model*EAU*

Chaire de Recherche du Canada
Modélisation de la Qualité de l'Eau

8me Séminaire
Adrien-Pouliot

9 Novembre '06

Peter Vanrolleghem

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model*EAU*

model*EAU* : son logo …

- Localisation
  - Québec, le long d'une rivière
- Liens avec nos objectifs à long terme
  - Récolte de données
  - Eaux urbaines
  - En continu (automatisé)
  - Qualité des données
- Son nom : Modélisation des systèmes des eaux

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model*EAU* : Histoire

- Février 2005: Chaire de Recherche du Canada en modélisation de la qualité de l'eau attribuée
- Février 2006: Début de model*EAU*
- Avril 2006: Premier collaborateur (Leiv Rieger)

- Septembre 2010:
  World Water Congress à Montréal !

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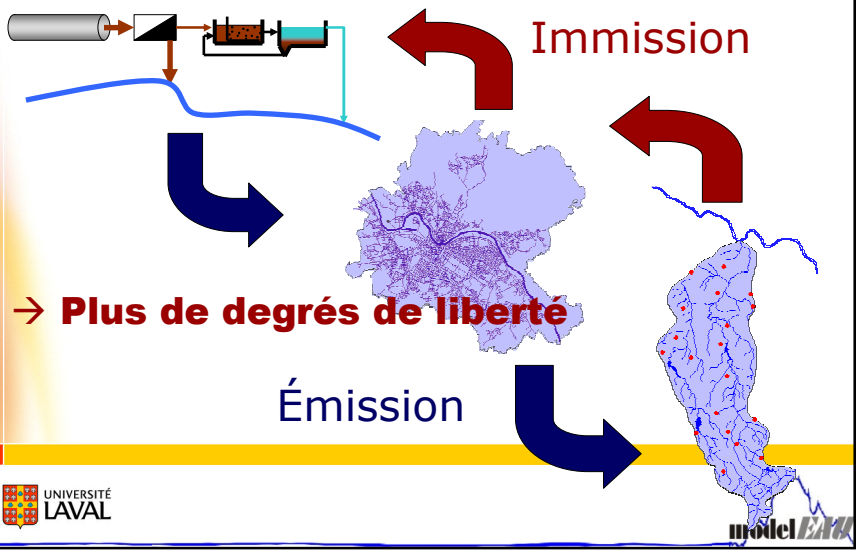
Gestion intégrée par bassins versants



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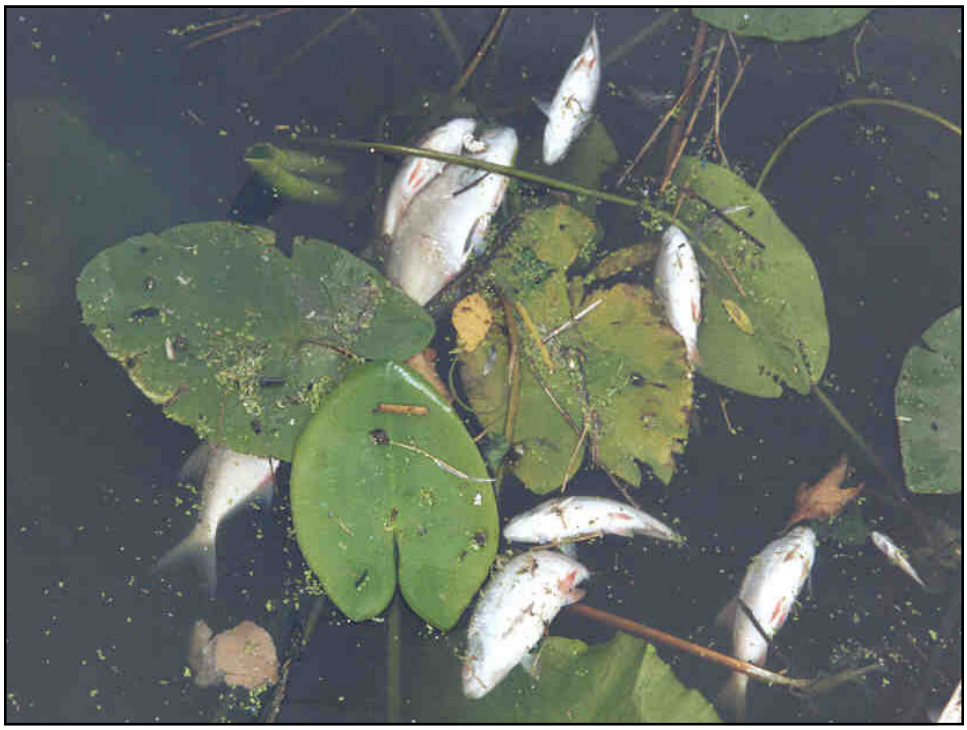
Eau de surface: Problématiques

- Eutrophisation

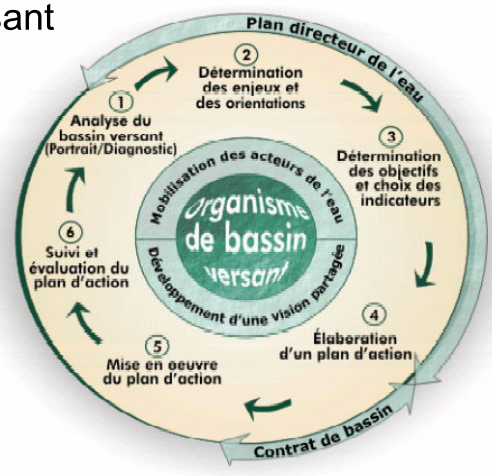


Eau de surface: Problématiques

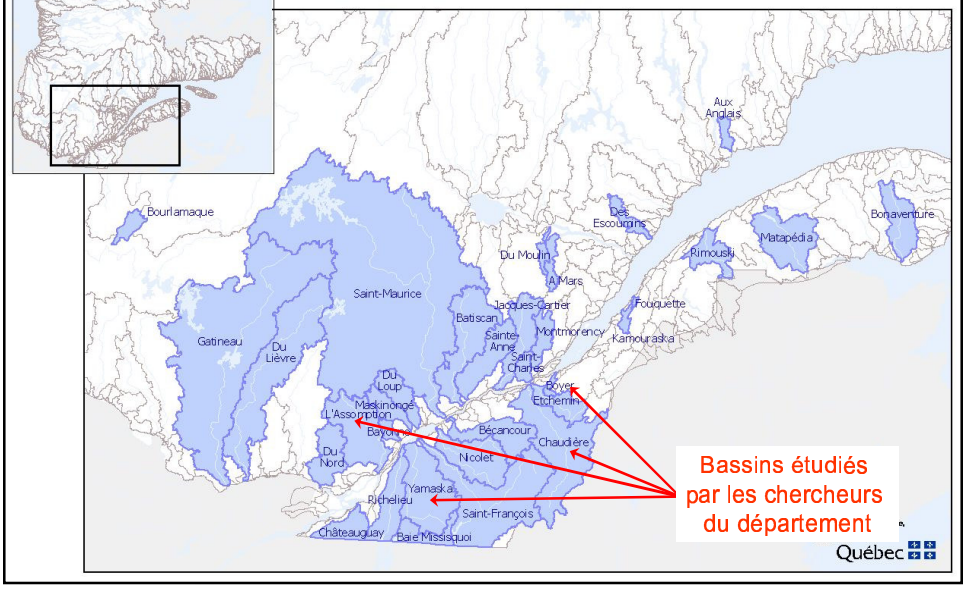
- Pesticides

Politique nationale de l'eau (2001)

- Schéma du cycle de gestion intégrée de l'eau par bassin versant

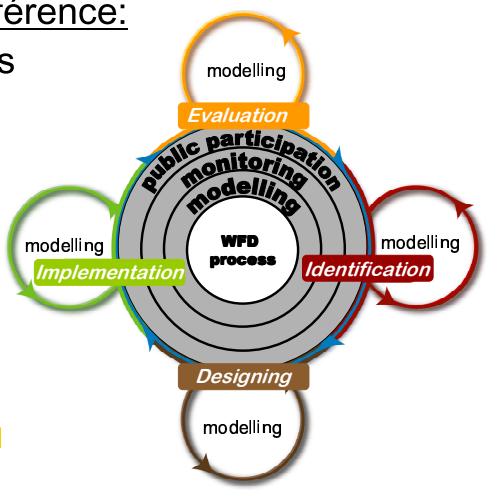


Les 33 bassins versants prioritaires



UE Directive Cadre de l'Eau (2000)

- Une politique de référence:
  Le rôle des modèles dans le cycle de gestion intégrée de l'eau par bassin versant



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model*EAU* : Objectifs

- Amélioration de la qualité de l'eau en
  - bassin versants
  - rivières urbaines
  - réseaux d'égouts
  - usines de traitement d'eaux usées
- En utilisant les méthodologies suivantes:
  - modélisation
  - instrumentation, contrôle et automatisation
  - logiciels de traitement des données, de modélisation et de simulation

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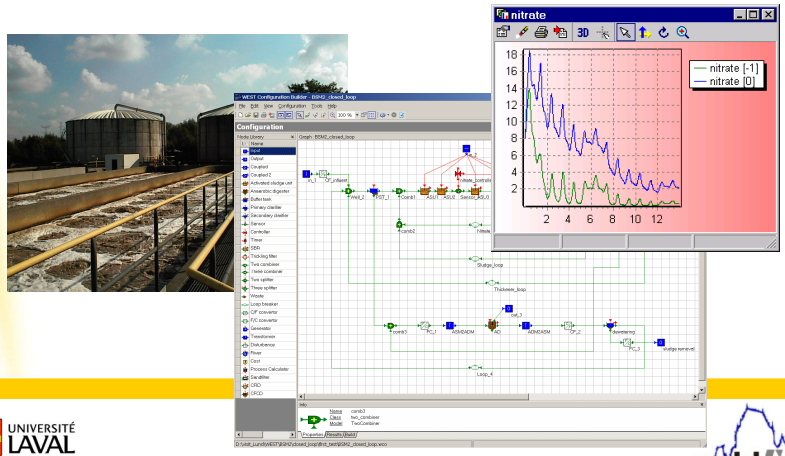
model*EAU*

Focus on Materials & Methods \ *Application focus*		Sewer system	Wastewater Treatment Plant	Whole Plant	Integrated urban wastewater system	River Basin	Micropollutants
Modelling	Model development						
	Calibration methodology						
	Good Modelling Practice						
	Risk, sensitivity & uncertainty anal.						
ICA	Data quality evaluation						
	Sensors & monitoring stations						
	Control and automation						
Soft	Numerical methods						
	Distributed computing (Grid)						

model*EAU* Software: WEST

- Modelling & Simulation (WEST, Biomath - Hemmis)



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model*EAU*

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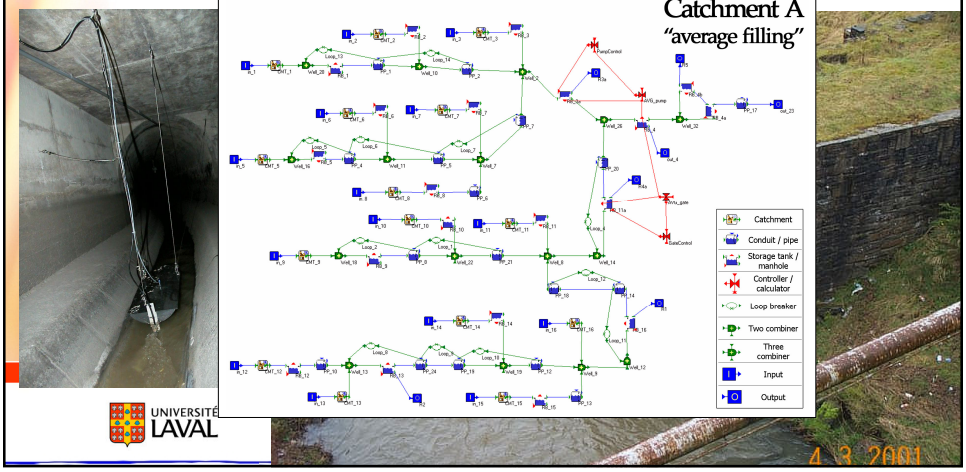

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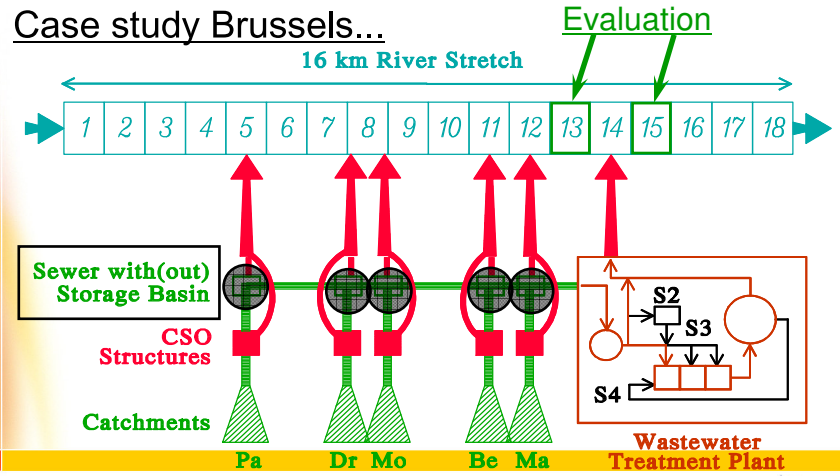
Integrated Urban Water Management

Case study Brussels...



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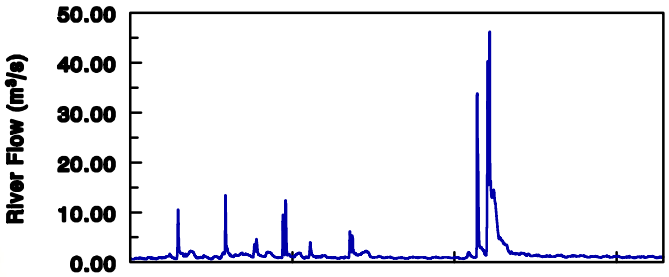
Integrated Urban Water Management

- Effect of 2 design options on river water quality



One large and different small rain events in summer

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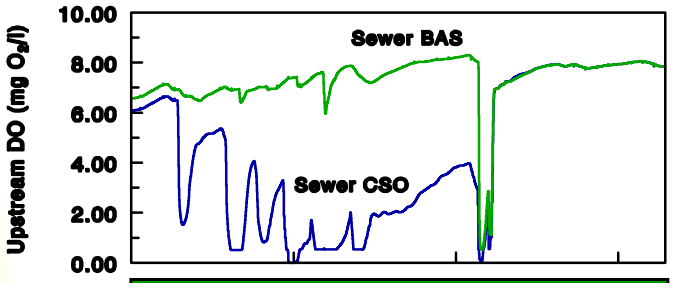
Integrated Urban Water Management

- River water quality (dissolved oxygen)

Downstream of CSO, upstream of WWTP



Clear positive effect of storage basins

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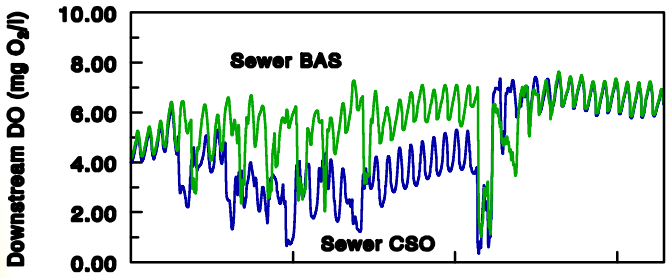
Integrated Urban Water Management

- River water quality (dissolved oxygen)

Downstream of WWTP



Positive effect of basins is reduced due to lower WWTP-efficiency under the increased loading

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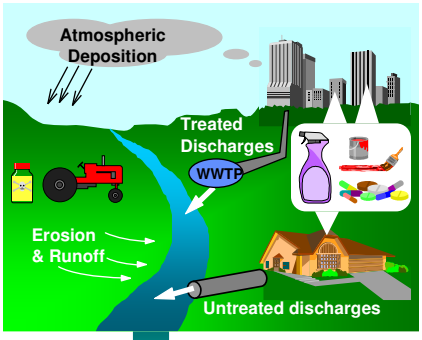
Ecological Risk Assessment

Exposure Analysis



Effects Analysis

Predicted Environmental Concentration (PEC)

Predicted No Effect Concentration (PNEC)

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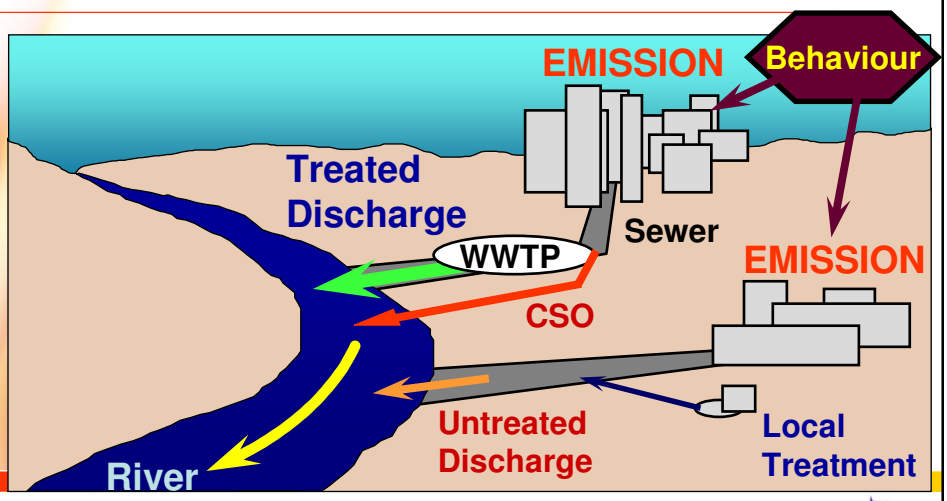
GREAT-ER: Model + Monte Carlo



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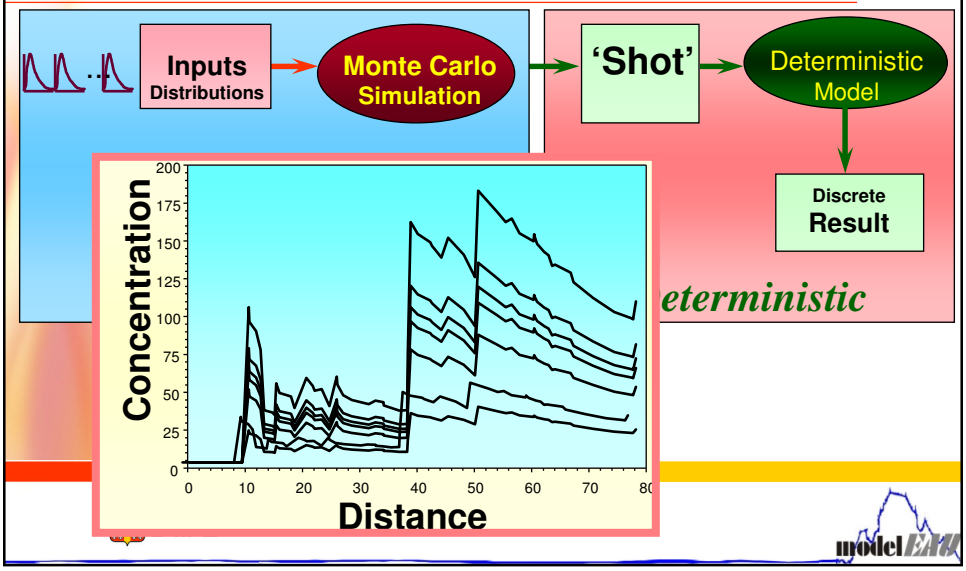
Uncertainty analysis: Monte Carlo



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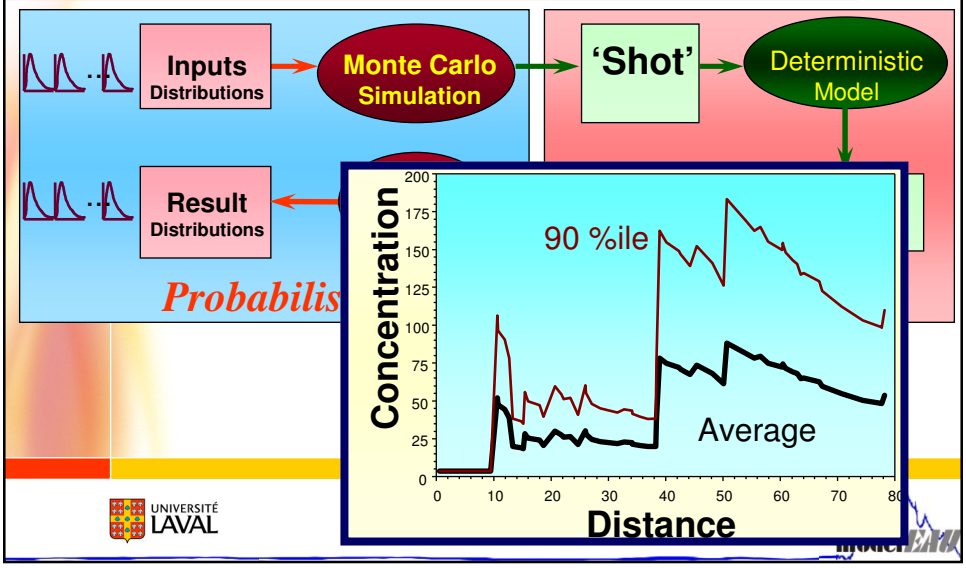
Uncertainty analysis: Monte Carlo



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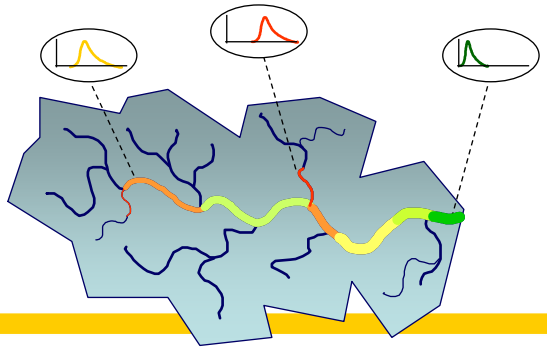
GREAT-ER: Data analysis

- direct GREAT-ER **simulation results**

  Geo-referenced concentration distributions



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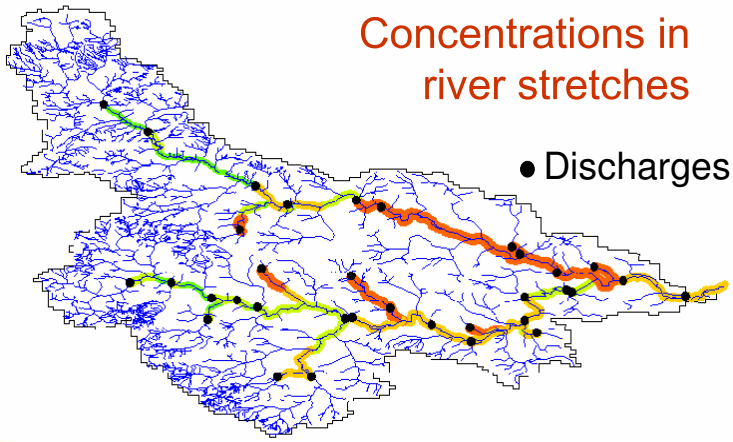
GREAT-ER: Validation

Concentrations in river stretches

- Discharges



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River basin in Yorkshire (UK)

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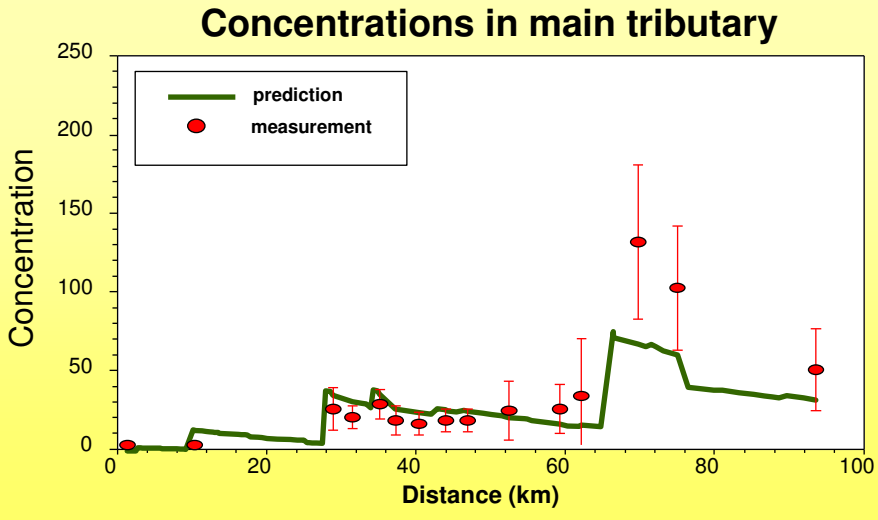
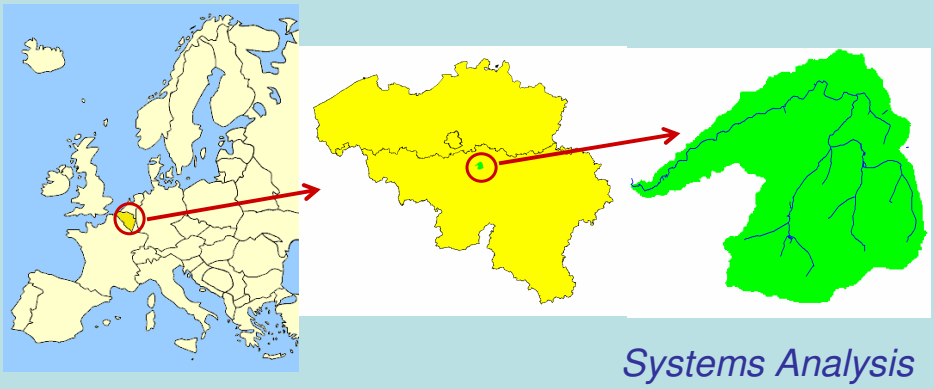
GREAT-ER: Validation



model*EAU* Software: SWAT

Nil case study for dynamic pesticide fate



Systems Analysis

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Intensive measurement campaign

- 8h composite samples for pesticide analysis

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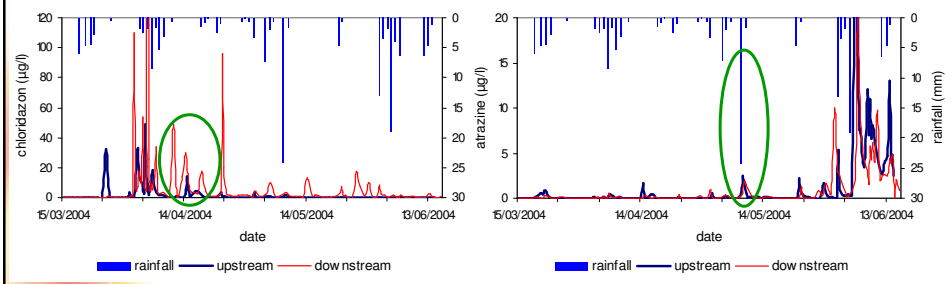
Intensive measurement campaign

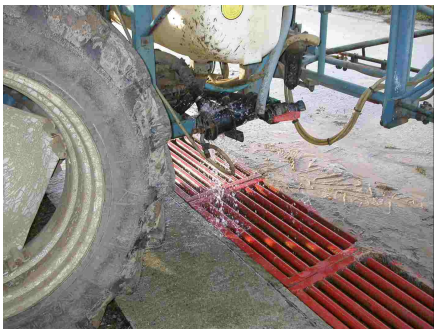


→ highly dynamic system with hourly variations

→ due to runoff but also to direct losses

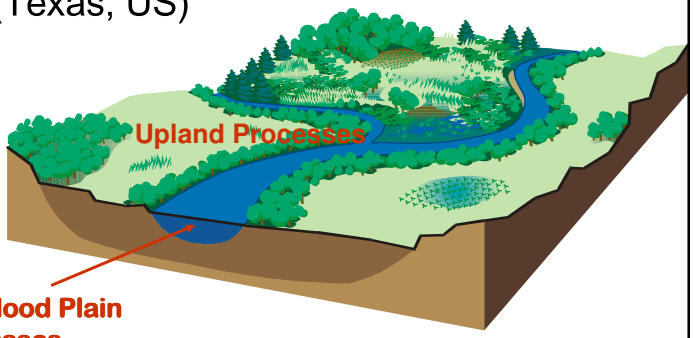
Intensive measurement campaign

- Direct losses …



model*EAU* Software: SWAT

- Modelling & Simulation of river basins
  USDA (Texas, US)



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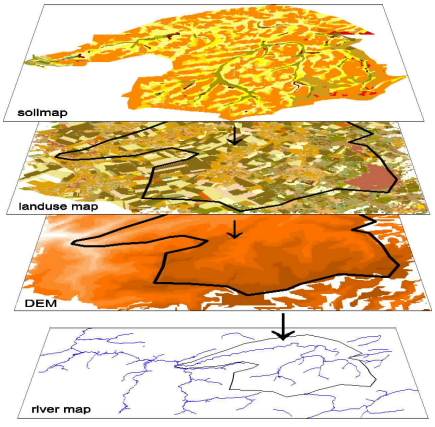
model*EAU*

model*EAU* Software: SWAT



Data collation (GIS)

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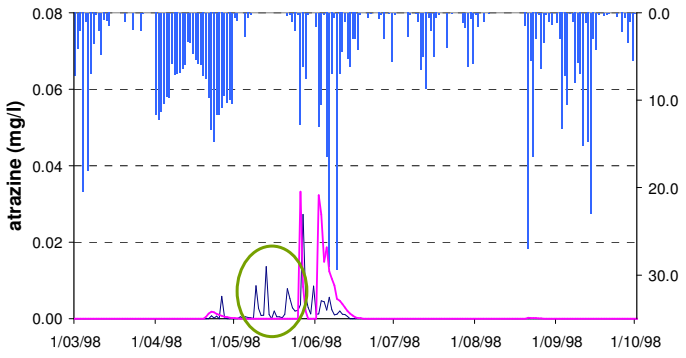
model*EAU*

model*EAU* Software: SWAT



⇒ adjustments to SWAT code necessary

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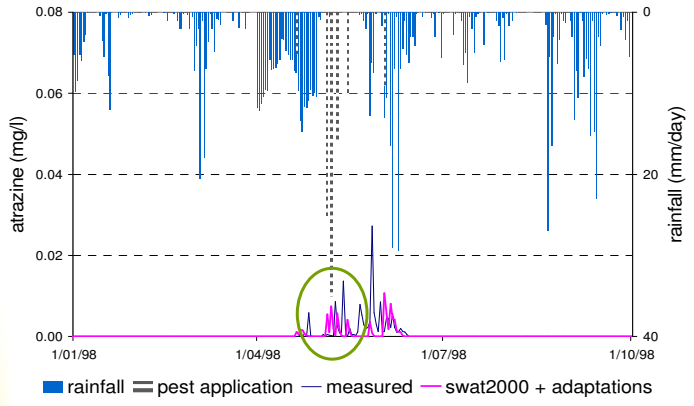
model*EAU*

model*EAU* Software: SWAT



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Complex virtual experimentation

- Virtual experimentation
  = model-based studies
  - For environmental systems:
    Simulation time determines overall time of a study
- The studies we undertake:
  - Always take maximum a weekend to calculate…
  - Become more complex obeying Moore's law (x 1.8/yr)

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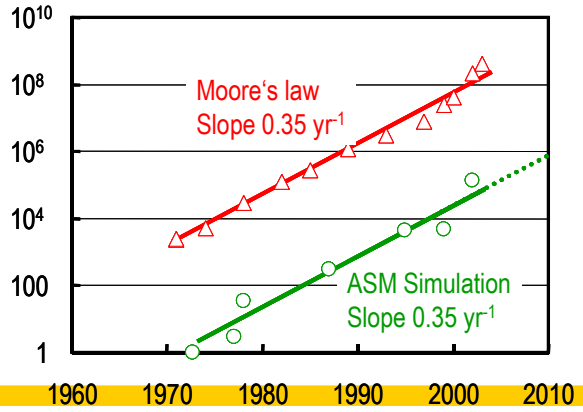
Complex virtual experimentation

- Gujer's law of modelling progress (2005)



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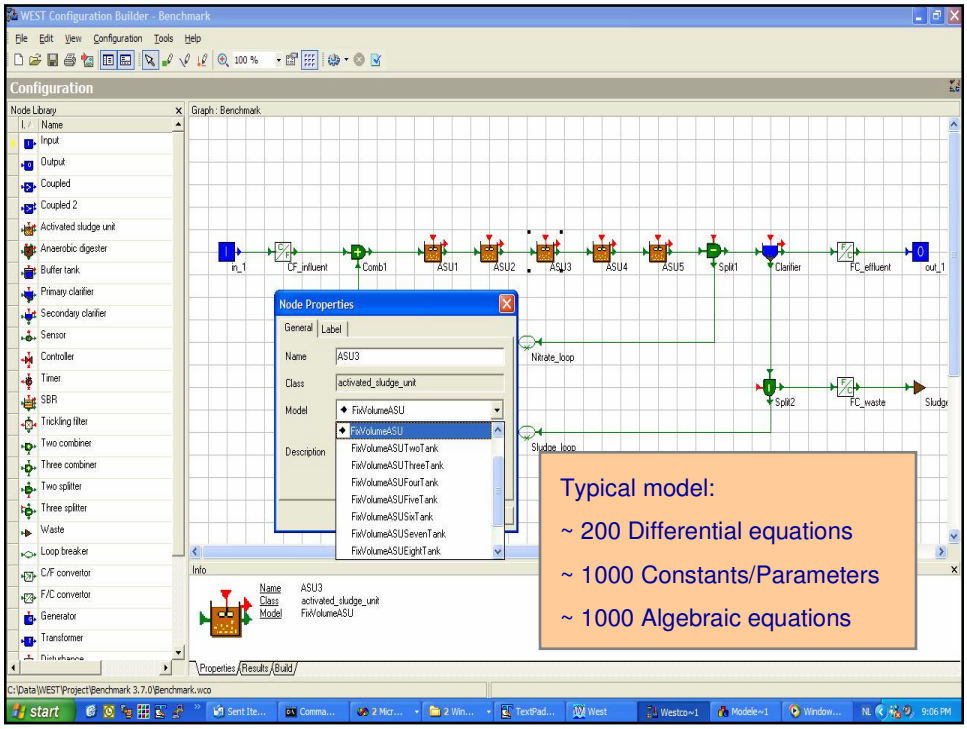
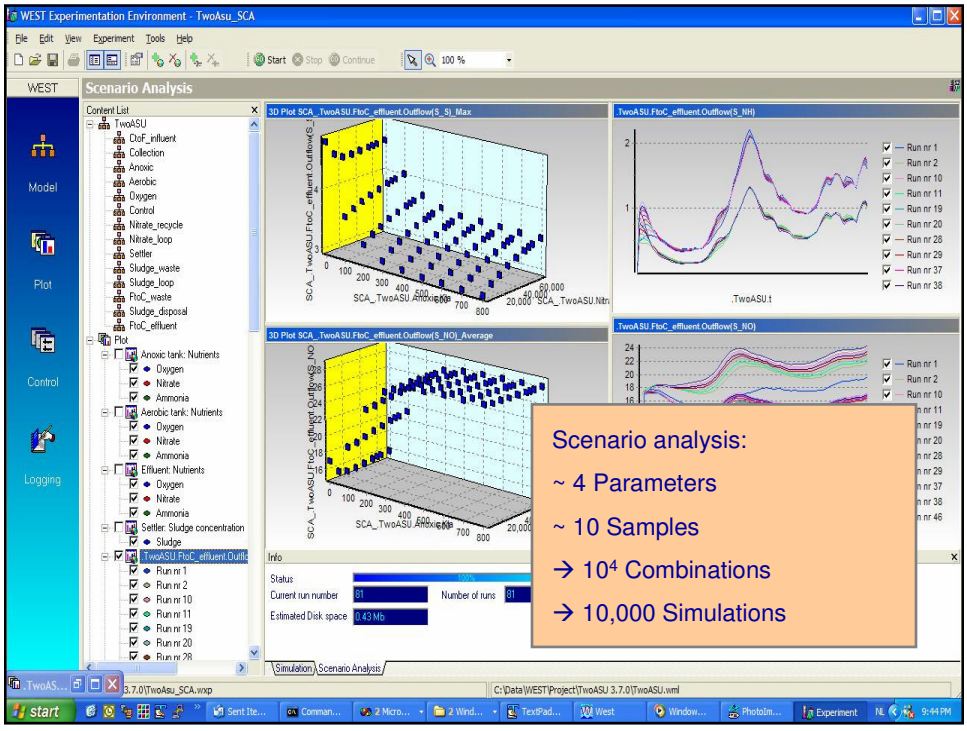

WEST Configuration Builder - Benchmark
Configuration
Node Properties
Typical model:
~ 200 Differential equations
~ 1000 Constants/Parameters
~ 1000 Algebraic equations


WEST Experimentation Environment - TwoAsu_SCA
Scenario Analysis
Scenario analysis:
~ 4 Parameters
~ 10 Samples
→ 10⁴ Combinations
→ 10,000 Simulations

CD4WC project

- Cost-effective development of urban water systems for Water Framework Directive compliance
  - EU-project
  - Integrated study of sewer-WWTP-river system
  - Methodology to evaluate design/upgrade scenarios
- Simulations of WWTP options
  - 5 climatic conditions
  - 3 plant sizes (3.000, 30.000, 300.000 PE)
  - 20 options
  - 100 Monte Carlo shots for uncertainty propagation

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= 30.000 simulations

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Distributed Virtual Experimentation

- Independent simulation can be distributed
- Different approaches to reach this:
  - Grid technology
  - Clustering
  - WEST Distributed Virtual Experimentation

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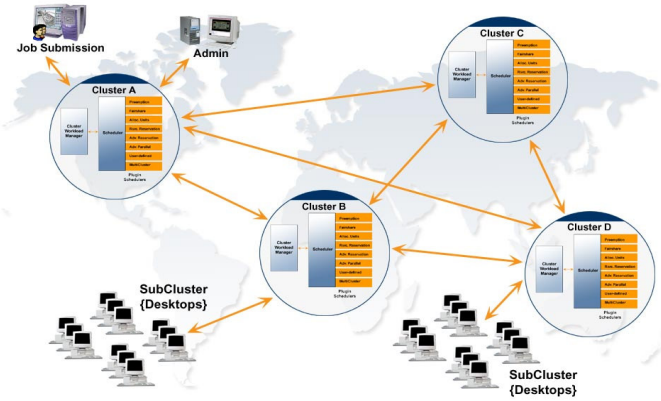
Grid technology

- World-wide network of computational nodes
- Virtual organizations



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SuperMUSE Cluster (US EPA)

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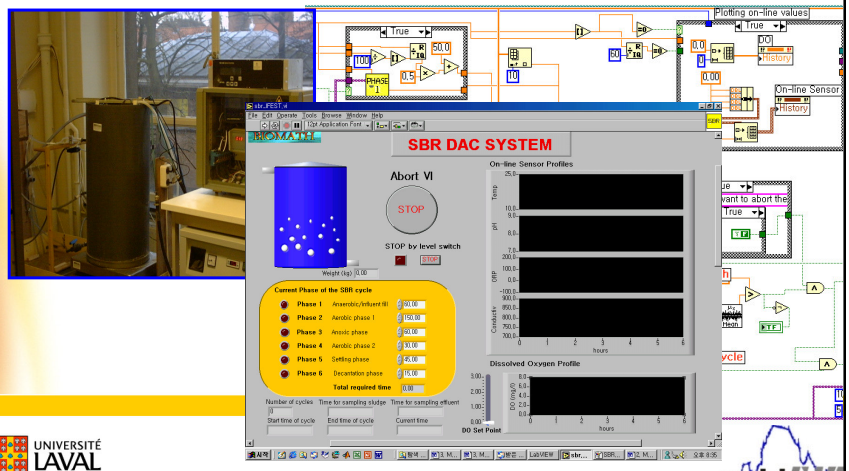
model*EAU* ICA: Instrumentation

- Data collection and treatment (LabView)



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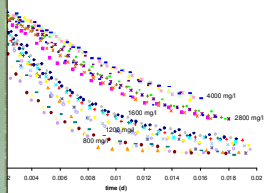
model*EAU* ICA: Instrumentation

- New sensors: robust hardware + interpretation

Titrimeter

Settlometer



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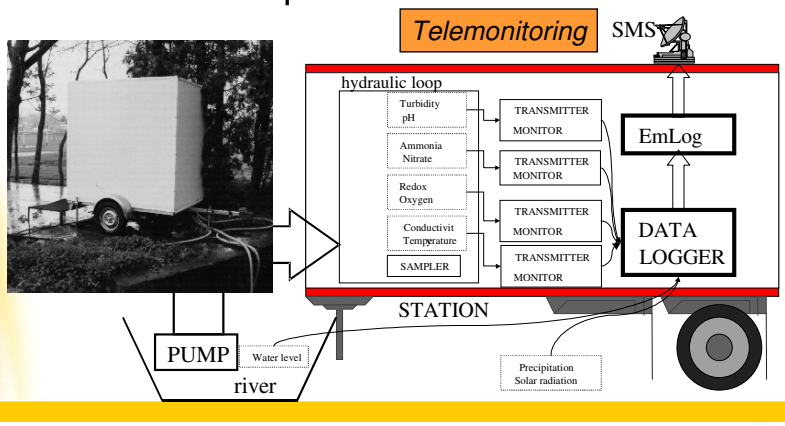
model*EAU* ICA: Monitoring station

- Traditional set-up :



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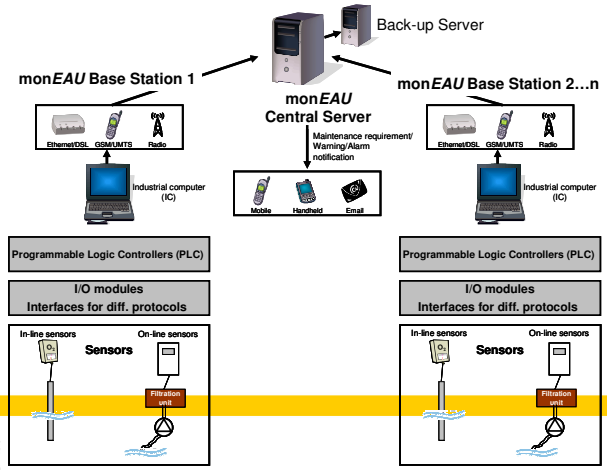
model*EAU*

model*EAU* ICA: Monitoring station

- mon*EAU* concept



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model*EAU*

modelEAU ICA: Monitoring station

IMW Endbericht (2005)

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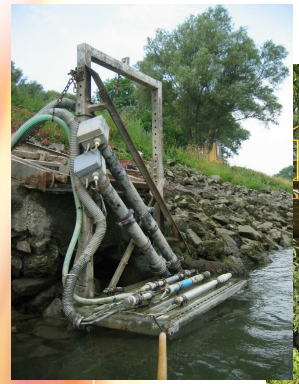
modelEAU

modelEAU ICA: Monitoring station



IMW Endbericht (2005)

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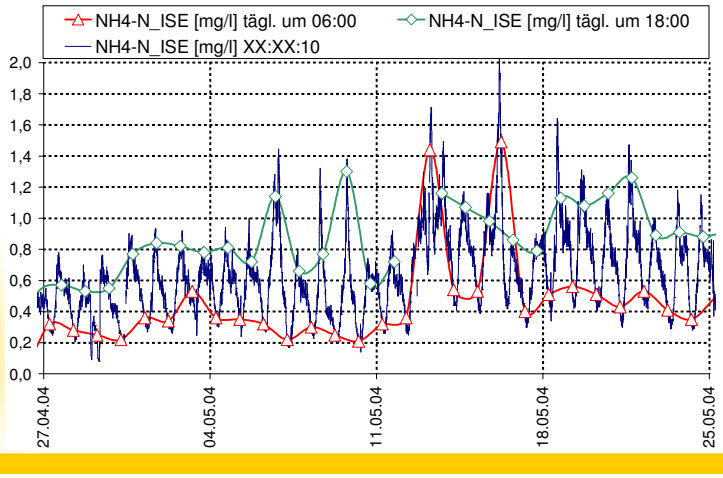
modelEAU

model*EAU* ICA: Monitoring station

IMW Endbericht (2005)

model*EAU* ICA: Monitoring station



IMW Endbericht (2005)

model*EAU* : Messages

- Amélioration de la qualité de l'eau en
  - bassin versants
  - riviéres urbaines
  - réseau d'égouts
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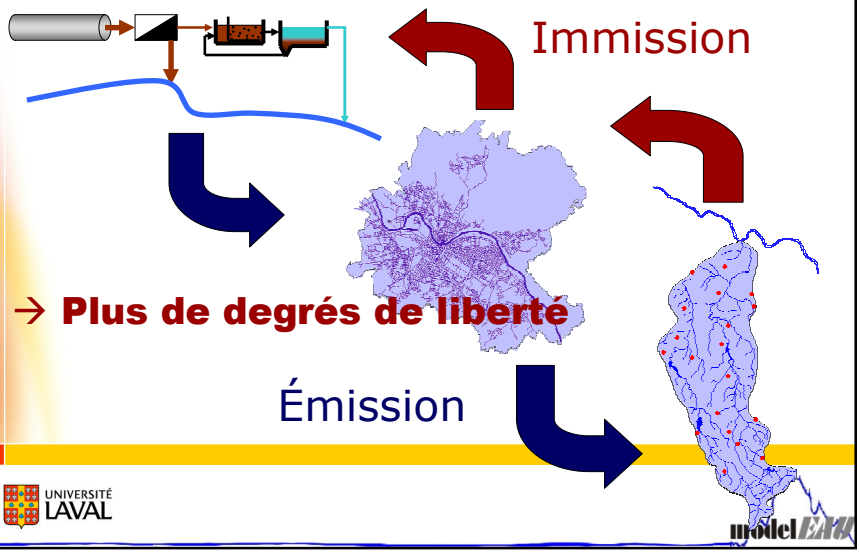
Gestion intégrée par bassins versants



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ICA	Data quality evaluation						
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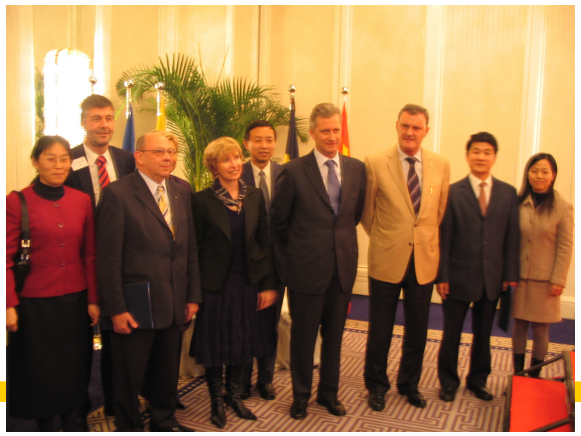
	Control and automation						
Soft	Numerical methods						
	Distributed computing (Grid)						

Entente ULaval-UGand-Hemmis

- Je ne serai pas ici cet après-midi …



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