

Low-cost level sensors, flow monitoring and fish continuity: a case study

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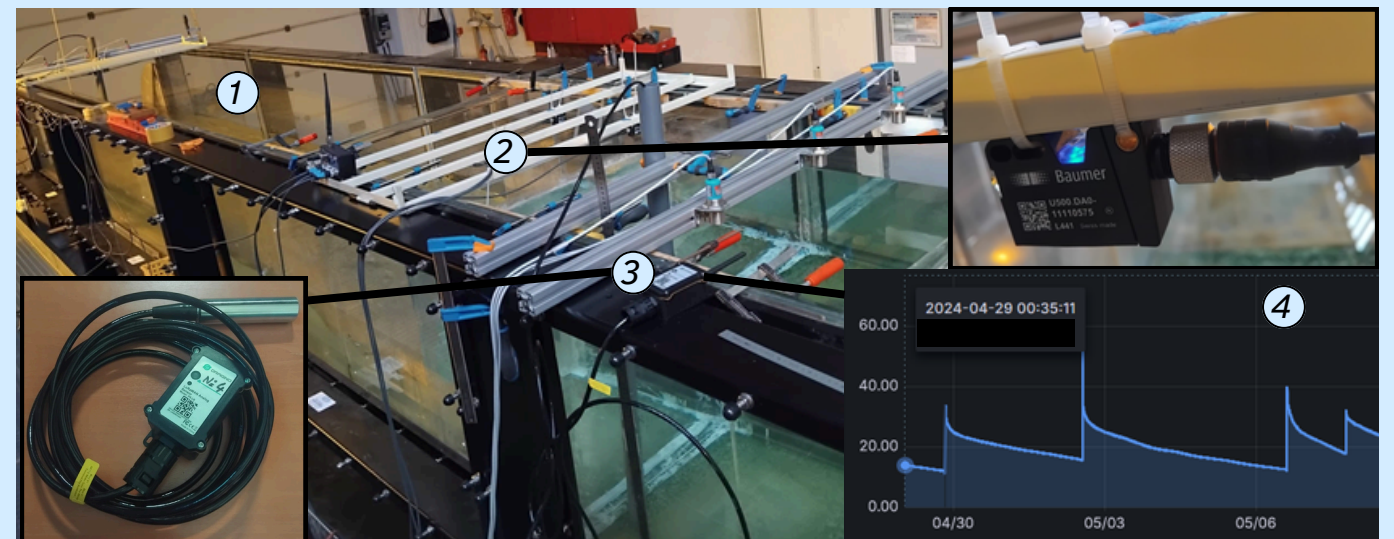
Introduction

- **Flow monitoring** is a key lever for water management transition, particularly in complex systems like the **Camargue basin**.
- The use of **low-cost digital tools** (as the pslb Dragino sensors) is increasing, but little is known about the uncertainty they introduce into hydraulic assessments.
- Hydraulic structures, such as **sluice gates**, are vital for regulation but impact **ecological continuity** for endangered species like the **European Eel (*Anguilla anguilla*)**.
- This study establishes an evaluation of sensor calibration methods and hydraulic models to assess the feasibility of low-cost on flow monitoring.

Instrumentation and study site

The lab experiments were conducted at Institut Agro Hydraulic lab, equipped with a 12-meter long glass canal (1) (max. discharge 160 L/s) and high-resolution level sensors.

Water depth was assessed by an **ultrasonic sensor Baumer** (2) with an 1 mm accuracy. Pressure instruments **pslb Dragino** (3) are monitored directly on the **Grafana platform** (4)



The junction of the channel connecting the Grandes Cabanes basin with the petit Rhone is regulated by a sluice gate, monitored with two pslb Dragino sensors

upstream side

downstream side

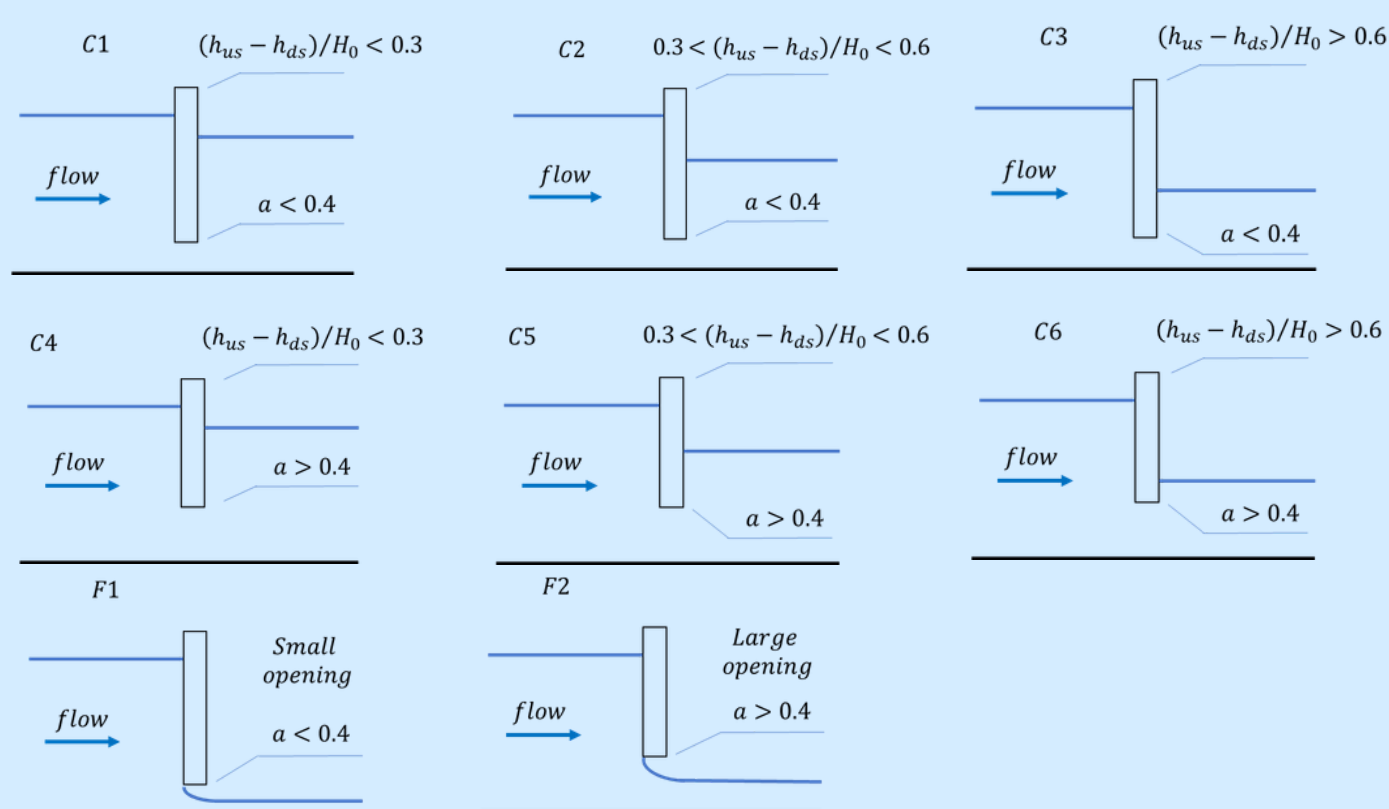


Control flow sluice gate (1)
Upstream pslb Dragino pressure sensor (2)

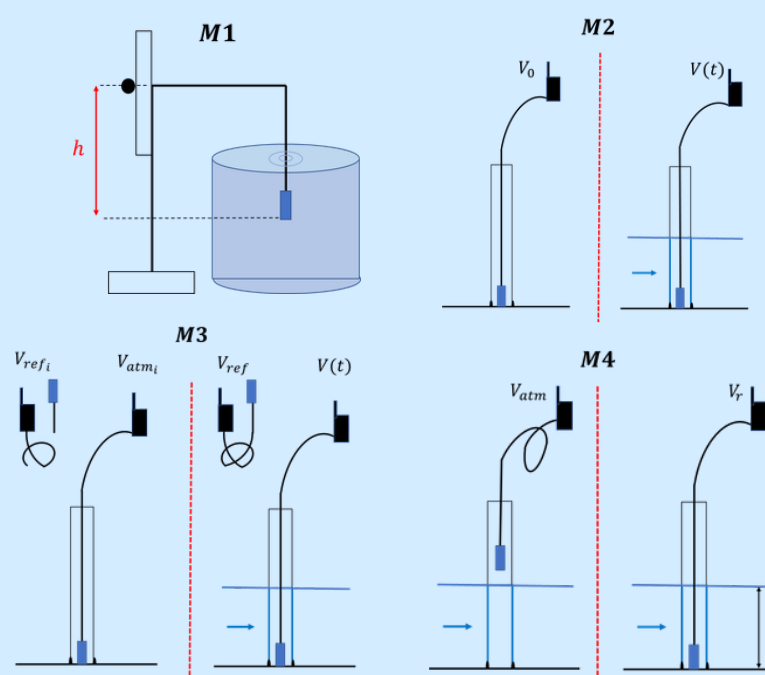
Downstream pslb Dragino pressure sensor (3)
Counting Eel net (4)

Method : A systematic investigation

Experimental Construction: Laboratory: 300 test observations across 8 programs covering 6 hydraulic cases (C1–C6) based on gate opening, submergence degree and head difference. Two free flow cases (F1, F2) are previewed to be evaluated



Calibration Construction: Four methods developed to transform raw pressure data into water depth:



M1 : Standard calibration on steady water

M2 : Standard calibration during setup with atmospheric correction

M3 : 2 sensors mutual calibration with synchronized dynamic correction

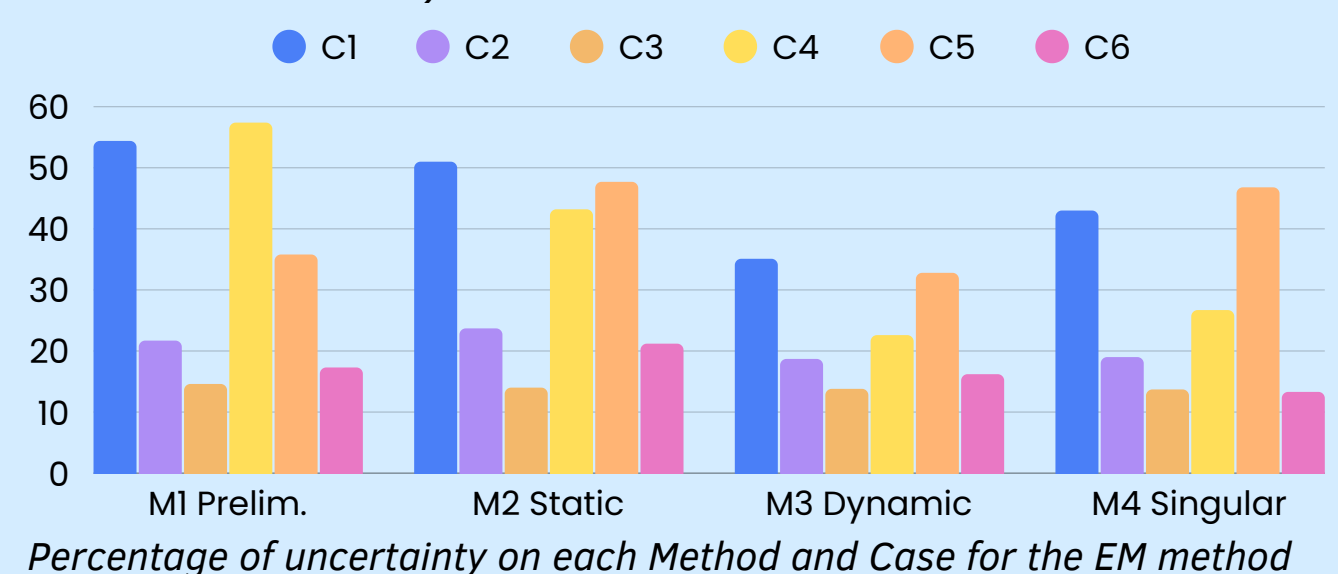
M4 : Baseline Two-Point Calibration

Model evaluation : Comparison of classical models Henry (1950), Swamee (1991), SIC-2 (2013)*, and Belaud et al. (2009)* EM modelling approaches. Laboratory uncertainty propagation utilized Monte Carlo sampling

*Models developed within the UMR GEAU research unit.

General statement : Key results

M3 is the most precise, with a typical uncertainty of **9.0 mm** and a maximal uncertainty of 11.9 mm, **M4** current used method, has the highest uncertainty (**typical 26.9 mm, and maximal of 47.8 mm**).



Henry (1950) achieved the lowest prediction error (MAPE) at 9.4–12.6%, but their uncertainty intervals are underestimated (only 31–35%) fall within the stated 95% confidence bands. The revised EM method, with **varying contraction coefficient** (Belaud et al. 2009) provided the **best balance** : Competitive prediction error and well calibrated uncertainty with near-nominal uncertainty intervals (93–98%)

Conclusions and perspectives

Low-cost digital monitoring is **feasible** for **environmental assessment** on the fieldsite, with dynamic correction the uncertainty is reduced by a 3 to 5 factor.

It opens perspective to a **webservice providing flow and passability** through control structures

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