Influence of acquisition and record time steps on estimation of cumulated values (volumes, pollutant fluxes)

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Abstract
Due to recent technological progresses, water quality and quantity data can be acquired at high frequency. Based on a synthetic daily profile, Monte Carlo simulations demonstrate, in contrast with the acquisition time step (A_{TS}), that the record time step (R_{TS}) does not have a strong influence on cumulated values and their uncertainties.

Keywords
Data, acquisition, strategy, uncertainty, sampling optimisation

INTRODUCTION

In order to understand processes and phenomena in sewers, various data are recorded (e.g. water level, velocity, water quality). For research, investigation or legal purposes, cumulated values are often calculated: daily volume, event or annual pollutant loads through CSO, *etc*. Recent advances in hardware (sensors, acquisition systems, computers) and data communication allow the recording of time series with high frequency (> 1 Hz). Based on a theoretical daily profile (as Joannis and Bertrand-Krajewski, 2009) and real data, this work analyses the influence of A_{TS} and R_{TS} on..... Materials, methods and initial results are briefly described in this abstract. Some conclusions and recommendations on data acquisition and management are also drawn.

MATERIALS AND METHODS

Materials

Two kinds of data have been used for this theoretical study: an artificial daily profile (discharges during a dry day) and *in situ* data collected in the Eindhoven catchment (Langeveld *et al.*, 2013). The artificial profile is the sum of three sinus functions and an offset to simulate morning, lunch and evening flushes. White noise (normally distributed, zero mean) has been added to both signals for the simulations (the standard deviation changes: fixed – from 1 to 50 L/s, or proportional to the discharge value – from 0.5 to 10 %).

Methods

Several scenarios have been used to study the influence on data acquisition and record time steps. For each of these, cumulated values (volume, flux) have been compared to the true one (for artificial time series).

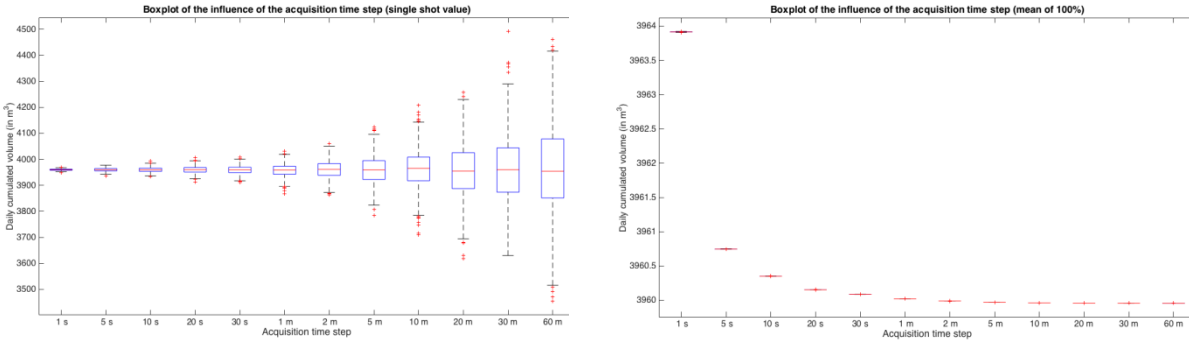
Influence of acquisition time step (A_{TS} = R_{TS}). Monte Carlo simulations (1000) have been generated for each of the following A_{TS}: 1s, 5s, 10s, 20s, 30s, 1m, 2m, 5m, 10m, 20m, 30m, 60m. For each sampling time (defined by the frequency and the starting time), the value has been assigned to the time intervals between sampling moments.

Influence of record time step (A_{TS} > R_{TS}). Assuming an A_{TS} of 1 ms, different time integration methods have been tested on different R_{TS}. As an example, for an R_{TS} of 120s, 120 000 values have been acquired and only one recorded. In order to summarize those 120 000 values in one number, several methods have been tested: mean, median of all or of a part of the acquired values. Effects of these different methods and record time step have been studied with Monte Carlo simulations.

RESULTS

Preliminary results (Figure 1) are consistent with the ones presented in Joannis and Bertrand-Krajewski (2009): the cumulated value seems to be slightly underestimated when the acquisition time step increases. This can be explained by the fact that the highest values of the time series might be missed for long A_{TS}. A basic method (Fig. 1, right) seems to offer an accurate estimation of the cumulated value.

Figure 1. Effect of A_{TS} (left) and R_{TS} (right) for a daily volume (theoretical profile, standard uncertainty of 0.01 m^3/s on the discharge). Real daily volume of 3960 m3.



CONCLUSIONS AND PERSPECTIVES

The preliminary results confirm the findings of Joannis and Bertrand-Krajewski (2009): a decrease of the A_{TS} leads to an underestimation of the cumulated value. Basic methods, usually applied when R_{TS} is lower than A_{TS}, deliver accurate estimation of cumulated values. These results will be confirmed or informed with more detailed analysis: variation of both A_{TS} and R_{TS}, sensitivity to standard uncertainties of time series values, add coloured noise instead of the white one and application of the method on real data.

ACKNOWLEDGEMENT

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No. 607000.

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