# Workshop D - Session 2: How to incorporate stochastics in permitting?

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WEF/IWA
Nutrient Removal and Recovery
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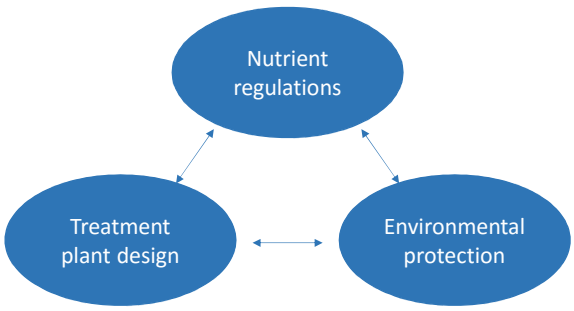
## Workshop D - Session 2 Introduction

- Innovation & Regulations project: InnovaReg
- Interactions between:



* It wouldn't be scientific if we understood it




# Project Scope

- Phase I: Critical survey of nutrient permitting approaches around the world
- Phase II: Getting better insight in regulations by comparing legislation through simulations
- Phase III: Suggesting changes to the current US regulatory framework

# Project Scope

- Phase I: Critical survey of nutrient permitting approaches around the world
  - Global survey: Peter Vanrolleghem (Monday, 9h15)
  - Innovation aspects: Thomas Maere (Wednesday, 8h30)
  - Poster WE&RF Nutrient Challenge (Tuesday, 17h15)



# Current Funding:

# Project Scope

- Phase II: Getting better insight in regulations by comparing legislation through simulations


InnovaReg workshop, 19-20 October 2015, Alexandria, VA



# Requested Funding:

NSERC CRSNG

Mitacs

modelEAU

UNIVERSITÉ LAVAL

HDR

# Simulation Case Study

- Objectives of case study?
  - Differences in regulatory approaches
  - Impact on ecosystem and public health
  - How can regulation innovation improve environmental performance
- Group discussions:
  - Who is our public? Who to convince?
  - How to prove innovation? Specific goals?
  - Do we need a real case?
  - Do we need to model everything?



# Simulation Case Study

- Who is our public? Who to convince?
  - Different points of view / stakeholders
  - Utilities:
    - Cost saving while maintaining water quality
    - Cost-effective water quality improvement
  - Permit writers:
    - No need for excessive conservatism
    - Ok to be flexible, beneficial for environment
  - Keep an international perspective

# Simulation Case Study

- How to prove innovation? Specific goals?
  - Compliance assessment (averaging, exclusion, %ile, …)
  - Effect of permit structure on plant design (capex, opex)
  - Effect of permit structure on environment (DO, Chl a, …)
  - Cost vs. water quality (trade-off?)
  - Point vs. diffuse sources (best management practices)
  - Innovative permitting (bubble, trading, performance)
  - Innovative technologies (limit of technology)
  - Stochastics and uncertainty (we live in an uncertain world, conservatism, safety factors)



# Simulation Case Study

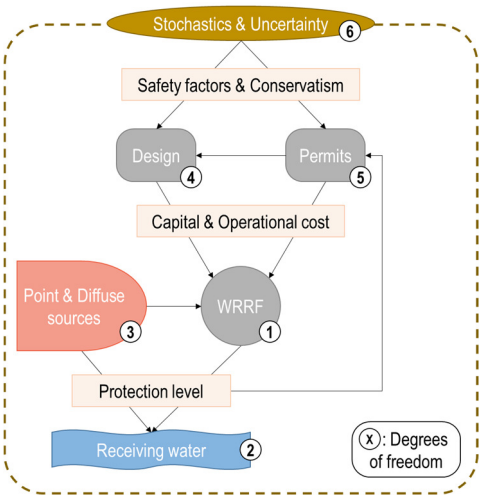
- Do we need a real case?
  - Not necessarily
  - Benefits:
    - More convincing, stronger message
  - Drawbacks:
    - Time consuming
    - Finding the right case
  - Doesn't matter which case (river, lake, estuary), as long as we have all the data
  - Flexible enough to accommodate various scenarios

# Simulation Case Study

- Do we need to model everything?
  - Not necessarily
  - Simplification:
    - Physical system: e.g. catchment, sewer, treatment
    - Input generator:
      - Point and diffuse sources
      - Water quality specs
      - Treatment technology specs
    - Modeling: e.g. hydraulics, water quality
    - Costing



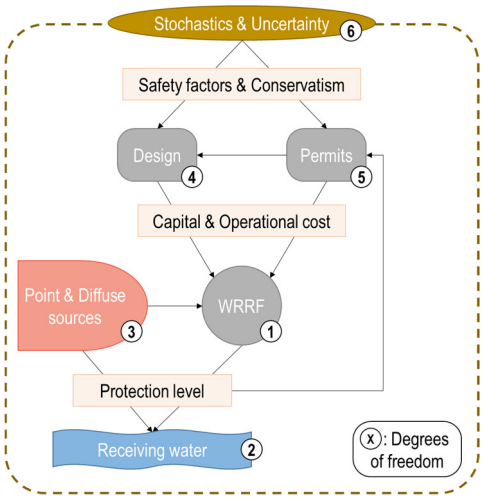
# Plan of Action




1) Equivalence of global effluent standards
2) Interactions: regulations, plant design & water quality
3) Innovative permitting & technologies

# Plan of Action:

## 1) Equivalence of global effluent standards



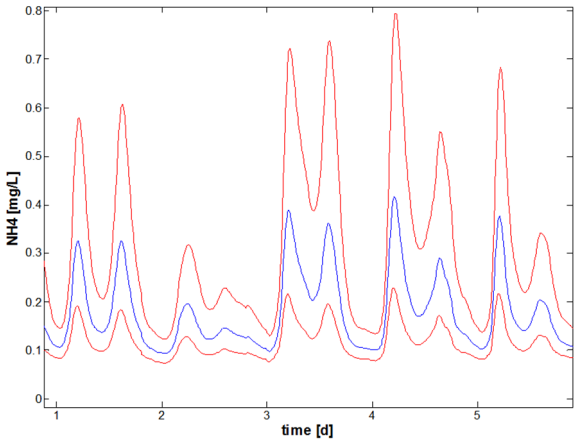

5

- Limits
  - Concentration / loads
  - Treatment efficiency
  - Treatment technology
- Compliance assessment
  - Grab / composite sampling
  - Chemical analysis
  - Data treatment
  - Assessment methods
    - 100% compliance
    - Percentiles
    - Averaging
    - Seasonal
- Water quality impact
  - DO, Chl a, …



# Plan of Action:

## 1) Equivalence of global effluent standards



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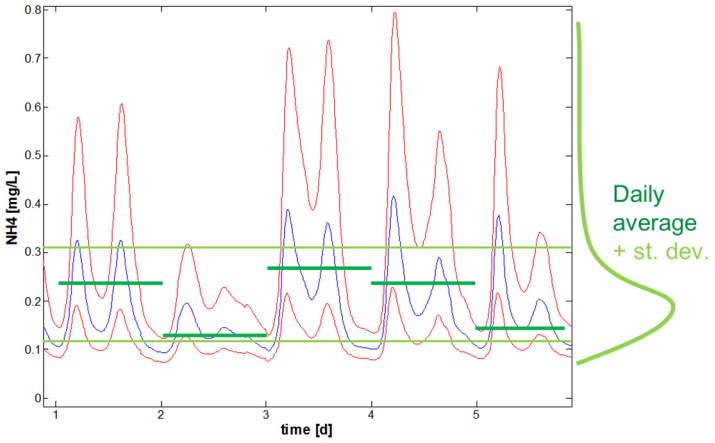




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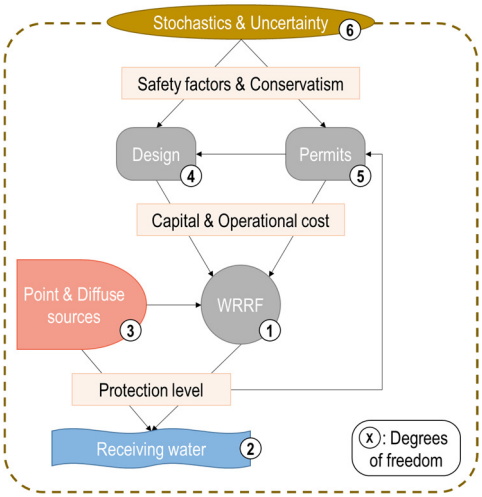
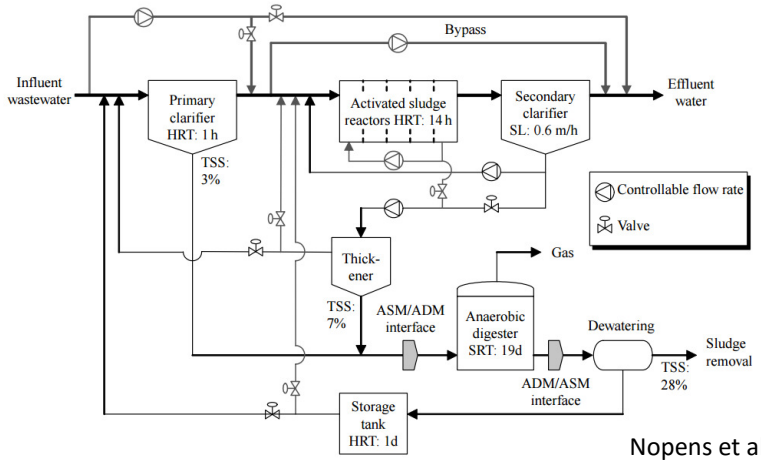



1
- Reference scenario
- Virtual case study
- Standard BNR plant (N, P)
- Benchmark Simulation Model (BSM1 or BSM2)
- Adapt to our needs

2
- River stretch
- Simplified hydraulics
- RWQM1 – Reichert et al., 2001 (nutrients, algae, …)
- All models in 1 software (flexibility, speed)

# Plan of Action:

## 1) Equivalence of global effluent standards

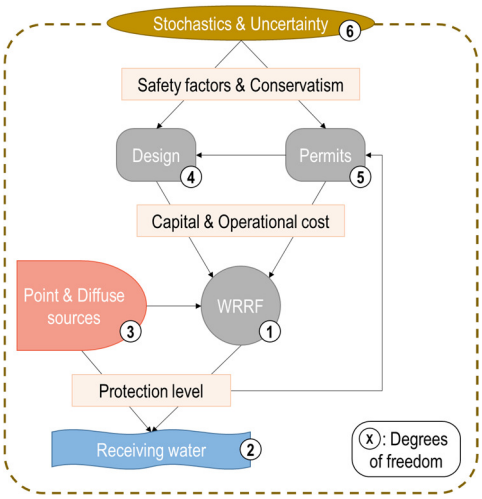



Nopens et al., 2010



# Plan of Action:

## 1) Equivalence of global effluent standards



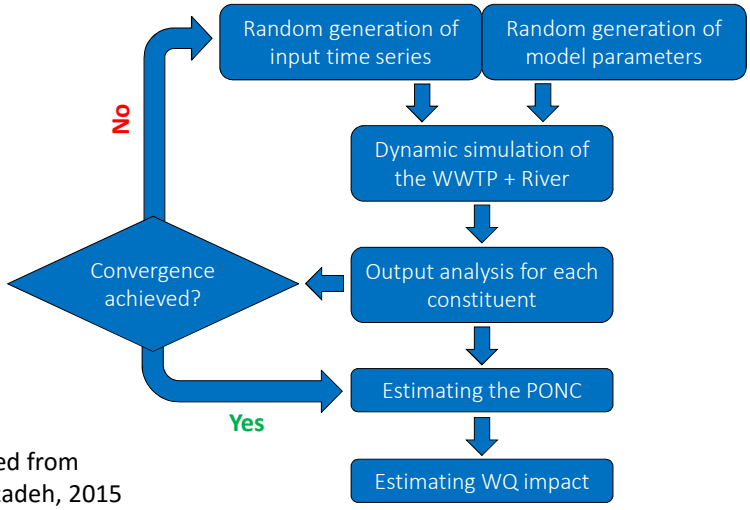

3

- Input generator
- Phenomenological: watershed, climate, dry vs. rain
- Dynamic influent data
- Flow, temperature, pollutant concentrations
- Talebizadeh (2016)
- Varying, statistically-based
- Probability of non-compliance

Talebizadeh, M., Belia, E., Vanrolleghem, P.A., 2016. Influent generator for probabilistic modeling of nutrient removal wastewater treatment plants. *Environ. Modelling & Software*, 77, 32-49.

# Plan of Action:

## 1) Equivalence of global effluent standards

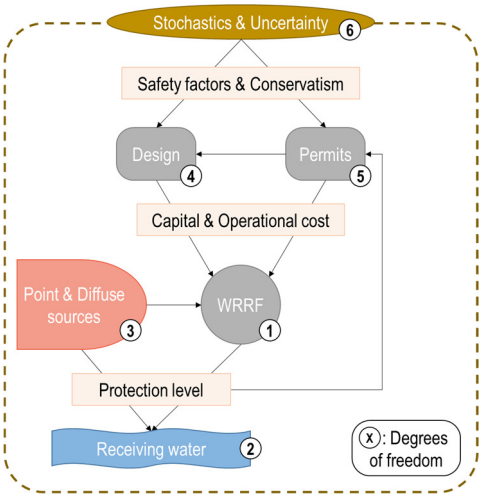



Adapted from Talebizadeh, 2015



# Plan of Action:

## 2) Interactions: regulations, plant design & water quality

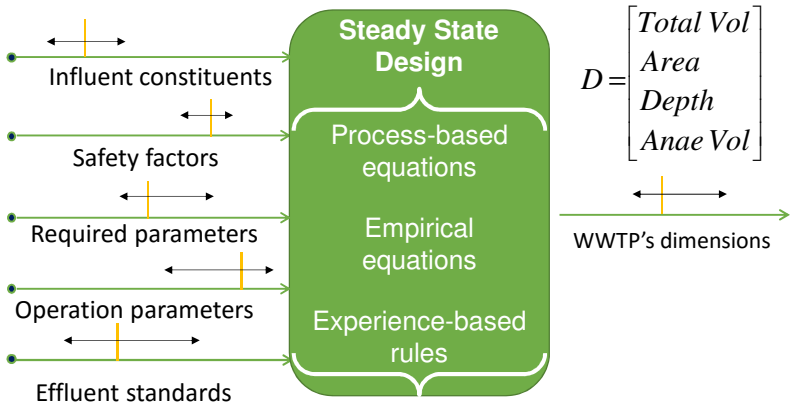



4

- Stochastics: variability in treatment plant efficiency, effluent dilution, …
- Uncertainty: safety factors, conservatism, worst case scenarios
- Approach: based on previous framework
- Add several designs with different levels of safety and cost
- Design guidelines
- Cost in orders of magnitude

# Plan of Action:

## 2) Interactions: regulations, plant design & water quality

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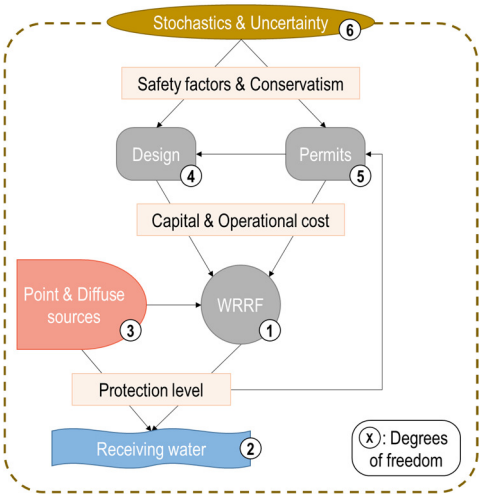
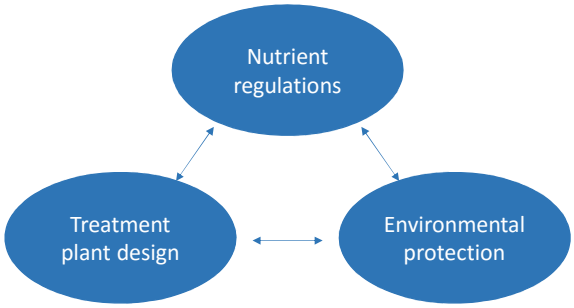
# Plan of Action:

## 3) Innovative permitting & technologies




- Watershed-based permitting: diffuse vs. point sources, effluent trading
- Limit of technology: nutrient speciation, performance variability
- More elaborate, real case study needed (CE-QUAL-W2, AQUATOX, ….)
- Lessons learned from previous work / validation
- Simplification: synthetic input files, no modeling of treatment plants

# Conclusions:



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# Discussion Topics:

- Are the goals of study of interest?
- Is it an adequate plan of action?
- Did we miss certain aspects?