Målinger på overløb – hvor svært kan det være?

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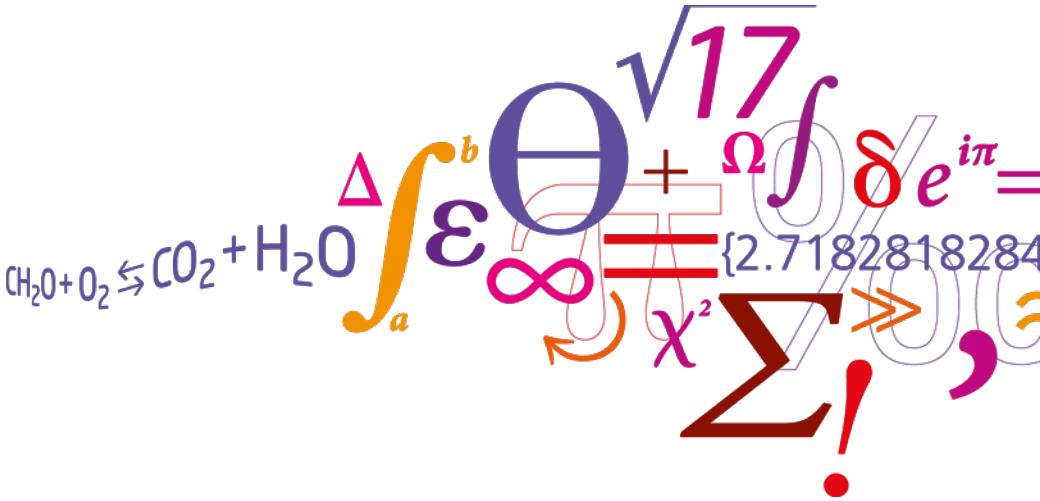
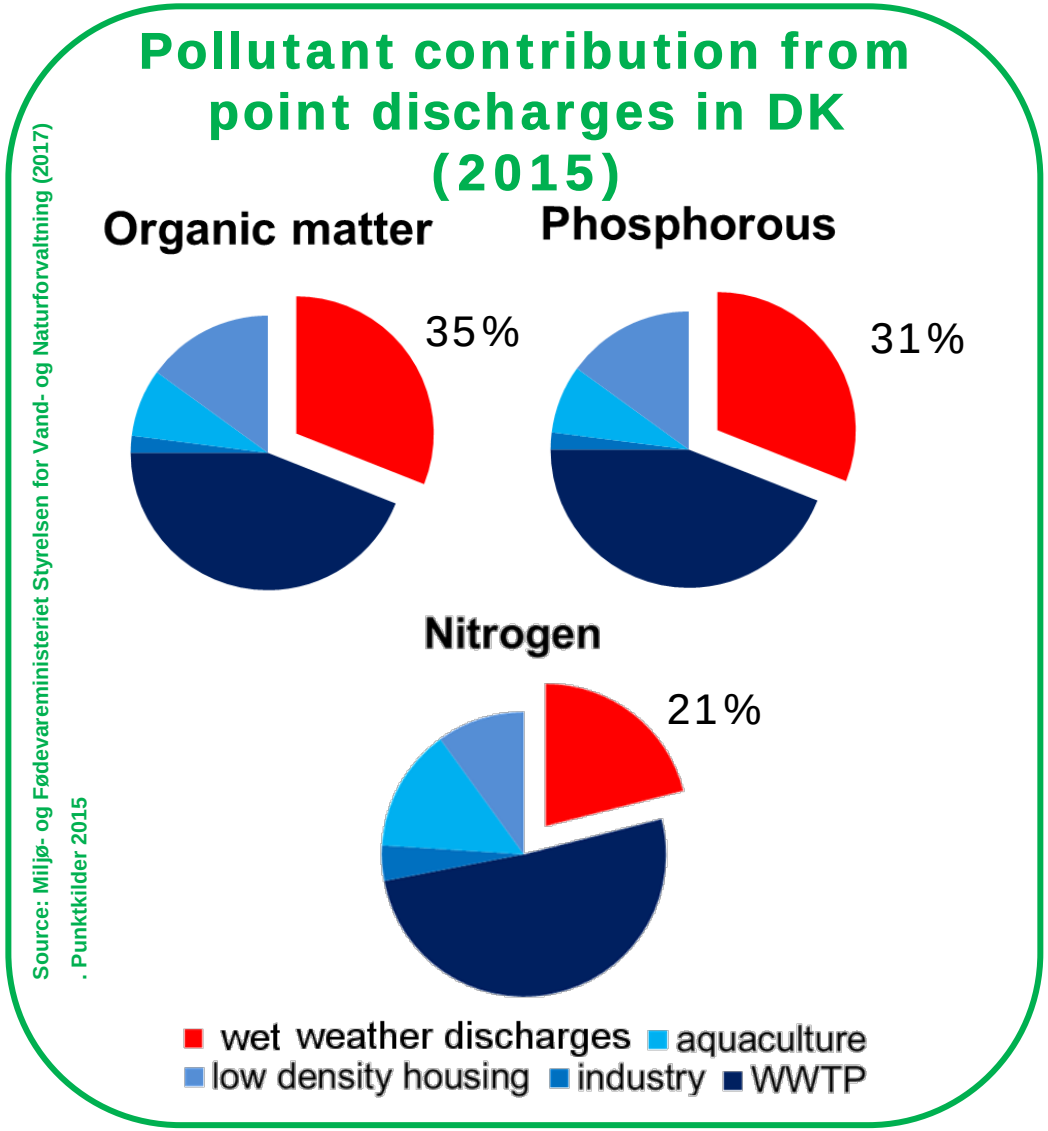
d. 29. Maj 2018



DTU Environment
Department of Environmental Engineering

Hvor stort er problem?

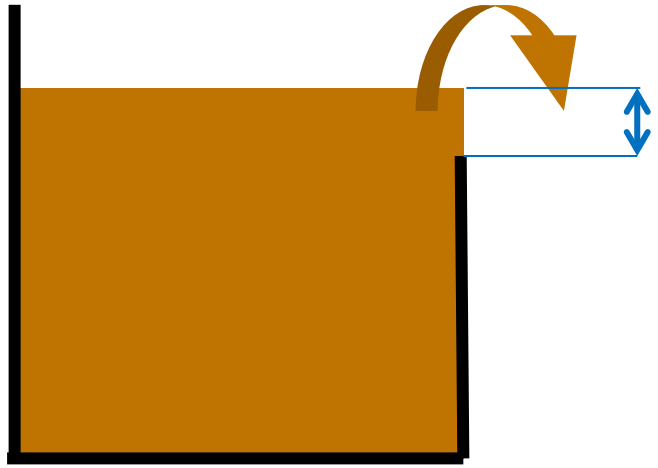


- Hvordan får vi disse tal?
- Målinger / modeller
  - Kvantitet

    Hvor meget overløbsvand blev udledt?
  - Kvalitet

    Hvor forurenet overløbsvandet var? (stofmængde / koncentrationer)

Hvor meget vand løber ud?



Længde af overløbskanten

(kendt)

$$Q = C_d \frac{2}{3} B\sqrt{2g}H^{\frac{2}{3}}$$

Koefficient (form af kanten)

(fra tabeller/boger)

Vandhøjde over kanten

(den måler vi)

Hydrauliske målinger

Overløbskanten

Hydrauliske målinger

Overløbskanten

Niveaumåler

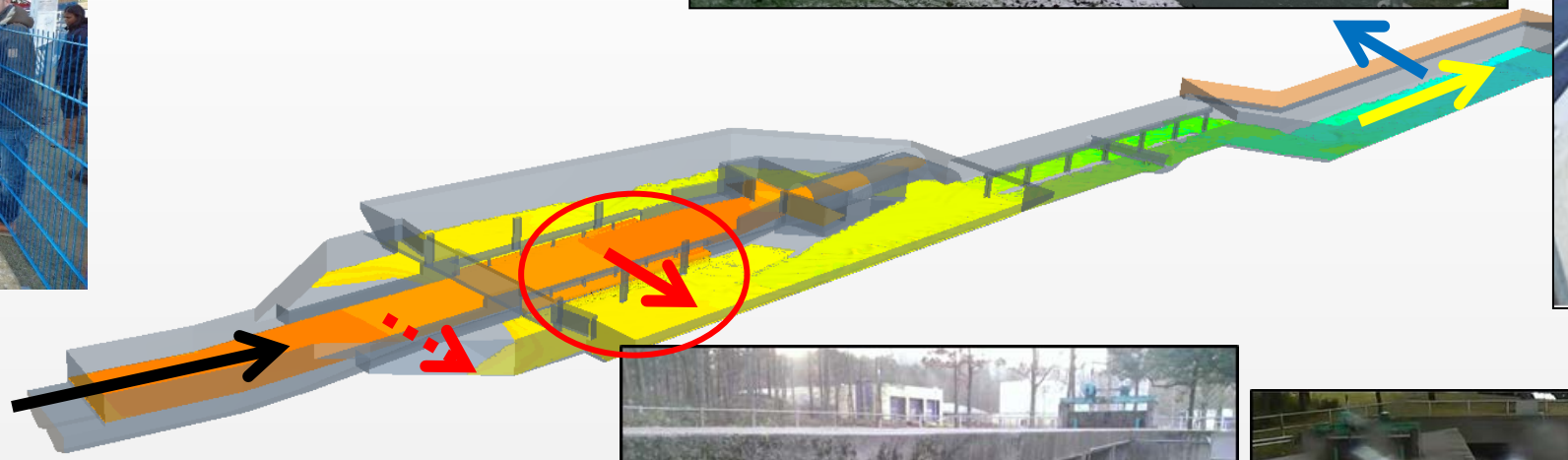
Hydrauliske målinger (lidt mere kompliceret)

Video courtesy of our colleagues
from TU Graz (Austria)

Hydrauliske målinger (lidt mere kompliceret)

Video courtesy of our colleagues
from TU Graz (Austria)

Viby Renseanlæg (Aarhus)



Slides courtesy of Malte Ahm – More details can be found in the AMOK report (cf. www.aarhusvand.dk)

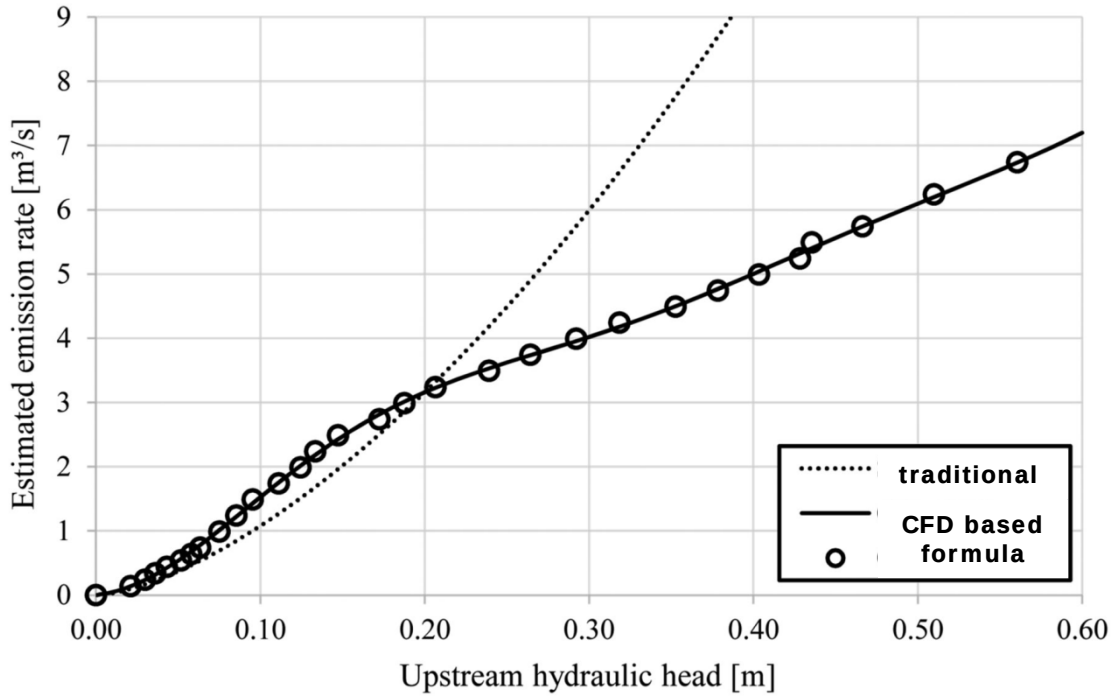
Kan vi stole på volume målinger?

Deviation Measured vs. Estimated

Event no.	Traditional weir formula[%]
1	−28.74
2	−26.82
3	−25.52
4*	−31.73
5*	−27.12
Total	−28.36

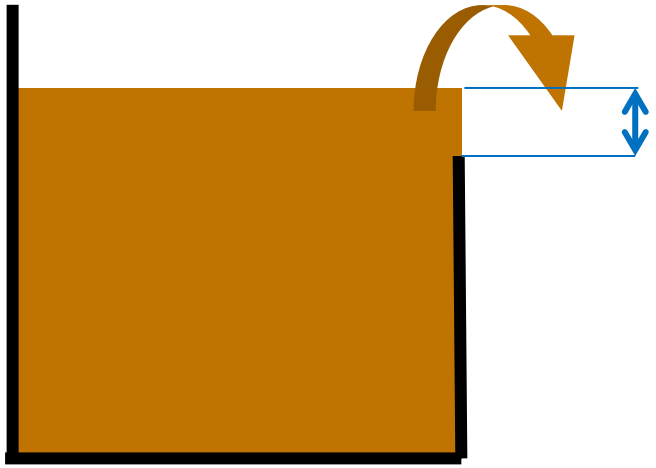
25-30% error on volume

<5% error with CFD based formula



Adapted from Ahm, M., Thorndahl, S., Nielsen, J. E., & Rasmussen, M. R. (2016). Estimation of combined sewer overflow discharge: a software sensor approach based on local water level measurements. Water Science and Technology, 74(11), 2683-2696.

Hvor meget vand løber ud?



Længde af overløbskanten

(kendt)

Vandhøjde over kanten

(den måler vi)

$$Q = C_d \frac{2}{3} B\sqrt{2g}H^{\frac{2}{3}}$$

Koefficient (form af kanten)

~~(fra tabeller/bøger)~~

Den kan vi regne ud med CFD

På et repræsentativ sted

Hvad er energitab koefficient for en tilstoppet riste????

Der vil altid være en vis usikkerhed på volumen beregninger (både målt og modelleret)

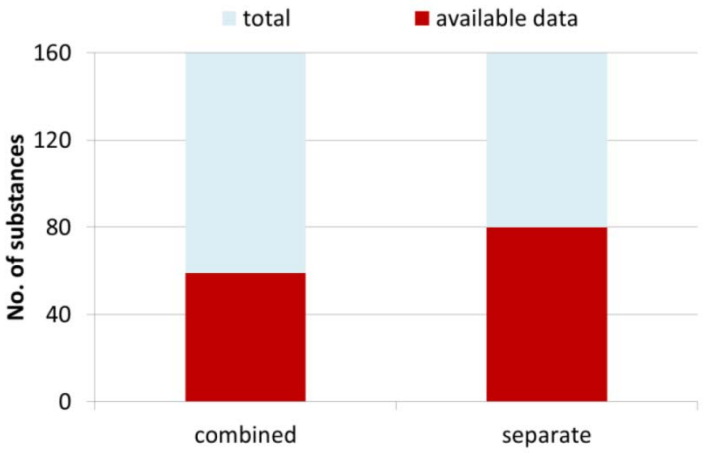
Hvor forurenet er overløbsvandet?

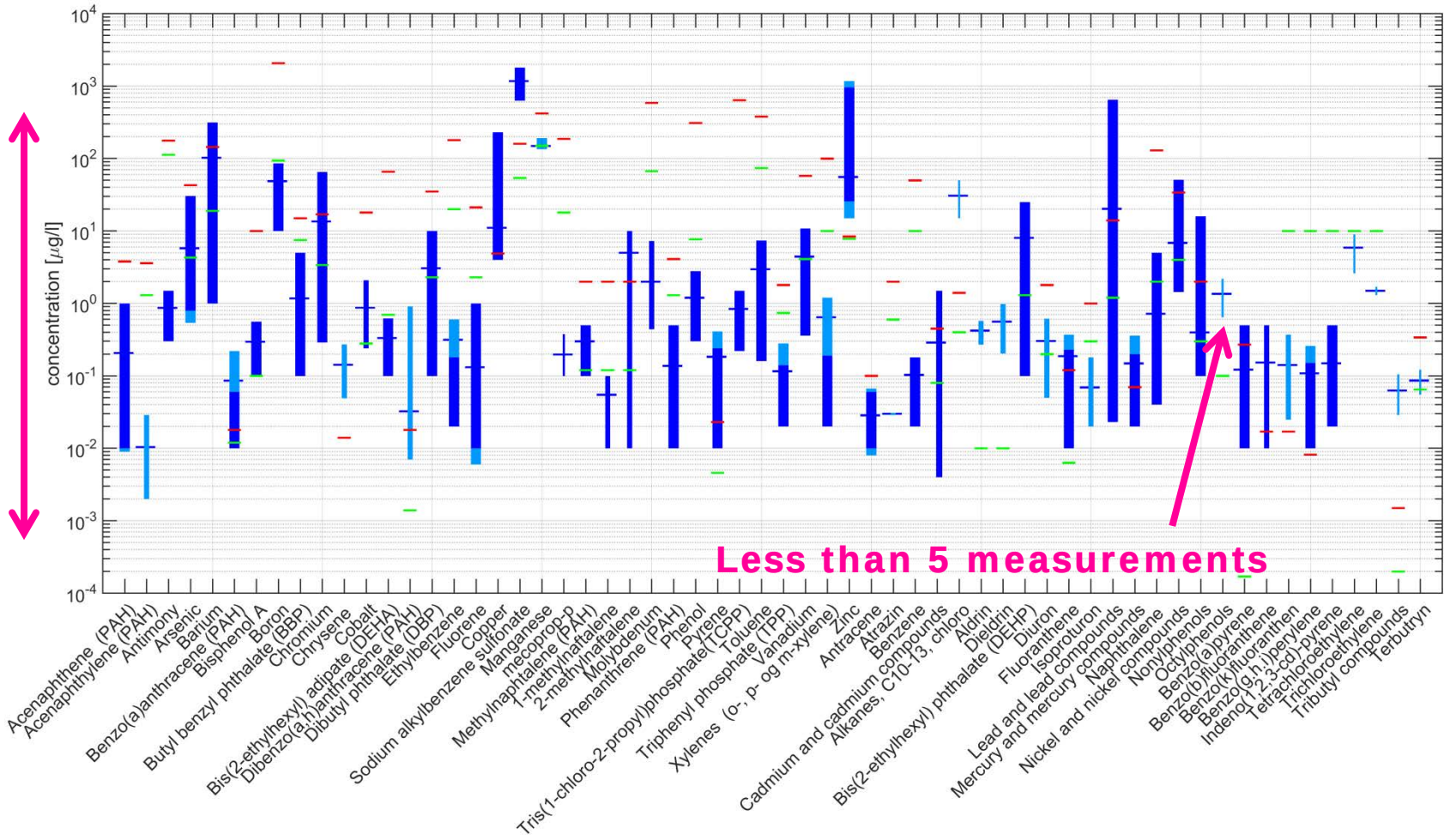
- Koncentrationer i overløbsvandet er afhængig af forskellige processer
- Forskellige muligheder for at måle overløbskvantitet
  - Mulighed #1: Ingen Målinger

    Man bruger typiske værdier fra litteratur
  - Mulighed #2: Automatiske prøvetager
  - Mulighed #3: Online sensorer

#1: Målte koncentrationer i overløbsvand

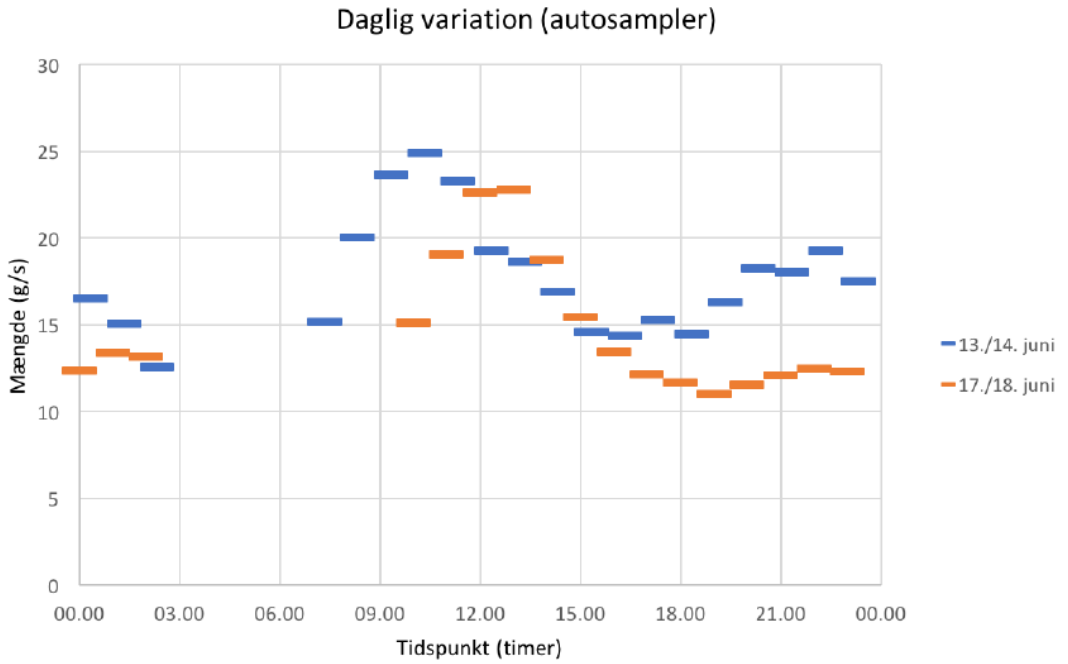
- Rain-related discharges are high variable
  - rainfall
  - pollutant sources
- Data for non-traditional pollutants are limited





Source: Vezzaro, L, Brudler, S, McKnight, US, Rasmussen, JJ, Mikkelsen, PS & Arnbjerg-Nielsen, K 2018, Operationelle udlederkrav for regnbetingede overløb fra fællessystemer til vandløb. DTU Miljø, Danmarks Tekniske Universtitet, Kgs. Lyngby..

#2 Automatiske prøvetager

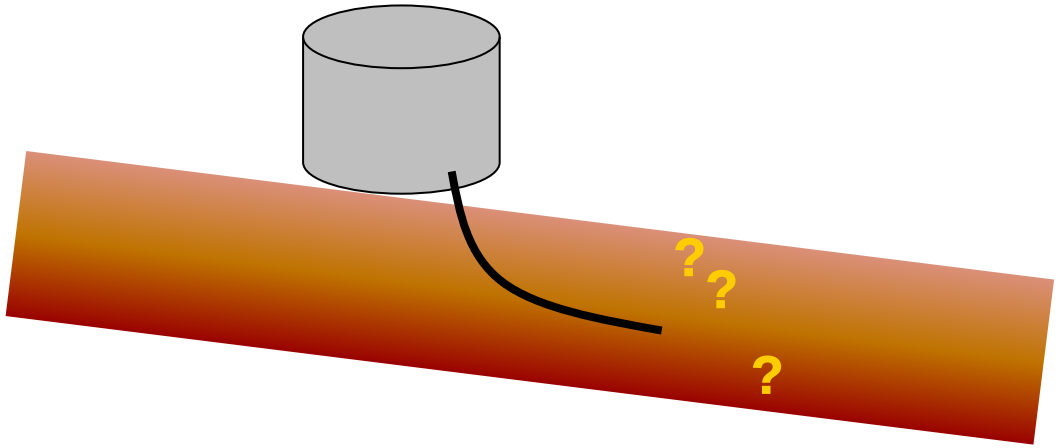


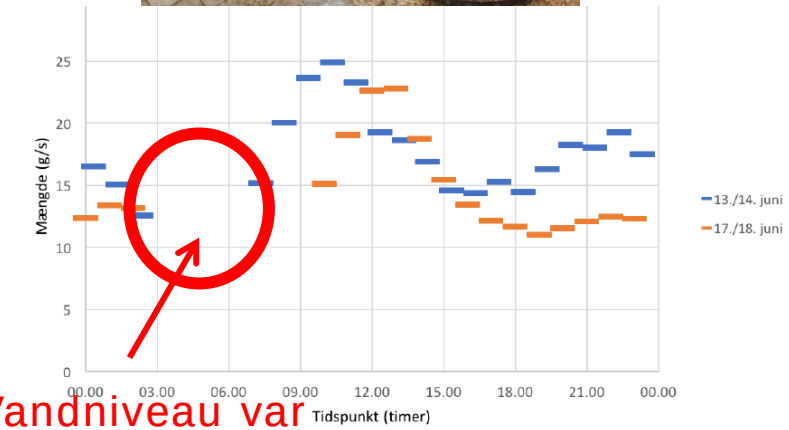
Slide credits: Camilla Høj & Karin L. Drenck

Hvad er problem med automatiske prøvetager?

- Problemer med installationen (adgang til overløbsbygværket)

- Placering af indsugning (hvor repræsentativ?)





- Man ved ikke hvornår overløb sker

(hvornår skal prøvetager tændes?)

Vandniveau var for lavt

#3 online sensorer

- En række vandkvalitet parameter kan måles med høj tidsopløsning (~ 1-5 minutter)

Photo: Ravi Kumar Chhetri

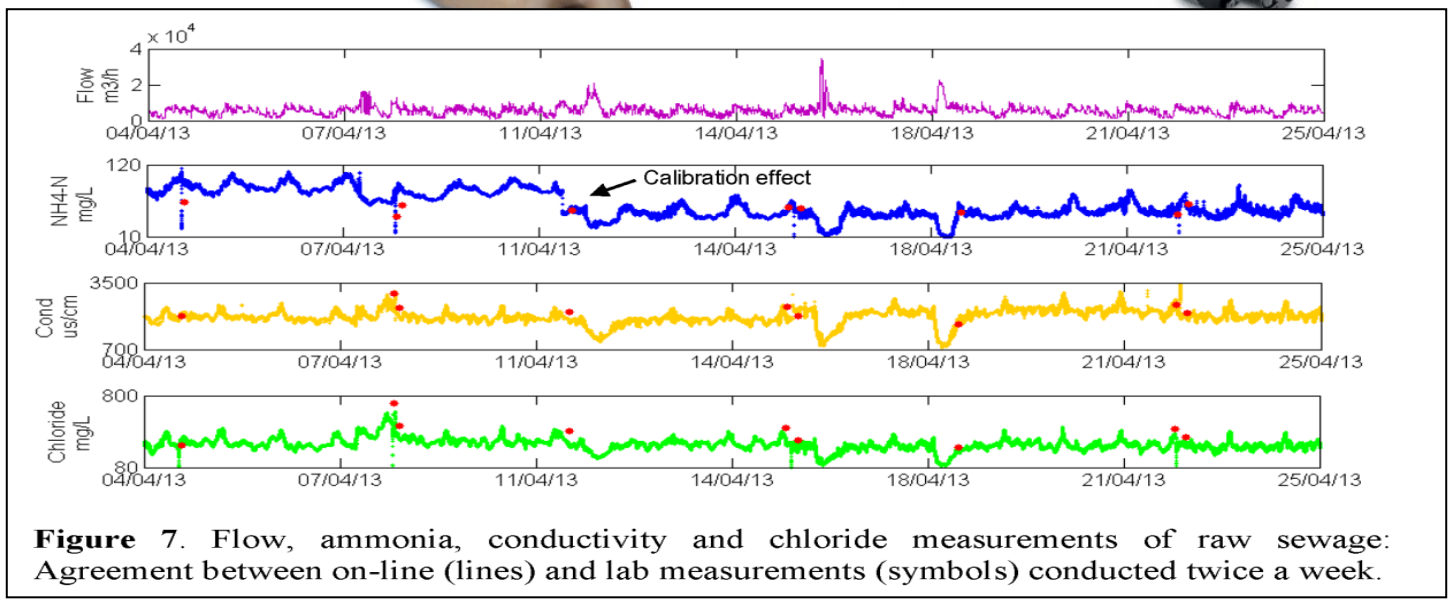
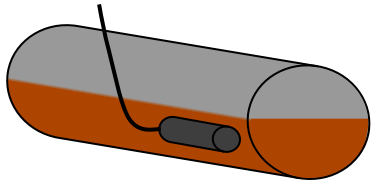


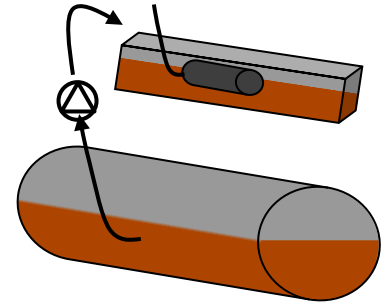
Figure 7. Flow, ammonia, conductivity and chloride measurements of raw sewage: Agreement between on-line (lines) and lab measurements (symbols) conducted twice a week.

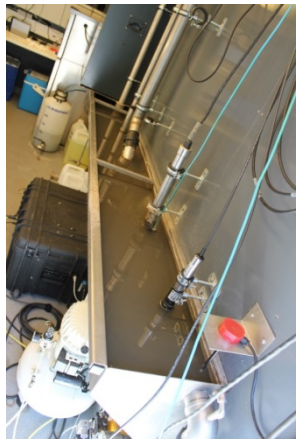
Source: *Alferes et al. (2014), Advanced monitoring of wastewater quality: data collection and data quality assurance, Proceedings of 13th ICUD2014*

Placering af sensorer

- Two main “sampling philosophies” used nowadays
  - In Situ
    (sensors are placed in sewer water)
  - Ex situ
    (sewer water is pumped up)
  - AMOK project
    (we had both)

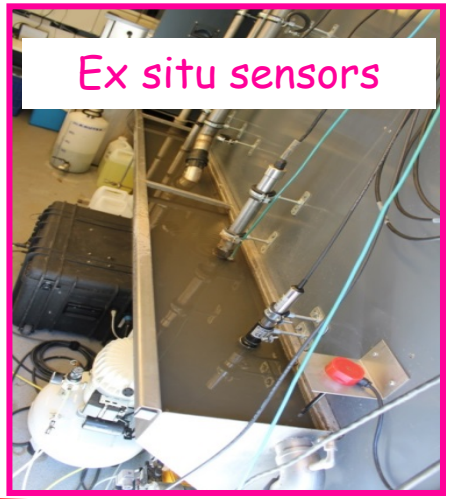


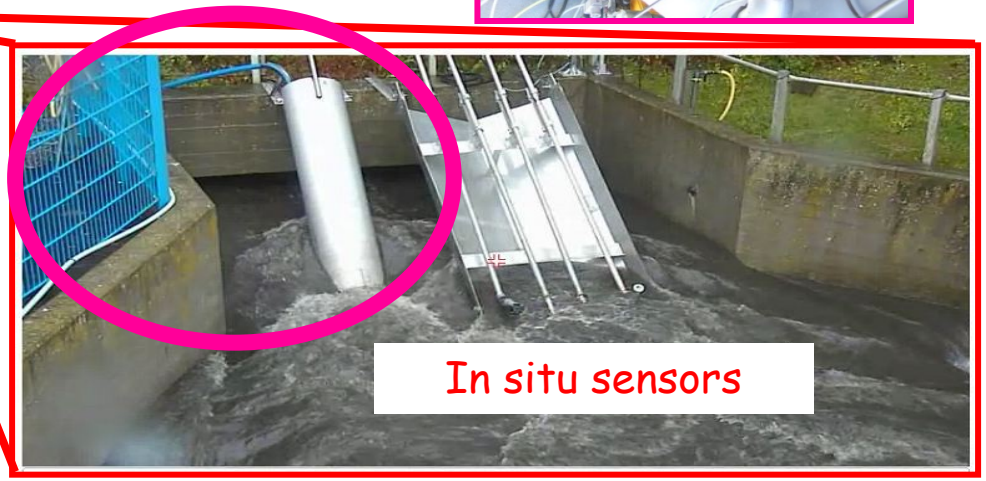




AMOK project
Testing site

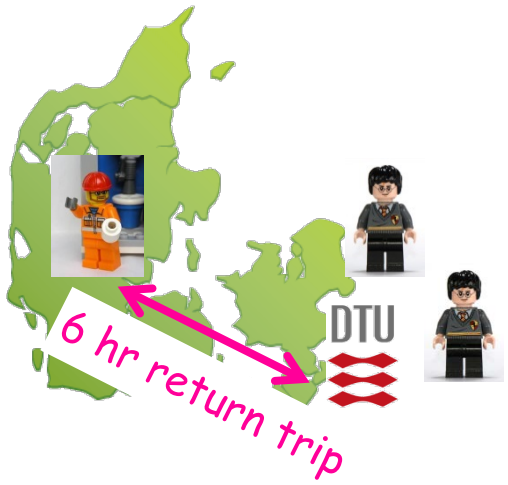
- Advanced Monitoring of Sewer Overflow
  - CSO at inlet of Viby WTTP (Aarhus, Denmark)
  - Catchment: ≈ 700 ha combined + ≈ 750 ha separate
  - Max flow in wet weather 1.26 m^3/s
- Five on-line measurements (in this study)
  - Flow, Temperature, Conductivity, Turbidity, NH_4
  - One minute resolution





AMOK – den perfekte dataset?

- Mere end 1.5 år målinger



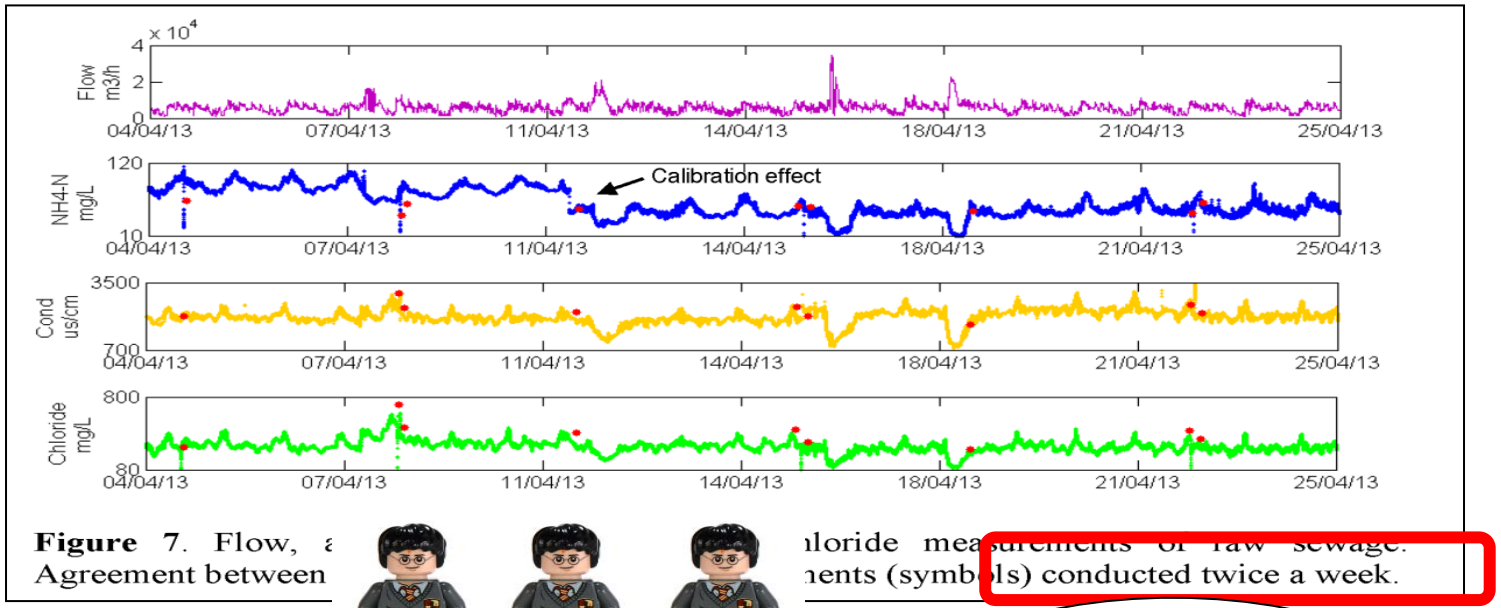
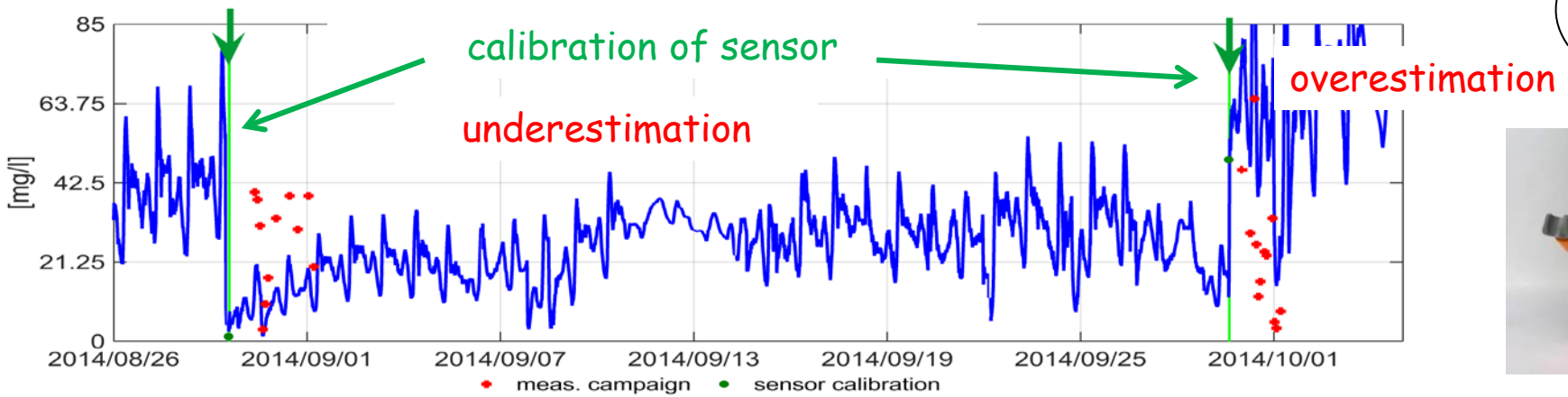


Figure 7. Flow, a … loride mea…ements of raw sewage. Agreement between … ents (symbols) conducted twice a week.

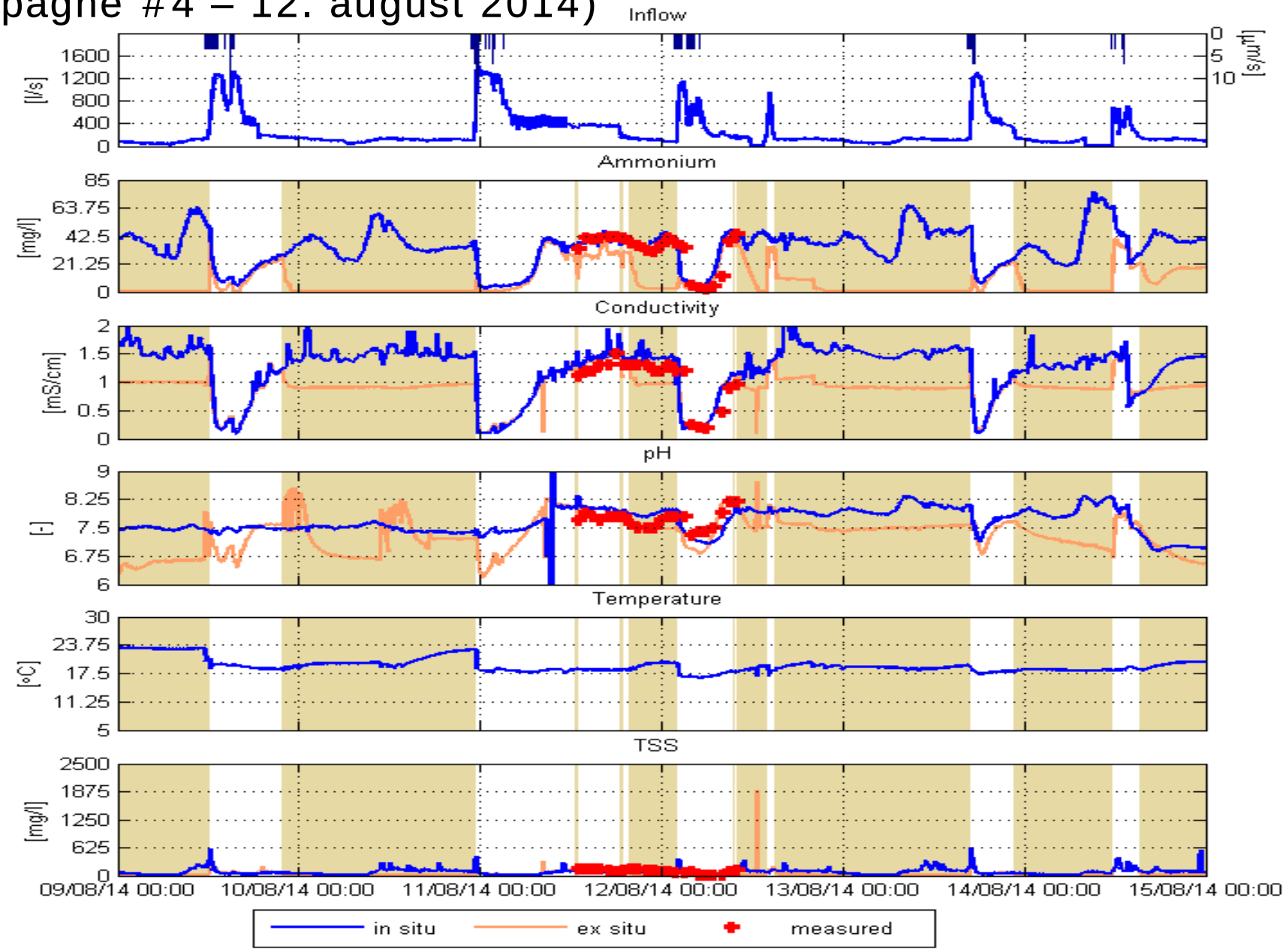


I have thousand other things to do!

Source: *Alferes et al. (2014), Advanced monitoring of wastewater quality: data collection and data quality assurance, Proceedings of 13th ICUD2014*

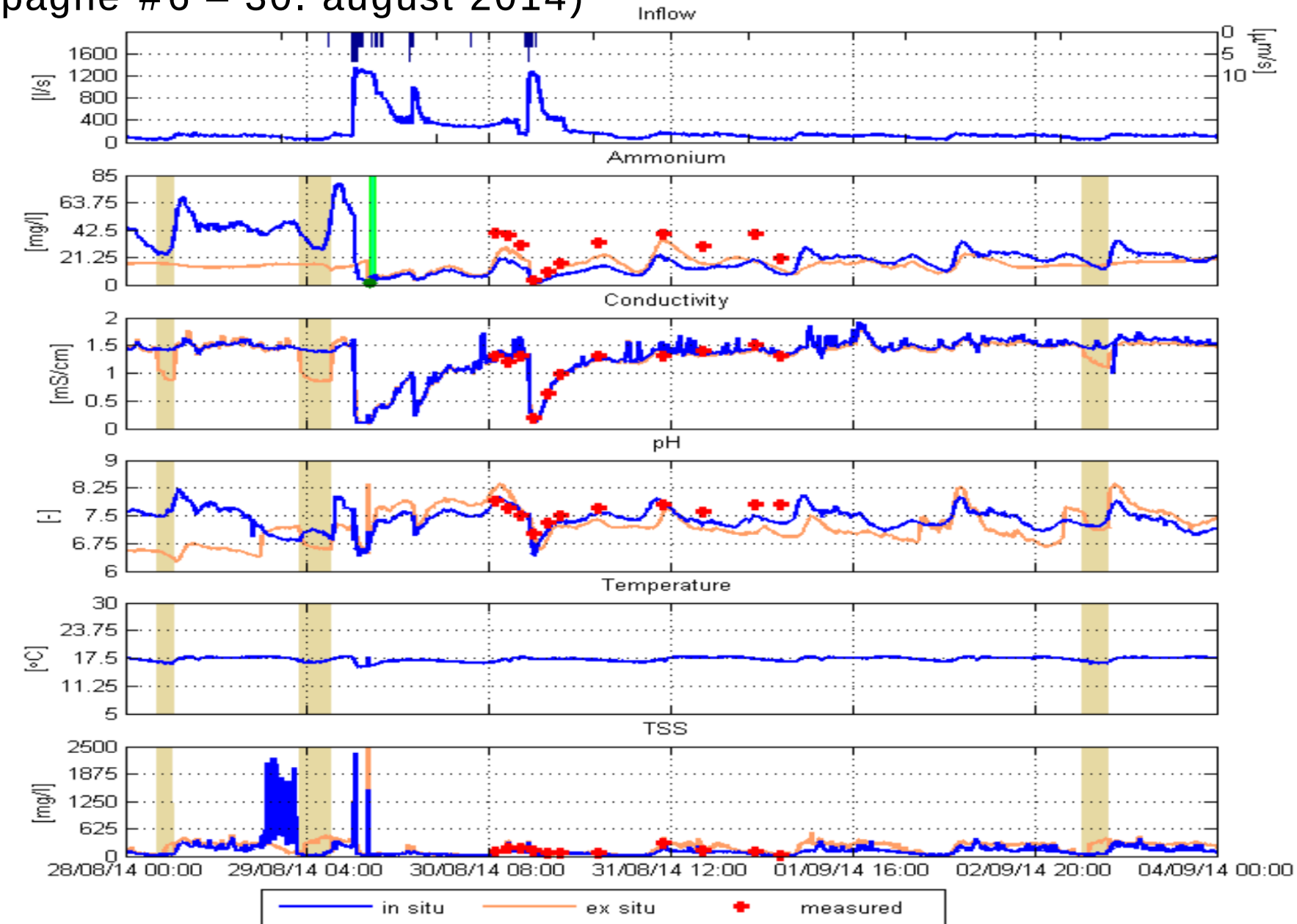
Resultat fra online sensorer

(Målekampagne #4 – 12. august 2014)



Resultat fra online sensorer

(Målekampagne #6 – 30. august 2014)

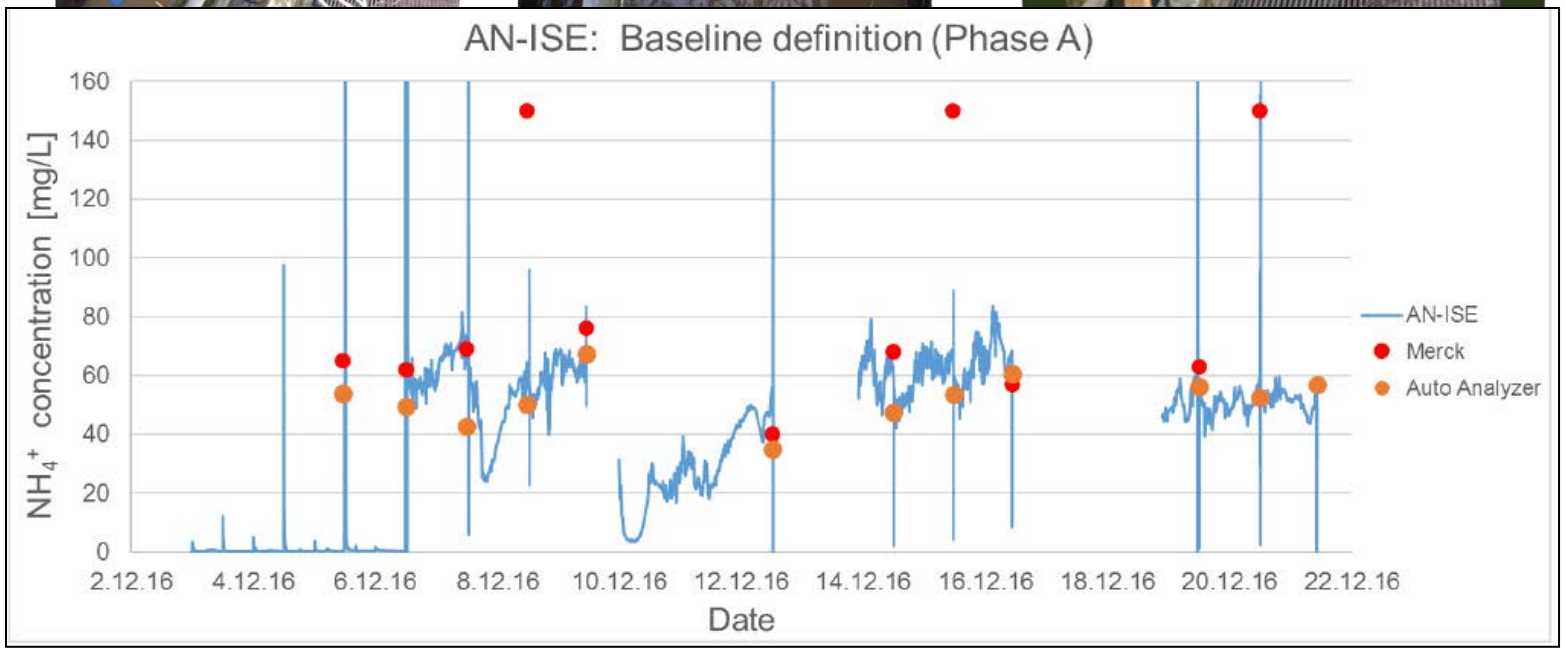


How long can we trust our sensors?

- Low-cost installation
- What happens if maintenance is not as good as it should?
- Three scenarios for sensor cleaning:
  - Every day (perfect world)
  - Once per week (typical Standard Operating Procedure)
  - Once every second week (not so ideal world)
- Comparison sensors vs. lab measurements

Slide credits: Linea S. Skov

How long can we trust our sensors?



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Slide credits: Linea S. Skov

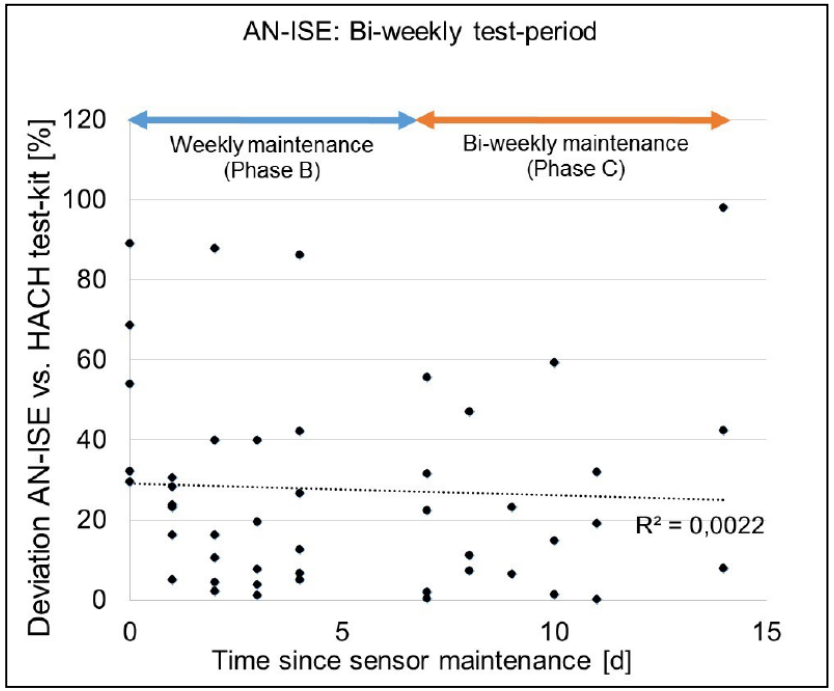
How long can we trust our sensors?

(Preliminary results)

- Three scenarios for sensor cleaning:
  - Every day (perfect world)
  - Once per week (typical Standard Operating Procedure)
  - Once every second week (not so ideal world)

→ Good precision (5-10%)

→ Measurement deteriorates already after 2-3 days



Slide credits: Linea S. Skov

Målinger på overløb – hvor svært kan det være?

Hydraulik

- Q-h formler skal tilpasses til de enkelte overløbsbygværker
- Placering af vandniveau måler er afgørende for præcision
- CFD modellering kan hjælpe (både med Q-h formler of placering af niveau måler)

Forurening

- Automatiske prøvetager kan anvendes kun for korte målekampagne
- Online sensorer giver et godt overblik over dynamikken af forureningsstoffer…
- …men de kraver store indsats til vedligeholdelse

Søges:

Billige vandkvalitet sensorer som kan overleve i en kloak næsten uden vedligeholdelse

Thank you for listening!

An overflow expert

luve@env.dtu.dk