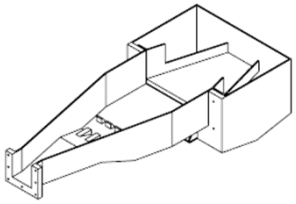
Monitoring CSO volumes and quality with the DSM-flux

Ainhoa MATE MARIN

Gislain LIPEME KOUYI Ronan PHILIPPE Nicolas RIVIERE



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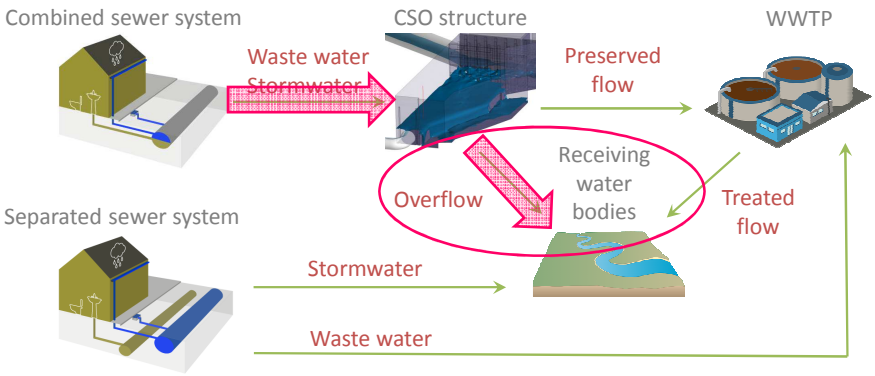
CONTEXT

- Combined Sewer Overflow (**CSO**)

WET WEATHER



Images sources/authors : www.sciences-en-ligne.net; A. Claro Barreto; T. Saxby

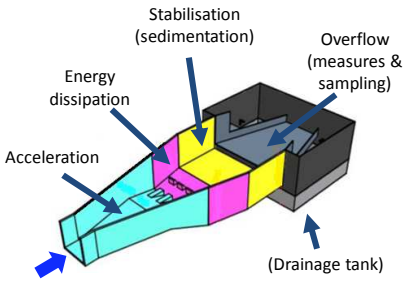
2

CONTEXT

- Combined Sewer Overflow (**CSO**)
- **Difficulties** when measuring volumes & quality
  - → CSO structures very different, complex geometries
  - → Unfavourable up & downstream hydraulic conditions for standard methods
  - → Little known about **uncertainties** and how they are estimated
    - Pre-calibrated devices under suitable conditions: uncertainties ≈ 10 %

DSM-flux

- **DSM-flux**: original channel to **monitor & control CSOs** quantity & quality
  - → Measure CSO volumes & TSS
  - → Trap particulate pollutants
  - → Reduce erosion



(Physical model 3D view)

PhD OBJECTIVES

- Evaluate the DSM-flux capacity to monitor overflows and protect the receiving waters

- **More specifically:**
  - → Understand hydrodynamics and TSS settling/re-suspension mechanisms.
  - → Determine measurement methodology and uncertainties for volumes and TSS loads.
  - → Analyse scale effects
  - → Estimate trapping efficiency
  - → Field validation of laboratory results

5

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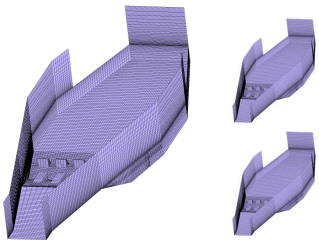
MATERIALS & METHODS

PHYSICAL MODEL

- Velocity field
- Measurement methodology
- Experimental data for numerical model calibration/validation
- Solid transport



3D NUMERICAL MODEL(S)

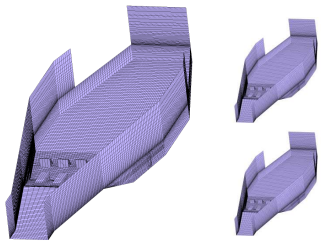
- Simulation of hydrodynamics
- Mimic of TSS settling/re-suspension mechanisms
- Prototype design
- Scale effects
- Evaluation of trapping efficiency

PROTOTYPE

- Monitoring strategies
- Validation of measurement methodology
- Verification of trapping efficiency

6

MATERIALS & METHODS



PHYSICAL MODEL | 3D NUMERICAL MODEL(S) | PROTOTYPE

Dimensions (m) ≈ 2 x 0.5 x 0.2
Q_{max} ≈ 30 l/s

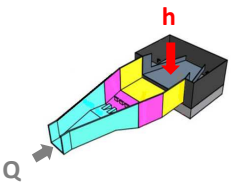
1
2
3

Dimensions (m) ≈ 4.5 x 1.5 x 0.6
(Scale ≈ 1:2.5)
Q_{max} ≈ 300 l/s

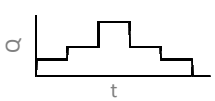
Scale ≈ 1:5
Q_{max} ≈ 1550 l/s

SOME RESULTS (1/4)

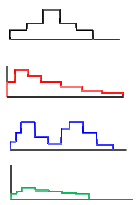
Measurement methodology and uncertainties for volumes

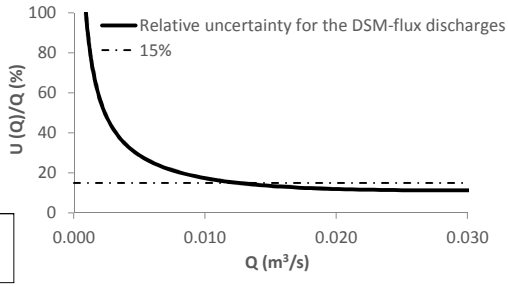


$$Q = 0.4639 \cdot \left(\frac{h}{w}\right)^{-0.135} \cdot 2 \cdot L \cdot \sqrt{2g} \cdot h^{3/2}$$



$$V = \sum_{i=2}^{m} \frac{Q_{i-1} + Q_i}{2} \cdot \Delta t$$





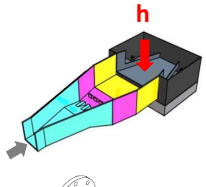
Relative uncertainties (propagation law)

U(Q)/Q ≈ 15% for greater flows
(Q > 0.015 m^3/s ≈ 50% DSM model capacity)

U(V)/V < 2% for 4 tested events

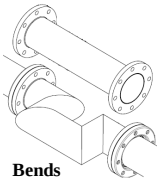
SOME RESULTS (2/4)

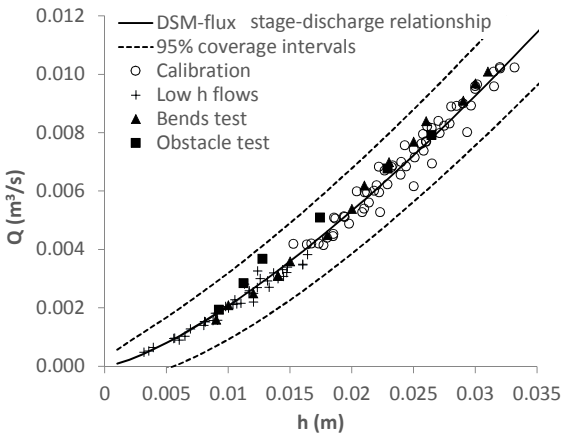
No effects of inflow conditions on results



Calibration:

- Subcritical
- Critical
- Supercritical



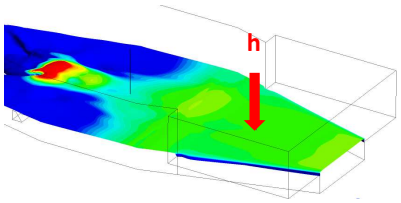


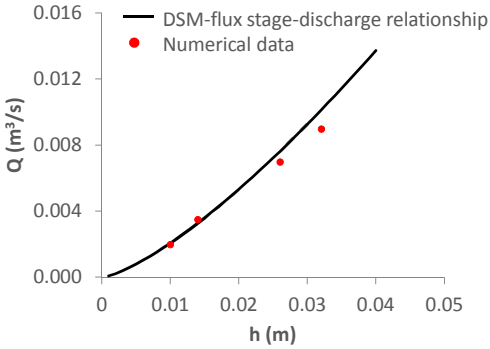
9

SOME RESULTS (3/4)

Numerical model validation

- Free surface reproduction (Q-h relationship)

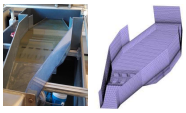




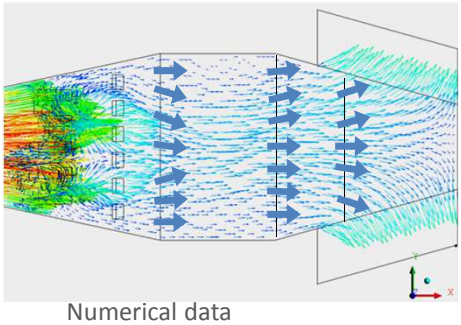
10

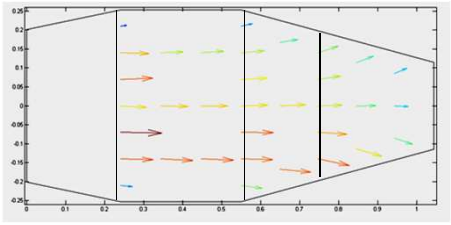
SOME RESULTS (3/4)

Numerical model validation



- Free surface reproduction (Q-h relationship)
- **Free surface streamlines**



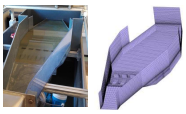


Numerical data Experimental data

2D velocity vectors for 2 l/s at the free surface of the DSM-flux

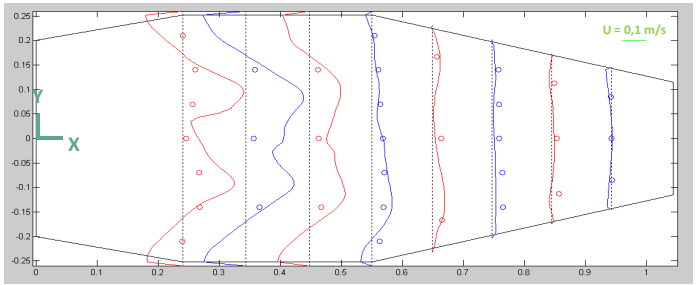
SOME RESULTS (3/4)

Numerical model validation



- Free surface reproduction (Q-h relationship)
- Free surface streamlines
- **3D velocities**

Numerical data
Experimental data



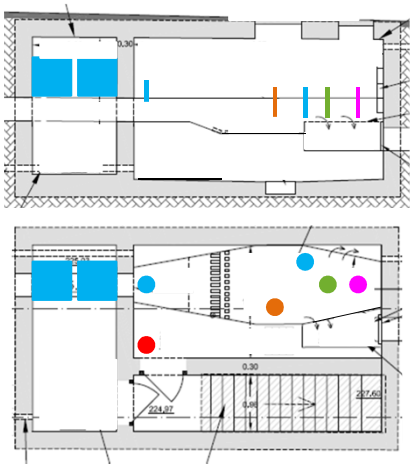
U velocity component for 2 l/s at the bottom of the DSM-flux

SOME RESULTS (4/4)

Field prototype

INSTRUMENTATION:

Automatic samplers
Turbidity probe
Dissolved O_2 probe
Water level radar
Camera



CONCLUSIONS and PERSPECTIVES

- **DSM-flux: accurate device for CSOs monitoring + good alternative to current methods** (independence from inflow conditions, pre-treatment)

- **Next steps:**
  - → Simulate TSS settling/re-suspension mechanisms.
  - → Analyse scale effects.
  - → Field validation of laboratory results.

THANK YOU

ainhoa.mate-marin@insa-lyon.fr

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