

Urban wastewater system modelling: Use of particle classes for a better characterisation of the settling process

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Thibaud Maréjols,
Paul Lessard and Peter A. Vanrolleghem



Outline

- Introduction
- ViCAs and settling velocity
- Integrated model
- Results
- Conclusions



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Intro VICAs and Vs Integrated model Results Conclusions

Introduction

Integrated physical systems

The diagram illustrates a simplified integrated physical system. It consists of three main components: a green circle labeled 'Sewer', a yellow circle labeled 'WWTP', and a light blue circle labeled 'River'. A solid red arrow points from the Sewer to the WWTP. A solid red arrow points from the WWTP to the River. A dashed red arrow labeled 'CSO' (Combined Sewer Overflow) points from the Sewer directly to the River, bypassing the WWTP.

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Introduction

Integrated physical systems

The diagram illustrates a more detailed integrated physical system. It is divided into two main sub-systems: 'Sewer' and 'WWTP'. The 'Sewer' sub-system includes a green circle for 'Transport' and another green circle for 'Storage'. The 'WWTP' sub-system includes a yellow circle for 'Separation treatment' and another yellow circle for 'Biological treatment'. A light blue circle labeled 'River' is also present. Solid red arrows show the flow from 'Storage' to 'Separation treatment', and from 'Separation treatment' to 'Biological treatment'. A solid red arrow points from 'Biological treatment' to the 'River'. A dashed red arrow labeled 'CSO' points from 'Transport' to the 'River'. Numerous black curved arrows indicate complex feedback loops and interactions between 'Transport', 'Storage', 'Separation treatment', 'Biological treatment', and the 'River'.

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Introduction

Integrated physical systems

The diagram illustrates the integrated physical systems for TSS (Total Suspended Solids) management. It starts with rain (represented by clouds and raindrops) falling into a sewer system. The sewer system consists of two green circular components: 'Transport' and 'Storage', both labeled 'TSS-settling'. A red dashed arrow labeled 'CSO' (Combined Sewer Overflow) points from the 'Transport' component to a 'River' (represented by a blue circle). The 'River' also has a 'TSS-settling' label and a yellow starburst indicating overflow. The wastewater treatment plant (WWTP) consists of two yellow circular components: 'Separation treatment' and 'Biological Treatment', both labeled 'TSS-settling'. Red arrows show the flow from 'Storage' to 'Separation treatment', and between 'Separation treatment' and 'Biological Treatment'. A red arrow points from 'Biological Treatment' to the 'River'. Yellow starbursts are also present above the 'Separation treatment' and 'Biological Treatment' components.

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Introduction

Integrated physical systems

This study

Particle classes:
Impact / modeling performance

This diagram is identical to the one on slide 5, but with a blue dashed box highlighting the 'SEWER' and 'Separation treatment' components. The 'SEWER' box encloses the 'Transport' and 'Storage' components. The 'Separation treatment' component is also enclosed within this blue dashed box. A red dashed arrow labeled 'CSO' points from the 'Transport' component to the 'River'. The 'River' also has a 'TSS-settling' label and a yellow starburst. The 'WWTP' components ('Separation treatment' and 'Biological Treatment') are shown with red arrows indicating flow between them and from 'Biological Treatment' to the 'River'. Yellow starbursts are present above the 'Separation treatment' and 'Biological Treatment' components.

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Objectives


- Develop an integrated model reproducing sedimentation taking advantage of the particle settling velocity distribution (PSVD)
- Assess the impact of retention tanks (RT) emptying to the WWTP in terms of TSS

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Intro **VICAs and Vs** Integrated model Results Conclusions

VICAs



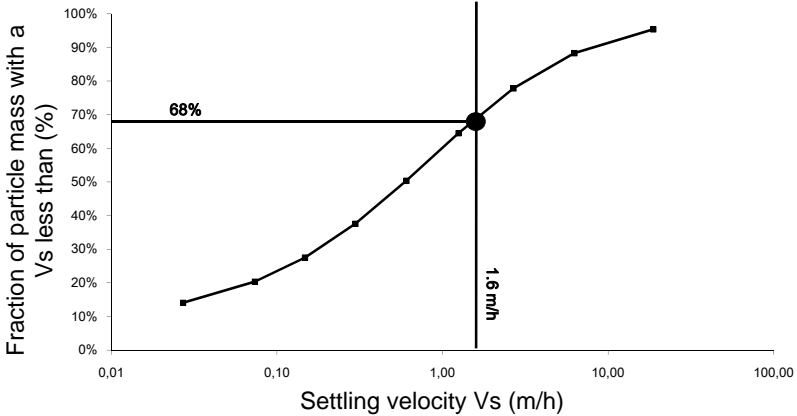
m/h)

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model 9

Intro **VICAs and Vs** Integrated model Results Conclusions

VICAs



Settling velocity V_s (m/h)	Fraction of particle mass with a V_s less than (%)
0.02	15
0.05	20
0.10	28
0.20	38
0.50	50
1.00	65
1.60	68
2.00	75
5.00	88
10.00	95

Chebbio and Gromaire (2009) – *Journal of Environmental Engineering*

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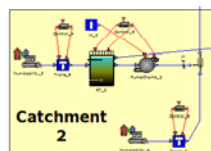
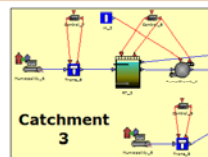
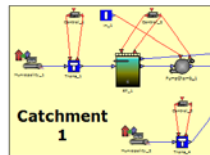
model 10

Outline

- Introduction
- ViCAs and settling velocity
- **Integrated model**
- Results
- Conclusions

Integrated model

- ✓ 3 identical catchments
- ✓ 9 reservoirs
- ✓ 1 primary clarifier



Intro	VICAs and Vs	Integrated model	Results	Conclusions
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Integrated system

RT model concept

- 5 particle classes
- Pumping well with resuspension
- ASM1 compatible

Maruejols et al. (2012) – Water Research

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Intro	VICAs and Vs	Integrated model	Results	Conclusions
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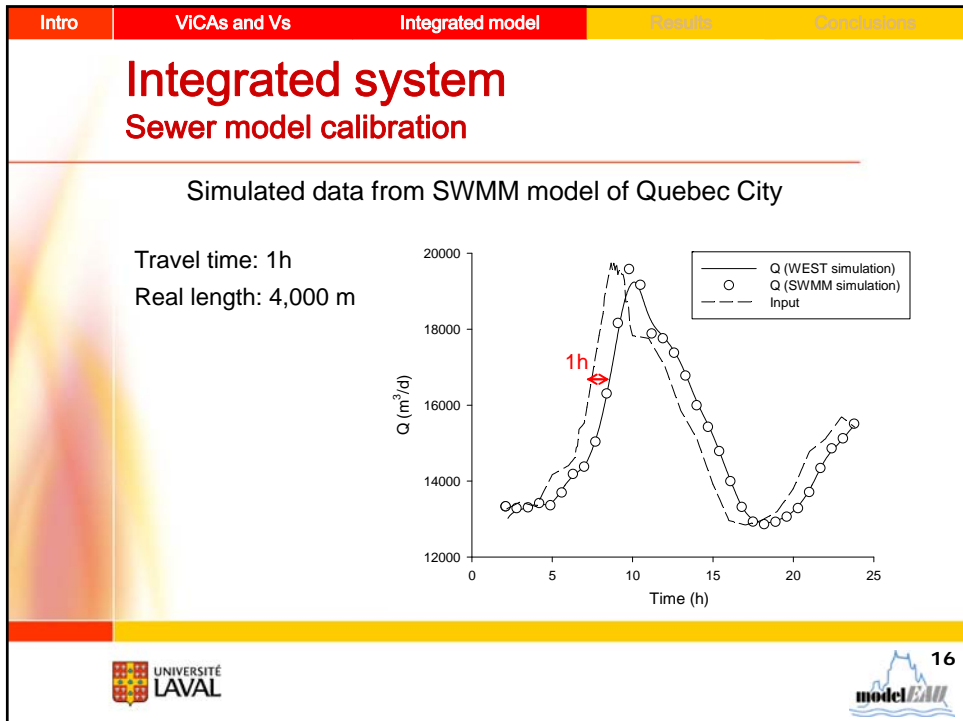
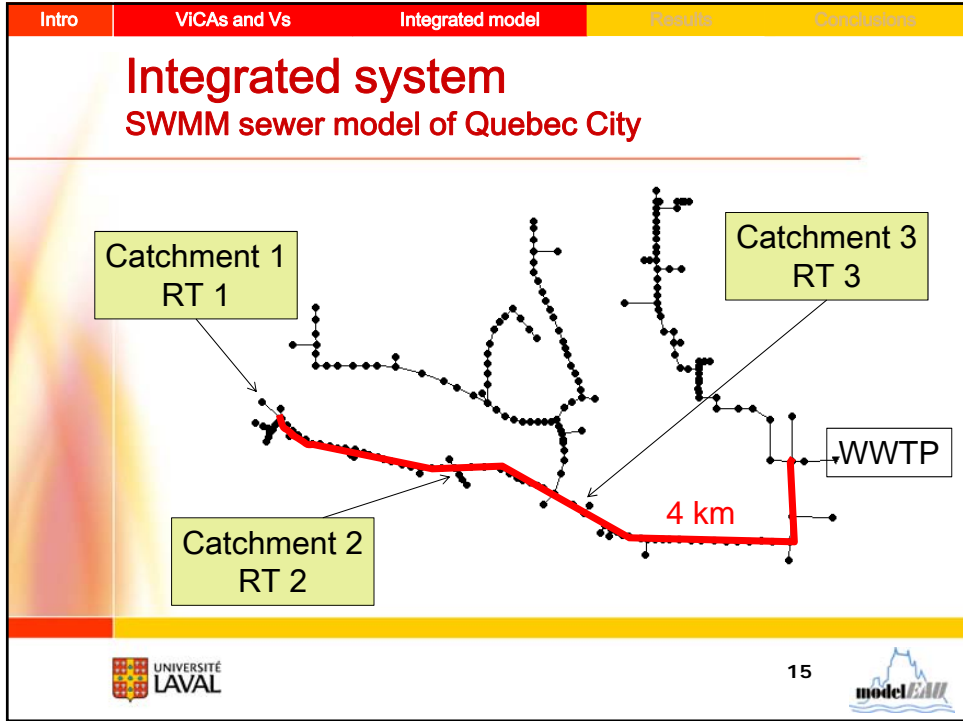
Integrated system

Sewer model concept

- 5 particle classes
- 9 reservoirs
- 8 tanks = 360 m³
- 1 tank = 600 m³

Schuetze, M. (1998) – Thesis

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Intro **VICAs and Vs** Integrated model Results Conclusions

Integrated system

Primary clarifier model

- Adaptation of model of Bachis *et al.* (2012) model to incorporate 5 particle classes
- 10 layers
- Calibrated with field data

Bachis *et al.* (2012) – Proceedings IWA Particle Separation Conference

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Intro **VICAs and Vs** Integrated model Results Conclusions

Integrated system

Primary clarifier model calibration

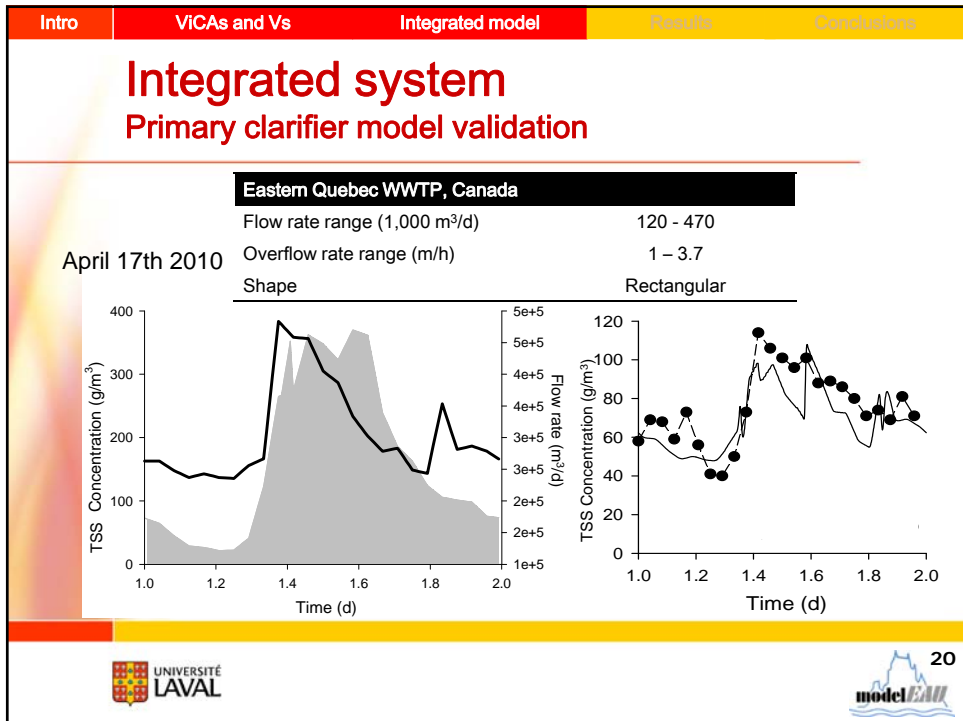
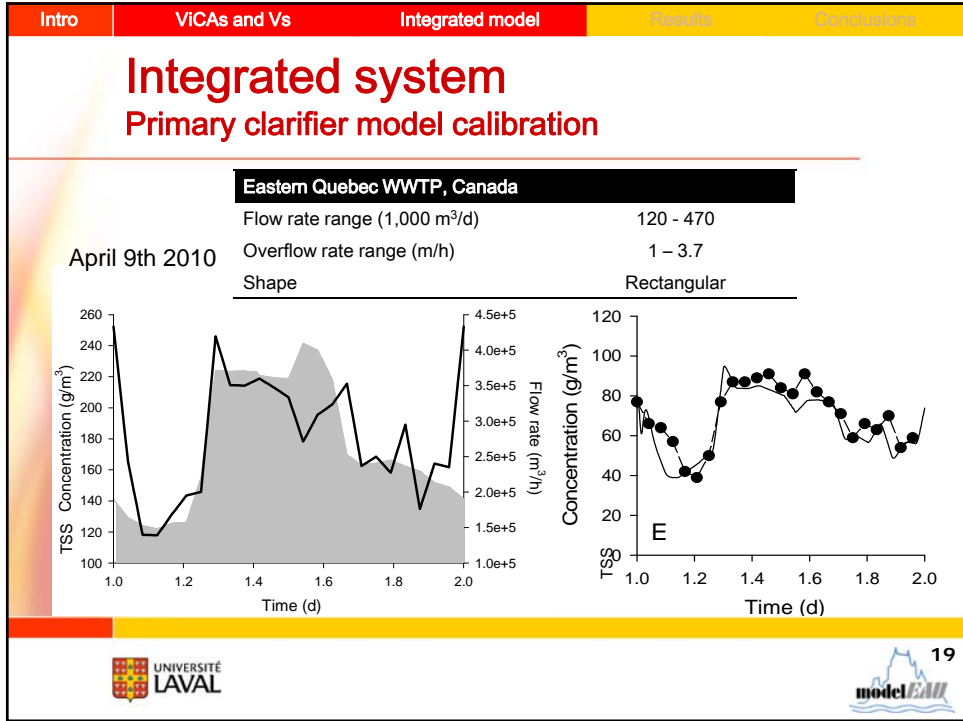
Norwich WWTP, England

Flow rate (1,000 m ³ /d)	10 - 35
Overflow rate range (m/h)	0.6 - 2
Shape	Circular

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Lessard & Beck (1988) – *Journal of Environmental Engineering*

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Intro

ViCAs and V_s

Integrated model

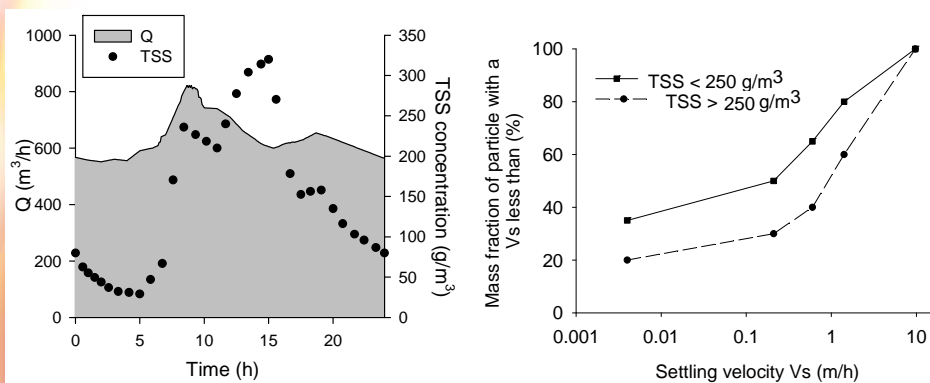
Results

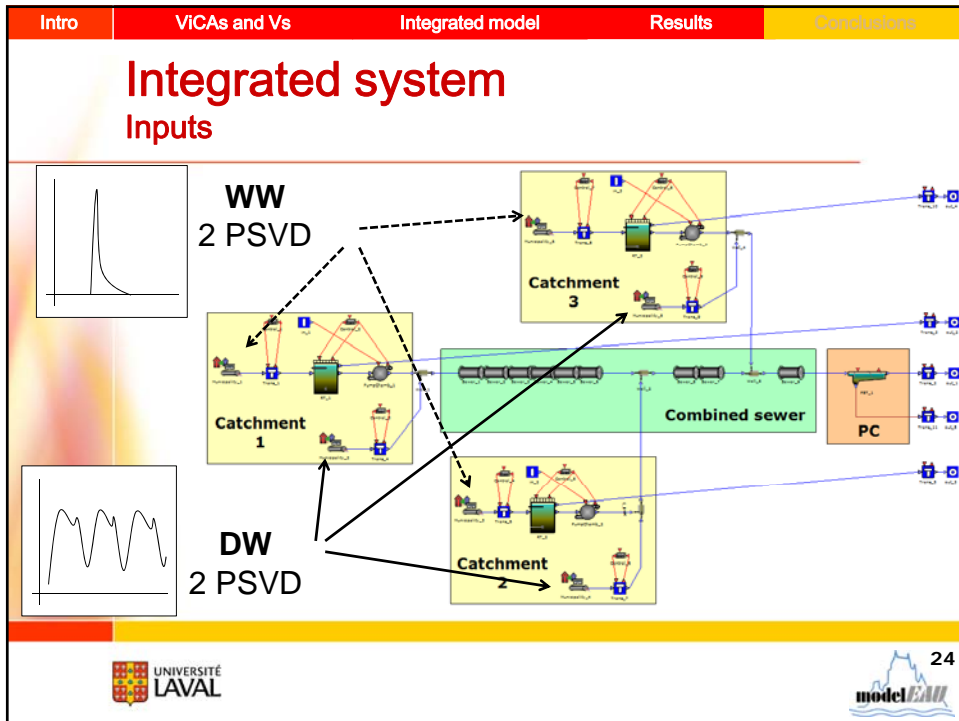
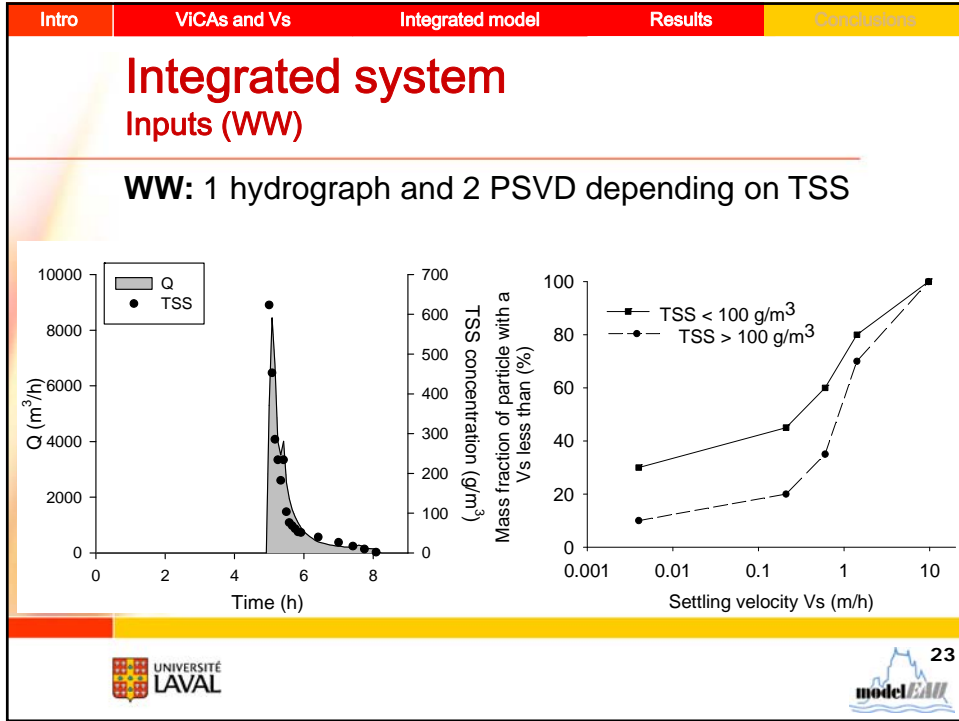
Conclusions

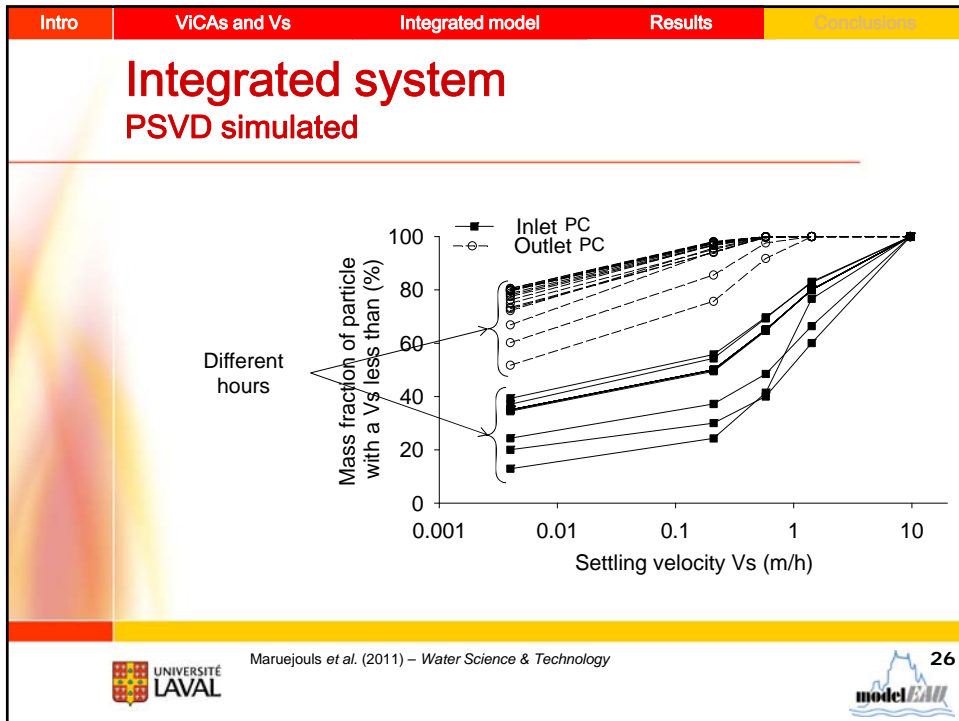
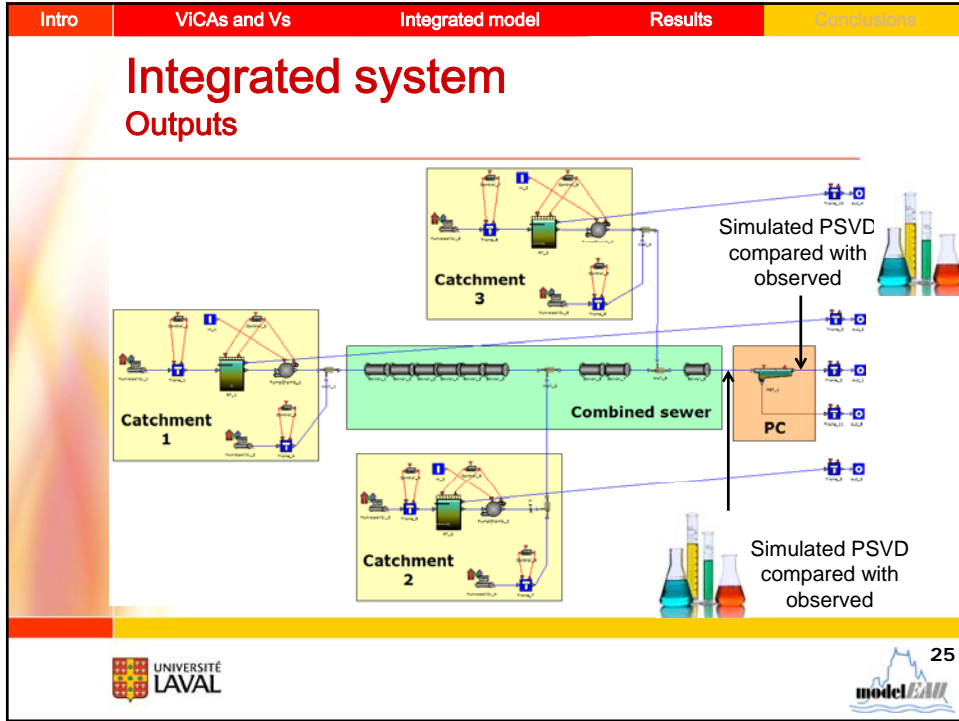
Integrated system

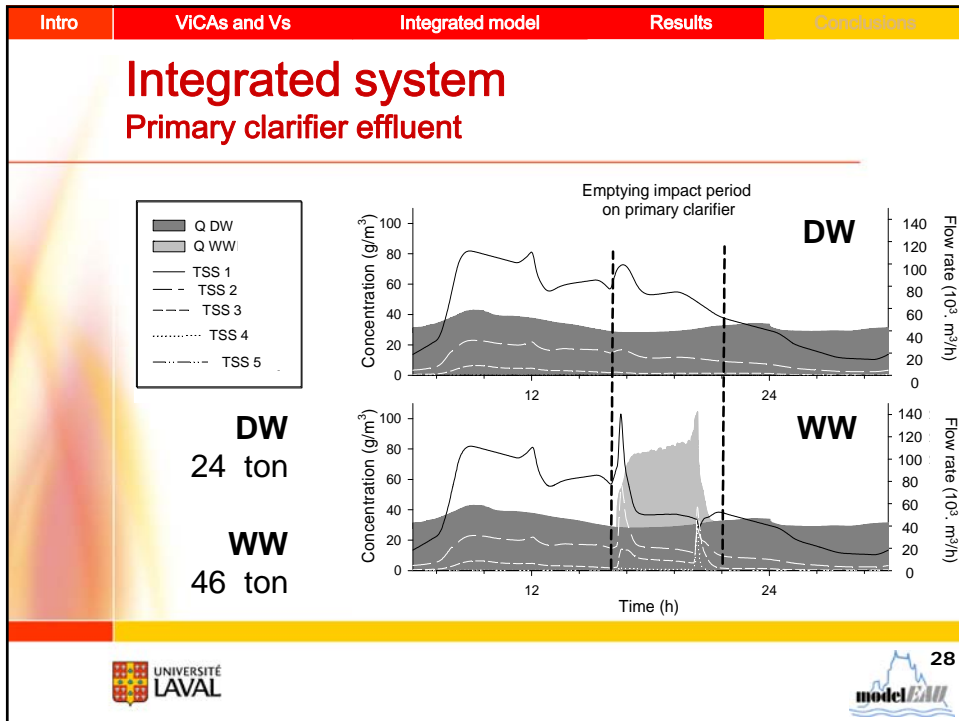
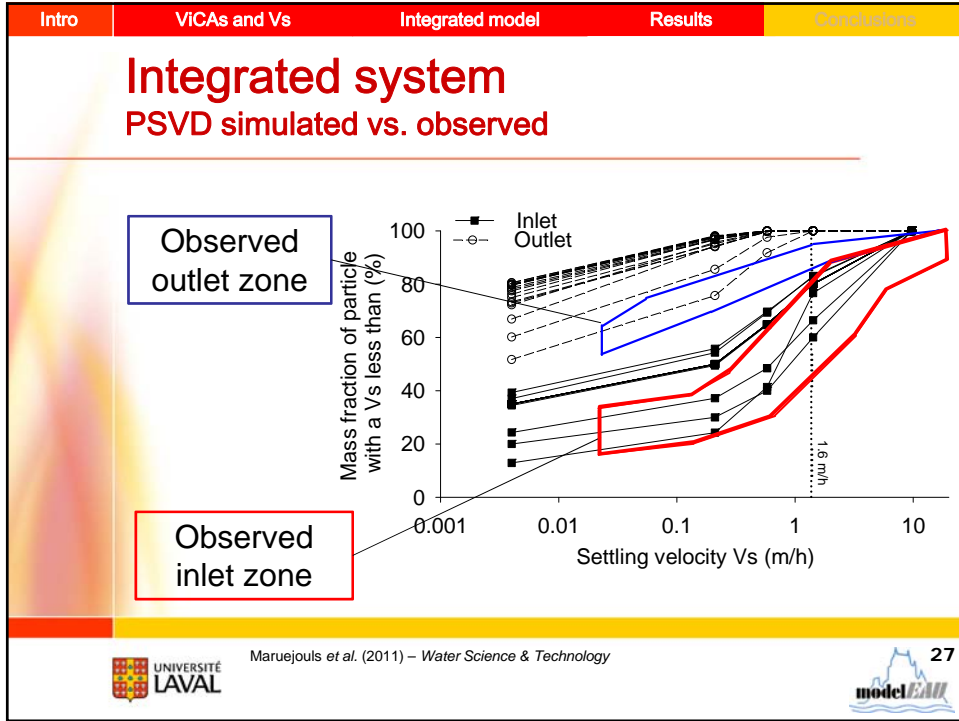
Inputs (DW)

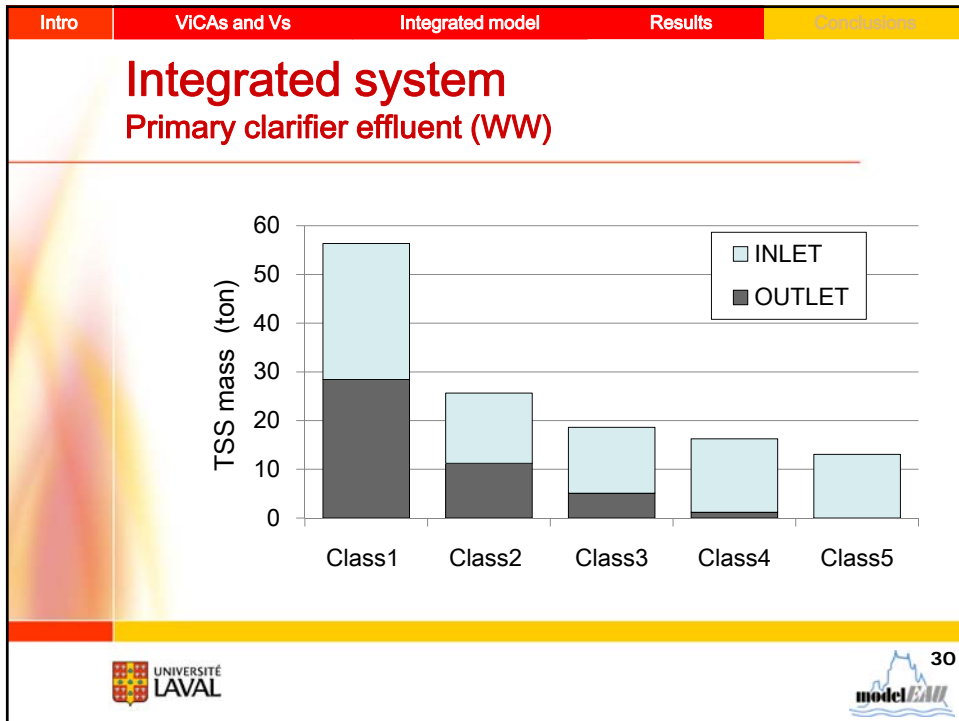
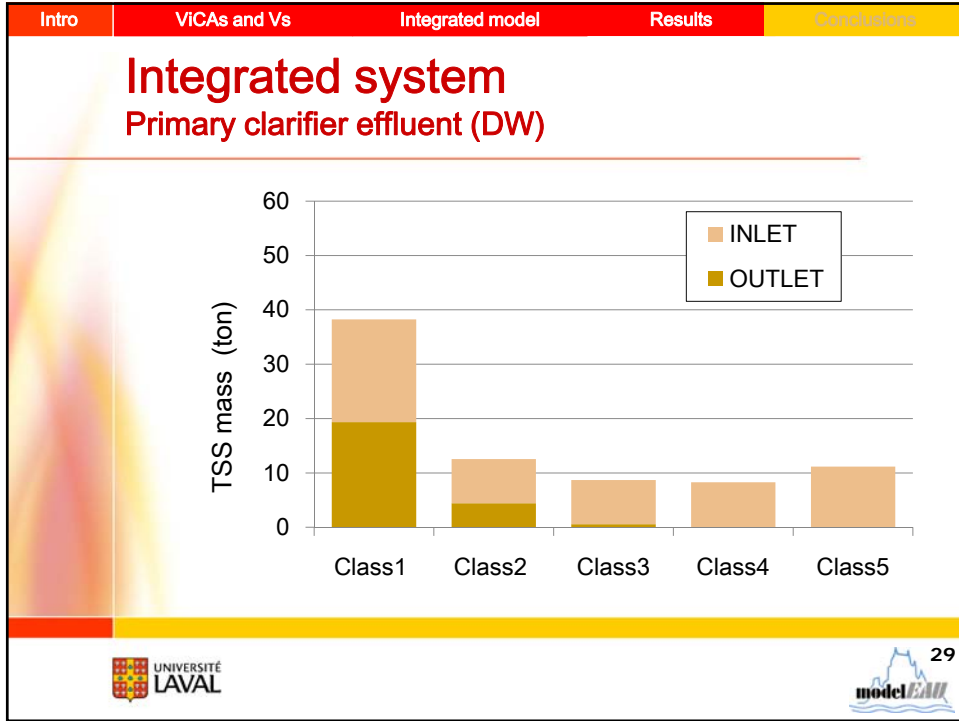
DW: 1 hydrograph and 2 PSVD depending on TSS















Intro	ViCAs and Vs	Integrated model	Results	Conclusions
<h2>Conclusions</h2> <ul style="list-style-type: none">▪ Integrated model with particle classes▪ Reproduces the PSVD evolution▪ Particle transport through urban system is improved▪ Many processes are simulated under DW and WW conditions: sedimentation, RT cleaning systems, pumps resuspension▪ Need of only few ViCAs				
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Intro	ViCAs and Vs	Integrated model	Results	Conclusions
<h2>Perspectives</h2> <ul style="list-style-type: none">▪ Analysis of various management scenarios: tuning RT emptying flow rate, setting delay between emptyings...▪ Investigate addition of chemicals for settling enhancement▪ Integrated RTC taking into account Vs for treatment optimization▪ Use of the model at Eindhoven WWTP				
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