Case study: integration of new sanitation technologies into current wastewater infrastructures exemplified by the Treatment Plant for Education and Research at the University of Stuttgart
Outline

- Motivation
- Objectives
- Materials and Methods
- Results and Discussion
- Conclusion and Outlook
Motivation
Motivation
Splitting of wastewater streams on a household level

- **Blackwater**: Faeces with flushwater, toilet paper and urine
  - Nutrient and energy recovery

- **Urine**: with flushwater
  - Yellowwater

- **Faeces**: with flushwater without urine
  - Brownwater

- **Domestic wastewater**: without urine and without faeces
  - Greywater
  - Water recycling

- **Nutrient and energy recovery**

- **Water recycling**
Motivation

How could the energy potential in blackwater be used, while best exploiting existing infrastructures?

HYDRAULIC RESERVE CAPACITIES IN MUNICIPAL DIGESTERS IN WWTPs EXIST

**BUT:**

BLACKWATER_{raw}

1 % TSS
7 L/(PE·d)

(PS+ES)_{raw}

1 % TSS
7 L/(PE·d)

(PS+ES)_{thickened}

4 % TSS
2 L/(PE·d)

HRT=25 d

20 d ↔ 2.5 L/(PE·d)
Objectives
Objectives

OBJECTIVES
• Assessment of the feasibility of blackwater co-digestion in municipal digesters and impacts upon plant operation

HOW?
• Through inhabitant-specific mass and volume balances

WHY?
• Resource-oriented systems are a necessity for the longer-term wastewater treatment
• Technology and ideas for resource-oriented sanitation exist; however, the integration in wastewater infrastructures has usually been neglected.
Materials and Methods
Materials and Methods
Treatment Plant for Education and Research at the University of Stuttgart

HRT_{actual} = 66 d
HRT_{desired} = 20 d
Mass and volume balances for the actual state

8,483 PE
1 PE=120 g COD/d
Results and Discussion
Results and Discussion

Mass and volume balances: 10 % transition
Results and Discussion

Mass and volume balances: 90 % transition
## Results and Discussion

### Benefits of the transition to resource-oriented sanitation systems

<table>
<thead>
<tr>
<th>Transition state</th>
<th>Measure</th>
<th>Benefits</th>
<th>Biogas production</th>
<th>Power demand for aeration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N recovery potential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td>Blackwater collection</td>
<td>0% ( N_{in} )</td>
<td>15.9 kWh/(PE·a)</td>
<td>11.7 kWh/(PE·a)</td>
</tr>
<tr>
<td>5%</td>
<td>Set-up dewatering digested sludge</td>
<td>20% ( N_{in} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Set-up N recovery from sludge liquor, ( \eta=60% )</td>
<td>1.4 g N/(PE·d)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>12.2 kWh/(PE·a) + 4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td>Set-up blackwater thickening</td>
<td>24% ( N_{in} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Set-up N recovery from sludge liquor and blackwater supernatant, ( \eta=60% )</td>
<td>1.7 g N/(PE·d)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>12.0 kWh/(PE·a) + 2.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90%</td>
<td>-</td>
<td>66% ( N_{in} )</td>
<td>17.5 kWh/(PE·a)</td>
<td>7.6 kWh/(PE·a) - 35 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.6 g N/(PE·d)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>10%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusion and Outlook
Conclusions

CONCLUSIONS

• Better energy balance (35% reduction in power for aeration and 10% improvement in biogas generation)
• High nutrient recovery rates from sludge liquor and blackwater (up to 40% N_{in} and 60% P_{in})
• Nutrient recovery offsets unfavorable C:N ratio
• Centralized greywater treatment proved better in terms of process stability
• No major structural alterations in the plant are required
• The means used is appropriate
• Conventional WWTPs can be beneficially integrated into transition concepts
• Blackwater co-digestion improves energy balance and nutrient utilization within the plant
OUTLOOK

- The integration of new sanitation systems is promising, but must be carried out in accordance with the capabilities of existing infrastructures and precise examination of the boundary conditions.
Team

Carlo G. Morandi
Institute for Sanitary Engineering, Water Quality and Solid Waste Management
University of Stuttgart

Stephan Wasielewski
Institute for Sanitary Engineering, Water Quality and Solid Waste Management
University of Stuttgart

Ralf Minke
Institute for Sanitary Engineering, Water Quality and Solid Waste Management
University of Stuttgart

Prof. Dr.-Ing. Heidrun Steinmetz
Department of Resource-Efficient Wastewater Technology
Technical University of Kaiserslautern
Thank you!

Carlo G. Morandi

e-mail  carlo.morandi@iswa.uni-stuttgart.de
phone  +49 (0) 711 685-65414
fax  +49 (0) 711 685-63729

University of Stuttgart
Institute for Sanitary Engineering, Water Quality
and Solid Waste Management
Bandtäle 2, 70569 Stuttgart, Germany