Practical Use of Online Sewage Turbidity Data to Develop Control Strategies in an Integrated Modelling Framework

EJSW2013

Graz, Austria

April 9-12, 2013

Sovanna Tik, Janelcy Alferes, Paul Lessard, Peter Vanrolleghem

VILLE DE QUÉBEC

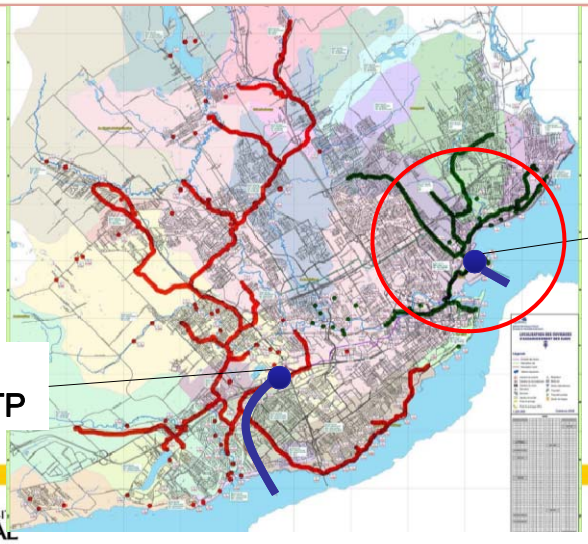
UNIVERSITÉ LAVAL

modelEAU

Presentation overview

- Context and project objectives
- Equipment installation and maintenance
- Data treatment
- Use of data (model calibration)
- Conclusions and perspectives

Context



VILLE DE QUÉBEC

UNIVERSITÉ LAVAL

modelEAU

Context

- ~ 500 000 inhabitants
- 2 WWTPs
- 14 retention tanks (150 000 m³)

Reduce CSOs (per summer season)

~50 → less than 4 (Saint-Charles River)
→ less than 2 (Jacques-Cartier Beach)

⇨ RTC system based on flow and level

UNIVERSITÉ LAVAL

modelEAU

Problems

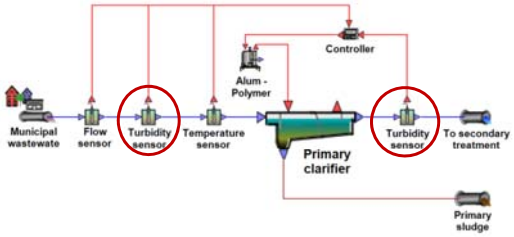
- WWTP → treatment deterioration, by-pass

⇨ Primary clarification enhanced by chemicals injection

⇨ Optimisation of chemical dosage
- ➢ Effluent limits compliance
- ➢ Cost reduction

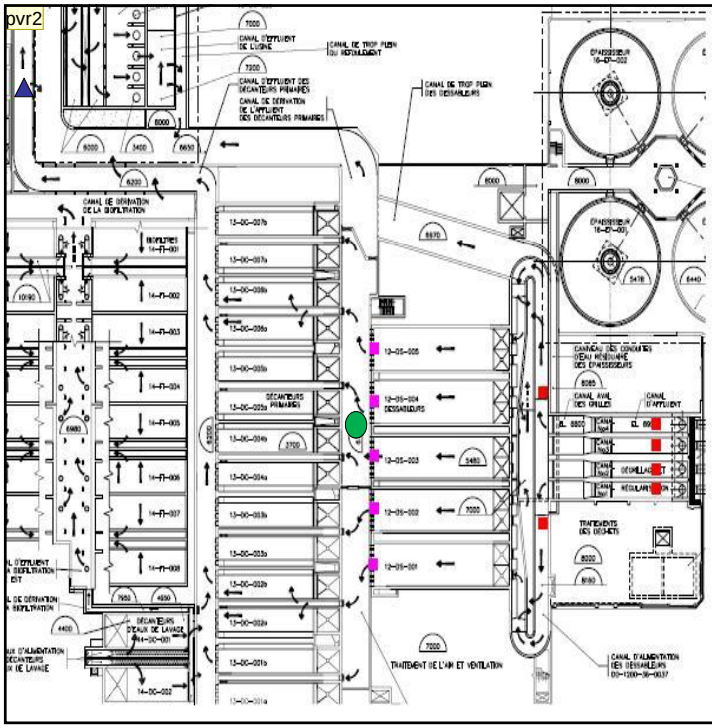
Project objectives

- Develop a simple primary clarifier model with the effect of alum addition
- Propose RTC system to optimise alum dosage



⇨ Need for reliable (online) turbidity data

East WWTP schematic



Injection points

- Alum
- Polymer
- Online monitoring station
- Turbidity sensor

Online monitoring station

Turbidity sensors

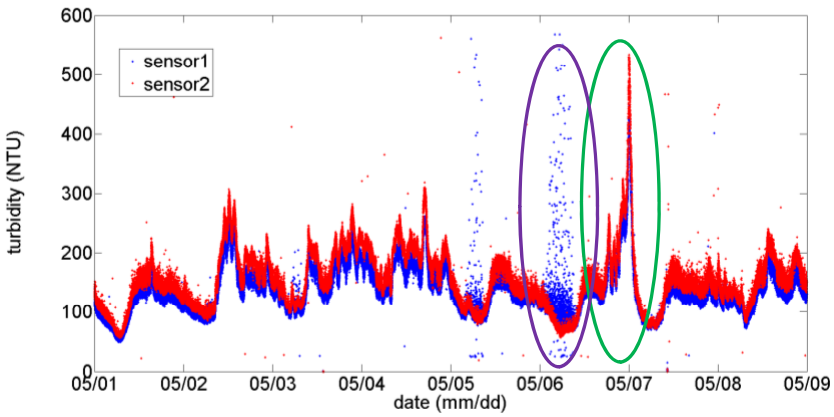
Sensors fouling



Practical set-up

- Sensor location (representativeness, flow)
- Operational procedure
  - Automatic cleaning at high frequency
  - Manual cleaning (once a week)
  - Control with standard solution
  - Use of redundant sensors to identify stability
- Avoid risks of sensor clogging

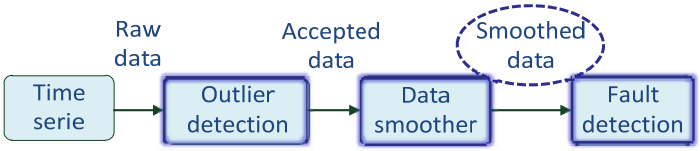
Redundant sensors – raw data



UNIVERSITÉ LAVAL

modelEAU

Data quality assessment tools



- Fault detection
  - % replaced data → data goodness
  - Slope → rate of change
  - Residuals correlation → good fit of model
  - Residuals std (RSD) → variance

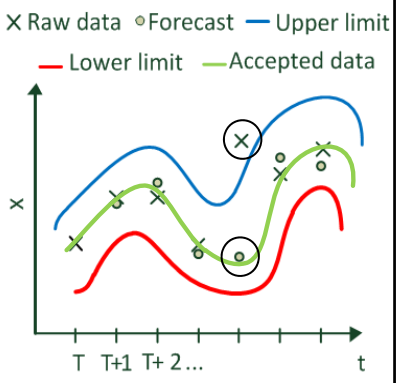
UNIVERSITÉ LAVAL

modelEAU

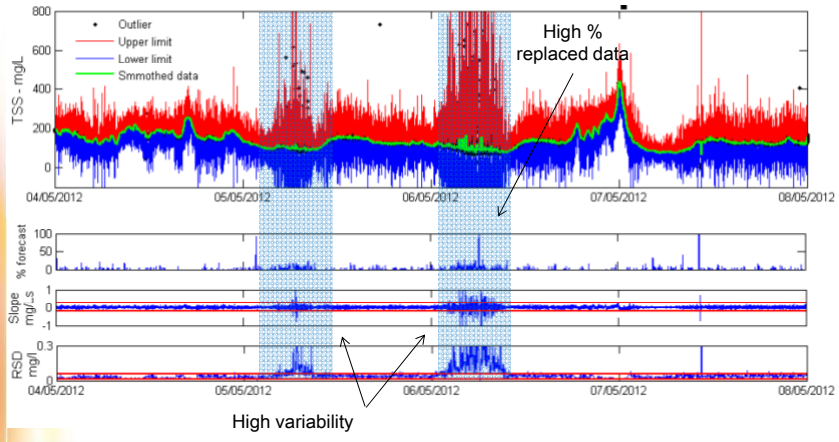
Data quality assessment tools

- Outlier detection
  - Autoregressive models
  - At T forecasting (T+1):
    - variable $\hat{x}$
    - std of error $\hat{\sigma}_e$
  - Prediction interval:

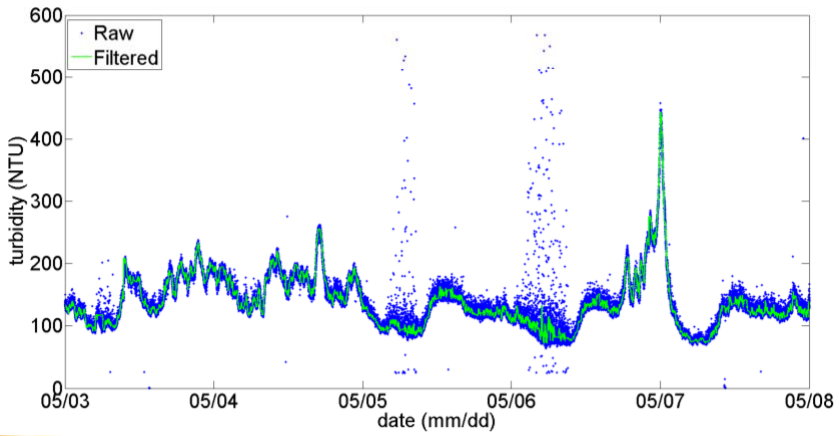
$$x_{\lim} = \hat{x} \pm K \cdot \hat{\sigma}_e$$



Results



Data treatment results

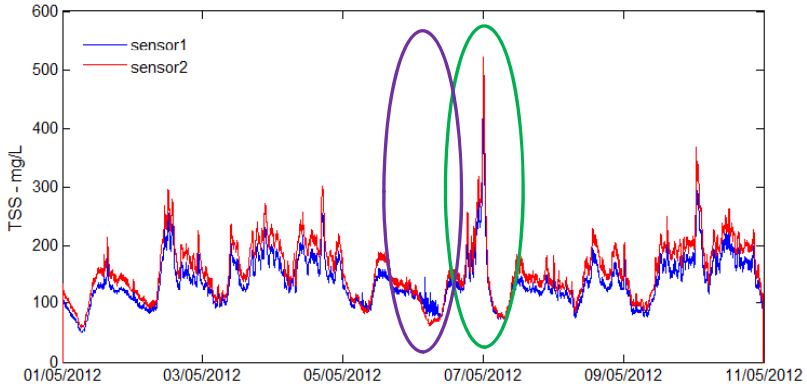


UNIVERSITÉ LAVAL

15

modelEAU

Data treatment results



UNIVERSITÉ LAVAL

16

modelEAU

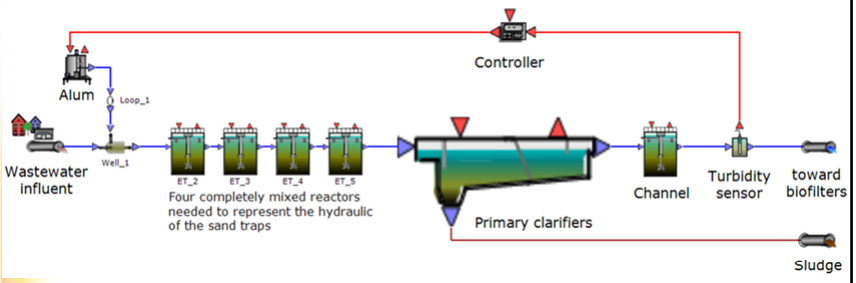
Redundant signal - observations

- Bias
  - Shift of 20 NTU on sensor 2
  - No evolution during experimental period
- Identify abnormal behaviour from sensors' failure

Use of turbidity data

- Model calibration and validation
- Controller input (on going)

Controller development

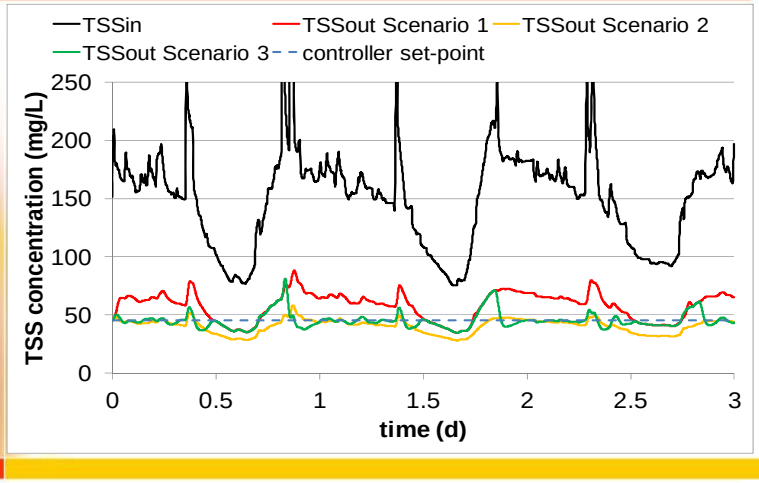


Model configuration in WEST® (mikebydhi.com)

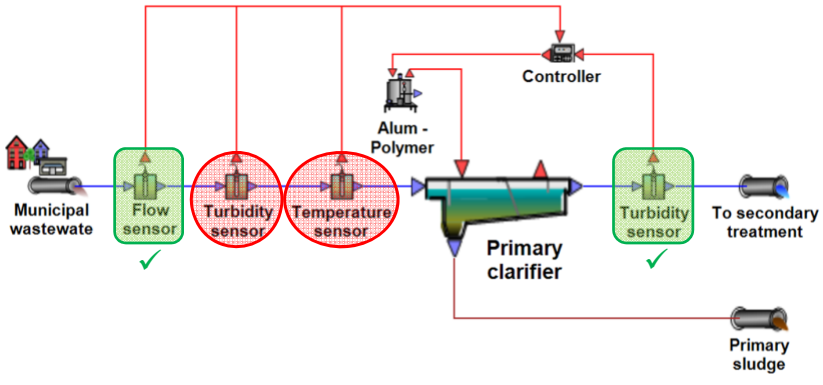
Control strategy

- Feedback control on outlet turbidity
- 3 scenarios :
  - Open loop
  - Constant dosage
  - Controlled dosage

Preliminary results



Controller development – next step



Model configuration in WEST® (mikebydhi.com)

Conclusions and perspectives

- Importance of careful fieldwork to collect reliable data
- Validation of data quality assessment tools
  → Online implementation
- Integrated model (network+WWTP)
  → Control of retention tanks emptying based on water quality

Acknowledgement

VILLE DE QUÉBEC

Canada Research Chair in Water Quality Modeling

Primodal
Earth Essential Technologies