Determining the transition between DWF and WWF based on water quality measurements

van Daal-Rombouts, Petra; Langeveld, Jeroen; Clemens, Francois

Publication date
2013

Document Version
Accepted author manuscript

Published in
Proceedings of the 20th European Junior Scientist Workshop on Sewer Systems and Processes

Citation (APA)
van Daal-Rombouts, P., Langeveld, J., & Clemens, F. (2013). Determining the transition between DWF and WWF based on water quality measurements. In *Proceedings of the 20th European Junior Scientist Workshop on Sewer Systems and Processes: EJSW 2013, Graz, Austria*

DETERMINING THE TRANSITION BETWEEN DWF AND WWF BASED ON WATER QUALITY MEASUREMENTS

Names: Petra van Daal-Rombouts[1,2], Jeroen Langeveld[1,3] and François Clemens[1,4]

Affilitations: [1] Delft University of Technology, Delft, the Netherlands
[2] Witteveen+Bos, Deventer, the Netherlands
[3] Royal HaskoningDHV, Amersfoort, the Netherlands
[4] Deltares, Delft, the Netherlands

Position: PhD-student

Mailing address: Delft University of Technology
Building 23
P.O. Box 5048
2600 GA Delft
The Netherlands

Telephone: +31 6 5090 9369

Fax: not available

E-mail: p.m.m.vandaal-rombouts@tudelft.nl

Keywords: conductivity; continuous monitoring; dry weather flow; turbidity; wet weather flow

Introduction

In wastewater management, real time control (RTC) is generally considered as one means for improving the performance of the available infrastructure and hence the wastewater system. Essentially, the potential of RTC for adapting this performance depends on three factors, each leading to its own RTC strategy:

1. available idle system capacity => volume based RTC
2. differences in pollution levels between discharge locations => quality based RTC
3. differences in vulnerability of the receiving water => impact based RTC

To apply quality based RTC, information on both the quantity and quality of the wastewater is necessary. When there is only a small amount of water (during dry weather flow, dwf), all water can be transported to the wastewater treatment plant (WWTP). If the water flow surpasses the hydraulic capacity of the WWTP (during wet weather flow, wwf), some water can be transported to the WWTP, while the rest has to be discharged to the receiving water. Here wastewater quality information can be used to decide which wastewater should be transported to the WWTP and which should be discharged, see figure 1.

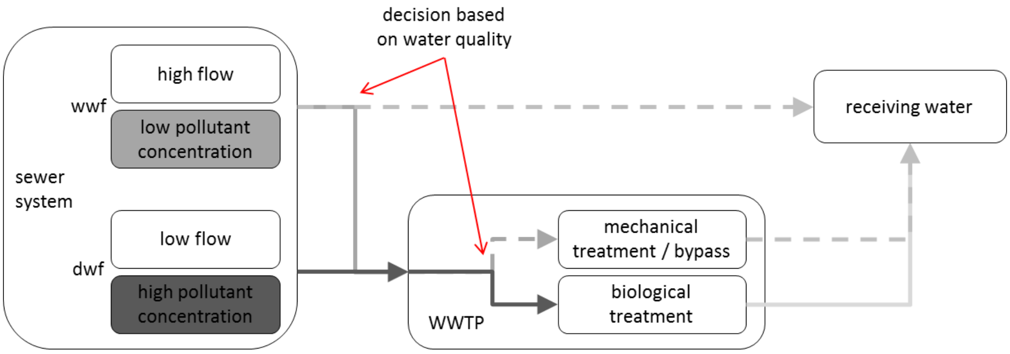

figure 1. Schematic overview of decision points where water quality measurements can be used in quality based RTC.

At the WWTP similar choices can be made. As long as the influent flow is below the maximum capacity of the biological treatment, all wastewater can be treated before being discharged to the receiving water. When the influent flow surpasses the maximum capacity of the biological treatment, the additional flow will be mechanically treated or bypassed only. Based on the quality of the wastewater, it can be decided if and how the mechanical treatment is taken into operation.

In both cases the quality of the wastewater is the parameter on which to decide what wastewater should be discharged (low pollutant concentration) or treated (high pollutant concentration), while the wastewater quantity is a prerequisite. In the case of dwf and wwf, these choices might be easy because of large differences in pollutant concentrations due to dilution. At the transition from dwf to wwf or vice versa, this is less obvious, due to the natural variability in the concentrations. Moreover, early detection of such a transition increases the opportunity to optimise the performance of the system.

In literature the distinction between dwf and wwf is made on quantity measurements only, or in hindsight. Hannouche et al. (2011) use a threshold value for the water level to distinguish dwf from wwf, to take grab samples under both conditions. Métadier and Bertrand-Krajewski (2011 and 2012) post-process the available data, determining storm events through combining a threshold flow value with rainfall measurements, or comparing several historically known dwf patterns (flow or turbidity) with deviating patterns to determine the wwf contribution the this pattern.

Aim of research

For quality based RTC, ideally, the transition between dwf and wwf can be determined using only a few (current) quality measurements. The aim of the research described here is to determine whether it is possible, in a simple and robust way, to find the transition between dwf and wwf directly from water quality measurements.

Available data

For this project a database with wastewater quality and quantity measurements from the wastewater system of Eindhoven, the Netherlands, is available. The database consists of 8 months of high frequency conductivity (EC), turbidity (TU), and flow (Q) measurements for the influent at the WWTP of Eindhoven. At 7 combined sewer overflow (CSO) locations and the internal and external weir of a stormwater settling tank, 1 year of high frequency EC, TU and level (h) measurements are available. Additional rainfall measurements are performed as well. The dataset and wastewater system are described in more detail in Van Daal et al. (submitted).

Method and preliminary results

The method investigated is based on a negative correlation between the derivatives for EC and TU at the transition between dwf and wwf in the measurement series at the WWTP influent, as can be seen in figure 2.

In this figure also ‘dwf/wwf indication’ is displayed. As a first experiment the dwf/wwf indication was calculated through:

- smoothing EC and TU measurements over N minutes (N/2 measurements, no future measurements)

- calculating the difference between 2 consecutive measurements for EC and TU
- for each timestep, summing these differences for the past N minutes for EC and TU
- for each timestep, multiply the sums for EC and TU

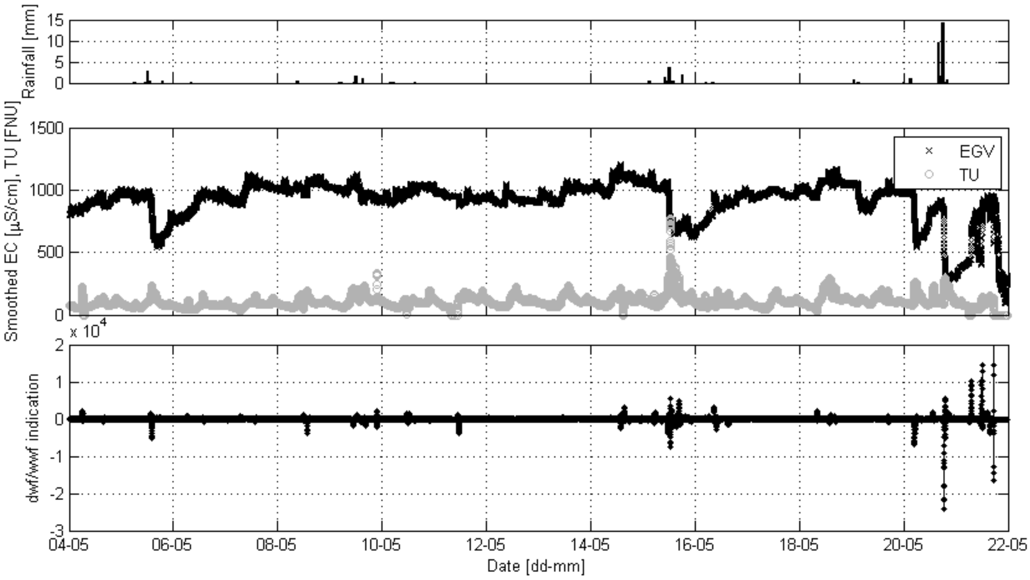

figure 2. The derivatives of EC and TU show a negative correlation at the start of rainfall, leading to an indication for the transition from dwf to wwf. N=10. WWTP influent. From May 21th both EC and TU measurements become unreliable.

The value for the dwf/wwf indication is close to 0 most of the time. Daily patterns and natural variation in EC and TU, lead to some positive and negative peaks in the dwf/wwf indication. At the start of rainfall the dwf/wwf indication, however, has a strong negative value. If a suitable threshold value is chosen, it should be possible to separate these from the natural variation in the dwf/wwf indication. This would mark the moment of the dwf to wwf transition (based on wastewater quality) for the wastewater transported to the WWTP.

Further research

Application of the current method leads to several issues. Firstly, the dwf/wwf indication sometimes has a negative peak due to natural variations in the EC and TU measurements that could lead to false positives. Secondly, the minimum value for the dwf/wwf indication approximately coincides with the maximum value for TU. This indicates that the actual transition was earlier, see figure 3. And last, the dwf/wwf indication only indicates the transition from dwf to wwf, not wwf to dwf.

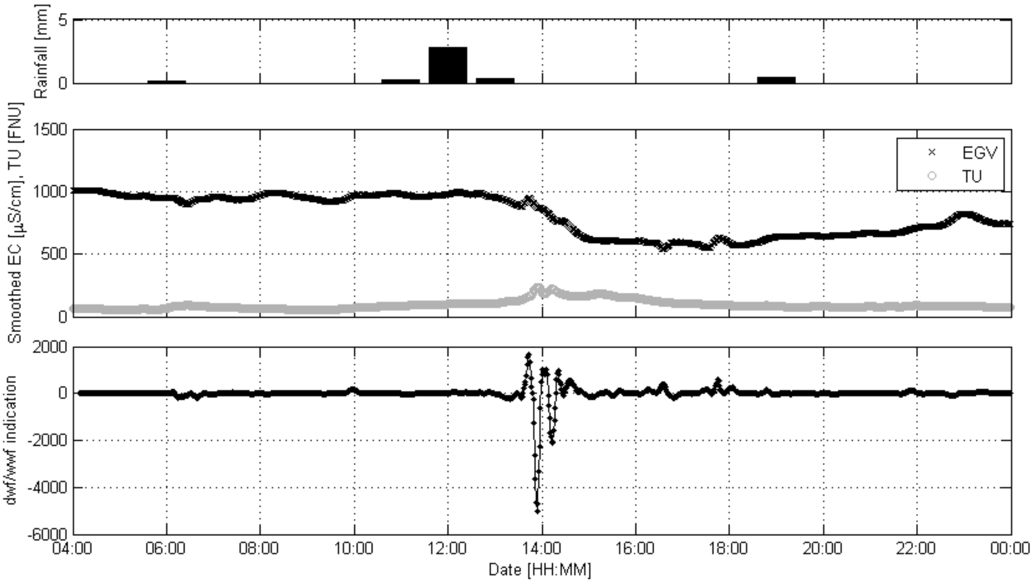

figure 3. The minimum value for the dwf/wwf indication approximately coincides with the maximum value for TU, indicating that the dwf to wwf transition has taken place earlier. N=10. WWTP influent. May 5th 2012

Further research will focus on refining the calculation of the dwf/wwf indication and the definition of a suitable threshold value, to minimise the number of false positives and false negatives and detecting the transition as early as possible. Since the method should be applicable in quality based RTC, there are restraints on the complexity of the calculations. The resulting method should be simple and robust: using only a limited number of measurements and no future information.

Other topics of interest are identifying the transition from wwf to dwf, and applying the method to the measurements in the sewer system.

Bibliography

Hannouche, A., Chebbo, G., Ruban, G., Tassin, B., Lemaire, B. J., & Joannis, C. (2011). Relationship between turbidity and total suspended solids concentration within a combined sewer system. *Water Science and Technology*, *64*(12), 2445–52.

Métadier, M., & Bertrand-Krajewski, J.-L. (2011). Assessing dry weather flow contribution in TSS and COD storm events loads in combined sewer systems. *Water Science and Technology*, *63*(12), 2983.

Métadier, M., & Bertrand-Krajewski, J.-L. (2012). The use of long-term on-line turbidity measurements for the calculation of urban stormwater pollutant concentrations, loads, pollutographs and intra-event fluxes. *Water Research*, *30*, 1–21.

Van Daal-Rombouts, P., Schilperoort, R., Langeveld, J., Clemens, F., submitted. CSO pollution analysis based on conductivity and turbidity measurements and implications for application of RTC. *Proc. of NOVATECH 2013*, 23-27 June 2013, Lyon, France.