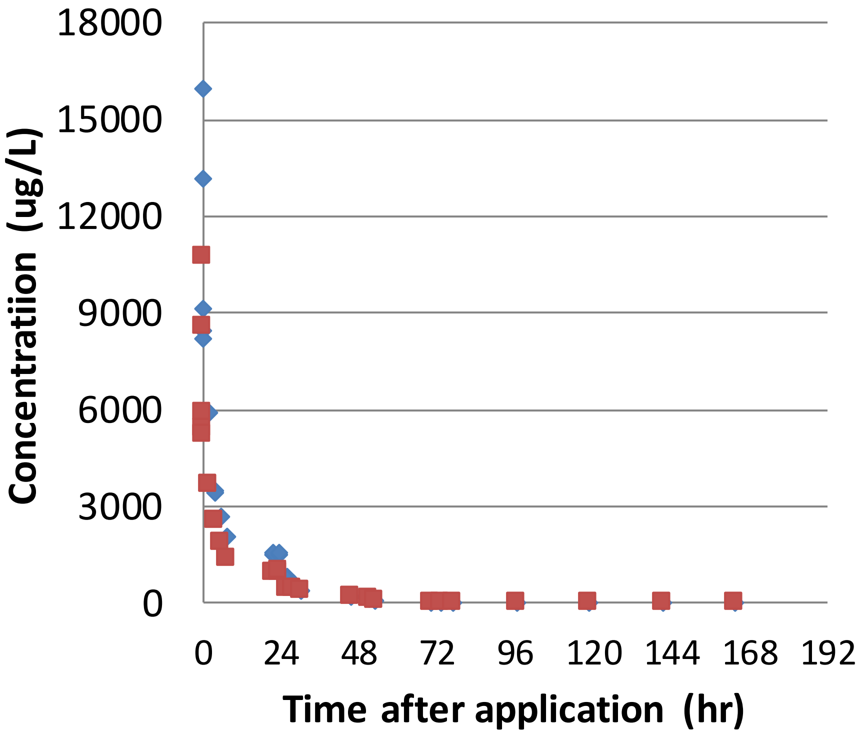
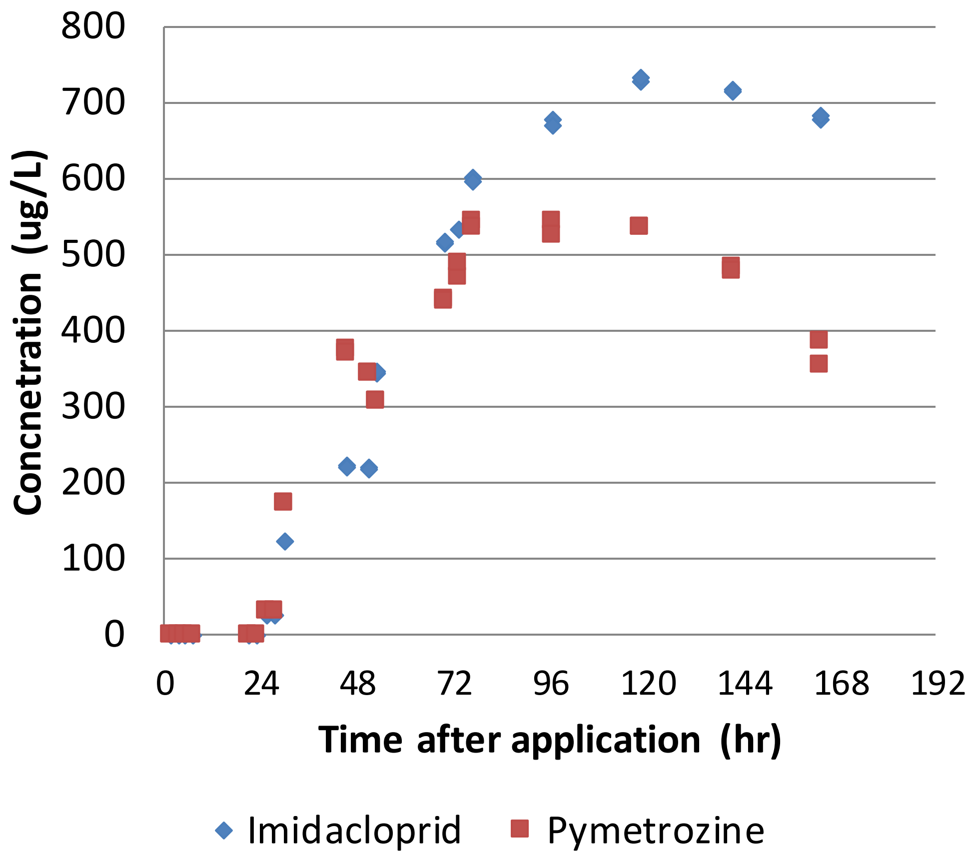
Measured concentrations

- mixing tank

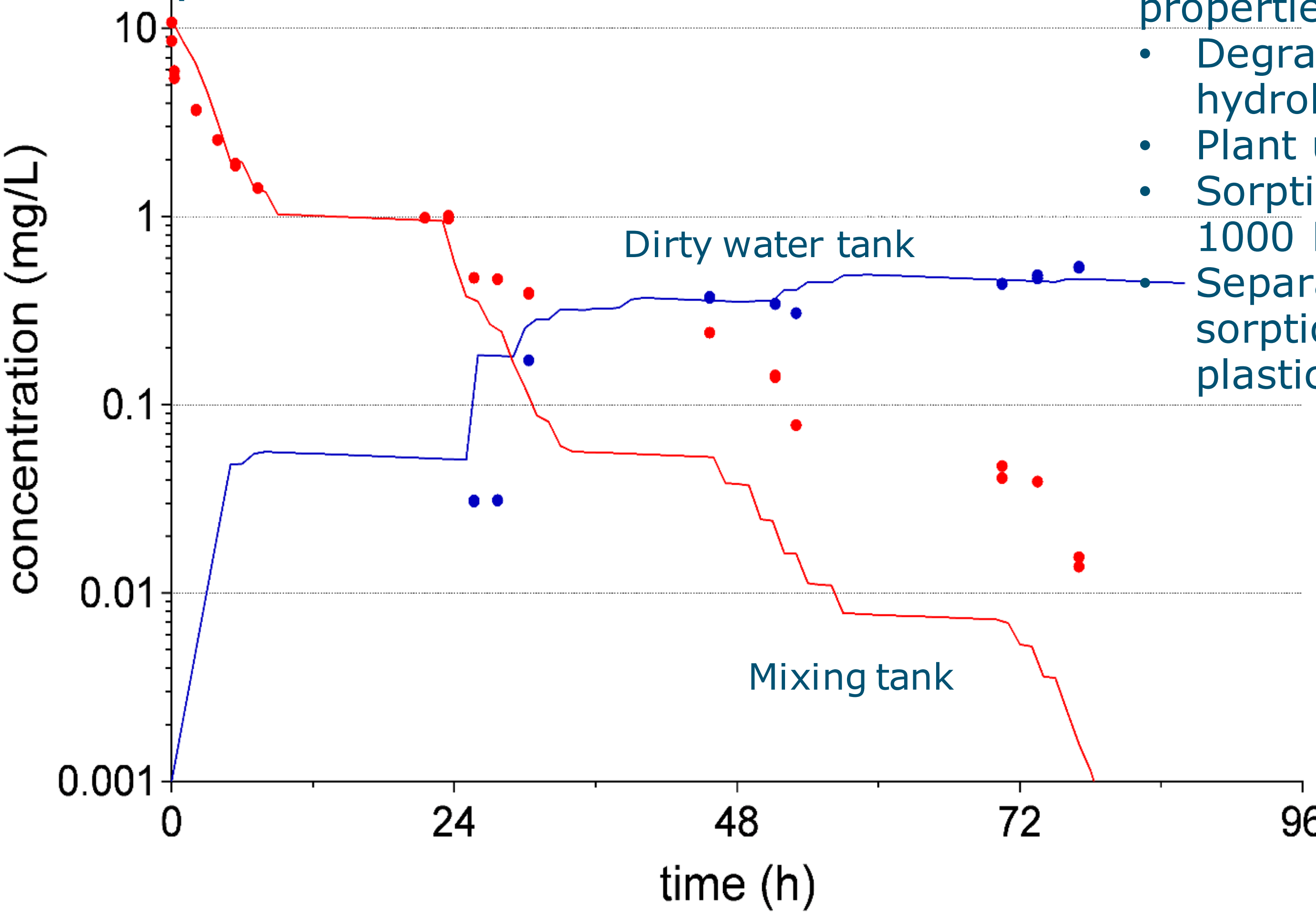


- dirty water tank



Simulated results: pymetrozine

- Measured water flows and volumes of the tanks are input to the model

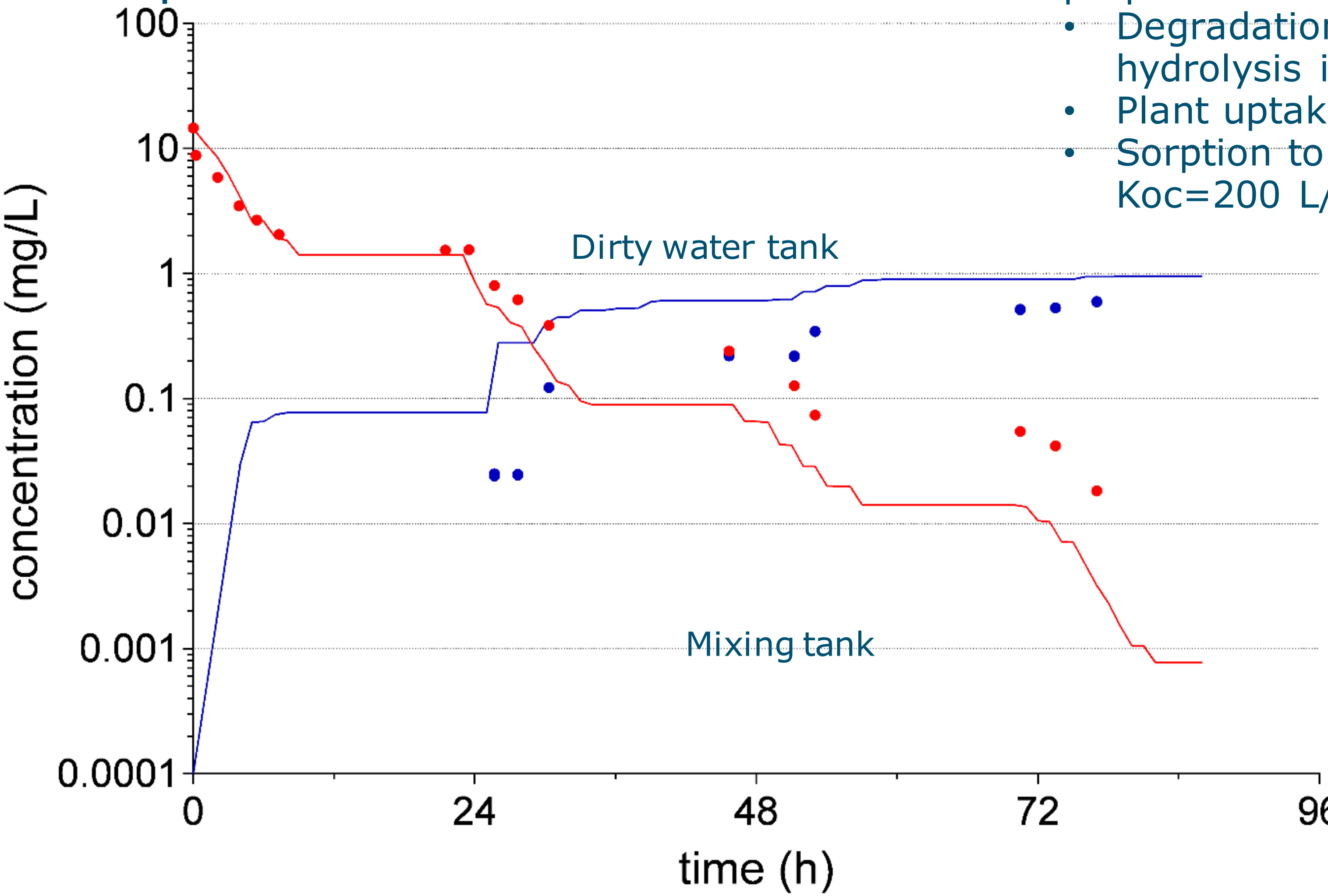


properties:
- Degradation due to hydrolysis (half-life 5 d)
- Plant uptake factor = 0.16
- Sorption to soil is Koc = 1000 L/kg,
  Separate study: no sorption detected to plastic tubes & stonewool

Simulated results: imidacloprid

- Measured water flows and volumes of the tanks are input to the model

properties:
- Degradation due to hydrolysis is negligible
- Plant uptake factor = 0.47
- Sorption to soil is Koc=200 L/kg



Lessons learned from earlier experiment 2014

- Earlier experiment was done with a similar experimental set up, but with a lower frequency of measurements at the start
- No disinfection unit→ recirculation of substance detected
- Poster at this conference
- Important lesson learned:
  - Effect plant uptake is significant

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Conclusions comparison measured and predicted concentrations

- Mixing tank
  - A good match on day 1,
  - After day 1: calculated concentrations decrease faster than the measurements→ probably due to incomplete mixing
- Dirty water tank
  - Pymetrozine: measured and calculated concentrations are the same
  - Imidacloprid: calculated concentrations are two times higher, TSCF may play a role
- Ozone installation causes the substance to decrease below detection level

Outlook

- Also compare measured concentrations with concentrations based on modelled water flows instead of experimentally determined water flows
- Compare experiment and model over a larger period
- Underpinning/understanding possible incomplete mixing