Unmixing in wastewater pump sumps

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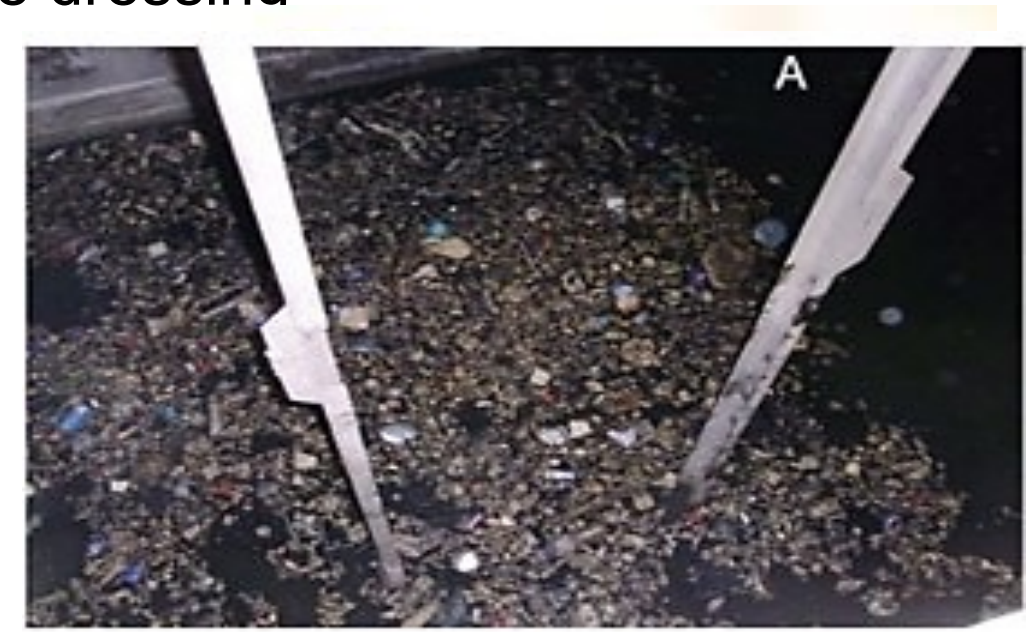
Let’s discuss unmixing

- Unmixing is often inconvenient, e.g. unmixing of your salade dressing



- This holds as well for Urban Drainage

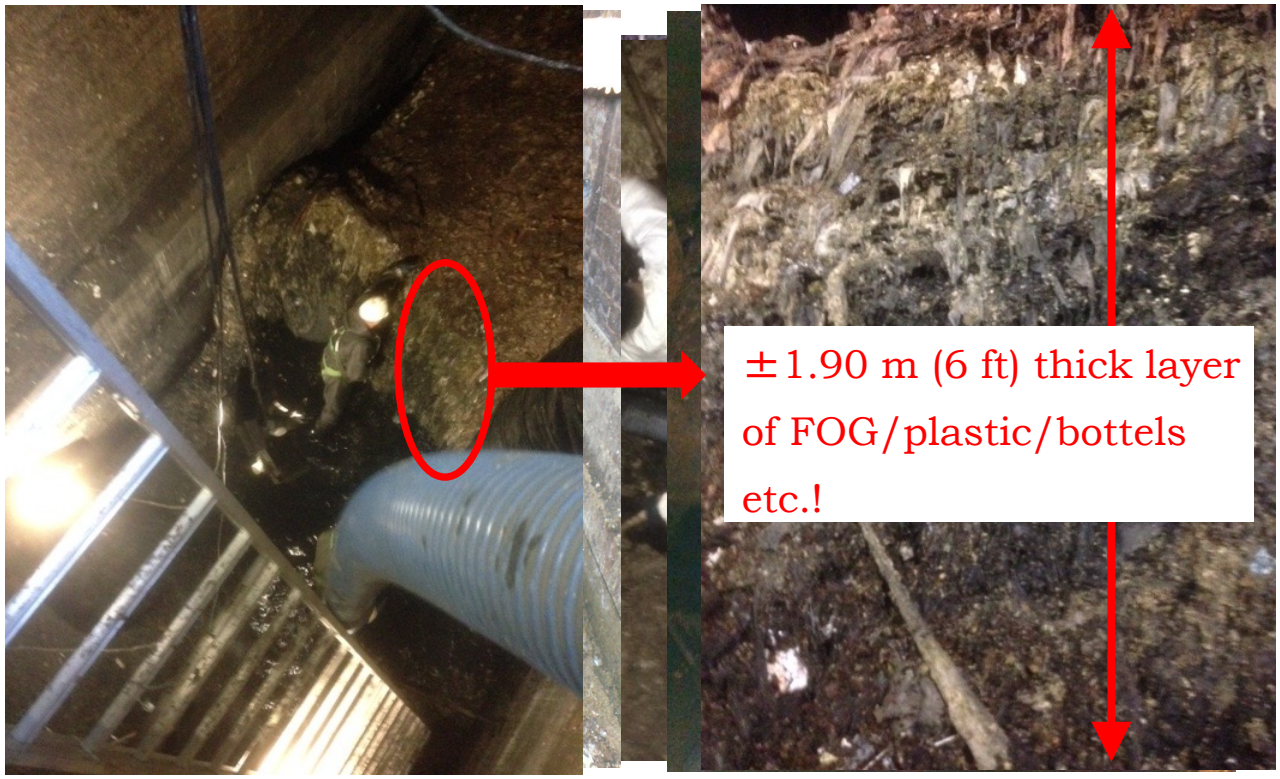
Some examples

- Turbulence induced degassing of wastewater releasing H_2S -> health hazard + inducing corrosion + explosion risks (loads of literature on this one, yet stil large knowledge gaps on e.g. air flow simulation/monitoring in drainage systems))
- Degassing in pressure mains -> energy/capacity losses (air lock) + gas pocktespotetially inducing corrosion(see literature e.g. CAPWAT project 2003-2011, in practise still largely overlooked)
- Sedimentation -> reduction of capacity of gullypots, drains and sewers, resuspension issues in small bore pressure mains (loads of literature, yet we still know very little)
- Floating materials -> FOG deposits -> damage to pumps, blockage of LEL alarm systems, blockage of syphons (little literature: work to be done)

Introduction
solution upstream

The problem downstream

Formation of floating layers in wastewater pump sumps..

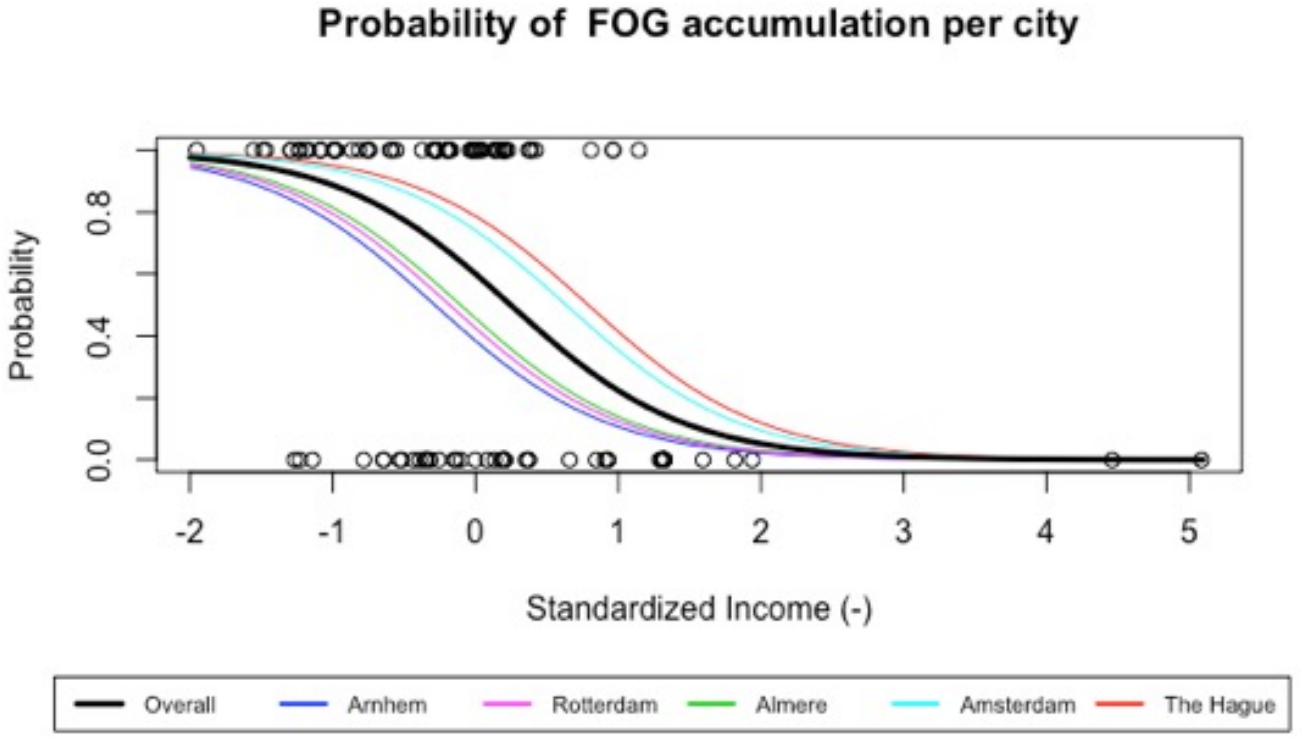


FOG deposits

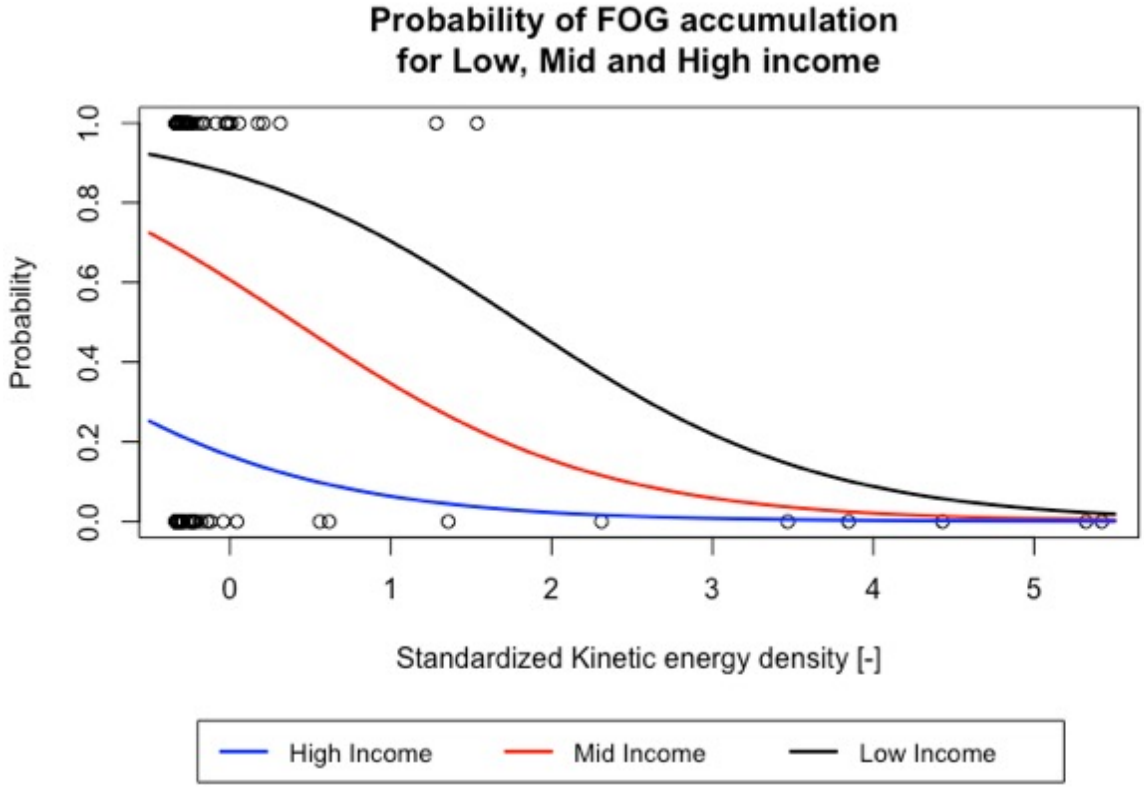
- Results from a MSc project in 2018 based on 126 wastewater pumping stations
- Results from a PhD project 2018-2021, based on lab and field research
- A measuring setup to monitor FOG deposits' dynamics in WWPS's

Logit model fittedon data from 126 pumping stations in 5 cities

$$\ln\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = 0.394 - 1.652 \cdot Income_{ij} - 1.068 \cdot Energy_{ij} + 1.749 \cdot FSE_{ij} + b_i$$



Effect of mixing

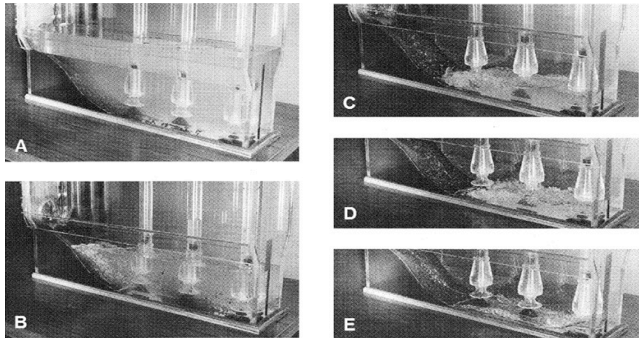


Statistical results

- Negative correlation between income and occurence of problematic FOG deposits in WWPS
- Positive correlation between ‘Pub, restaurant and Hotel density) and occurence of problematic FOG deposits in WWPS
- Negative correlation between ‘mixing’ and occurence of problematic FOG deposits in WWPS

Additional questions

- What are timescales of the formation of FOG-layer?
- What is the effect of
  - Pump sump geometry
  - Pump management



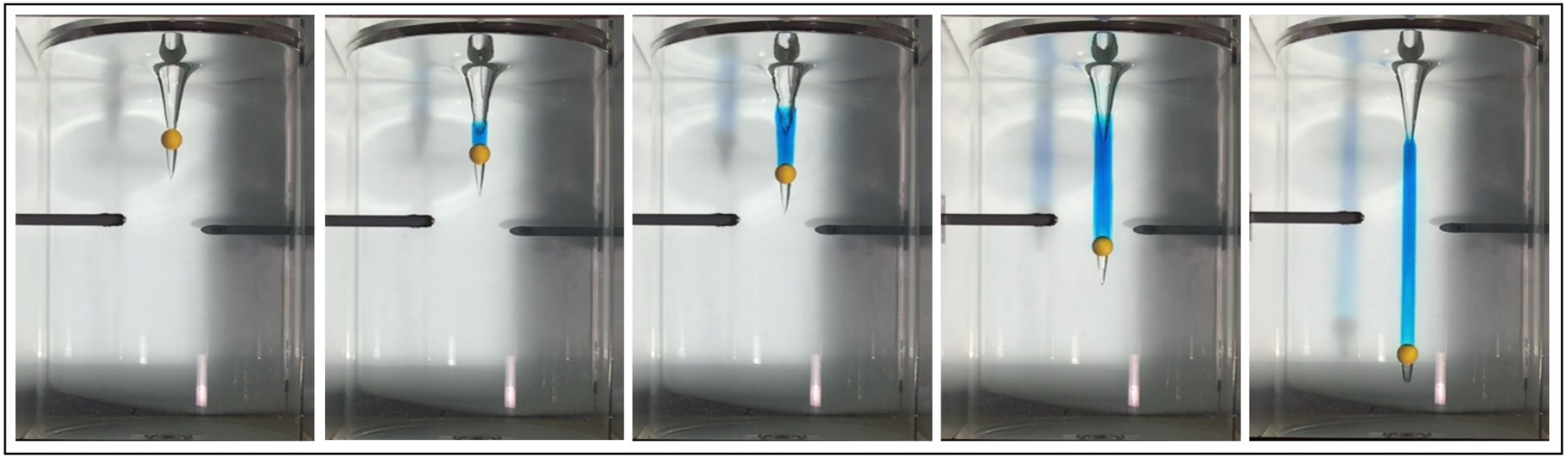
- What methods can be employed to stop/slow down the accumulation process?

Two projects

- Reducing FOG layers using controlled vortices (PhD project Alex Duinmeijer)

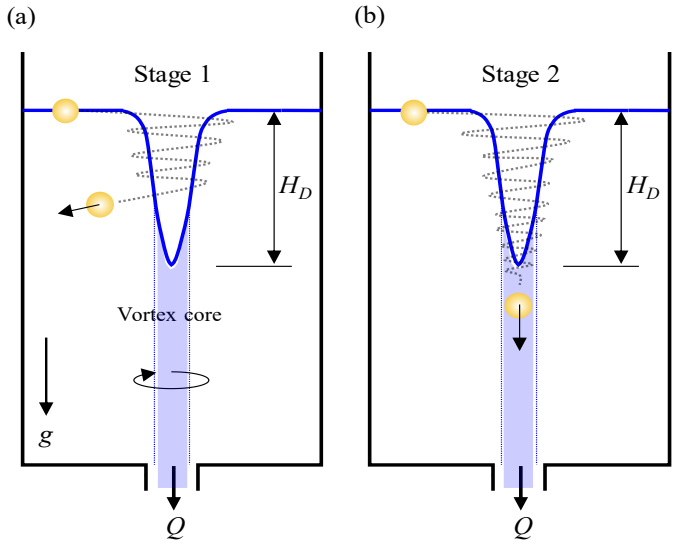
- High frequency Measuring FOG layer dynamics using Semantic Segmentation

Controlled vortices

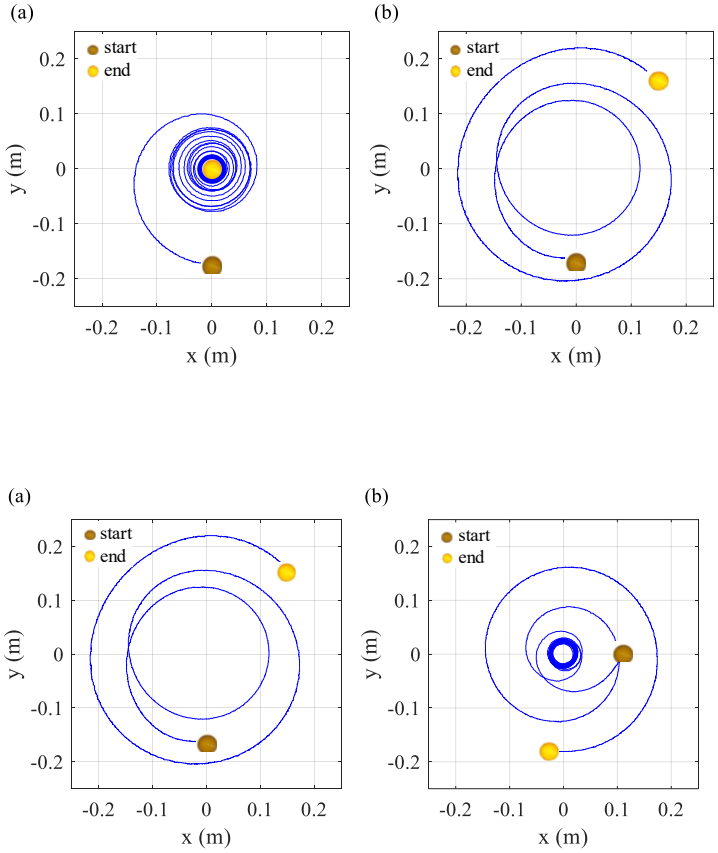


Transport modes by a vortex

Modes of transport



Fundamental issue: Chaotic behaviour



Main conclusions

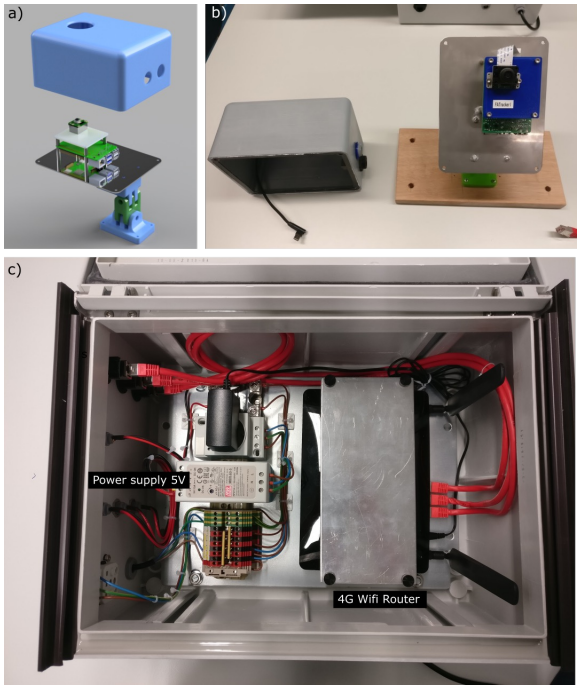
- A vortex cannot be controlled easily (at least in the context of a pumpsump)
- When caught in a vortex: behave like a sphere: best chance to get out ☺)
- Not useable for practical applications

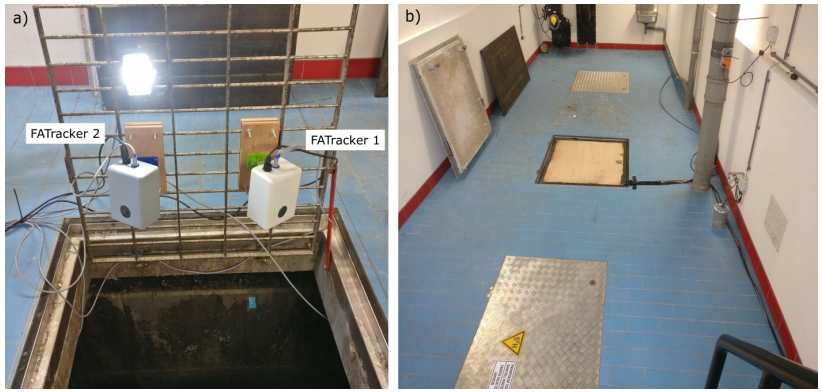
FATracker I

- Research project Deltares, Municipality of Rotterdam (Antonio Moreno-Rodenas, Alex Duinmeijer, Francois Clemens-Meyer)

- Long term high frequent measuring of the evaultion of the FOG layer using an optical (non-intrusive) sensor (also know as a camera)

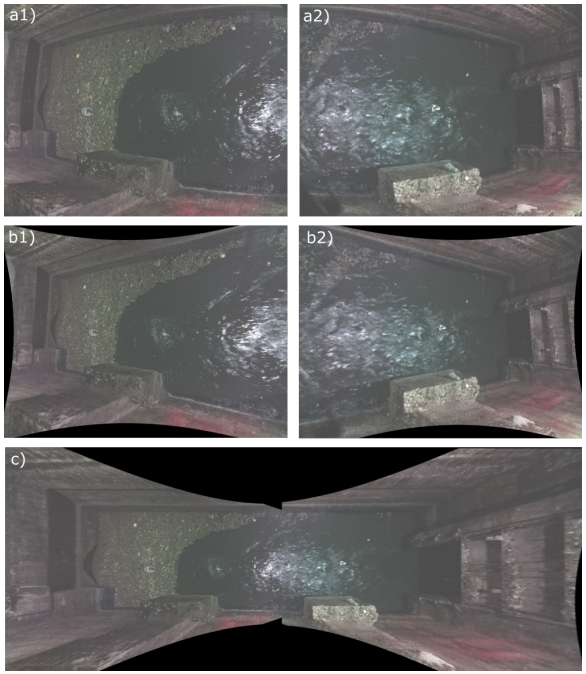
Technology applied

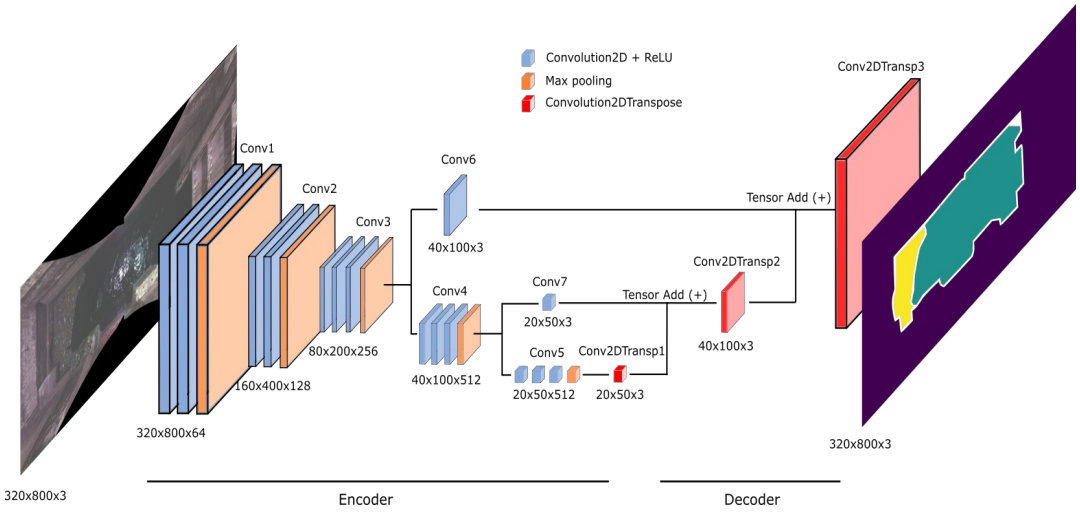




- Raspberry Pi 4 Model B, ARM CPU Quad core Cortex-A72
- 8-megapixel camera (Sony IMX219) 98° viewing angle, fisheye lens (ENTANIYA RP-L98).
- 3 LED floodlight lamps (KONIG LED, 750 lumens, 10W)
- 3D printed casing (survived > 24 months in a WWPS)
- Locale postprocessing 9.8 seconds per image.

Postprocessing raw images





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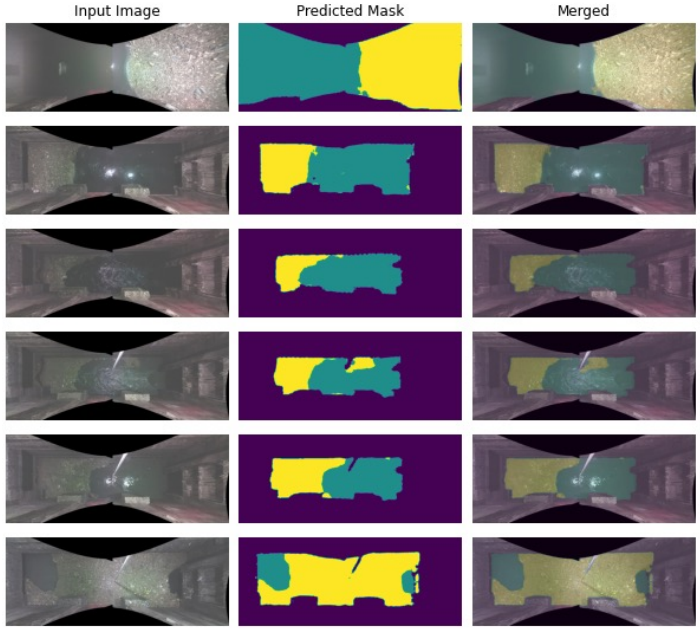
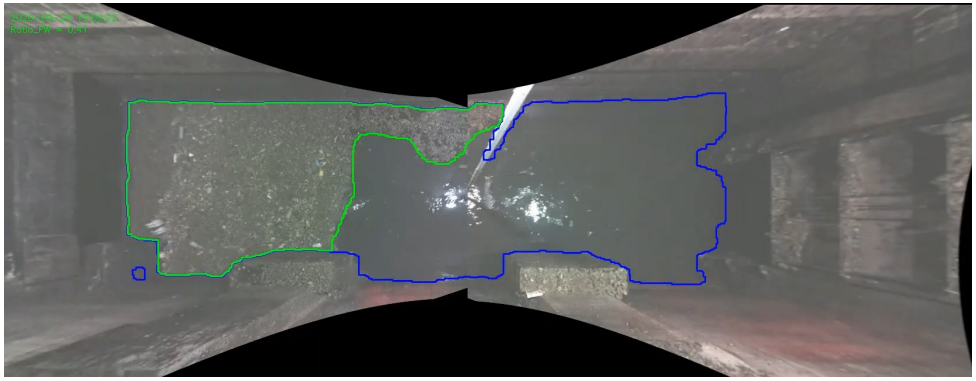
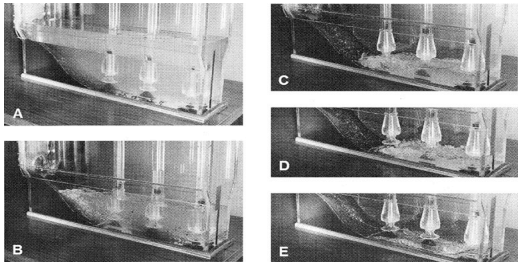
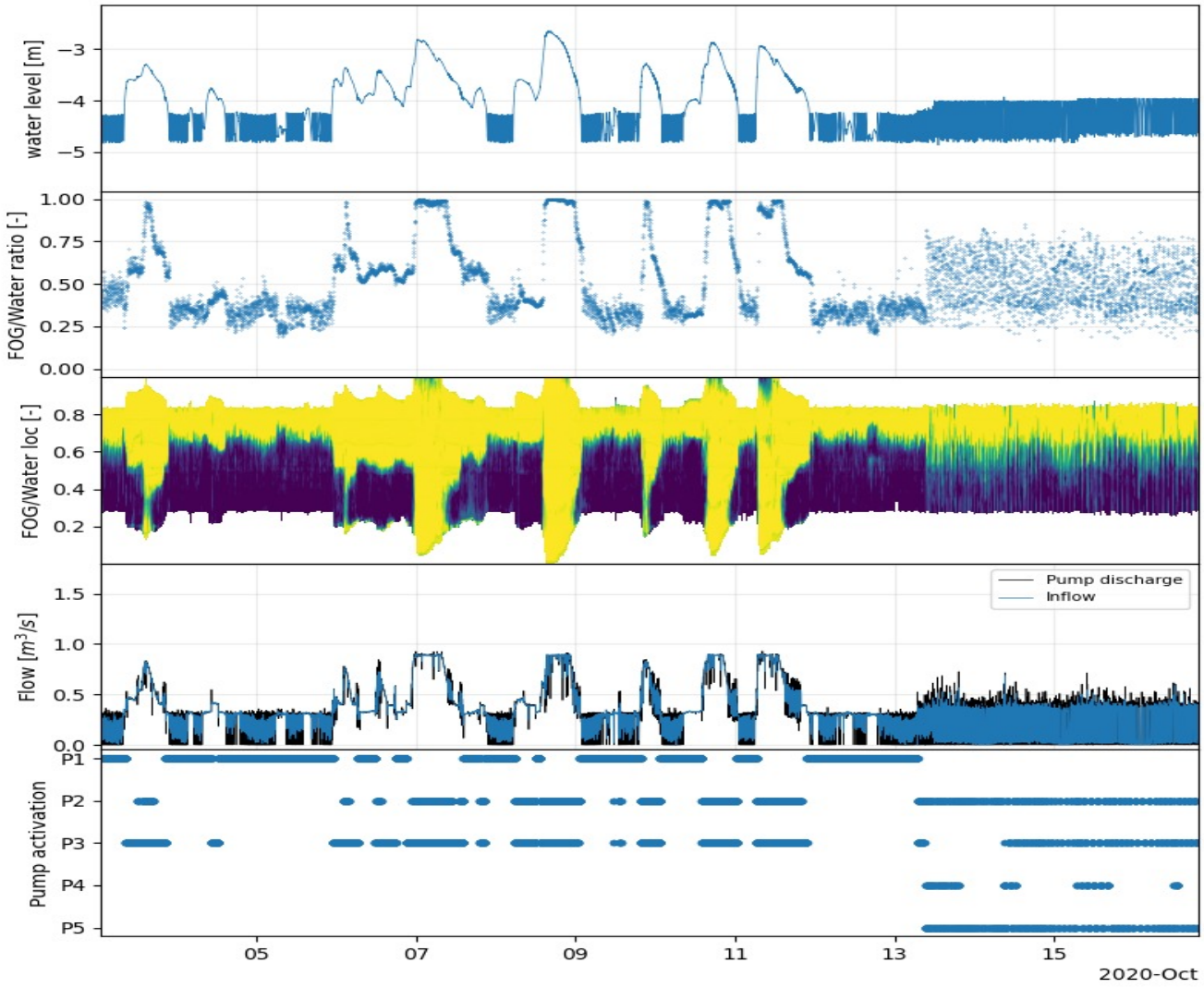
Some examples









- Clear influence of storm events
- Pump management has a effect on the FOG dynamics

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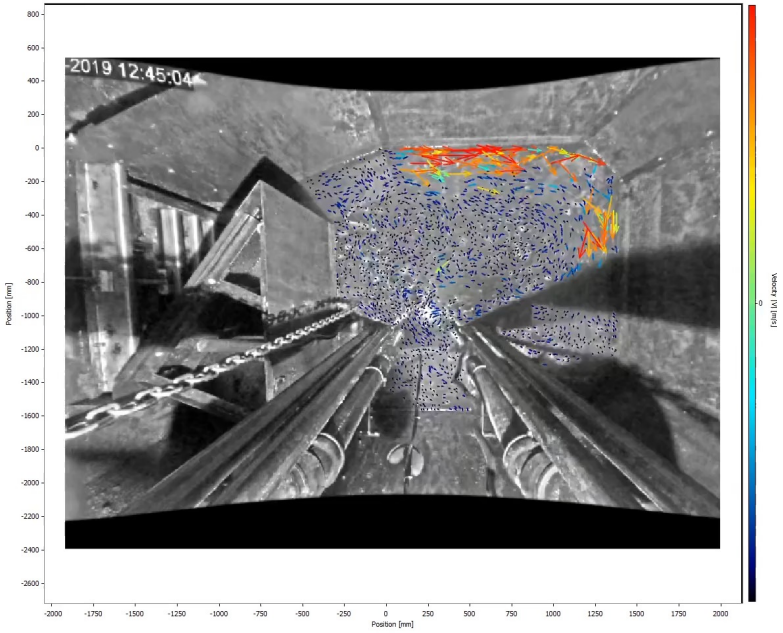
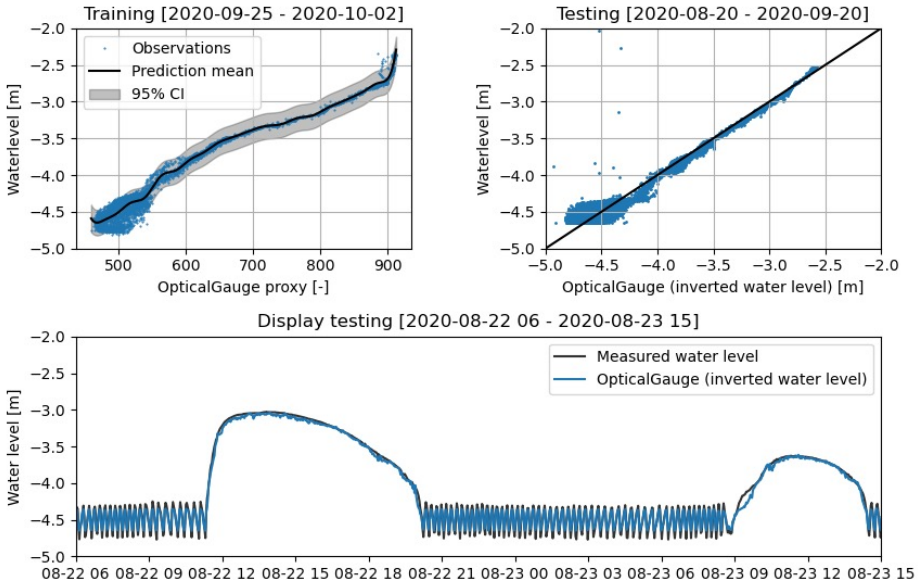
Additional information extracted from the video footages





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Fatracker II

- Similar hardware installend in 6 WWPS (Rotterdam, Arnhem, Maastricht, Maastricht Airport,…….., Marseille)
- In operation for ~ 1 year
- So far: very different behaviour (in terms of dynamics) in the diffferent PS, one with occasional formation of foam)
- Expecte dto be finalised in the course of 2023

Future developments

- Quantifying volume of the FOG layer
- Adaptive pump management based on FOG dynamics
- Analysis of (huge amounts of) data to find indications of effects of sump design, pump management, etc. (nice challenge for CHAT GTP-4???)

References

- Moreno-Rodenas, Duinmeijer & Clemens-Meyer (2021) Deep-learning based monitoring of FOG layer dynamics in wastewater pumping stations. *(Water Research: preprint:* https://doi.org/10.1016/j.watres.2021.117482
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Co-UDlabs

BUILDING COLLABORATIVE URBAN DRAINAGE RESEARCH LABS COMMUNITIES

Co-UDlabs April18nd, 2023

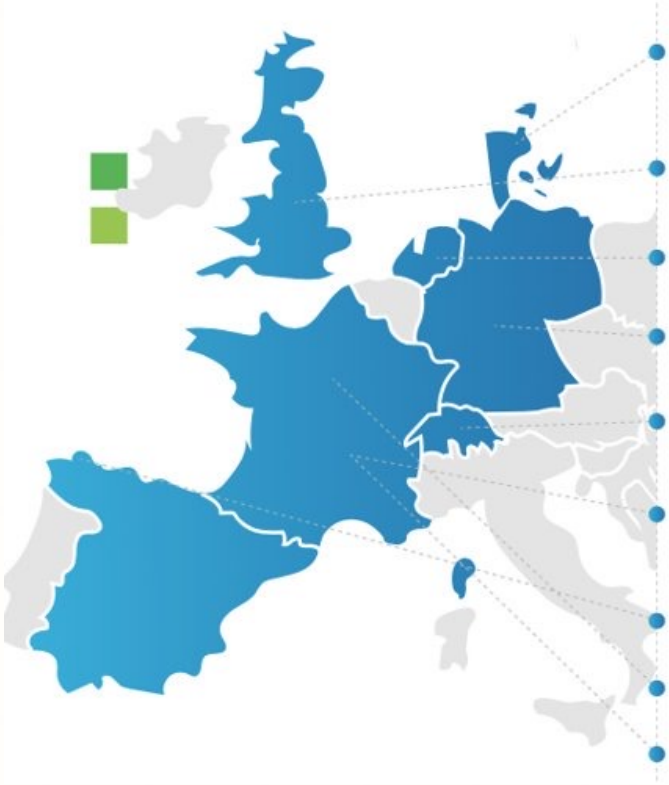
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101008626

Co-Udlabs

Collaborative urban drainage laboratories

- The main objective of Co-UDlabs is to **strengthen a collaborative European Urban Drainage innovation community.**
  - **Access to top-class research infrastructures** makes allows to develop, improve and demonstrate innovative UD concepts in **17 key large scale research facilities** of seven Research Infrastructures (RI).
  - Build network of operators, enterprises and academics will allow the community to come together, **share ideas, problems, solutions and co-produce project concepts**.
  - Perform harmonization of protocols and test new ideas through joint research activities within the consortium.

Co-Udlabs: The consortium



AALBORG UNIVERSITY
- Frejlev research station (FREJLEV) 4, 6, 7

The University Of Sheffield.
- Above/Below Ground Urban Drainage Facility (A/B FLUME) 1, 2, 4, 7
- Temperature controlled Annular Flume (ANNULAR) 3, 7
- Full Scale Buried Water Infrastructure Test Facility (BURIED FACILITY) 1, 3, 4, 6, 7
- Real Time Control Testing Facility (RTC RIG) 1, 2, 4, 7

Deltares
- Alpha-loop (A-LOOP) 4, 7
- Beta-loop (B-LOOP) 3, 4, 7

IKT
- IKT Large Test Facility (IKT LTF) 4, 6, 7
- IKT Hydraulic Test Stand (IKT TEST) 2, 4, 5, 7

eawag aquatic research
- Urban Water Observatory – Digital Lab (UWO) 3, 4, 7
- Experimental Hall–recirculating flume (HALL) 3, 4, 7

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES LYON
- Green ROOF experimental Facility (GROOF) 4, 5, 7
- Django Reinhardt detention and settling basin (OTHU-DRB) 2, 4, 5, 7
- OTHU SuDS research facilities (OTHU SuDS) 2, 4, 5, 7

UNIVERSIDADE DA CORUÑA
- Scale street surface model (STREET) 1, 2, 4, 5, 7
- Scientific platform for urban runoff tests (BLOCK) 1, 2, 5, 7
- Bens waste water flume facility (BENS FLUME) 3, 4, 7

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Second call for Transnational access (please see: **https://co-udlabs.eu/**)

- Formal start during a workshop held during NOVATECH Lyon (July 3rd-7th)
- Free access to large scale research facilities. (travelling and stay EU-refunded)
- Consortia preferably encompass different nationalities and backgrounds (research, industry, authorities)
- Very straight forward application procedure.

Global timeline 2nd TA call

- Start July 2023 (NOVATECH)
- Hackaton session (September 2023)
- Closure for submissions (October 2023)
- Selections of proposals (December 2023-January 2024)
- Start of TA (February 2024) onwards
- Download TA brochure with details: https://co-udlabs.eu/wp-content/uploads/2023/04/Co_UDlabs_brochure_web.pdf