



Operation of sewage facilities in the context of climate protection and resource conservation

Influence of Climate Change on Water Systems in Japan and Germany

Workshop: Urban Water within a changing Globe



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Challenges for
the water sector

- climate change
- micro-pollutants
- economic transition
- demographic transition
- scarcity of resources

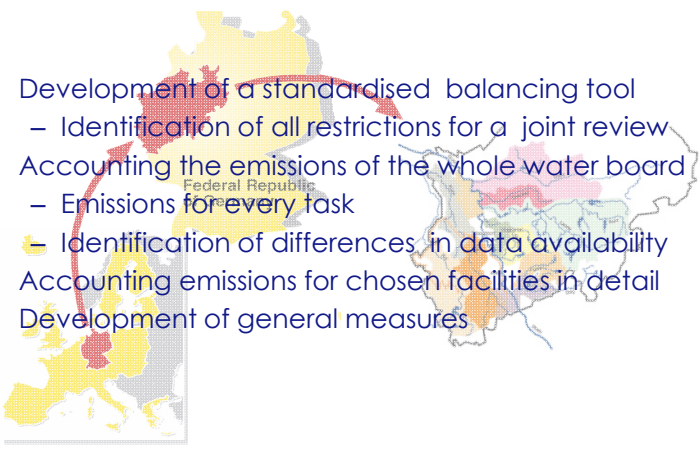
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Aims of the CO₂-project

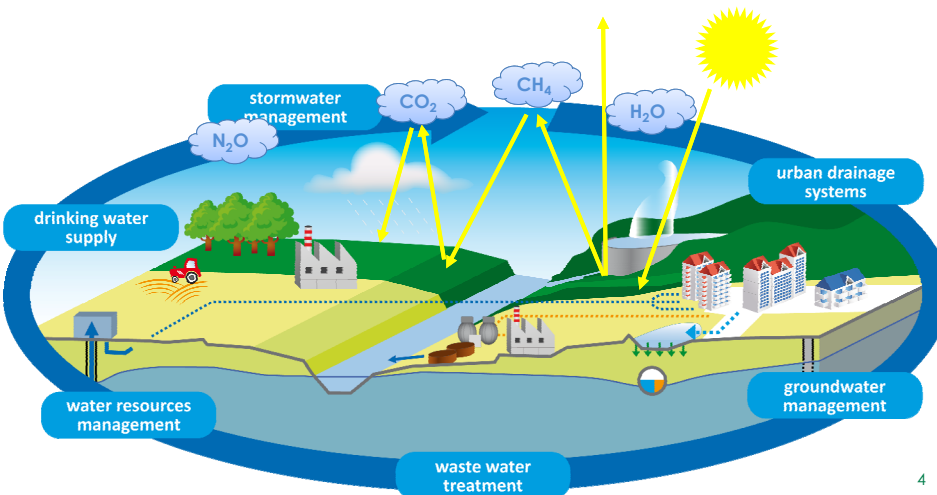
- Development of a standardised balancing tool
 - Identification of all restrictions for a joint review
- Accounting the emissions of the whole water board
 - Emissions for every task
 - Identification of differences in data availability
- Accounting emissions for chosen facilities in detail
- Development of general measures



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Effect of the water sector on the greenhouse impact



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Emission sources



direct emissions

- waste water treatment
- waste water disposal
- water bodies



indirect emissions


- consumption of fossil fuels
- electricity



indirect emissions

- traffic
- outsourced activities
- supplies
- waste ...

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Greenhouse gas emissions in the water sector


Greenhouse gas	Global Warming Potential (2001)	Global Warming Potential (2007)
CO ₂	1	1
CH ₄	23	25
N ₂ O	296	298
SF ₆	22.200	22.800

Climate impact is nominalised to CO₂
 → CO₂-equivalent (CO₂e)

$$CF = \sum_{i=0}^n \text{energy}_i \cdot EF_i + \sum_{i=0}^n \text{feedstock}_i \cdot EF_i + \sum_{i=0}^n \text{GHG}_i \cdot GWP_i$$

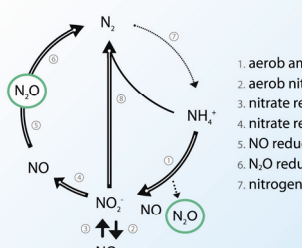
Quelle: IPCC, 2001, 2007

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Nitrouse oxide Emissions

the biological nitrogen cycle



1. aerob ammonium oxidation
2. aerob nitrite oxidation
3. nitrate reduction to nitrite
4. nitrate reduction to NO
5. NO reduction to N2O
6. N2O reduction to N2
7. nitrogen fixation

} nitrification
} denitrification

N₂O-emissions indicated in different studies from the last years


source	N ₂ O [%-TKN]	WWTP
(Czepiel et al., 1995)	0,0035	AO 11.000 p.e.
(Wicht et al., 1995)	0-14,6	25 WWTP
(Zeng et al., 2003)	90	SBR
(Zhu et al., 2011)	46	anaerob-aerob-proces
(Kampschreur et al., 2008)	4	WWP 620.000 p.e.

nitrification

$$O_2 + NH_4^+ \rightarrow \frac{1}{2}N_2O + \frac{3}{2}H_2O + H^+ \Delta G^{0'} = -2$$

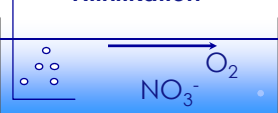
$$O_2 + \frac{2}{5}NH_4^+ \rightarrow NO_2^- + \frac{2}{5}H_2O + \frac{4}{5}H^+ \Delta G^{0'} = -$$

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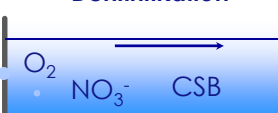
Impacts on N₂O-synthesis

Nitrifikation



N₂O

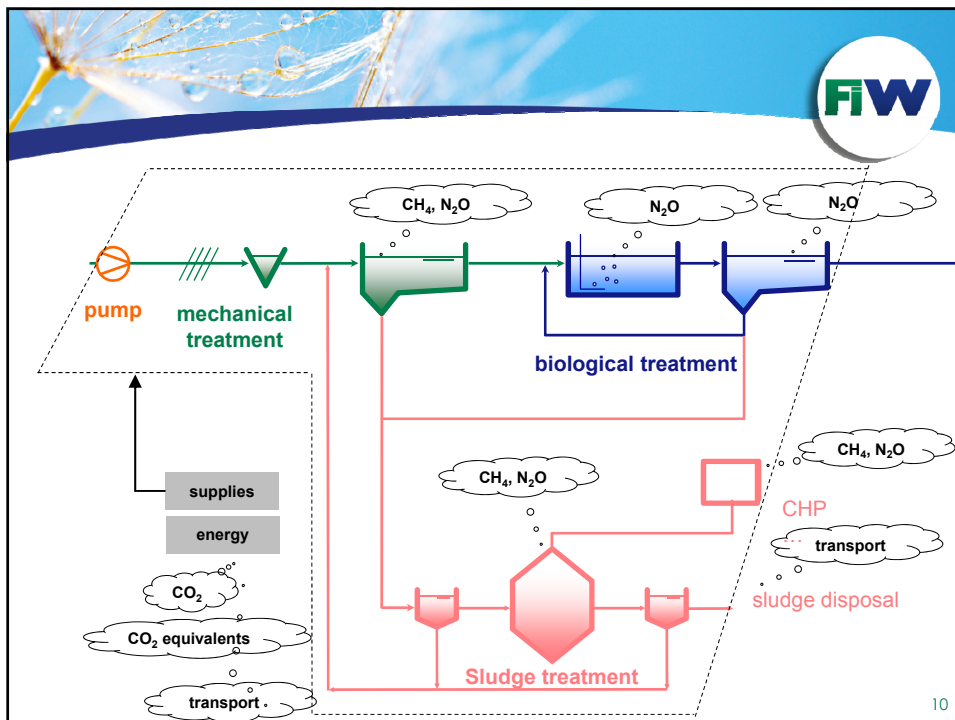
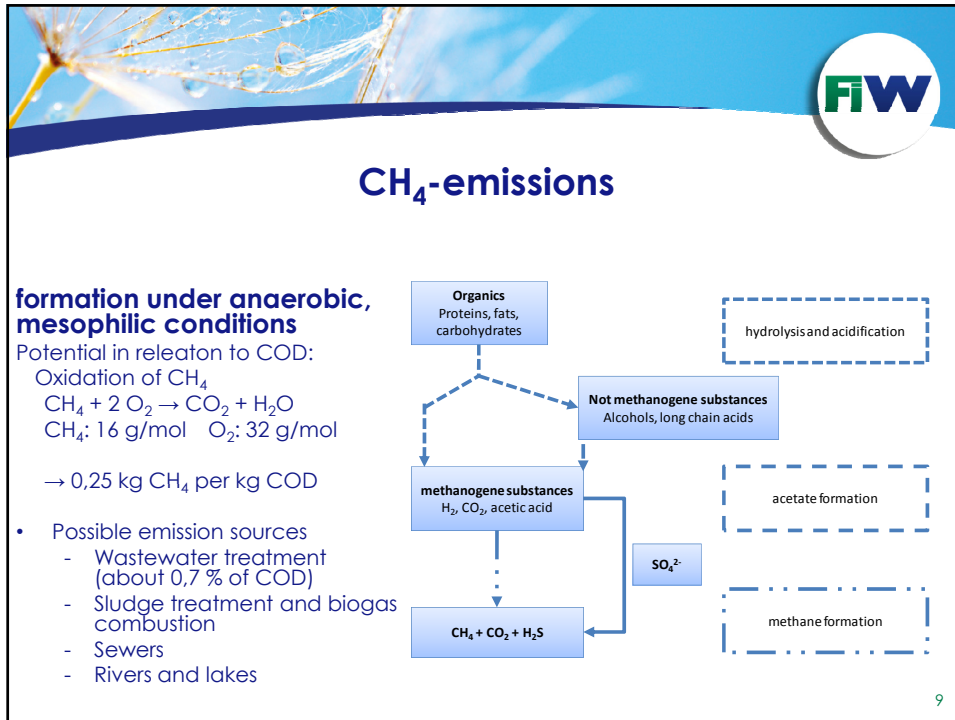
Denitrifikation

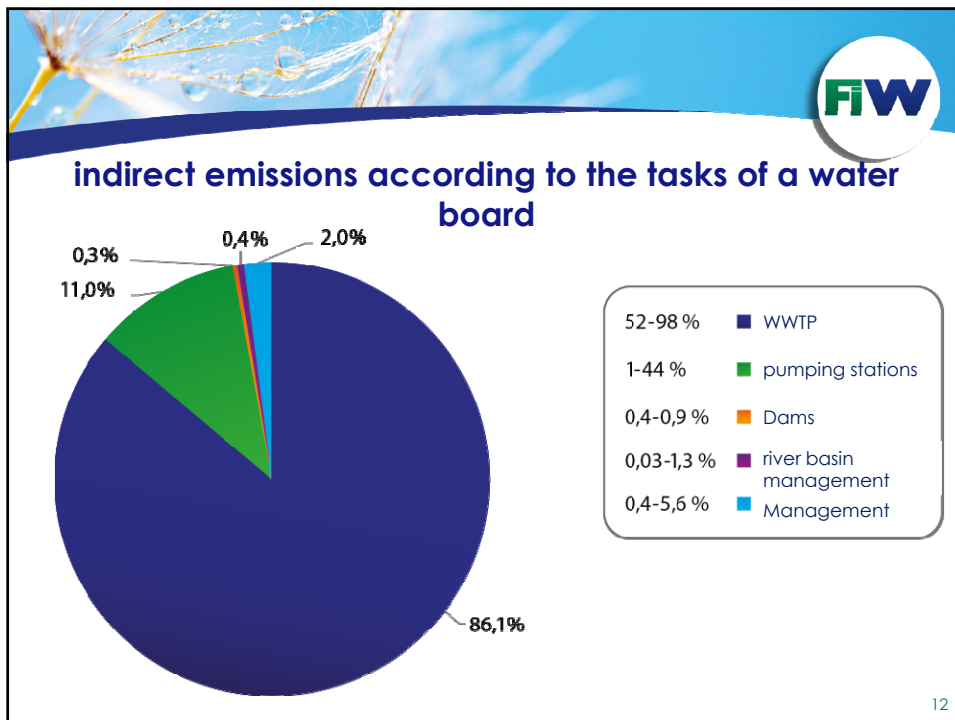
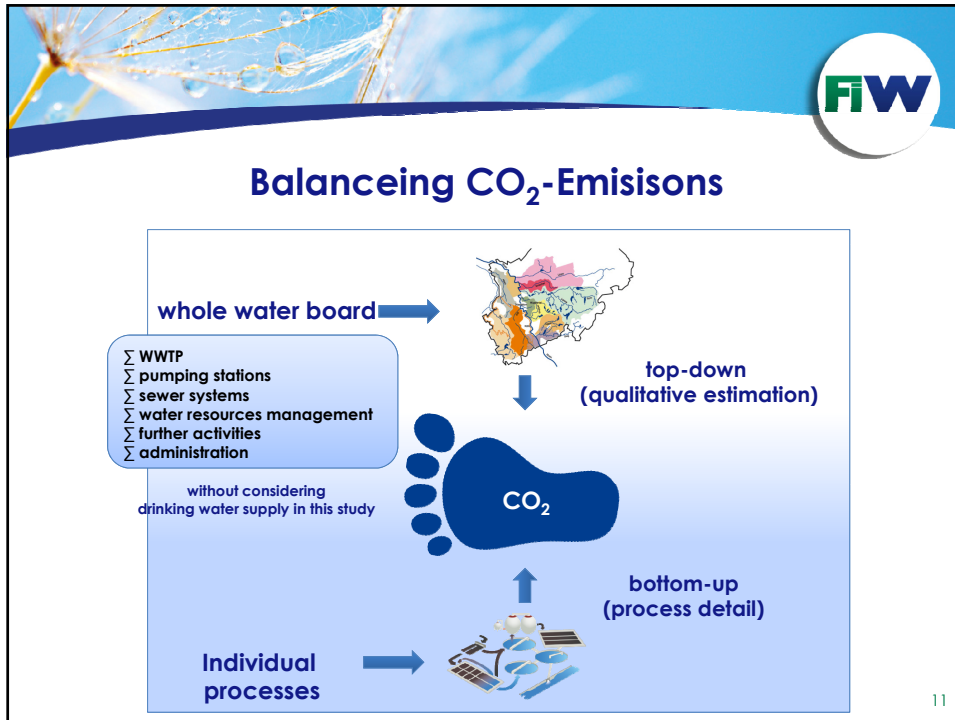


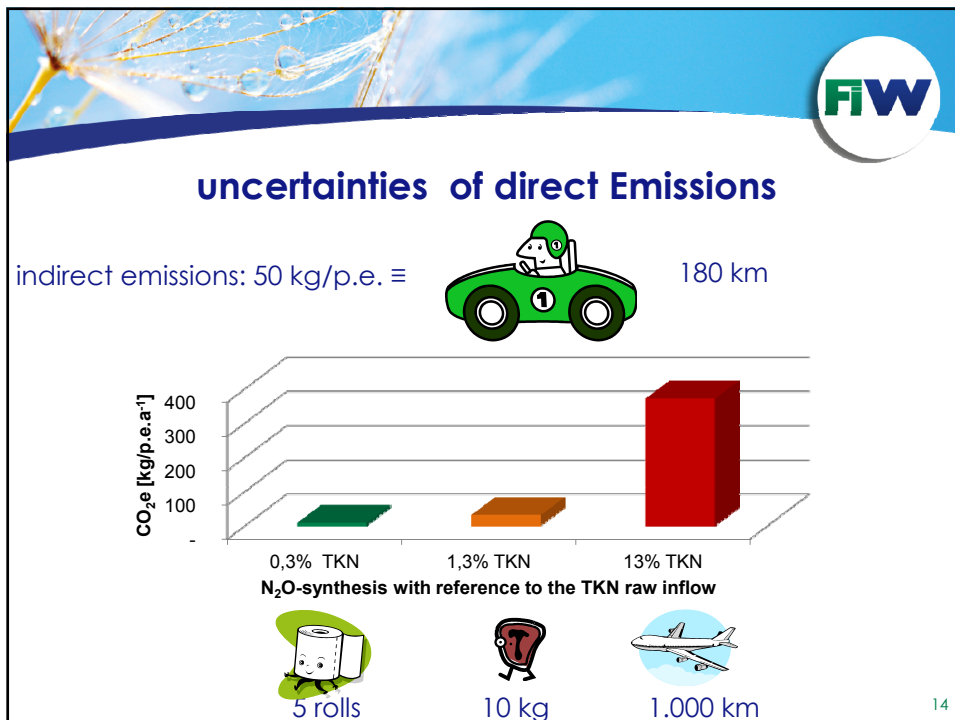
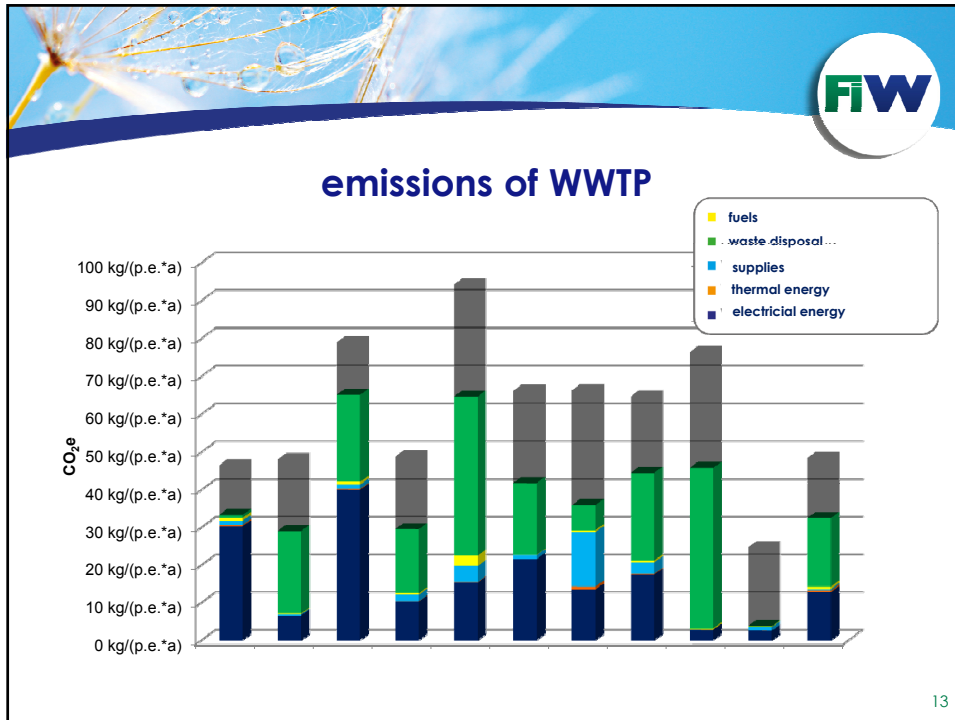
- Insufficient airtation
- High organic load
- Low sludge age
- Nitrate load
- operating fluctuations


- Oxygen inibition
- low C/N-ratio
- Low sludge age
- Nitrate load
- inhibitors (sulfide, ...)

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conclusions and prospects for the water sector

- Clear prioritization of sustainable and economical optimization
- Internal communication and control
- Research projects world wide – pooling and standardisation needed
- Support of new technologies
- Still need for research to quantify direct Emissions
 - Avoid conflicts of aims (energy saving vs. CO₂)
 - new approaches in nitrogen elimination?



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Many thanks for your attention!

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