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Assessing Combined Sewer Overflows (CSOs) – A growing need for evidence base, compliance assessment, and future regulation

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Highlights

- With highly advanced wastewater treatment and emerging stormwater pollutants such as particles and microplastics, CSOs become more and more relevant
- Policy and organizational issues are the biggest barrier against sustainable CSO management
- Urgent need for evidence demonstrating the extent of CSO problems and benefits of data sharing

Combined sewer overflows (CSOs) can be a significant source of surface water quality deterioration for four major reasons.

First, discontinuous but highly dynamic discharges of organics, nutrients, and water volumes evidently lead to an impaired ecological status of aquatic ecosystems. This impact will be more pronounced due to increasing urbanization and more frequent occurrence of extreme events due to a changing climate. Second, several emerging micropollutants, such as microplastics and pesticides, are often stormwater-driven. Third, with progressing urban wastewater treatment, such as the removal of micropollutants of emerging concern, the relative importance of CSOs as a pathway of urban pollution is likely to increase. Finally, people are expecting higher environmental standards, i.e. bathing water quality (Badevand, 2019; Garneau and Vanrolleghem, 2017), and pollution incidents can attract fines (UK Environment Agency, 2019, 2017) as well as significant negative publicity (Carrington, 2017; BBC, 2018).

Triggered by regulation, water utilities are making big investments to mitigate CSO pollution. However, there are hundreds of thousands of CSO structures across Europe and it is currently not known whether money is actually spent efficiently and in the right places. The availability of increasingly efficient (low-tech, low-cost, low-power) online monitoring techniques and data evaluation routines is currently changing the way researchers, utilities and regulators are monitoring CSOs. However, in many countries, CSO related data is unstructured, not used in compliance assessment, nor well organized or widely shared. **So, although an increasing amount of CSO data is being collected, the amount of useful information on CSO related problems is very limited.**

Methodology and Results

Community Workshop

To discuss current drivers and barriers for the assessment and regulation of CSOs, a **workshop organised by the IWA International Working Group on Data and Models (IWGDM) took place at the 2019 SPN9 conference**. The goal of the workshop was to collect the opinion of the community, share knowledge and ideas, and derive a set of specific recommendations. This paper summarizes the major results and recommendations to chart a way forward, given the recent developments around the i) standardization and evidence from monitoring data, ii) assessment of stormwater pollution, e.g. regarding particulate matter, microplastics and micropollutants, and iii) novel wastewater treatment technologies, e.g. with the elimination of micropollutants.

Main workshop recommendations

1) Provide an evidence base on the functioning and the impact of CSOs

- a) There is a need for more summarising studies of local bodies of evidence on the functioning and impact of CSOs, as well as Separated Sewer System Outflows (SSOs) (Figure 1, left). This should not only include aggregated performance data, such as e.g. the annual number of spills, spill volumes, usage of tank volume and event-mean concentrations. It should also provide evidence, based on continuous field monitoring data, on the activity of CSOs including the spatial and temporal variability of pollution, allowing for conclusions on observed impacts of CSOs on surface water quality.
- b) There is a need to appraise the overall impact of CSO also with respect to other sources of pollutants. A first attempt at quantifying CSO loads at European scale (Pistocchi et al., 2019) was admittedly based on generic assumptions and required evidence to support model parameterization. The same need is likely to exist in many river basin districts across Europe and elsewhere.

2) Develop a culture of evidence-based CSO compliance assessment

- a) Develop robust, relevant and cost-effective CSO performance indicators based on field monitoring data. There is an urgent need to perform more field studies and data analyses that link problem-oriented water quality metrics (e.g. O₂ deficits, NH₃ peaks, trace pollutant dynamics) to observable emissions (e.g. duration of spill or volume). Further, there is a need to quantify the levels of uncertainty in deriving such metrics from field monitoring data collected at different space and time scales, or sensors of different levels of accuracy. This enables CSO performance assessment to be cost-effective and reliable, i.e. qualified through a designated uncertainty assessment.
- b) Establish standard procedures for data collection, data quality checking and data accreditation (Figure 1, right). Collaborate with stakeholders to develop guidance for data-based assessment.

3) The need to tap the hidden potential of creating value from data

- a) Information regarding the occurrence and magnitude of CSOs should be made public, as in the U.S. and Denmark. Data should be shared online to moderated domains, and in ways easy to interpret, so as to foster more public engagement and participation.
- b) Gather more evidence for utilities on the potential benefits of sharing and further analyzing field monitoring data. For example, people who are more engaged may delay flushing the toilet during heavy rain (NYTimes, 2018). Or, water levels in tanks can provide a basis for plausibility checks of rainfall-runoff models, which in turn ensure good decision support in long-term urban drainage planning.
- c) Develop pilot projects to collect information on CSO performance into a central database. This would include conceptual data models as well as standards for (meta)data sharing, e.g. such as the Norman database (Norman, 2019). Carry out research into what type of data should be shared, with what level of aggregation and with what levels of access, and how such a database might be funded and sustained in the longer term.

4) The need for addressing non-technical issues

- a) Investigate barriers to the adoption of policies related to data gathering and sharing, as well as providing

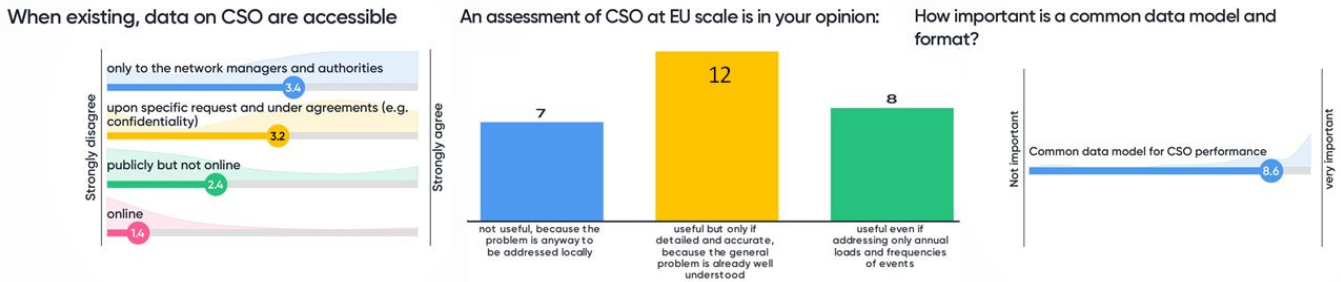


Figure 1. Real time opinions of the participants (online and offline) in the CSO workshop at the SPN9 conference regarding 3 questions related to CSO data. From left to right: 1) who should have access to CSO data? 2) is a CSO assessment at the EU scale useful? and 3) how do you rate the importance of having a common model and format for CSO data?

stakeholders with more evidence and demonstration studies showing the benefits of sharing monitoring data, e.g. through benchmarking.

b) The revision of the UWWTD should include improved regulations for CSOs. Any new regulation should permit to test new methodologies; regulations that reinforce inflexible *status quo* practices should be avoided. Instead, authorities should rather develop incentives to adopt an integrated view of the wastewater system.

c) Thoroughly investigate the cost-effectiveness of CSO as water pollution control. This should not only take into account the net present value but also include the benefit of flexibility, i.e. the possibility to adapt infrastructure to a changing climate or socio-economic boundary conditions.

Conclusions and future work

Regarding minimizing the impact of CSOs on the aquatic environment, the biggest barriers towards more sustainable management of CSOs seem related to policy and organizational adjustments. Issues, such as insufficient or missing regulations, missing guidelines and standards, lack of enforcement, and organizational issues, such as not using data in planning, no data-based compliance assessment, no education on monitoring in universities and professional courses, were generally considered more important than technical issues (SPN9, 2019). Future initiatives should concentrate on raising awareness in the wastewater community and also propose robust incentives to significantly reduce the impacts of CSOs and operate jointly sewer systems and WWTPs.

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