Measuring the solids loading of urban drainage systems via run off

Mesure de l'apport de matières solides par ruissellement dans les systèmes d'assainissement urbains

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RÉSUMÉ

Les systèmes d'égouts et d'assainissement urbain permettent de gérer le ruissellement des zones dont les capacités d'infiltration sont insuffisantes. Par temps pluvieux, les matières solides qui se trouvent dans la rue sont (re)mobilisées et transportées par ruissellement vers le système d'assainissement. Ces matières solides et les polluants qui y sont associés peuvent avoir des effets néfastes sur la qualité des eaux entrantes.

Cet article présente un nouvel appareil de mesure conçu pour mesurer l'apport de matières solides dans les avaloirs. Ce dispositif a été appliqué à 100 avaloirs sur une période d'un an, ce qui a permis d'obtenir un vaste ensemble de données sur les apports de matières solides dans le système d'égouts.

Les résultats indiquent que sans cet appareil, seuls 25 % des matières solides sont retenus dans les avaloirs. Il existe donc un énorme potentiel d'optimisation de la gestion des avaloirs, qui sont généralement optimisés pour prévenir les obstructions plutôt que pour éliminer le plus de matières solides possible.

ABSTRACT

Sewer and urban drainage systems deal with the runoff of areas that lack infiltration capacity. During wet weather, solids that are present on the street are (re)mobilised and transported to the drainage system by the runoff. These solids and their associated pollutants can have detrimental effects on receiving water quality.

This paper presents a new measurement device which has been developed to measure the inflow of solids in gully pots. This device has been applied to 100 gully pots over a period of a year, rendering a large dataset of solid inflows to the sewer.

The results indicate that only 25% of solids is captured in gully pots without this device. This renders a huge potential for further optimisation of gully pot management, which is typically optimised towards prevention of blockage rather than removing a maximum amount of solids.

KEYWORDS

Catch basin, gully pots, maintenance, solids, urban drainage

1 INTRODUCTION

1.1 Function of gully pots

Sewer and urban drainage systems deal with the runoff of impervious areas. During storm events, solids that are present on the street can be (re)mobilised and transported to the drainage system by the runoff. These solids and their associated pollutants can have detrimental effects on receiving water quality.

Road runoff typically enters drainage systems via gully pots (also known as catch basins). Gully pots are usually equipped with a sand trap to limit the solids loading of downstream sewers and pollutant loading of receiving water bodies. Bolognesi et al. (2008) concluded that the continuous inflow of solids will unavoidably lead to gradual silting and possibly to clogging of the gully pot, which increases the propability of urban flooding .

Literature on the solids loading of gully pots, however, is scarce and can be divided in two main approaches.

One approach is to determine the type and amount of solids available on the streets. This gives information on the pollutant potential of the street surface. However, not all of these solids will enter the drainage system and during the runoff processes solids are graded, because finer particles are normally more easily transported than bigger ones (e.g. Walker and Wong (1999), Vaze and Chiew (2002), Grottker (1987).

Another approach is to determine the suspended solids at the end of the sewer pipe. This approach is questionable as solids may, to some extent, settle in the drainage pipes (e.g. Chebbo et al. (1995)).

This paper presents a new measurement device which has been developed to measure the inflow of solids in gully pots. This device has been applied to 100 gully pots over a period of a year, rendering a large dataset on solid inflows to the sewer.

2 MATERIALS AND METHODS

2.1 Experimental setup

A measurement method was developed that does not interfere with the runoff to the drainage system, but at the same time retains all solids entrained in the storm water. Pratt and Adams (1984) used a stack of sieves in gully pots to filter the solids out of the storm water. Their approach could not be applied, given the objective of monitoring 100 gully pots for a period of a year, to be able to include possible seasonal variations.

Based on the method of Pratt and Adams (1984), it was initially tried to apply a steel wire mesh filter. However, the mesh proved to be very sensitive to clogging by the fine particle fraction entrained in the run off.

Therefore, the wire mesh filter was replaced by nylon filter bag (shown in Figure 1a). These bags are flexible and are less susceptible to clogging. The nylon filter bags have a pore size of 50 micron. This allows to capture nearly all suspended solids, while still allowing sufficient hydraulic capacity.

The nylon filter was attached to a metal plate, which was installed in the gully pot. This plate was sealed off around the gully pot wall to prevent leakage of solids. This setup is shown in Figure 1b.

Figure 1. a Filter bag with a diameter of 18 cm and a length of 50 cm. b Experimental setup.

2.2 Measurement location

104 gully pots were selected in a relatively new residential area (start of construction in 2000) in the city of Rotterdam. This area was selected for its homogeneity of gully pot types (which made a uniform to design of the experimental possible) and homogeneity in land use (which makes it possible to split up the area for comparisons). The location of the area is shown in Figure 2a and the gully pot locations are shown in Figure 2b.

Figure 2. a. Measurement location b. In red the selected gully pots and in blue not selected gully pots.

2.3 Experimental procedure

The project started in April 2018. The filters were emptied approximately every 3 weeks, both to prevent clogging of the filters and to detect changes in the inflow rate over time.

The wet weight of the solids was determined at the measurement locations. The water content of the samples strongly depended on the time passed since the last rainfall event. Therefore, samples were taken to the lab and analysed on their dry content. The dry mass in each gully pot was estimated by multiplying the dry content with the measured wet mass. The average inflow rate of solids was determined by dividing the dry mass with the length of the measurement period.

In addition, samples were analysed to determine the particle size distribution and the organic content.

3 RESULTS

3.1 Data exploration

During the emptying of the filters, it has been observed that in a small number of gully pots not only runoff entered the gully pot, but also construction materials like concrete, wall plaster and paint. These solids loads were weighted and registered, but excluded in the results of runoff data shown in figure 4.

3.2 Mean inflow rate

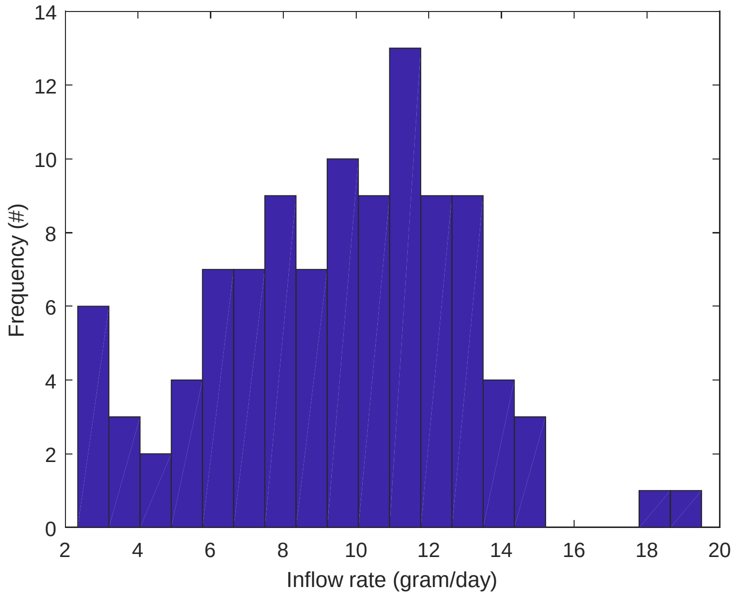

Figure 4. Histogram of mean inflow rate per gully pot.

Figure 4 shows the mean inflow rate per gully pot. This shows a relatively high variance between the different gully pots. There might be parameters, such as the surface area connected to a gully pot, that could explain these differences, this has not been analysed yet..

Preliminary results show that during the first 195 days of the research, the total dry material collected was approximately 189 kg. The total paved area was approximately 11.000 m^2, which results in an expected mean inflow rate of 332 kg/ha/year. This is nearly 4 times the solid weight removed per ha by annual gully pot cleaning (STOWA and Stichting Rioned (2016)).

4 CONCLUSIONS AND DISCUSSION

The amount of solids flowing into gully pots is much higher than the amount of solids normally captured in the gully pot. On an annual basis, it is estimated that only 25% of solids is captured in the gully pots. This renders a huge potential for further optimisation of gully pot management, which is typically optimised towards prevention of blockage rather than removing a maximum amount of solids. In April 2019, a full year of data will be available, allowing to analyse solids inflow for temporal and spatial variations.

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