



Integrated modelling in Denmark: Current applications and research projects

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Integrated modelling in Denmark: Current applications and research projects

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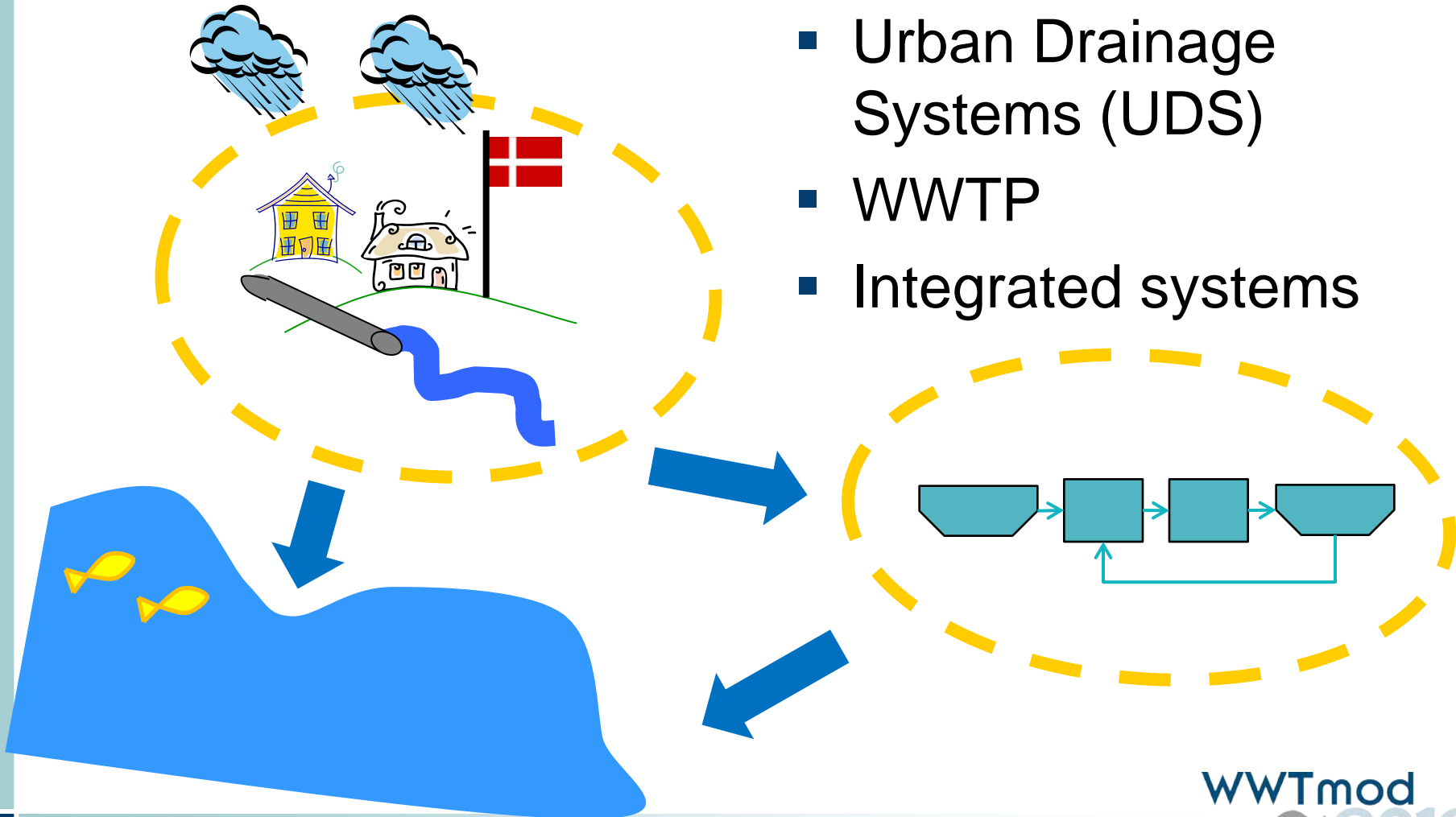
²⁾ Krüger A/S, Søborg, Denmark



International
Water Association

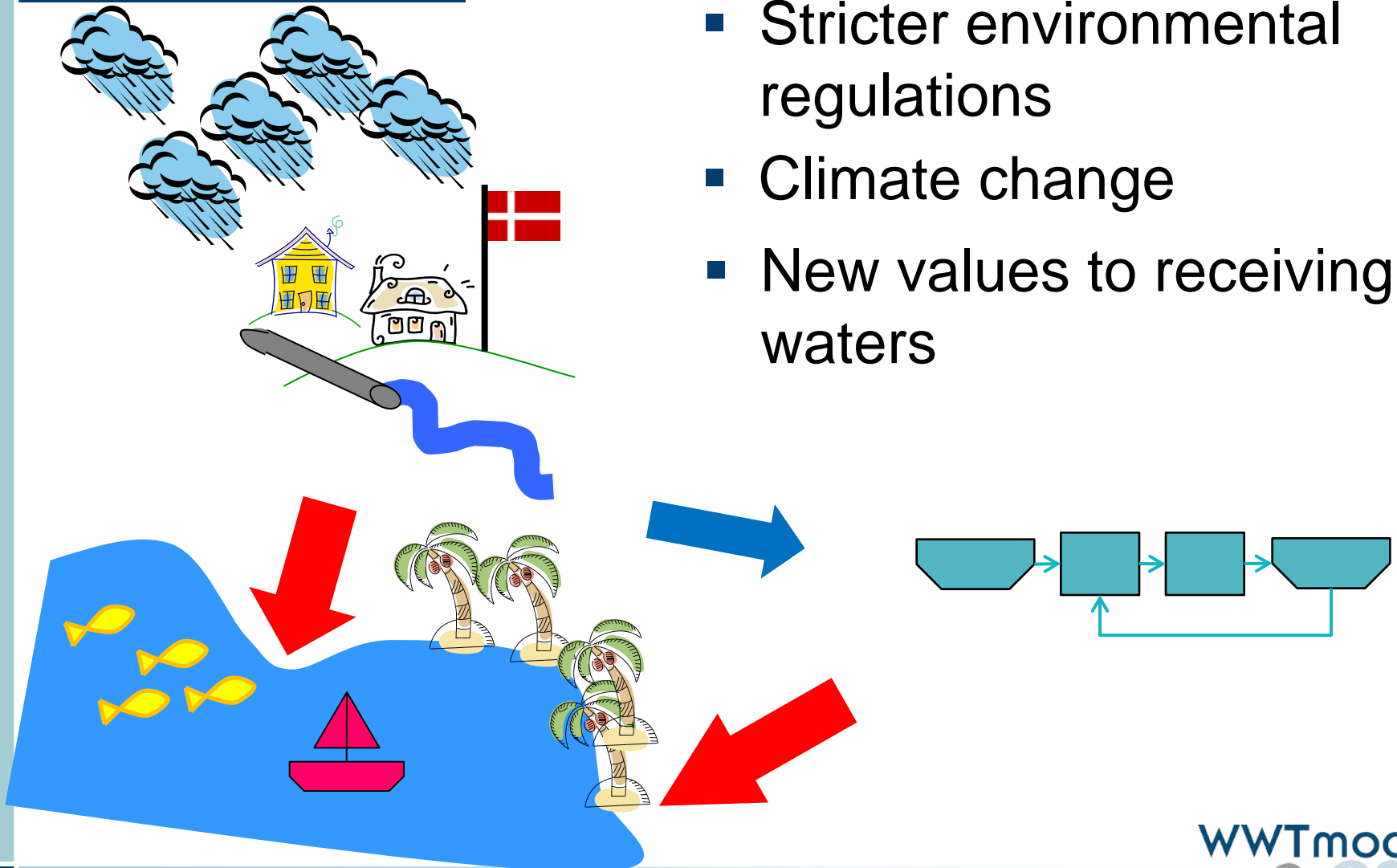
Modelling and control in the past

- Long experience in
 - Urban Drainage Systems (UDS)
 - WWTP
 - Integrated systems

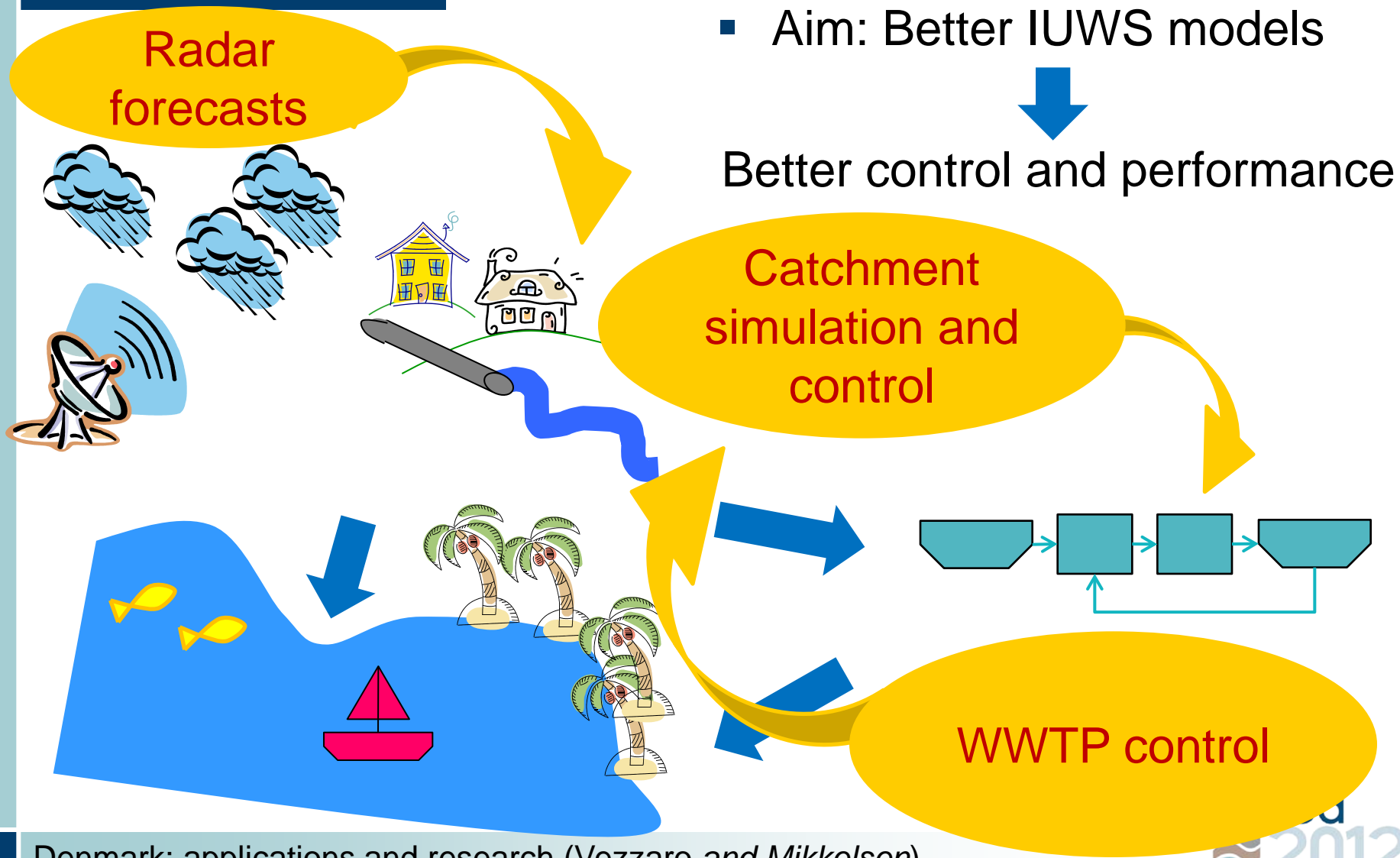


New drivers for IUWS control

- Stricter environmental regulations
- Climate change
- New values to receiving waters



Storm- and Wastewater Informatics (SWI)



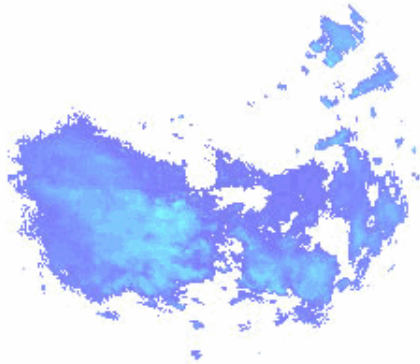
SWI study areas

Radar based forecasts

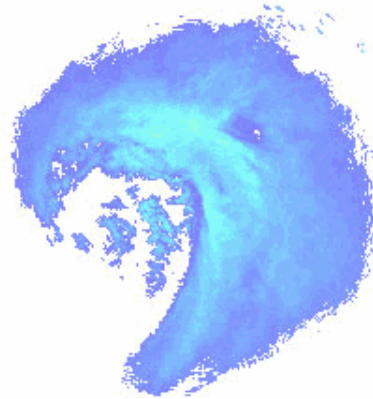


- Coupling of X-band and C-band radar for forecast prediction (*Jesper Ellerbæk Nielsen*)

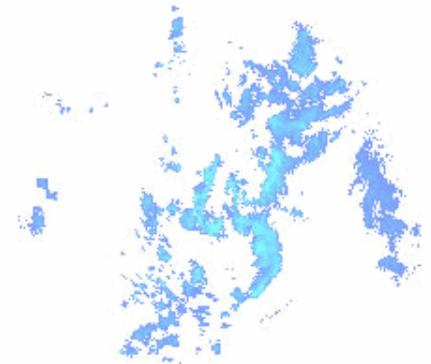
Stratiform event



Cyclonic event



Convective event



Problems for IUWS performance

Low

Uncertainty in model predictions

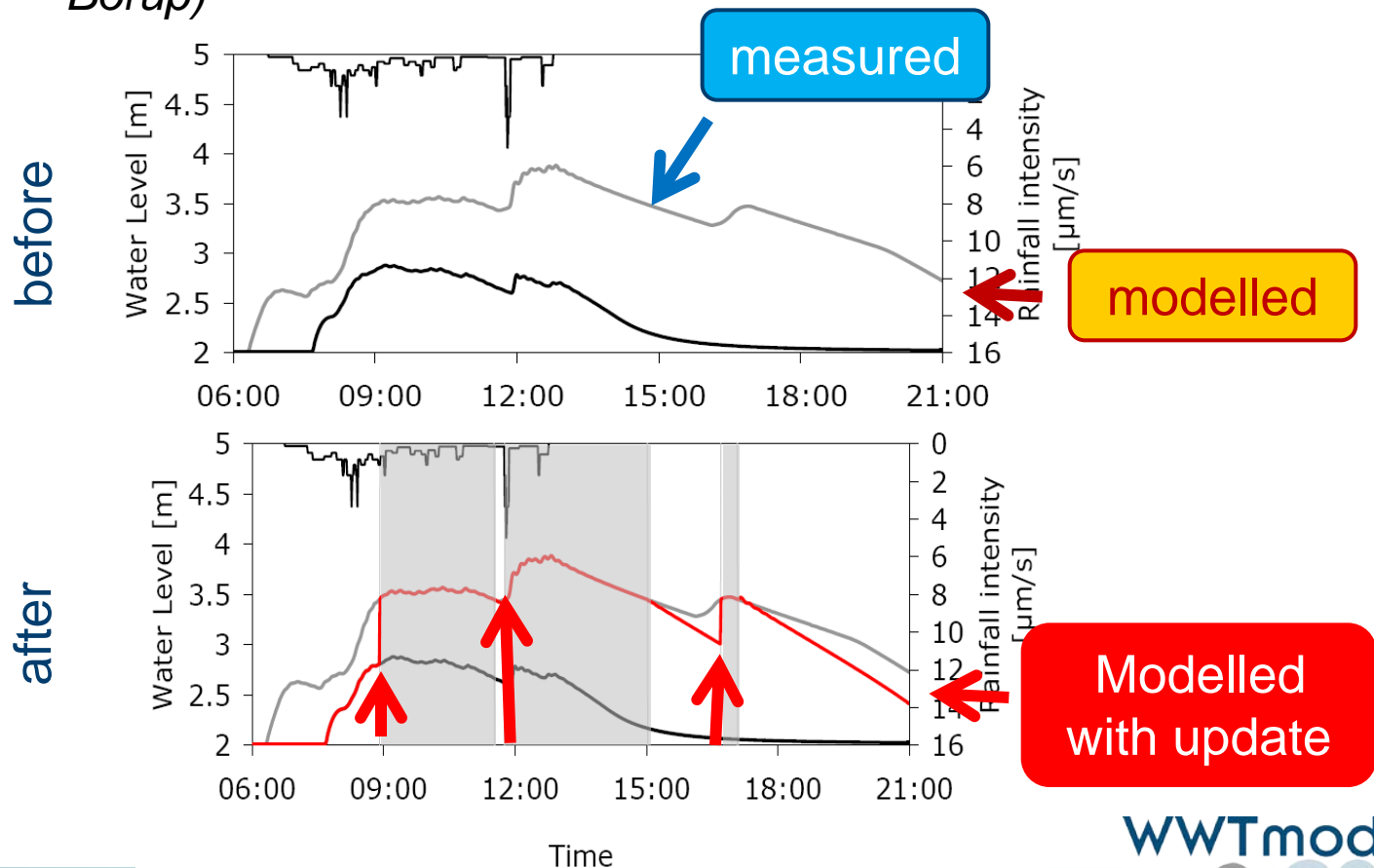
High

SWI study areas

Urban drainage models



- Data assimilation in urban drainage models (*Morten Borup*)



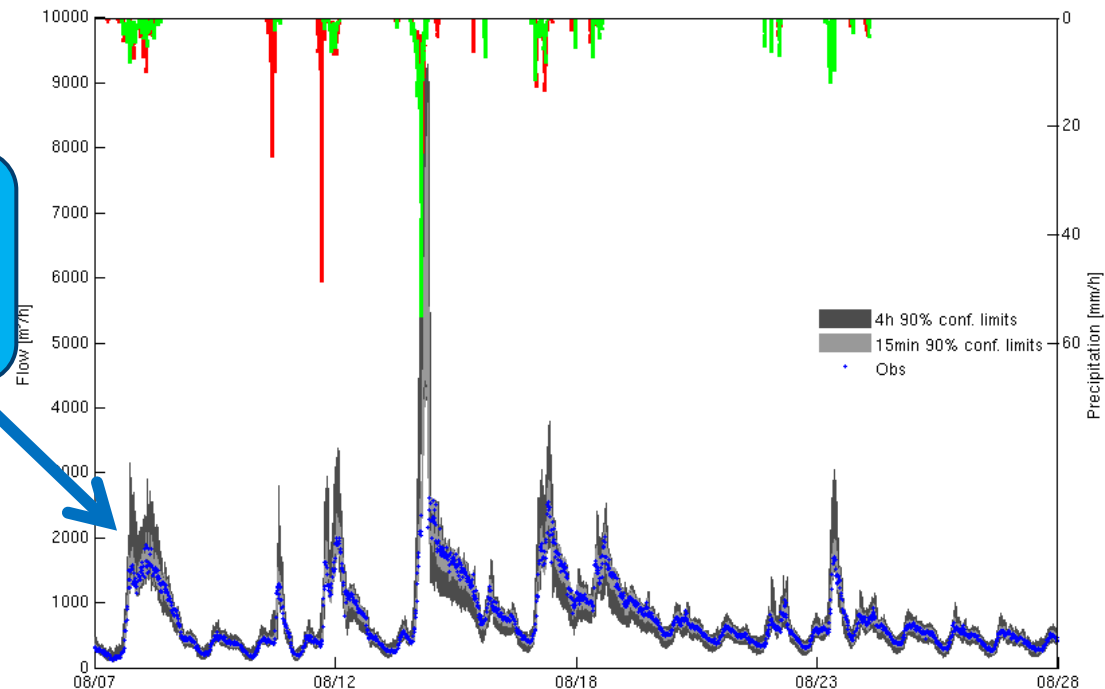
SWI study areas

Urban drainage models



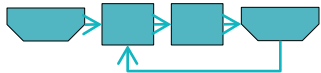
- Grey-box models for flow forecasts (*Roland Löwe*)

Probabilistic
estimation of
uncertainty bounds

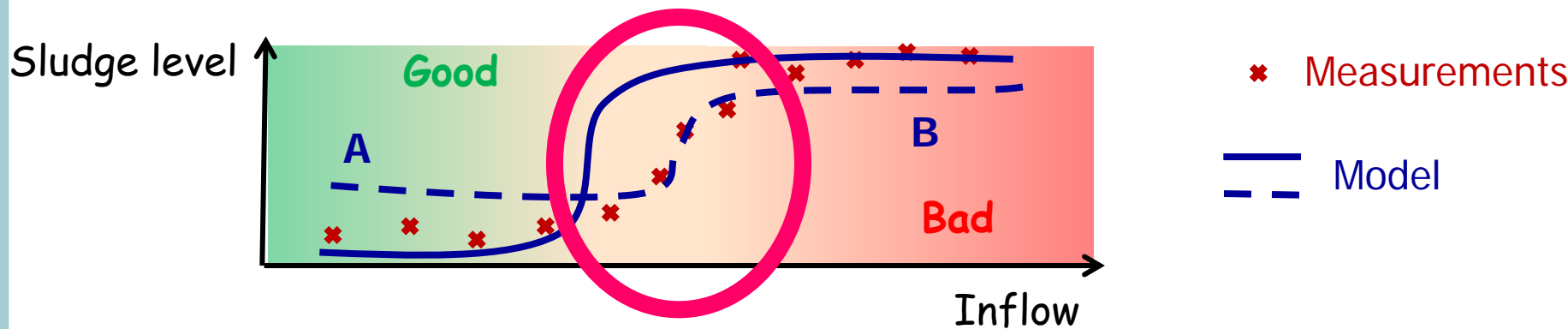


SWI study areas

Clarifier models



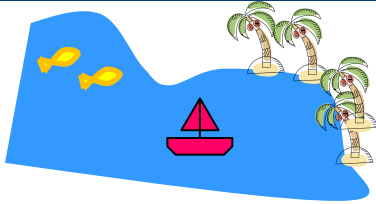
- Better models for sludge blanket (*Elham Ramin*)



Which model is better? A or B?

SWI study areas

Risk analysis



- Quantitative microbial risk assessment (*Signe Tanja Andersen*)



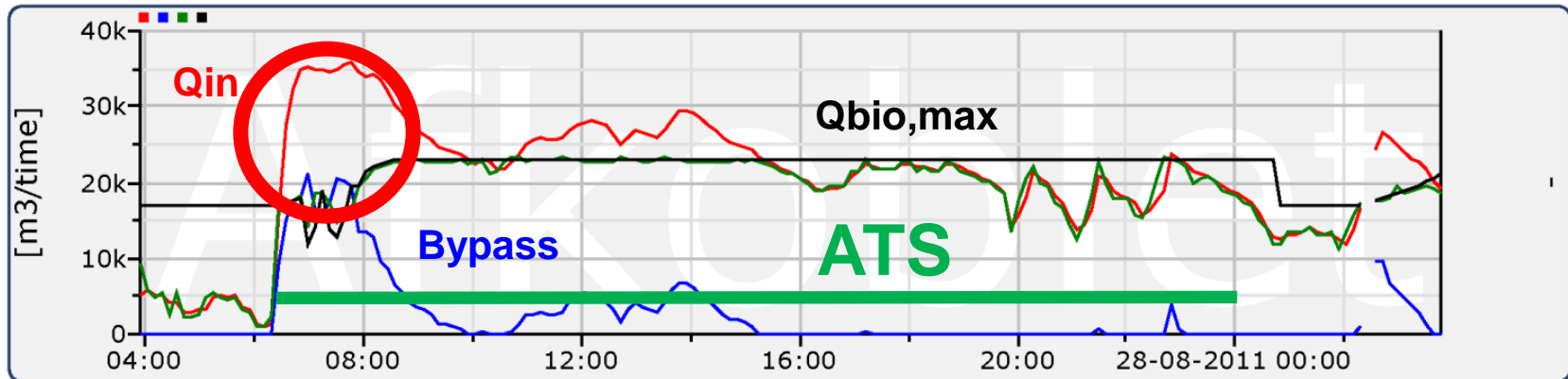
What is the quality during rain events?



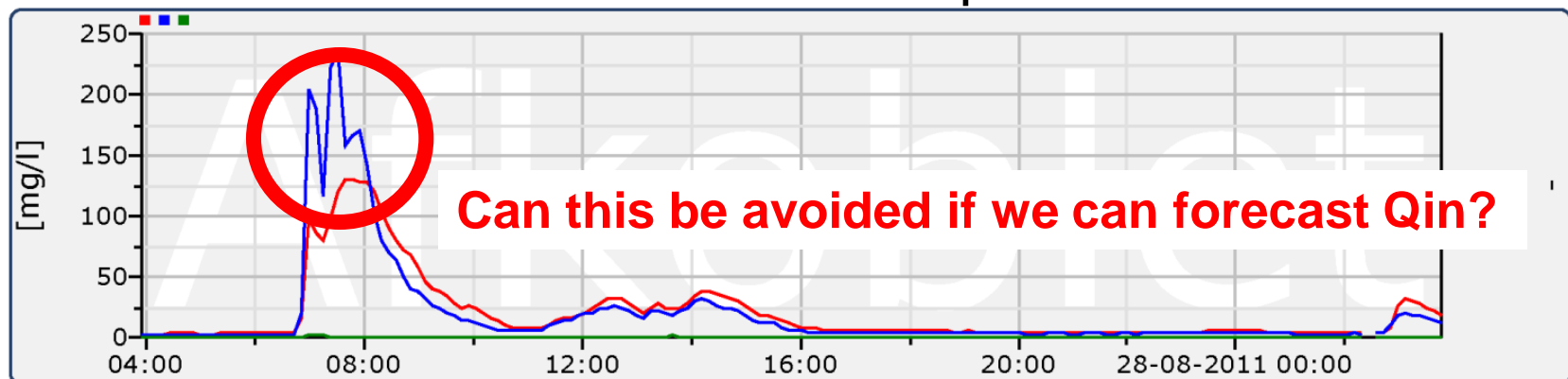
Benefit of IUWS integrated modelling

example from Lynetten in Cph, with Aeration Tank Settling

Inflow to WWTP



SS in settler output



Benefit of IUWS integrated modelling

Model Predictive Control of Marselisborg catchment (Aarhus)



KRÜGER

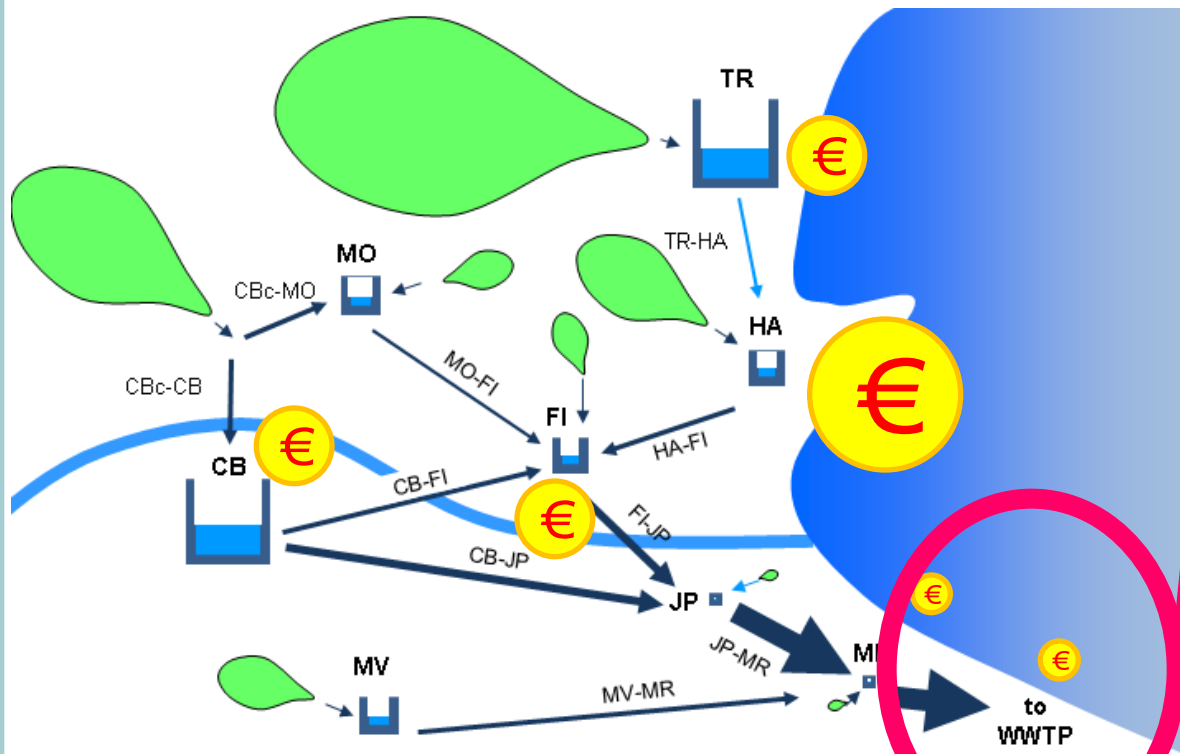
Runoff forecast



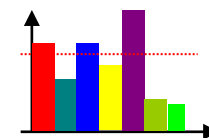
Uncertainty



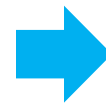
Less overflows in sensitive points



State



Wanted state



How much water can I send downstream to the WWTP?

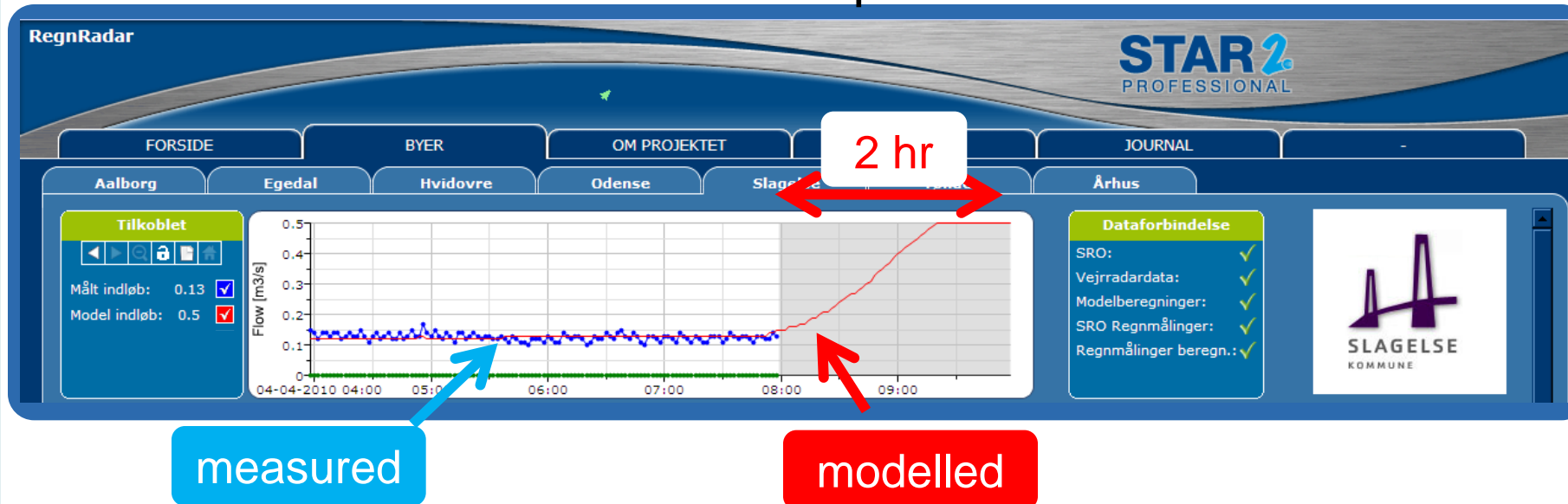
WWTmod
2012

How good are we?

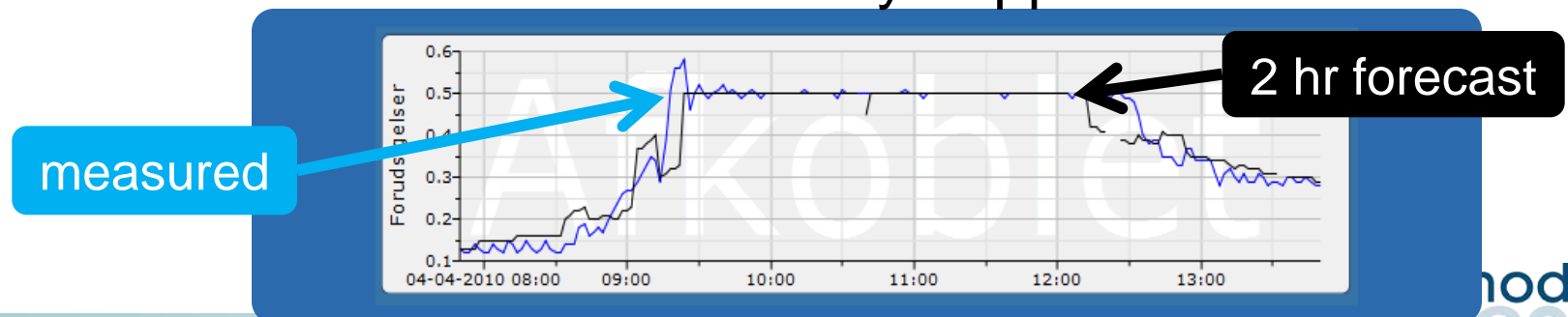
Radar-based runoff forecast as input to WWTP

KRÜGER

What the model predicts



What actually happened



How good are we?

Not always things go well...

KRÜGER

Inflow to Hvidovre WWTP (15-06-2010)

Fast periode

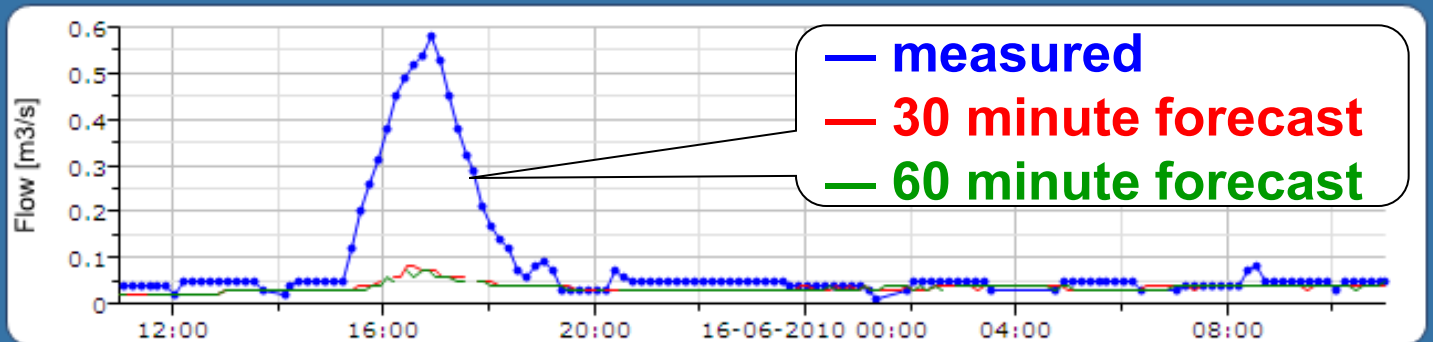
Navigation icons: back, forward, search, lock, print, home

Målt flow: 0.05 ☒

Forud 30min: 0.04 ☒

Forud 60min: 0.05 ☒

Y-akse min.: 0 ☒



Fast periode

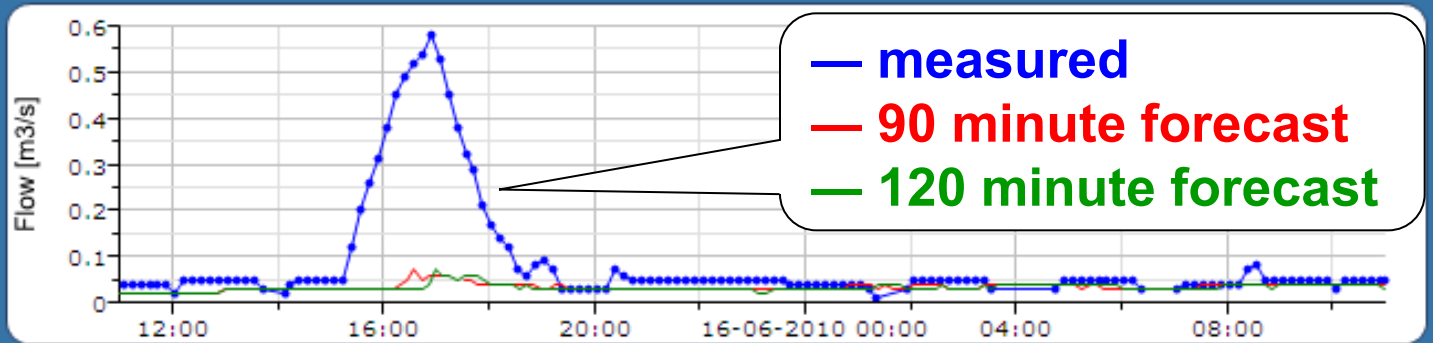
Navigation icons: back, forward, search, lock, print, home

Målt flow: 0.05 ☒

Forud 90min: 0.04 ☒

Forud 120min: 0.03 ☒

Y-akse min.: 0 ☒



Uncertainty in radar-based forecasts

TV2



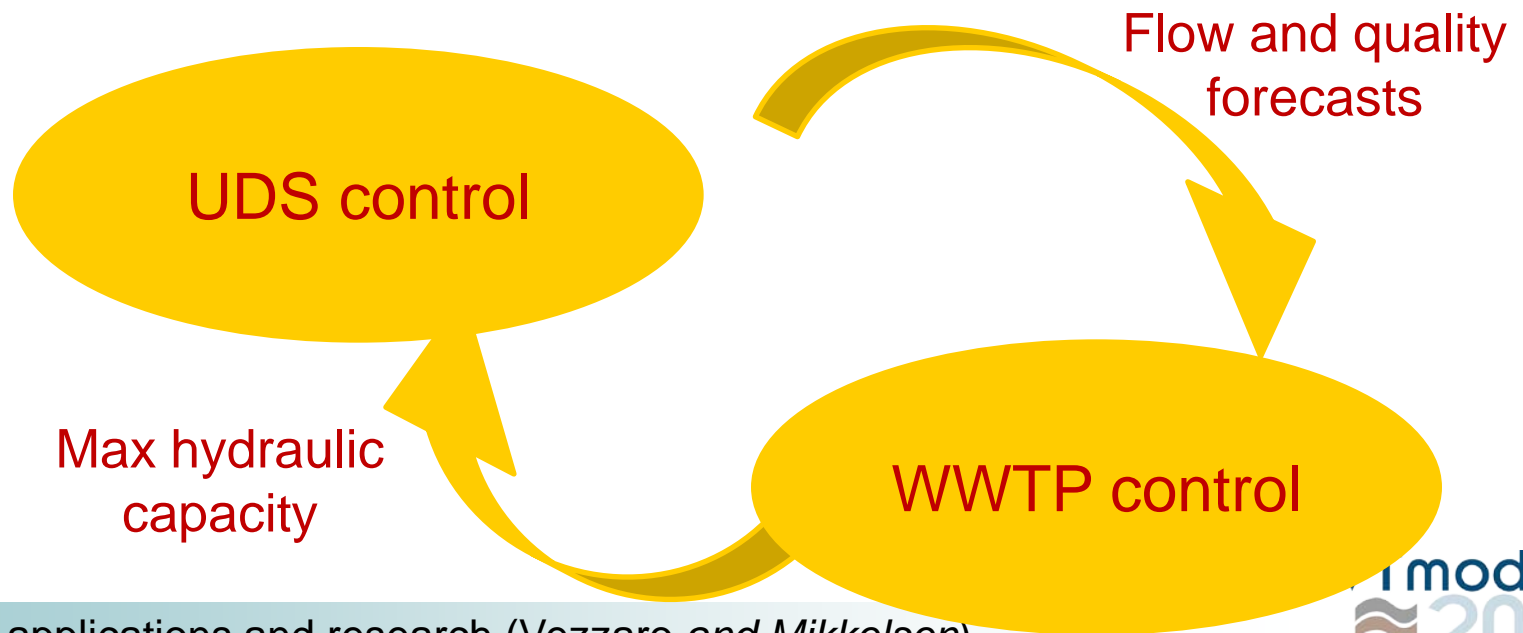
Foto: Oliver Winther
Hagl i Dragør på Amager den 15/6 2010.



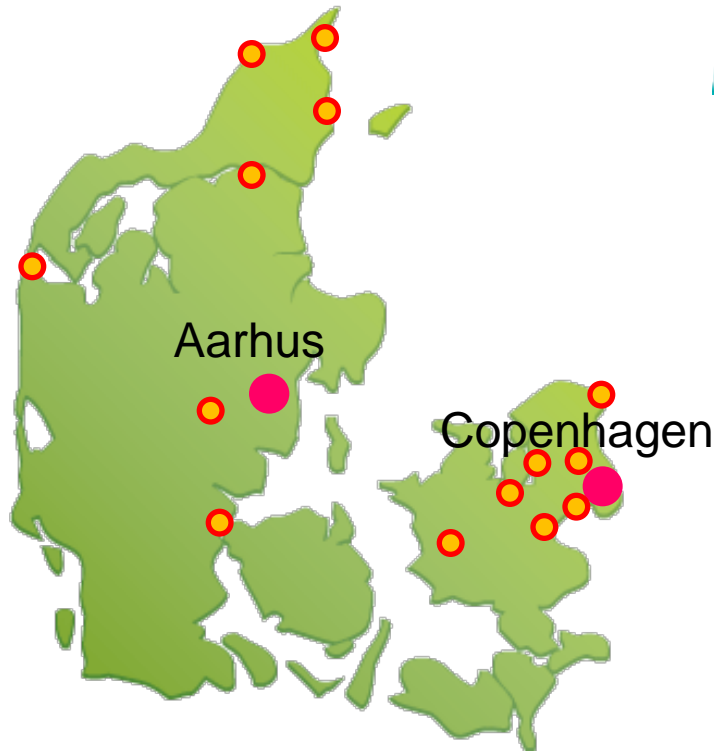
Foto: willy jensen
Haglvejr på Amager den 15/6 2010.

Integrated real time control of UDS and WWTP

- Potential of reducing environmental impacts through integrated control of SS and WWTP
- Great potential for developments



Several implementation in Denmark



- Several WWTP are equipped with advanced RTC



Methods and knowledge
(research)



- Intelligent Wastewater handling (implementation)
 - Radar (3) + catchment (28 km² - MOUSE) + WWTP (700.000 PE – WEST)
- METSAM (demonstration)
 - Global RTC based on uncertainty
- Integrated control of drainage and WWTP/ PREPARED (implementation)
 - Radar + catchment + WWTP + receiving water (river and sea)

Conclusions

- A lot of theory, but few applications (so far)
- New knowledge from SWI project
- Several demonstration projects are on their way
- A lot of new tools and examples from Denmark!

SWI partners



www.swi.env.dtu.dk