Regulation and its effect on the design and operation of WRRFs: A global perspective

IWA Sustainable Wastewater Treatment and Resource Recovery

Kathmandu, Nepal

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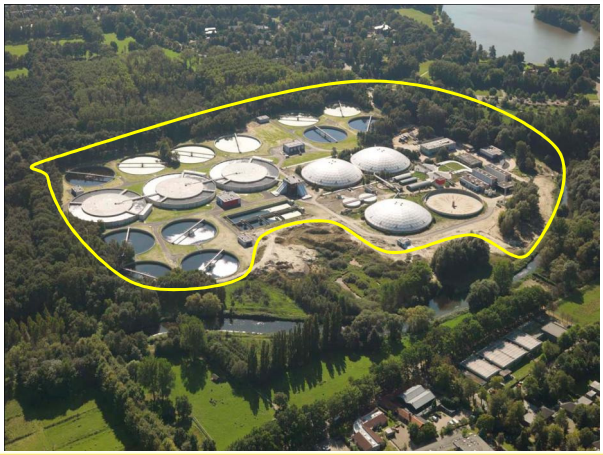
Tension over the fence…



De Dommel WWTP, Eindhoven

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Environmental protection

- Many things we can do to protect water quality
- How do we go about choosing among them?

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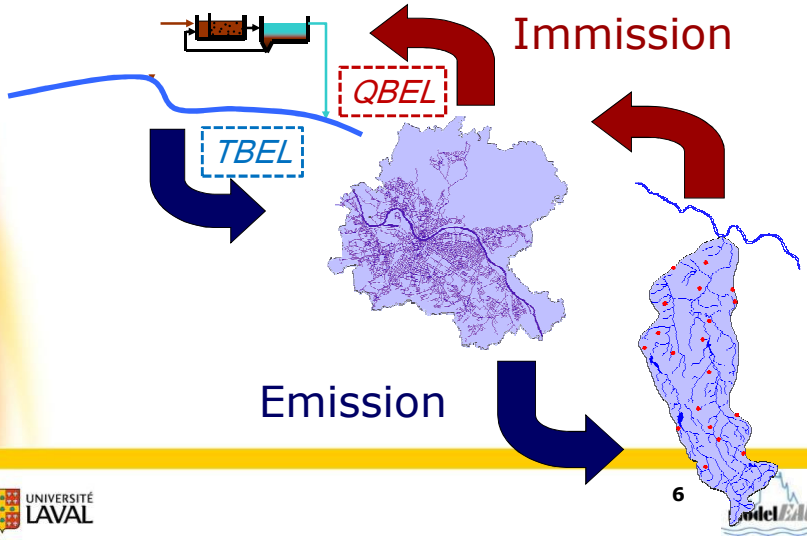
Environmental protection



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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
  - Quality

  to 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

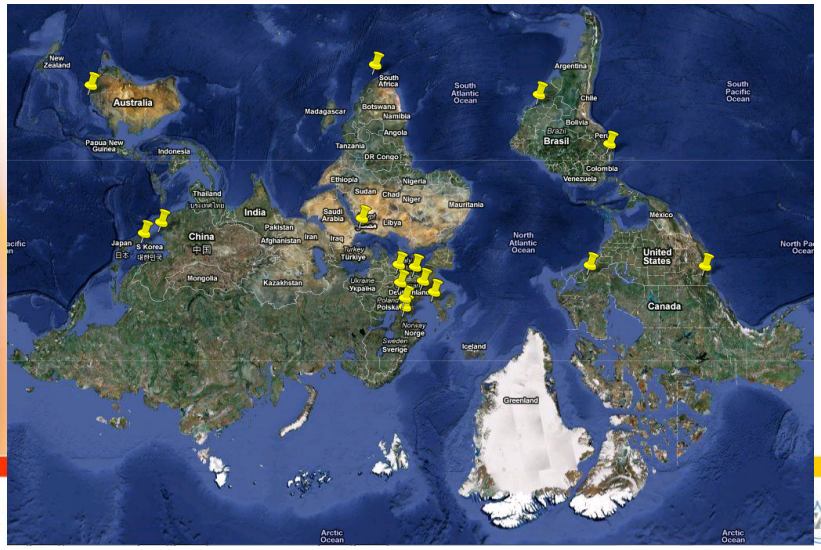
Regulations: Principles

- 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



Comparison of regulations

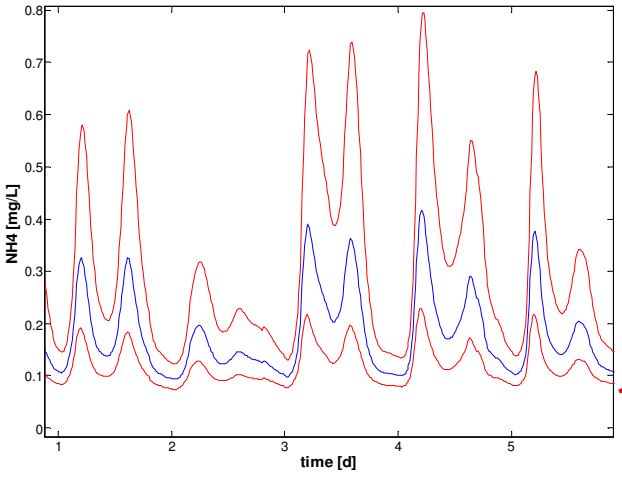
- Effluent limits
  - P_{tot}: 0.07 – 10 mgP/L (developing/developed nations) (sensitive/non-sensitive areas)
  - N_{tot}: 3 – 60 mgN/L
  - NH_4: 2 – 20 mgN/L
  - NO_x: 1.5 – 15 mgN/L
  - NO_2: 0.3 mgN/L (Switzerland)
- Analysis limited to nutrients

Comparison of regulations

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

Compliance testing: Assessment

- Effluent limit depends on sampling frequency

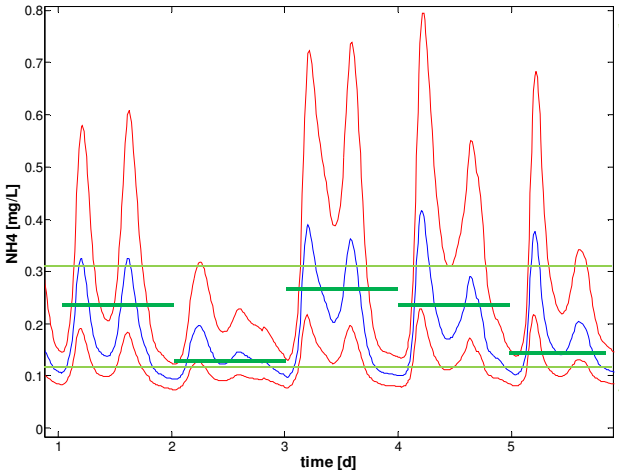


Simulation study with uncertainty:

2-hourly average + st. dev.

Compliance testing: Assessment

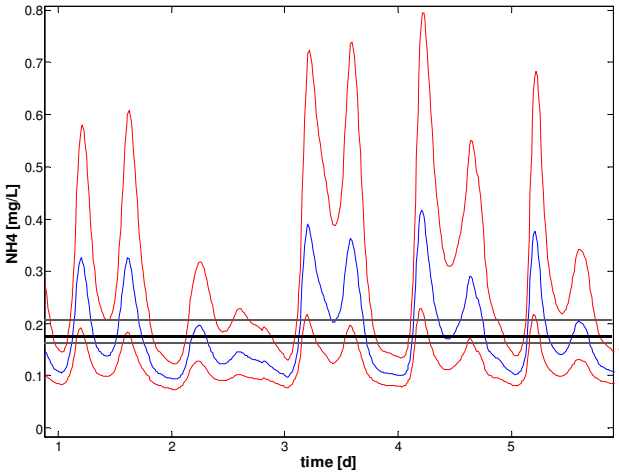
- Effluent limit depends on sampling frequency



Daily average + st. dev.

Compliance testing: Assessment

- Effluent limit depends on sampling frequency

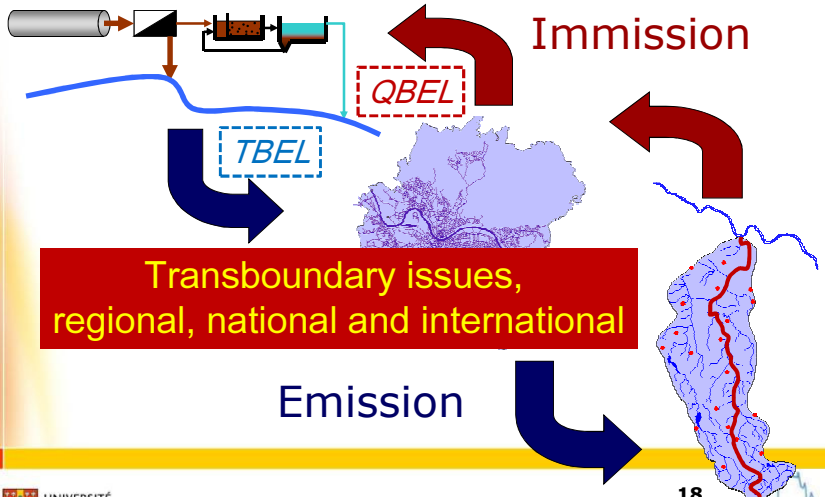


Yearly average + st. dev.

Comparison of regulations

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

Financial mechanisms

- Denmark (1994)
- NH_4:

  $C_{discharge}$: 1.5 mgN/L

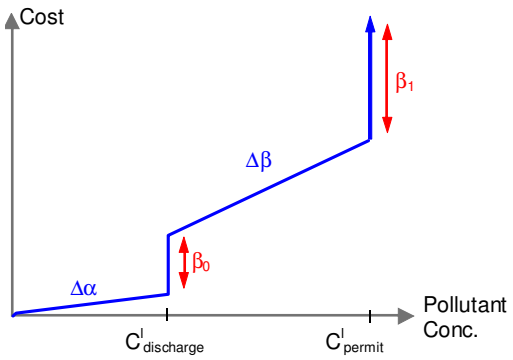
  $\Delta\alpha$ = 4 € /kg N

  $\Delta\beta$ = 12 € /kg N
- NO_3:

  $C_{discharge}$: 8.0 mgN/L

  $\Delta\alpha$ = 2.5 € /kg N

  $\Delta\beta$ = 7.5 € /kg N



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

Making it happen: Financial means

- Flanders – Belgium: Pollution units

$$Fine = Unitfine \cdot \left(k_{organic} \cdot N_{organic} + k_{metals} \cdot N_{metals} + k_{nutrients} \cdot N_{Nutrients} + N_{heat}\right)$$

- Switzerland:

  WWTP owner pays effluent load fee to fund:
  - 0.05 $/m^3$
  - 0.70 $/kg COD
  - 4.00 $/kg NH_4-N
  - 1.00 $/kg NO_3-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
- Can we do better?
- Can we stimulate faster adoption of innovation?

Thank you:

- Marc Neumann, Ludiwine Clouzot, postdocs at model*EAU* - ULaval
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- WEF/WERF/EPA/EDF/DCWATER/HRSD-project
- Canada Research Chair in Water Quality Modeling

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