

Survey of How Nutrients are Regulated and Managed around the World

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WEF/IWA

Nutrient Removal and Recovery

2016





Tension over the fence...

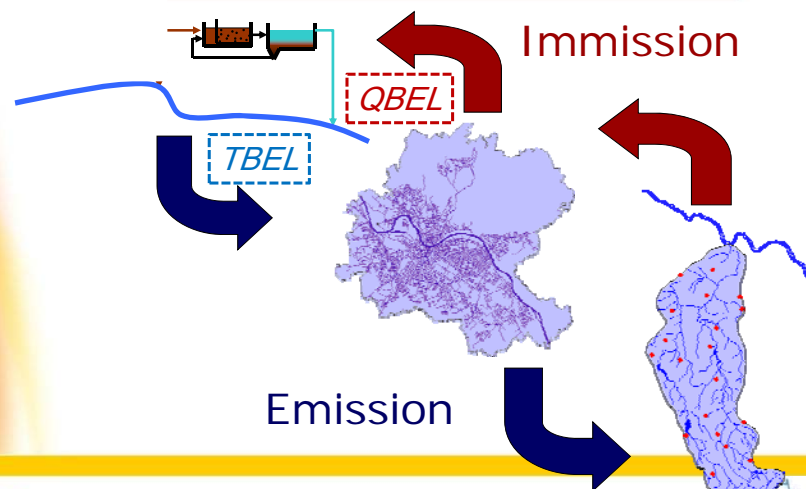


Environmental protection

- We can do many things to manage water quality
- But how do we go about choosing among them?



Environmental protection



Outline

- Environmental protection
- Regulations: Principles followed
- Diversity of regulations: A global comparison
 - Effluent limits
 - Compliance assessment
 - Compliance enforcement
- Perspectives

Regulations: Principles

- WWTP effluent regulations reflect the requirements in terms of:
 - Quantity
 - Qualityto meet the water quality objectives of a receiving water (driven by the water uses)

B.N. Jacobsen & T. Warn (1999) European Water Management, 6, 25-39

Regulations: Principles

- Should we regulate average (e.g. yearly av.) or extreme values (e.g %iles of daily values)?
 - Extremes for:
 - Oxygen, NH_4 , toxics
 - Hygiene
 - Aesthetics
 - Average for:
 - Eutrophication
 - Bioaccumulation



Regulations: Principles

- Compliance assessment = evaluation of whether a given WWTP effluent meets the criteria defined in the effluent standard
- Includes:
 - Limit values of the regulation
 - Specification of the methods for
 - Sampling (grab, composite)
 - Analysis (APHA, DIN, CEN, ...)
 - Assessment of the data (e.g. rejection, statistics)
- Compliance enforcement

Regulations: The global perspective



Regulations: The global perspective

- Survey expanded and updated recently



Comparison of regulations

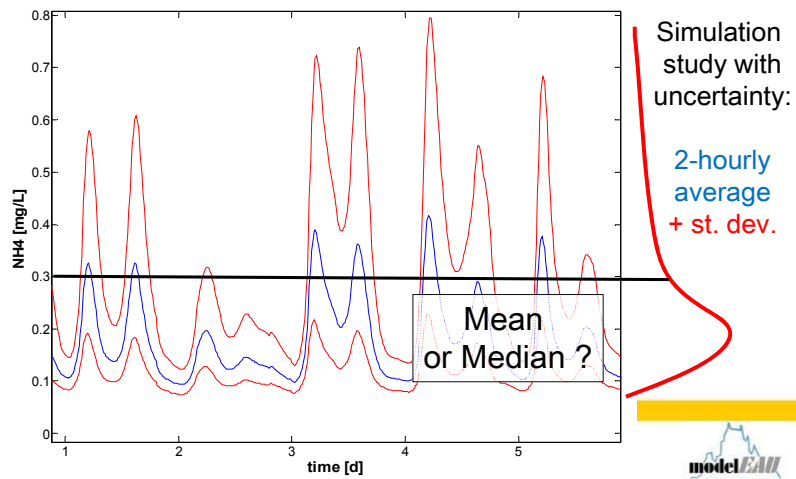
- Effluent limits
 - P_{tot} : 0.07 – 10 mgP/L (developing/developed nations)
(sensitive/non-sensitive areas)
 - N_{tot} : 3 – 60 mgN/L
 - NH_4 : 2 – 20 mgN/L
 - NO_x : 1.5 – 15 mgN/L
 - NO_2 : 0.3 mgN/L (Switzerland)
- Survey data analysis limited to nutrients

Comparison of regulations

- Compliance assessment:
 - Not specified (developing & emerging countries)
 - Grab versus daily composite sampling
 - Number of samples (interval between samples):
 - 2hr
 - Daily
 - Weekly (every 6 days to capture weekend effects)
 - Monthly
 - Averaging over a week, 3 months, a year
 - No exceedance vs. %ile exceedance (50-80-90-95%)

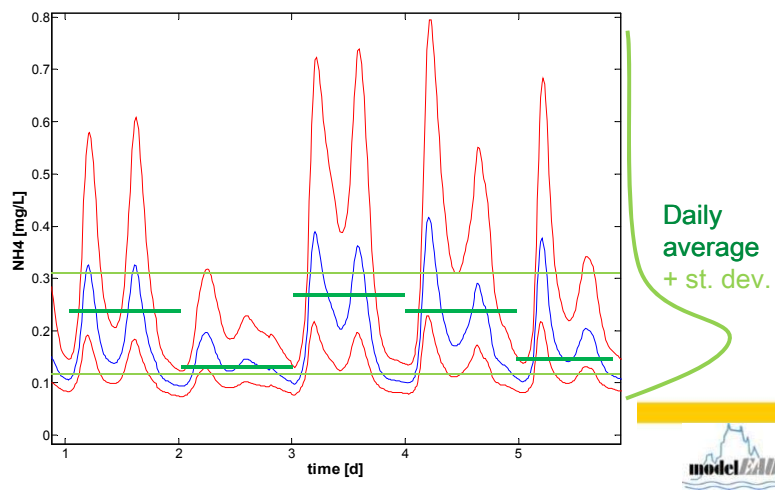
Compliance testing: Assessment

- Effluent limit depends on sampling frequency



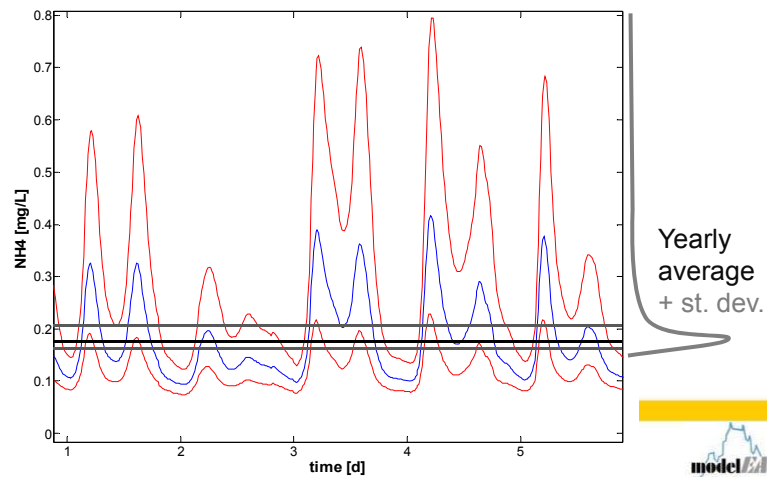
Compliance testing: Assessment

- Effluent limit depends on sampling frequency



Compliance testing: Assessment

- Effluent limit depends on sampling frequency



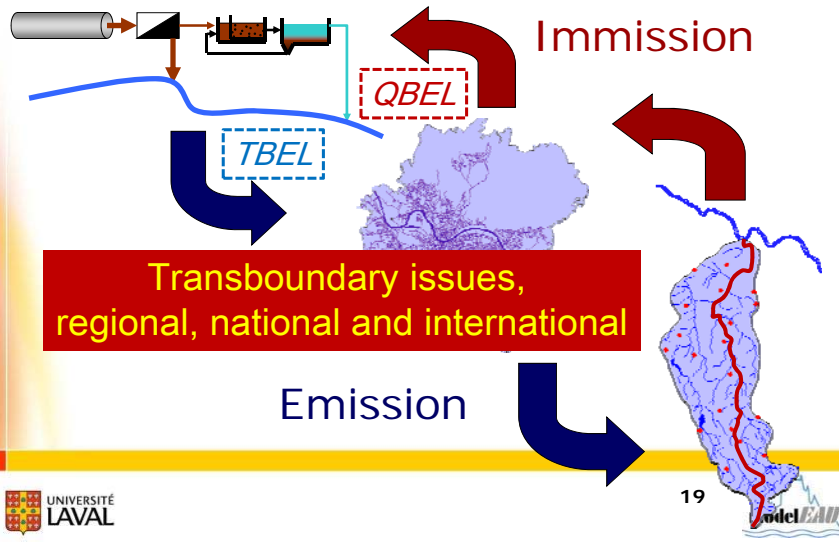
Comparison of regulations

- Origin of effluent limits:
 - Sensitive versus non-sensitive areas
 - Based on water quality uses
 - WQ simulations
 - Dilution with reference flow (Q10)
 - Best available technologies

QBEL

TBEL

Equity of regulations?



Comparison of regulations

- Origin of regulation:
 - Sensitive versus non-sensitive areas
 - Based on water quality uses *QBEL*
 - WQ simulations
 - Dilution with reference flow (Q90)
 - Best available technologies *TBEL*
 - National law, local permitting body
 - Negotiations between discharger – permit writer
 - EU Urban WWT directive

Compliance enforcement

- Lose permit to discharge (industry)
- Public humiliation – blacklisting
- Benchmarking (“peer review”)
- Financial mechanisms

PROGRAMME D'EXCELLENCE
StaRRE



StaRRE = Station de Récupération des Ressources de l'Eau
≈WRRF = Facility for Recovery of Resources from Water

Financial mechanisms

- Denmark (1994)

- NH_4 :

$C_{\text{discharge}}$: 1.5 mgN/L

$\Delta\alpha = 4 \text{ € /kg N}$

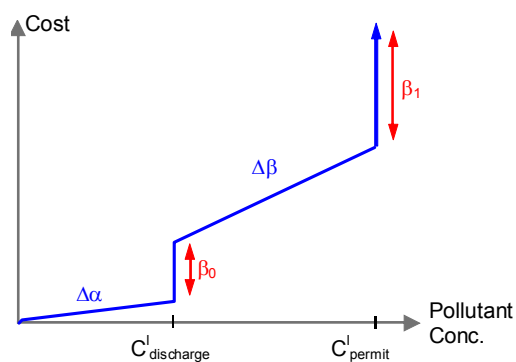
$\Delta\beta = 12 \text{ € /kg N}$

- NO_3 :

$C_{\text{discharge}}$: 8.0 mgN/L

$\Delta\alpha = 2.5 \text{ € /kg N}$

$\Delta\beta = 7.5 \text{ € /kg N}$



Vanrolleghem et al. (1996), WST, 34(3-4), 159-171

Making it happen: Financial means

- Flanders – Belgium: Pollution units

$$Fine = Unifine \cdot (k_{organic} \cdot N_{organic} + k_{metals} \cdot N_{metals} + k_{nutrients} \cdot N_{nutrients} + N_{heat})$$

- Switzerland:

WWTP owner pays effluent load fee to fund:

- 0.05 \$/m³
- 0.70 \$/kg COD
- 4.00 \$/kg NH₄-N
- 1.00 \$/kg NO₃-N
- 30.00 \$/kg P_{tot}

Used to fund WWTP upgrades (instead of subsidies)

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Perspectives

- WEF/WERF/EPA/EDF/NACWA/DCWATER/HRSD-funded project for critical evaluation of regulations:
 - Overview of current & emerging regulations globally
 - Simulation-based analysis of the impact of the different regulations on WRRF design and operation
(workshop D, yesterday)
 - Can we stimulate faster adoption of innovation?
(presentation 14A, Thomas Maere, Wednesday, 8:30)



Thank you:

- Marc Neumann, Ludiwine Clouzot, Thomas Maere postdocs at modelEAU – UlaVal
- IWA/WEF DOUTgroup
- WEF/WERF/EPA/EDF/DCWATER/HRSD-project
- Canada Research Chair in Water Quality Modeling

