System-wide Benchmark Simulation Model for integrated analysis of urban wastewater systems

Ramesh Saagi¹, Xavier Flores-Alsina², Krist. V. Gernaey², Ulf Jeppsson¹

¹ Division of Industrial Electrical Engineering and Automation (IEA), Lund University, Sweden
² Department of Chemical and Biochemical Engineering, Technical University of Denmark (DTU), Denmark
Outline

1. Objective
2. The urban wastewater system (UWS)
3. Modelling the UWS
   - Catchment
   - Sewer network
   - WWTP
   - Receiving water
4. Evaluation criteria
   - River quality based evaluation
5. Results
6. Conclusions
Objective

- Spatial extension to plant-wide BSM
  “Outside the fence” of WWTP

- River quality based evaluation

- Benchmarking of integrated control strategies
The urban wastewater system
Modelling the UWS - Catchment

<table>
<thead>
<tr>
<th>subcatchment</th>
<th>Area (ha)</th>
<th>PE</th>
<th>DWF (m³/d)</th>
<th>Infiltration (m³/d)</th>
<th>Storage tank volume (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Domestic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Industrial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>99</td>
<td>15,920</td>
<td>2,390</td>
<td>700</td>
<td>5500</td>
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<tr>
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<td>21</td>
<td>3,920</td>
<td>590</td>
<td>150</td>
<td>1000</td>
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<tr>
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<td>440</td>
<td>200</td>
<td>2000</td>
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<td>1,440</td>
<td>500</td>
<td>4000</td>
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<td>71</td>
<td>7,840</td>
<td>1,180</td>
<td>1,600</td>
<td>4000</td>
</tr>
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<td>6</td>
<td>249</td>
<td>39,760</td>
<td>5,960</td>
<td>1,700</td>
<td>15000</td>
</tr>
<tr>
<td>Total</td>
<td>540</td>
<td>80,000</td>
<td>12,000</td>
<td>4850</td>
<td>31500</td>
</tr>
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</table>
Modelling the UWS - Catchment

Generation of wastewater

• Domestic
• Industrial
• Stormwater
• Infiltration to sewers
Modelling the UWS – Sewer system

- Sewer transport – Linear reservoir model
- First flush model for particulate pollutants
- Storage tank models
Modelling the UWS – WWTP
Modelling the UWS – River

**Hydraulics**
- Length of each stretch: 1km
- Total river length: 30km

**Biology (RWQM1)**
- 18 state variables
  - Organics, biomass, oxygen, nitrogen, phosphorus
- 17 processes
  - Heterotrophs, Autotrophs, Algae
  - Hydrolysis
  - Phosphate processes
Evaluation criteria

River quality based evaluation

- Total exceedance duration
  - NH$_4$
  - DO
Evaluation criteria

River quality based evaluation

- 1-hour max/min conc.
  - 1-hour max. NH4 conc.
  - 1-hour min. DO conc.
Results - Catchment

Domestic

Industry

Infiltration

Rain
Results – Sewer system

Sewer transport – Linear reservoir model

First flush model for particulate pollutants
Results – Sewer system

Storage tanks

Online tanks with valves

Offline tanks with pumps

Online storage

Offline storage
Results - River

Ammonia variation is generally straightforward

DO variation is highly dynamic and depends on various factors
Conclusions

- System-wide extension to BSM2
- Wastewater generation in the catchment
- Sewer transport model with storage tanks
- Biochemical model for simulation of river dynamics
- River quality based evaluation of control strategies
Thank you!

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