Mitigating wastewater utility GHG footprints – Development of a Benchmark Simulation Model

Microbial Resource Management in Biotechnology

Gent
Belgium

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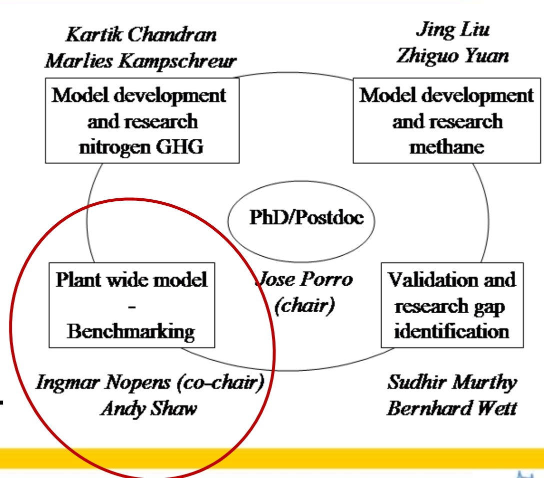
IWA Task Group on GHG

- International voluntary collaboration under IWA umbrella
- Output = Scientific and Technical Rpt.



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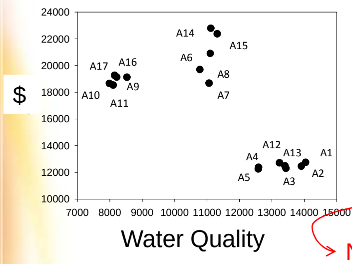
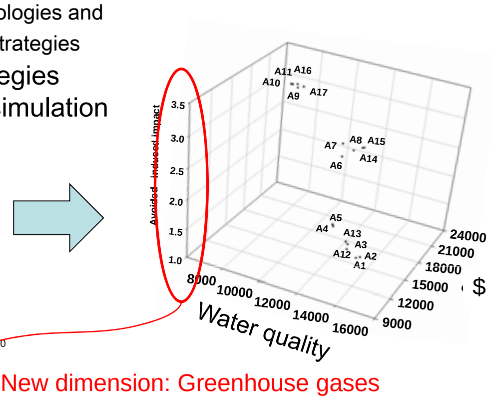
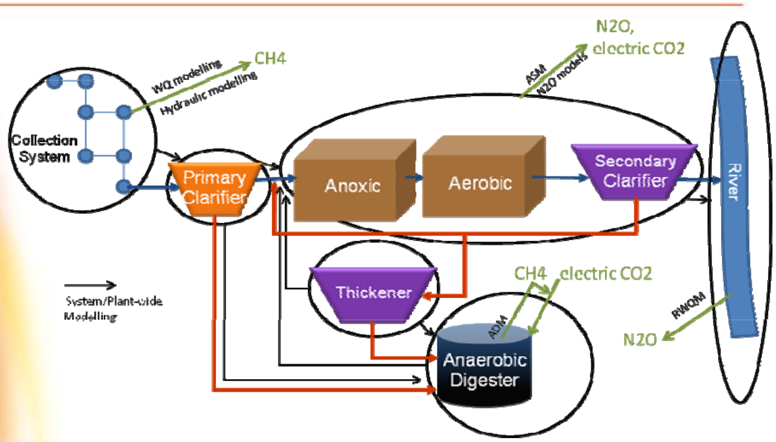
Benchmarking concept

- Increasing demands on water quality at lower costs:
  - Development of new technologies and
  - Implementation of control strategies
- Evaluation of control strategies by using dynamic model simulation



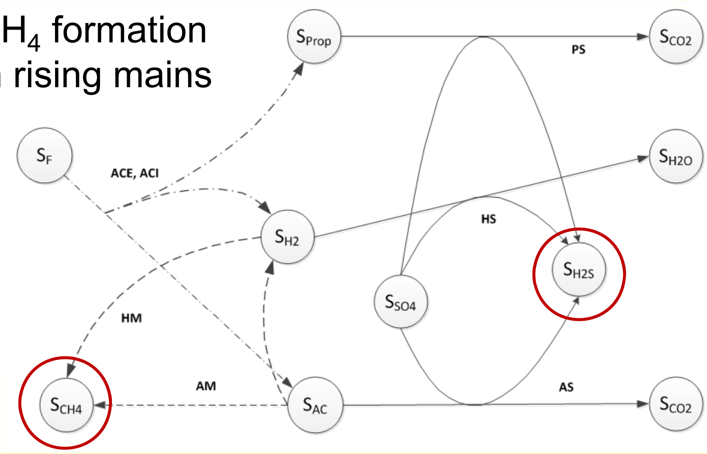


Wastewater utility GHG



GHG in sewer systems

- CH_4 formation in rising mains



Guisasola et al. (2009) Water Research 43: 2874-2884 5

GHG in wastewater treatment

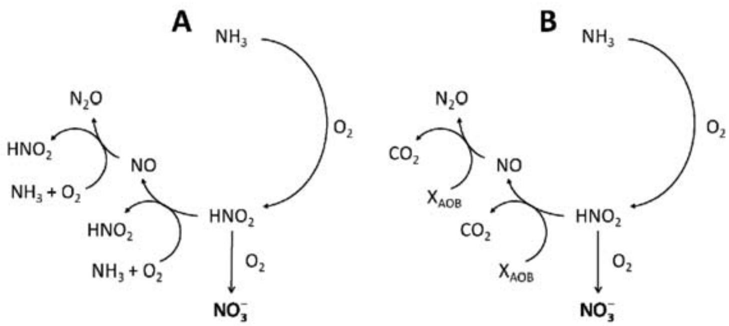
- N_2O-formation during denitrification

$$NO_3 \rightarrow NO_2 \rightarrow NO \rightarrow N_2O \rightarrow N_2$$

Hiatt & Grady (2008) Wat. Env. Res. 80: 2145-2156 6

GHG in wastewater treatment

- N_2O-formation through nitrifier denitrification



Mampaey et al. (2011) Nutrient recovery, Miami, Jan 2011

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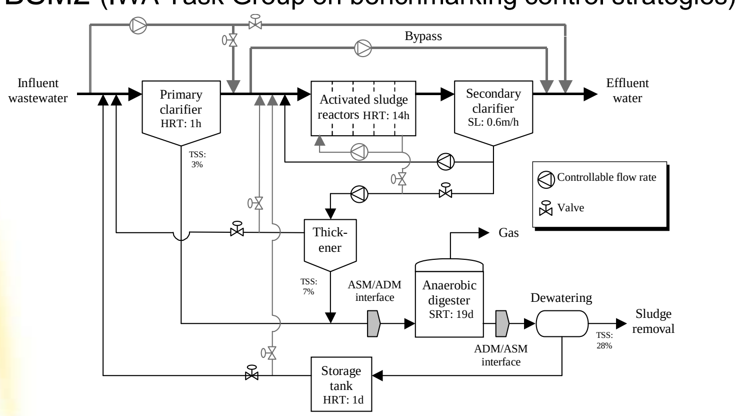
Benchmark simulation platform

- BSM2 (IWA Task Group on benchmarking control strategies)



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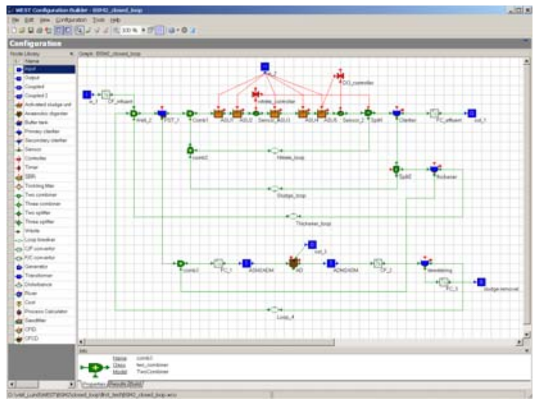
Benchmark simulation platform

- BSM2GHG



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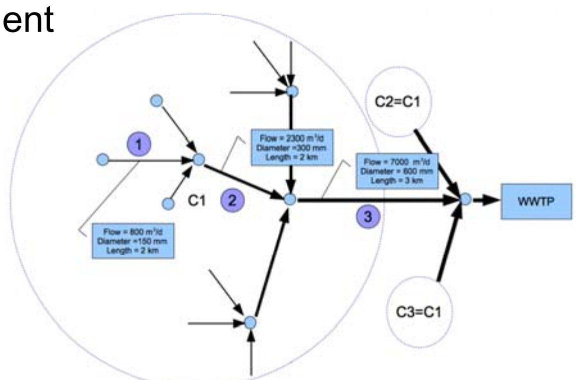
Benchmark simulation platform

- Trunk sewer model (rising mains)
  → BSM2 influent
  → all CH_4 stripped at inlet pump station



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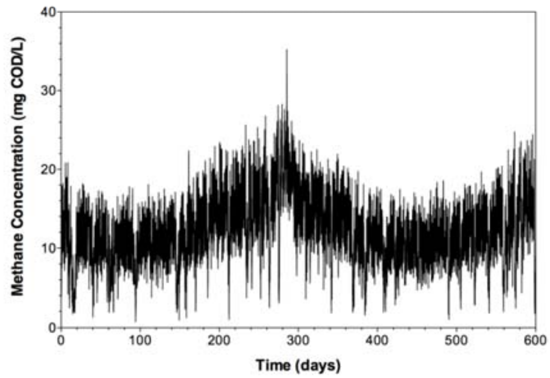
GHG simulation results: Sewer

- CH_4 emissions at influent pump station



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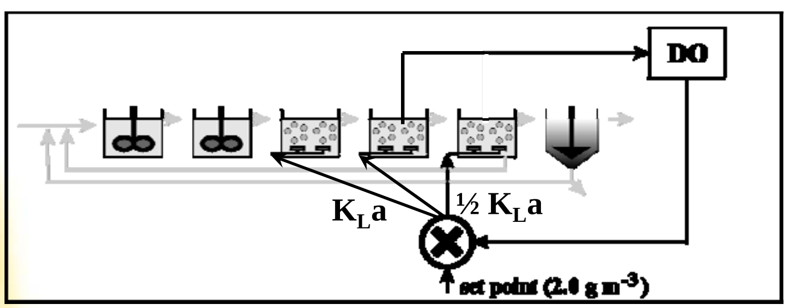
GHG simulation results: WWTP

- Standard DO control in aerobic tanks



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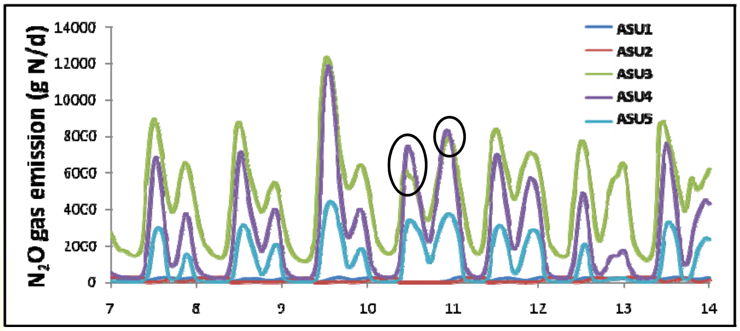
GHG simulation results: WWTP

- Dynamics of N_2O emissions in different tanks
  (none in anoxic, most in 1st (or 2nd) aerobic tank)



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GHG simulation results: WWTP

- Comparsion of ***no control*** and
  yes control (DO control in aerobic reactor, DO = 2mg·L-1)

	No control	Yes control	%
Effluent Quality, EQI (kg poll·d-1)	6461	6181	-4
Costs, OCI (-)	14107	13254	-6
GHG emissions (kg CO_2e·m-3)	0.975	0.860	-12

$$EQI = \frac{1}{t.1000}\int_{to}^{tf}(a\cdot TSS + b\cdot BOD + c\cdot COD + d\cdot TKN + e\cdot NO3)\cdot Q\cdot dt$$

OCI = Sludge production + Aeration + Pumping + Mixing + Carbon addition + Heating – Methane production

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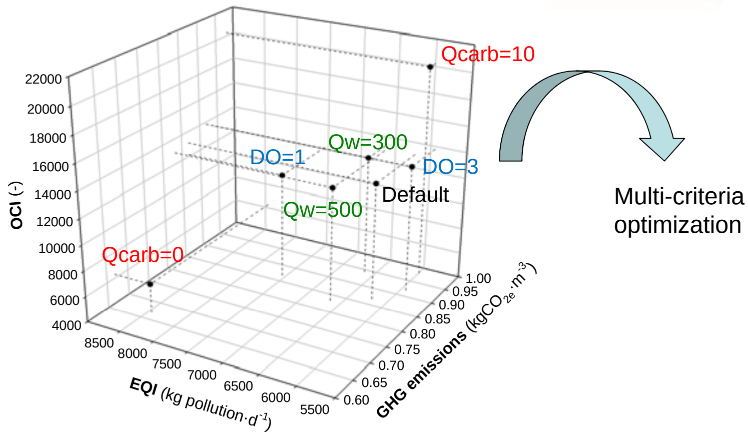
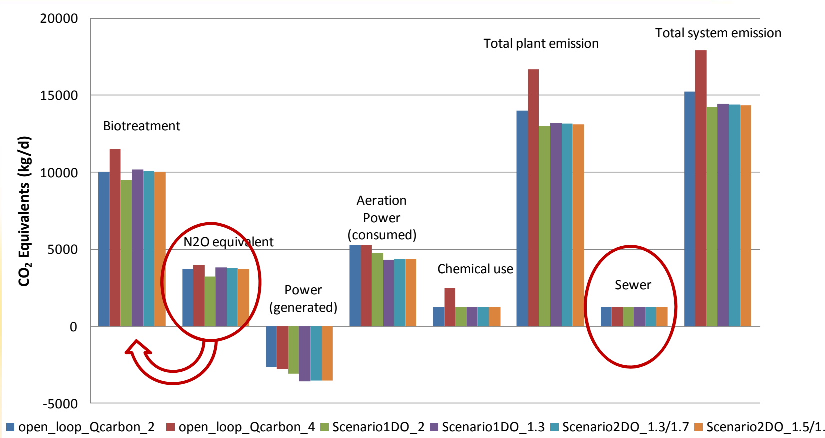
GHG simulation results: WWTP



GHG simulation results: Integrated



Take home

- We are getting better at:
  - understanding GHG production and emission
  - understanding influencing process conditions
  - describing the processes in mathematical models
- We start using GHG process models to:
  - identify knowledge gaps
  - optimize process design and operation (control)
- We observe that:
  - A compromise must be sought between water quality, costs, greenhouse gas emissions

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