Biniam Biruk Ashagre
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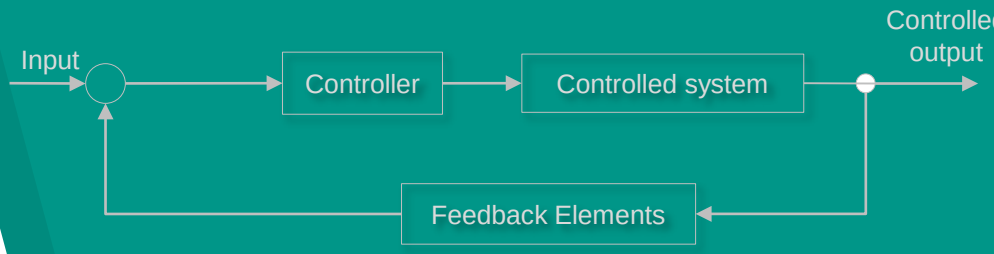
Dynamic licensing and active control of wastewater systems



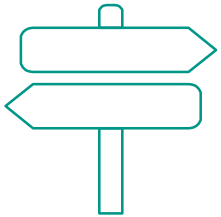
The challenges
Regulations

Committee on Climate Change

Climate Change Act 2008

High standard effluent quality

- Greenhouse gas emissions ↓
- Energy consumption ↓
- Operational cost ↑



Solutions for regulation related challenges

Option 1

Creating an efficient system using existing process units through **active control**

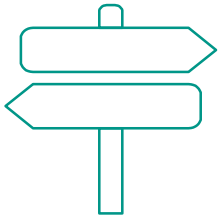
- ↔ Smaller capital investment
- ↓ Greenhouse gas emissions
- ↓ Energy consumption
- ↓ Operational cost

Option 2

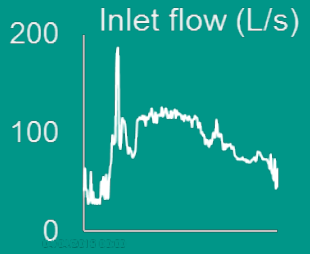
Replacing existing process units with **new advanced** units

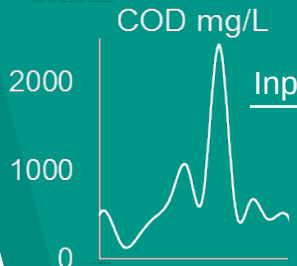
- ↑ Higher capital investment
- ↔ Still requires appropriate control systems

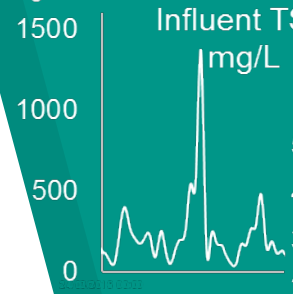
Automation and active control can help in creating a robust system that can cope with dynamic loads

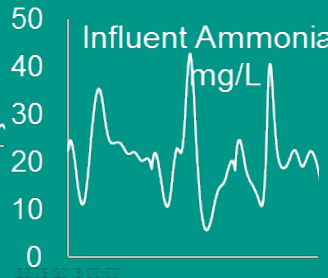


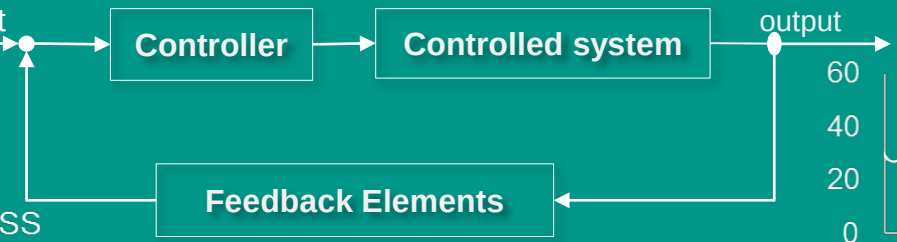
Solution for load-variability related challenges

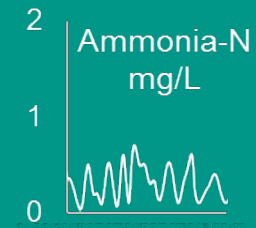


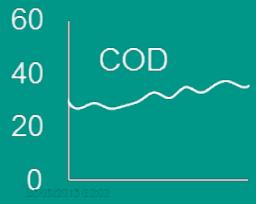


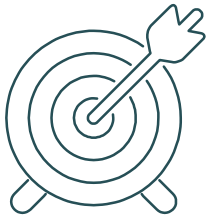












Project aim

The aim of this project is to develop a **systematic framework** for controlling existing wastewater treatment works through the development of **control strategies** and testing **regulation approaches** in order to reduce **energy** use, and reduce greenhouse gas (**GHG**) emissions while keeping the quality of the **environment**.

Control Design

Goals and objectives

- Formulation of control problems

Control Strategies

Control structure

- Selection of suitable control structure and design of control algorithm

Performanc evaluation

- Assess the performance of the system through simulation

Application

Full scale application of control strategies

- Control of the wastewater hydraulic
- Control of anoxic zone and aerobic zones in activated sludge systems
- Biomass control
- Secondary settler controls

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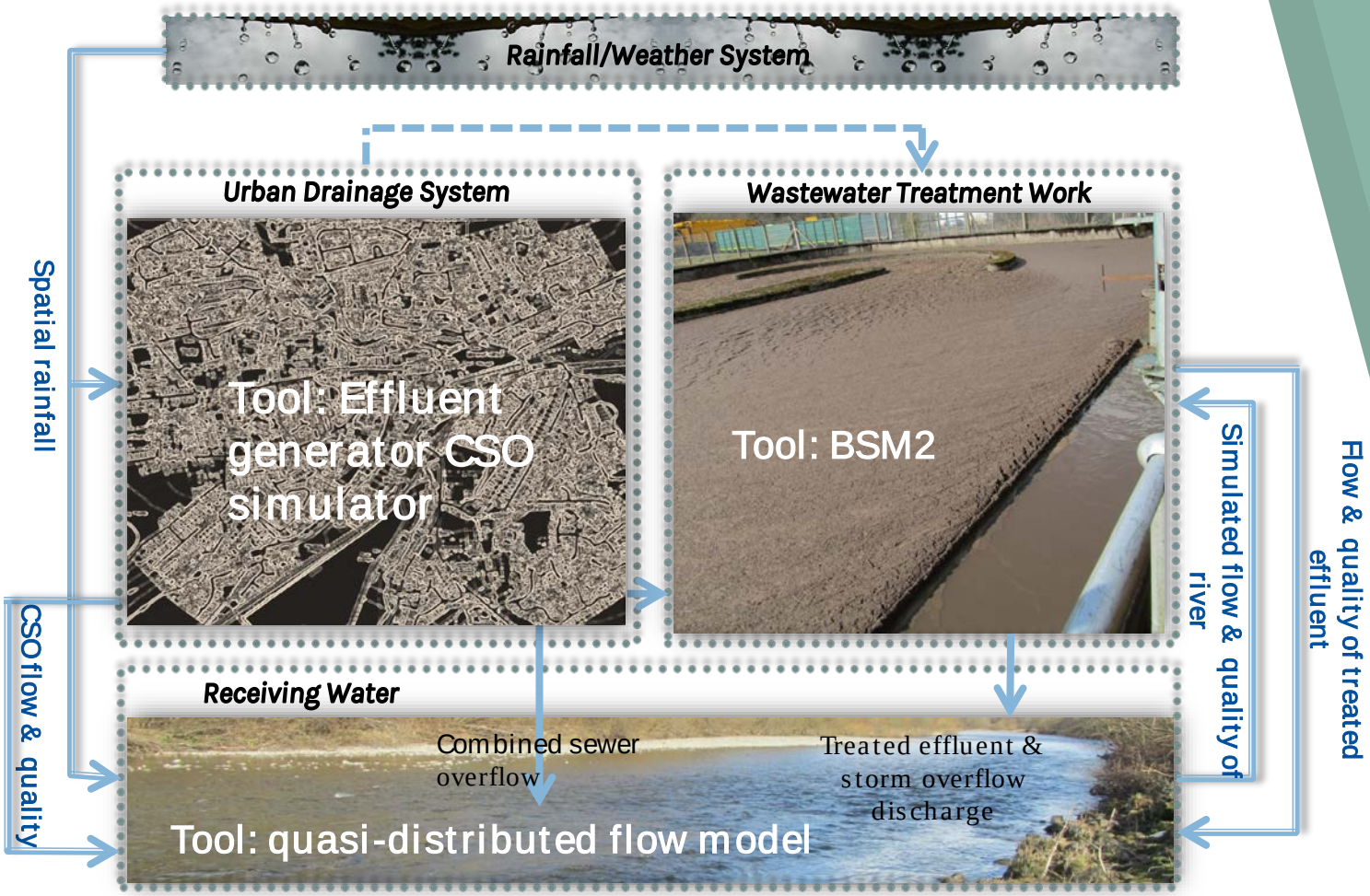
Performance evaluation of integrated active control strategies



Integrated Active Control - What Does it Need?

A high quality model with good accuracy

The challenges

Limitations within the model

Assumptions to simplify computationally demanding processes

Details of available data and quality of information

Modeller experience

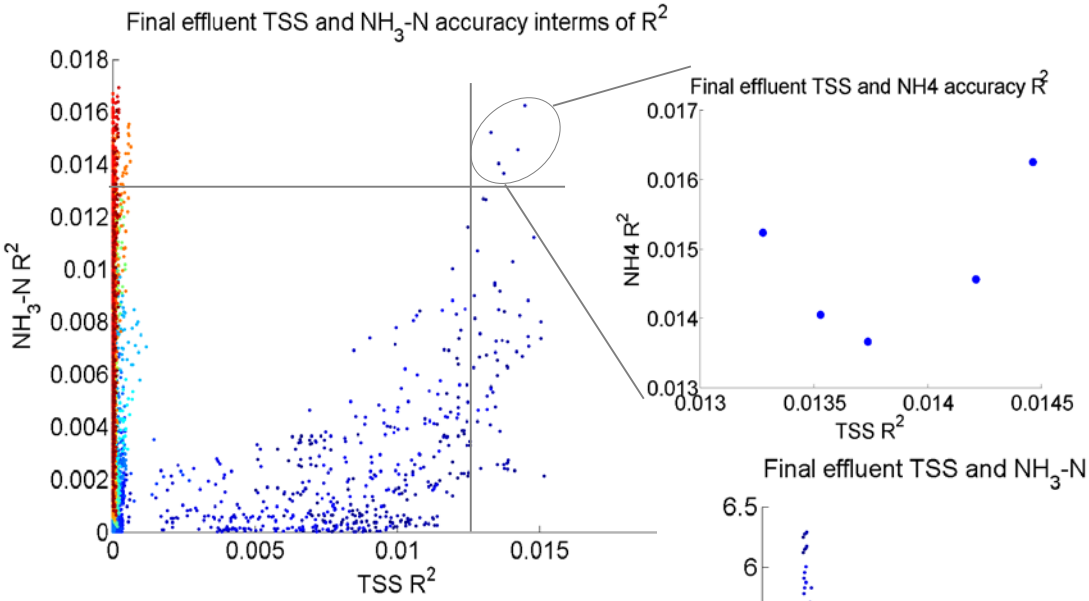
Impact of Data Availability on Control designs

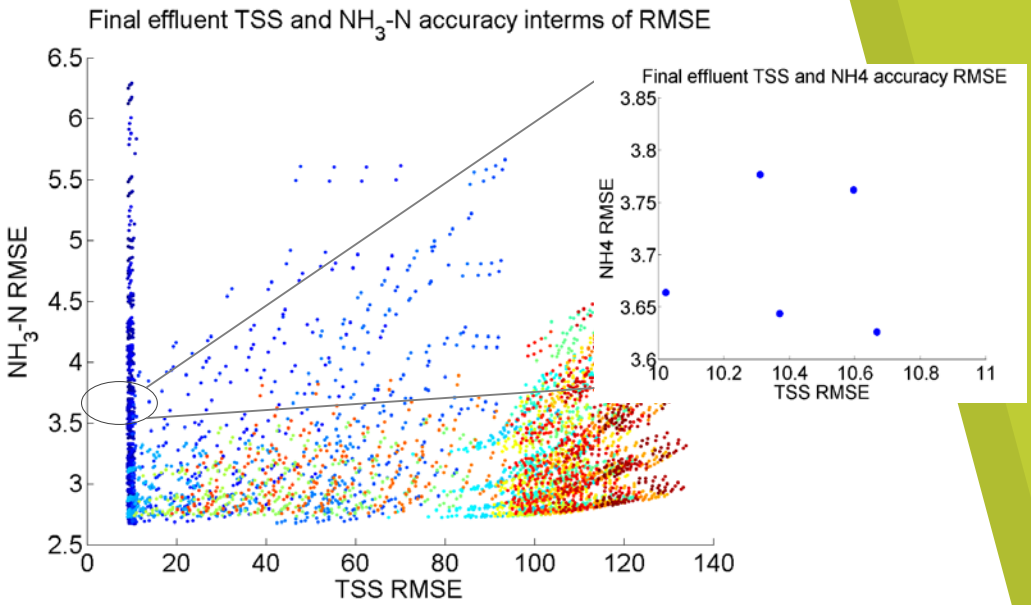
Assessing the impact of Data Availability on Control designs

- Investigate performance of a WwTP model by using different levels of datasets.

- The increase/decrease in model performance among three scenarios was assessed to investigate the benefit of using specific dataset in model setup and calibration processes.

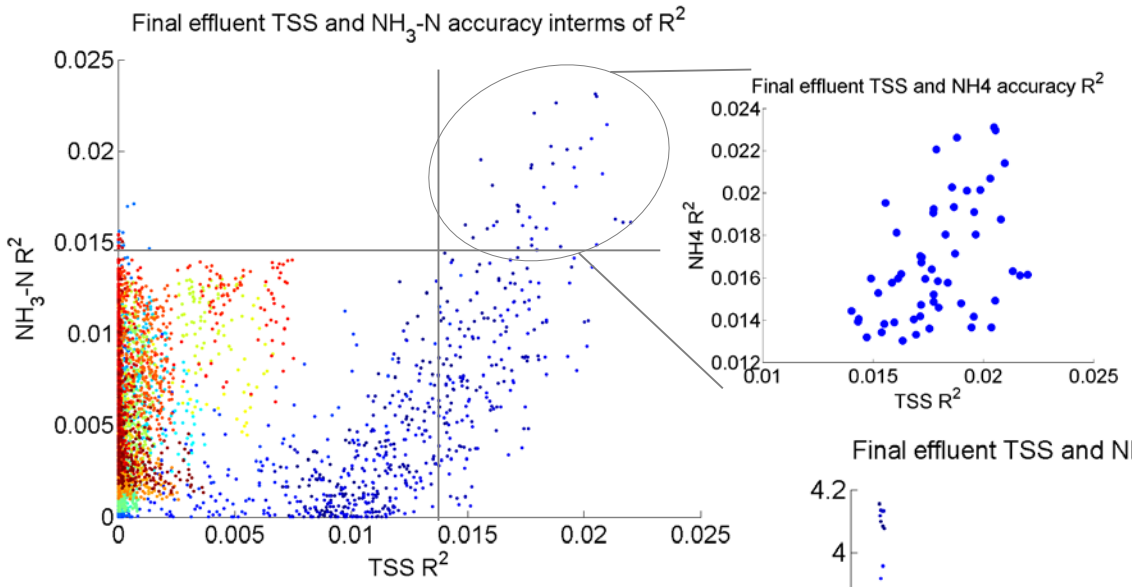
Dataset 1

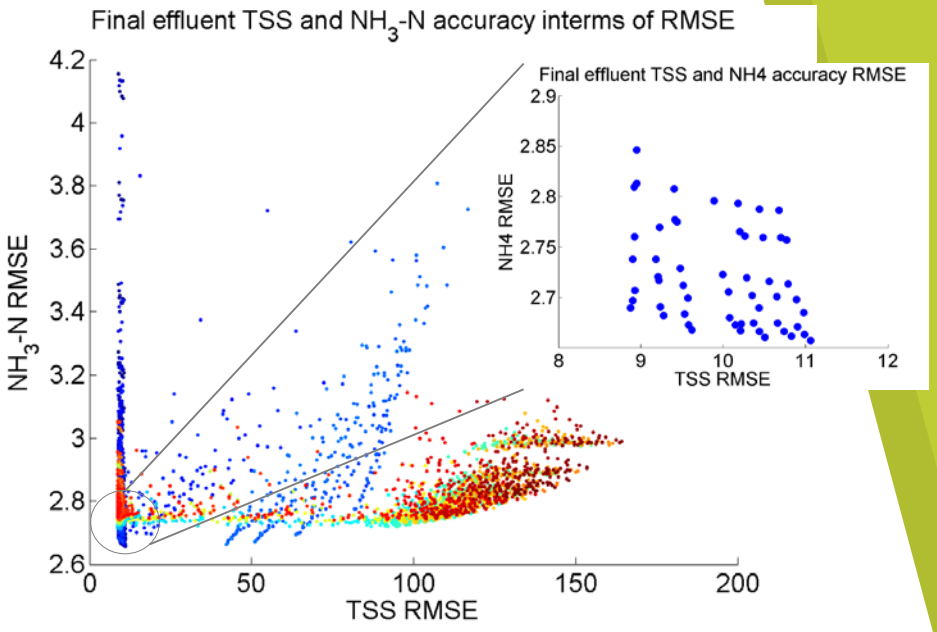




Commonly monitored parameters like **flowrates** which were monitored at 15 time step at influent and effluent points, and **daily average** influent and final effluent quality indicators (**TSS** and **NH_3-N**)

Dataset 2

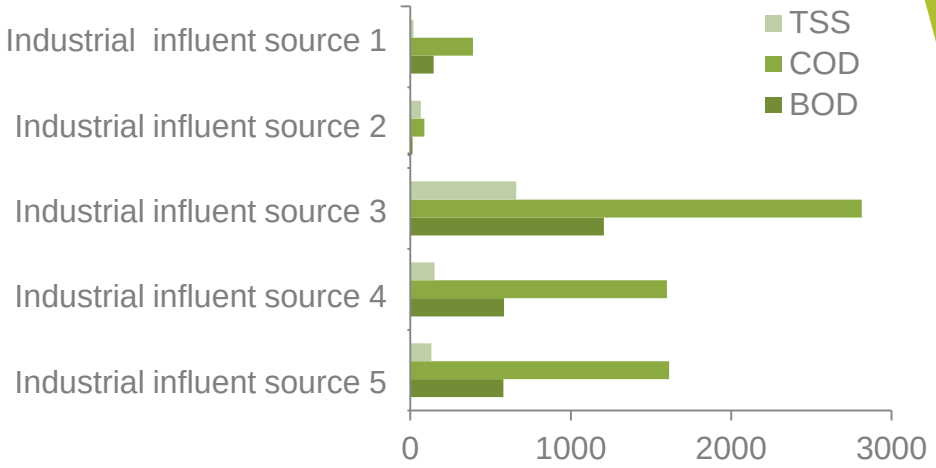


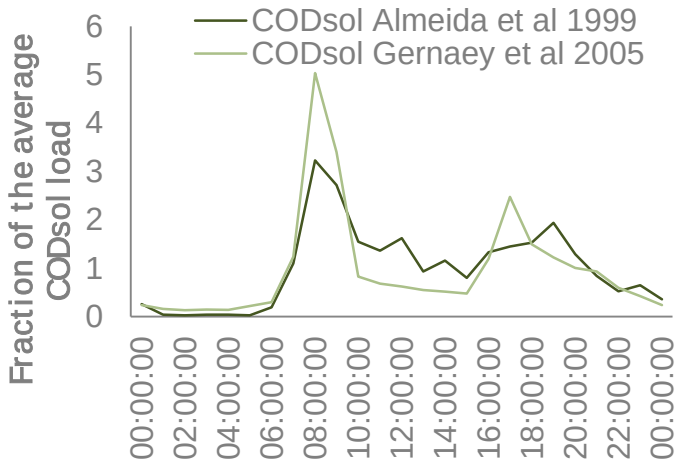


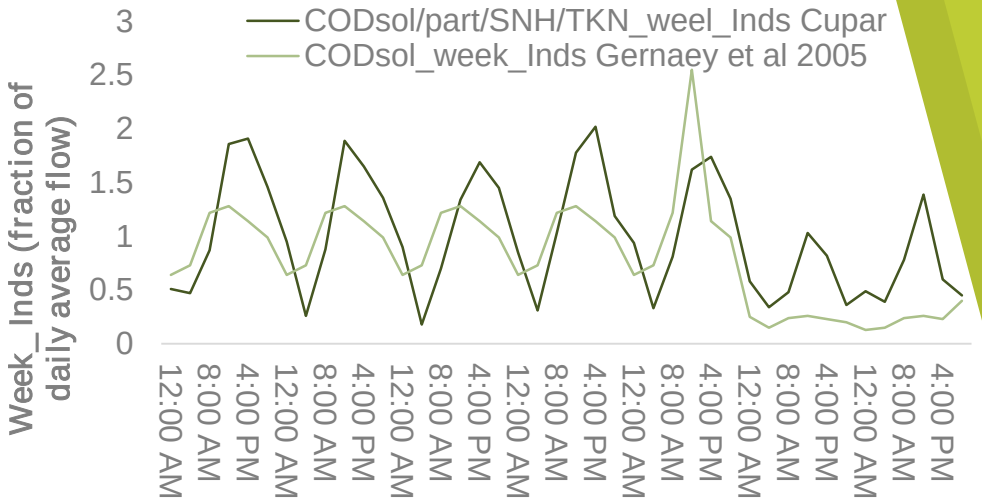
- **Mixed liquor suspended solid** data used to match mimic SAS flow control
- **Dissolved oxygen** (DO) level in oxidation ditch used to understand the DO control structure.

Dataset 3

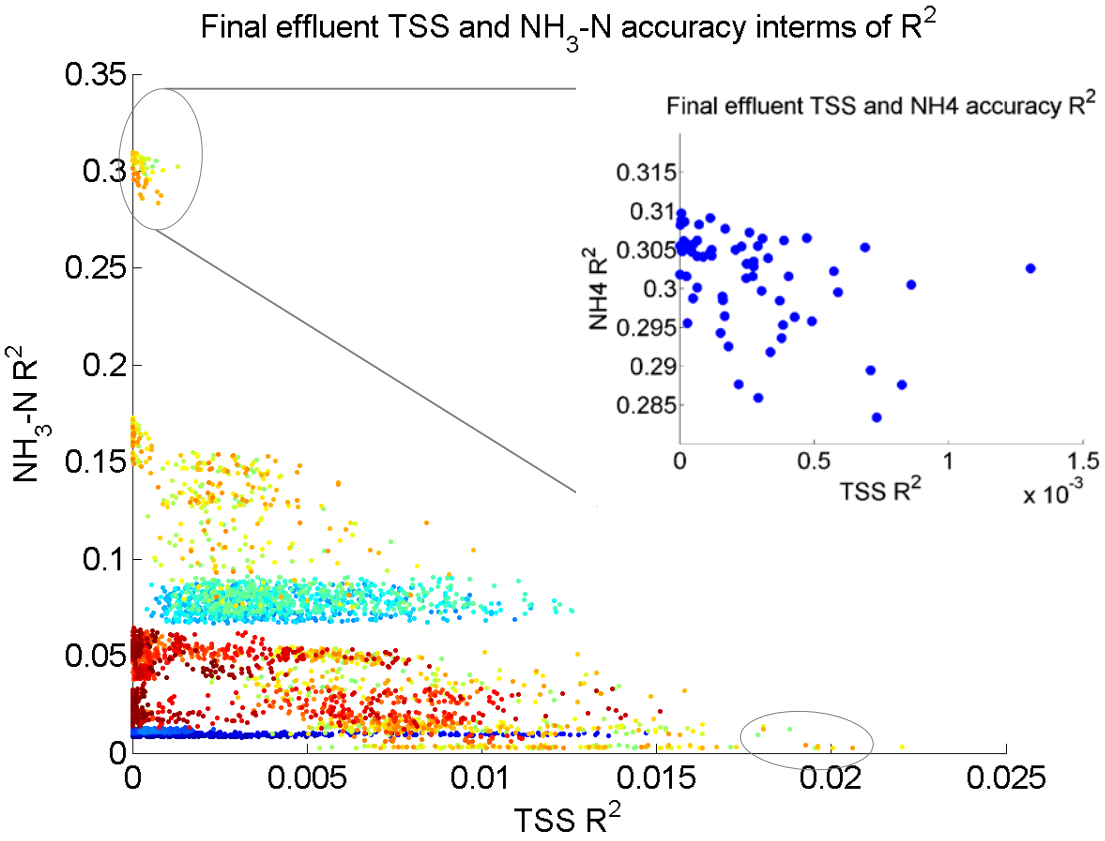
Detailed process based modelling and **characterisation** of the influent **wastewater**



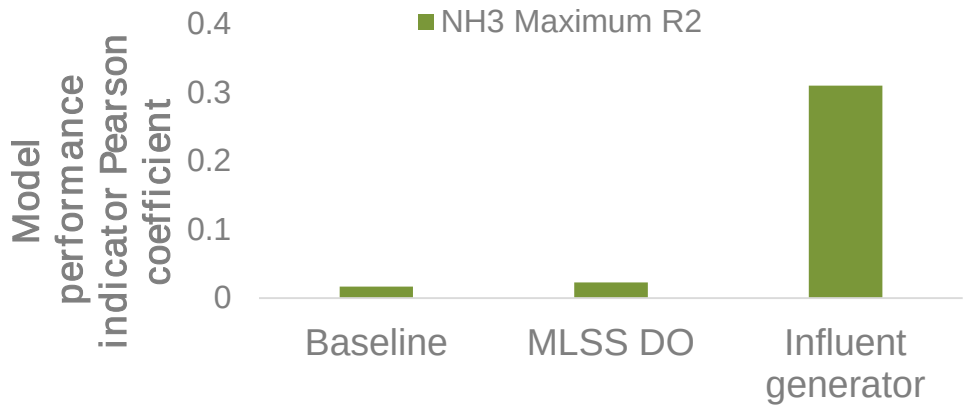




Dataset 3


Final effluent TSS and NH3-N accuracy interms of R2
NH3-N R2
TSS R2
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.005
0.01
0.015
0.02
0.025
Final effluent TSS and NH4 accuracy R2
NH4 R2
TSS R2
x 10-3
0.315
0.31
0.305
0.3
0.295
0.29
0.285
0
0.5
1
1.5

Key findings of the Assessment of the Impact of Data availability on model predictive accuracy



- Not all measured data increase model performance at equal level

- Monitoring the influent quality on a finer time scale and fractionating the COD and the total nitrogen of the influent wastewater plays a significant role in improving model performance and therefore formulating a reliable control design.

Anticipated outcomes

- Evaluation of different control strategies using fixed standard approach and evaluation of different integrated control strategies using dynamic licensing

- A systematic framework that can be used by Scottish Water to identify suitable control strategies depending on the various goals

Thank you for your attention

Any questions?