Can this sensor monitor an on-site wastewater treatment plant?

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Identifying the performance of on-site wastewater treatment plants

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Photo: Max Maurer

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**Identifying the performance of
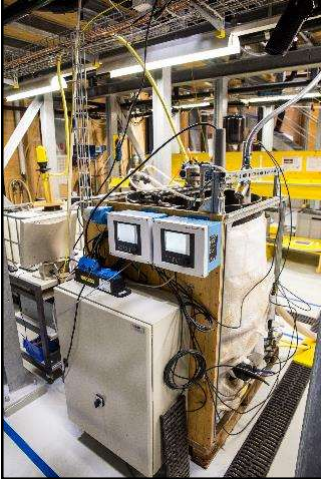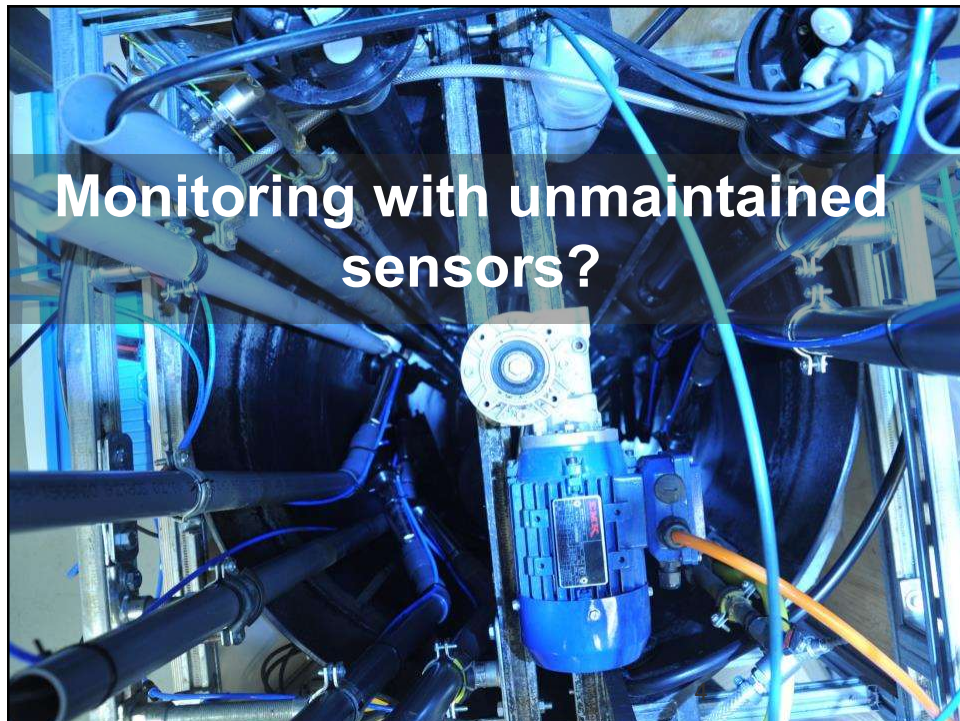on-site wastewater treatment
plants**

unstaffed

**Mariane Y. Schneider, J. P. Carbajal, V. Furrer,
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Photo: Max Maurer

**Monitoring with unmaintained
sensors?**

Setup: unmaintained vs. maintained

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Storage tank:
- From primary clarifier
- Combined sewage
- Dose urine

Pilot scale SBR:
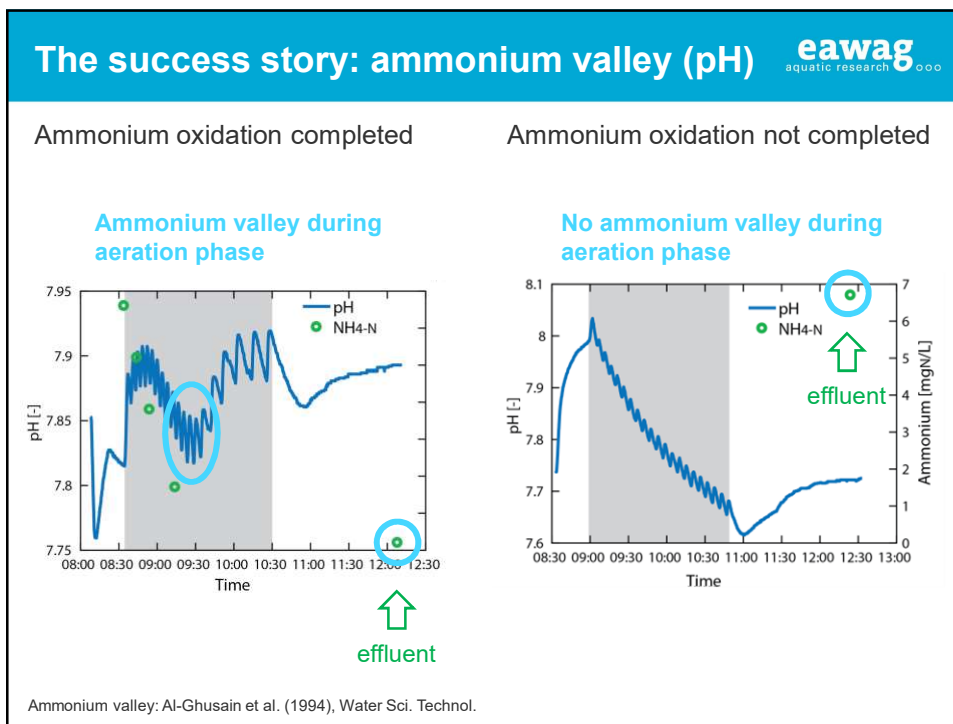- 6 cycles per day
- 430 Liters
- 19 sensors

5

The sensor model

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$$NH_4^+ - N = M(pH) + \varepsilon$$

$$\text{Target value} = \text{Model (sensor signal)} + \text{error term}$$

e.g. Feature 'ammonium valley'

The success story: ammonium valley (pH)

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Ammonium oxidation completed

Ammonium oxidation not completed

Ammonium valley during aeration phase

No ammonium valley during aeration phase

effluent

effluent

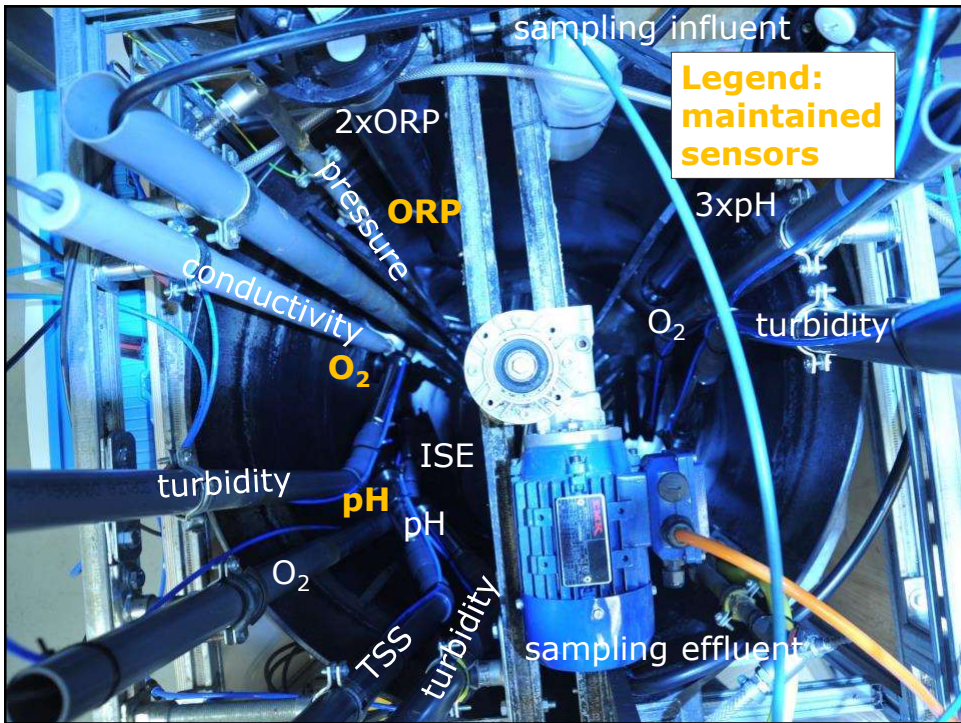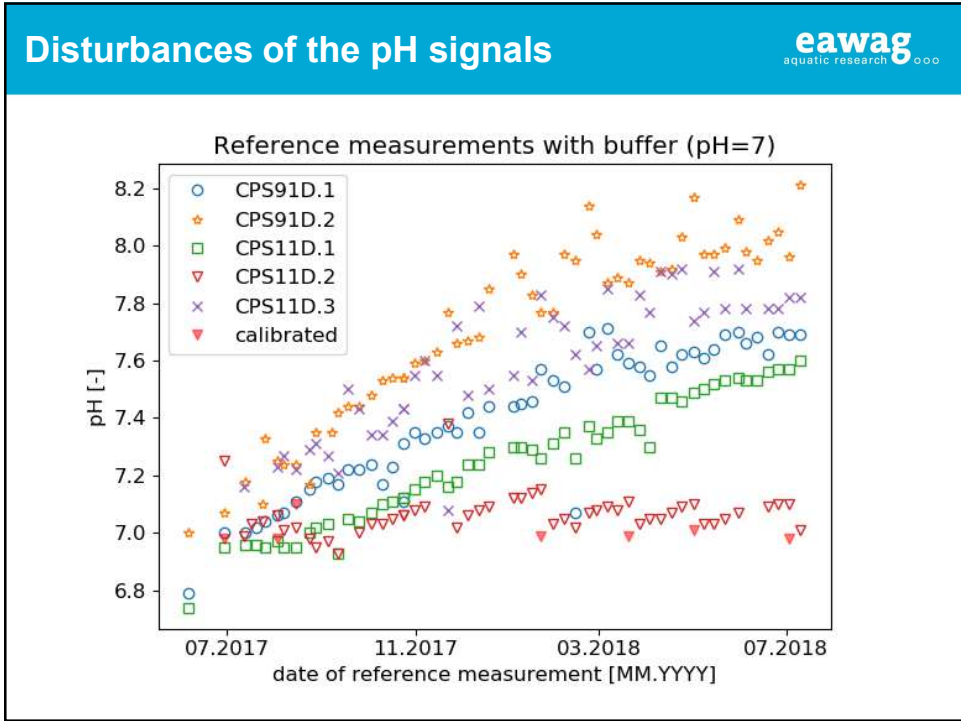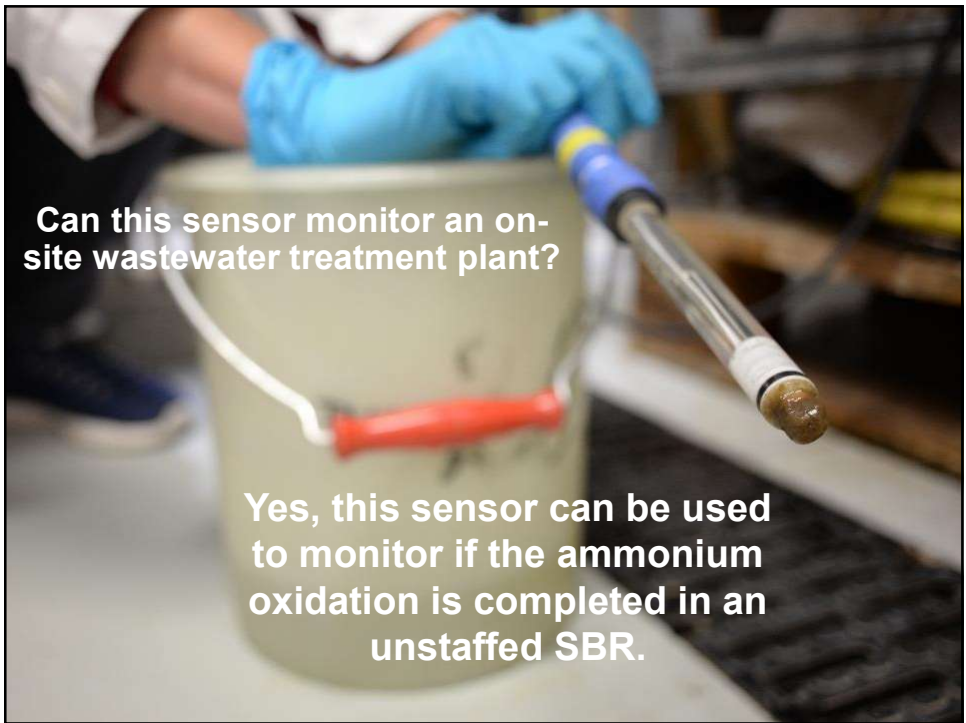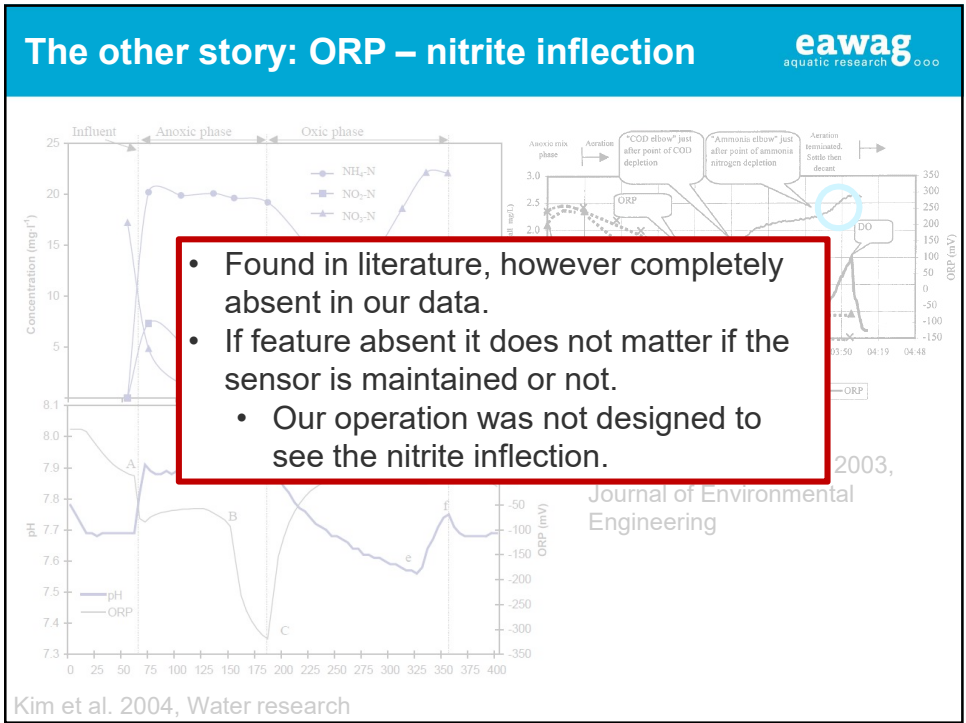Ammonium valley: Al-Ghusain et al. (1994), Water Sci. Technol.

Result automatic detection of NH$_4$ valley

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maint. Maintained pH sensor
unm. unmaintained pH sensor

	Actual class (measured effluent conc.)									
	≤ 1 mg-N/L					> 1 mg-N/L				
	maint.	unm. 1	unm. 2	unm. 3	unm. 4	maint.	unm. 1	unm. 2	unm. 3	unm. 4
	41	40	41	40	40	1	1	1	1	1
	15	16	15	16	16	50	50	50	50	50

- If a valley is detected, the ammonium oxidation is completed.
- No difference between maintained and unmaintained sensors:
  - ➤ The ammonium valley is a robust feature against offset.

The other story: ORP – nitrite inflection

- Found in literature, however completely absent in our data.
- If feature absent it does not matter if the sensor is maintained or not.
  - Our operation was not designed to see the nitrite inflection.

Kim et al. 2004, Water research

Can this sensor monitor an on-site wastewater treatment plant?

Yes, this sensor can be used to monitor if the ammonium oxidation is completed in an unstaffed SBR.

Performance quantification of a system

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Performance of one unit

System performance of e.g. 1000 units

→ Prediction of the performance based on signals of an unmaintained pH sensors

Goal: equivalent performance monitoring

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1 Million x

1 x

Outlook

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- Prediction of the effluent concentration for those cycles which do not show a feature.
- Use multiple sensor types.
- Collect data from plants in operation.

Cycles without ammonium valley

- System performance modelling: How well can we quantify the performance of an entire system of unstaffed wastewater treatment plants?

Result automatic detection of NH$_4$ valley

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		Actual class (measured effluent conc.)								
maint.	Maintained pH sensor	< or = 1 mg-N/L					> 1 mg-N/L			
unm.	unmaintained pH sensor	maint.	unm. 1	unm. 2	unm. 3	unm. 4	maint.	unm. 1	unm. 2	unm. 3	unm. 4
Predicted class (feature observed)	Ammonium valley detected	41	40	41	40	40	1	1	1	1	1
	No ammonium valley detected	15	16	15	16	16	50	50	50	50	50

- If a valley is detected, the ammonium oxidation is completed.
- No difference between maintained and unmaintained sensors:
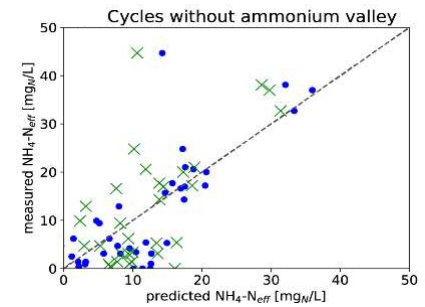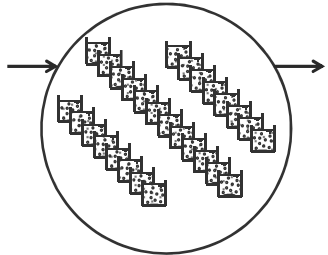 - ➤ The ammonium valley is a robust feature against offset.

Aeration Ramp (dissolved oxygen)

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Result automatic detection of NH$_4$ valley

Dissolved oxygen - disturbance I

Dissolved oxygen – disturbance 2

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Result automatic detection of aeration ramp

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- Despite disturbances, automatic detection possible.
- Would recommend to use the pH signal instead.