

Assessment of EMC in periods of flood and drought season at urban stream in Brazil

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Introduction

Water use and urban growth are increasing exponentially, as well as climate changings and soil use. Referring to drainage, it causes the aggravation of diffuse pollution and floods, water quality deterioration and soil impermeabilization, intensifying the washup phenomenon (Righetto et al., 2017).

A way to quantify the global action of the diffuse discharges is through composed sampling, denominated Event Mean Concentration (EMC). It is defined as the relation between the total mass of the transported pollutant and the total volume of drained during the event. Besides being a trustable parameter, the EMC also depends on the use and management of the soil and on the days of drought that precedes the event, but it can be used as a base for water quality analysis. (Righetto et al. 2017, Thomson et al., 1997; Novotny & Chesters, 1981).

This study intends to determine the differences between the concentration of pollutant discharges on flood and drought events into the Vicente Pires stream, aiming to reach accurate results so we can propose the better mitigation solutions in the urban drainage scope.

Methodology

Vicente Pires stream has 97km² of contribution area, comprising about 350,000 population, situated downstream of 5 neighborhoods (Pdad, 2018), including Vicente Pires and Arniqueiras where does not have drainage neither sewage system.

The samples were collected in two events: a flood, on January 2nd 2020, and during a drought period, on June 19th 2019. To collect the samples were utilized an automatic sampler ISCO 6400 and a level logger to measure the levels of river variation, and with the rating curve estimating the flows rate. The interval time between each sample during the flood event was ten minutes and there were collected twelve samples, during the drought period the interval time between each sample was one hour and there were collected twenty-four samples. Those samples were taken to the Laboratory of Environmental Sanitation from University of Brasilia, where were made analysis of organic matter, nutrients, such as nitrite, nitrate, ammonia, total phosphorus, reactive phosphorus, and sediments, as total solids, suspended solids and COD. The utilized methods for the analysis were the ones recommended by Standard Methods (APHA et al. 1998). The Event Mean Concentration (EMC) was calculated through Equation 1 (Martins, 2017).

$$EMC = \frac{\sum_i^n (Q_i \cdot C_i) \cdot \Delta t}{\sum_i^n Q_i \cdot \Delta t} = \frac{L}{R} \quad (1)$$

EMC = Event Mean Concentration

Q = flow rate (m³/s)

C = pollutant concentration (mg/L)

Δt = time interval

L - total mass of the pollutant (mg)

R = total volume drained on the event (L)

Results and discussion

In Table 1 there are the obtained results of EMC for each parameter. Besides this data, were utilized poluttograms and hydrograms, which are not on this assessment, that were built to improve the accuracy of the results and compare with the other references.

Table 1. EMC each parameter at 02/01/2020 and 06/19/2019 in Vicente Pires stream

Parameter/EMC(mg/L)	Flood	Drought
COD	341,73	22,30
Total Phosphorus	0,27	0,17
Reactive Phosphorus	0,07	0,07
Nitrite	0,03	0,02
Nitrate	2,03	5,12
Ammonia	0,42	0,31
Suspended Solids (SS)	2666,36	11,93
Dissolved Solids (SD)	350,44	86,09

The higher values of some parameters, like nitrate, in dry season comparing to rainy season, is due the phenomenon of dilution, promoted by the increase of the drained volume by the stream (Vieira, 2008). The elevated values of nitrate suggest clandestine sewage discharges (Sabará et al. 2005). The values of COD, solids and turbidity were considerable higher in the rainy season. Ammonia and total phosphorus values had a small difference between the seasons, while the reactive phosphorus remained stable.

Comparing the EMC results from the Vicente Pires stream, a urban basin in the city of Natal (Righetto et al., 2017), Botafogo stream (Salgado 2013) and a sub-basin in the city of Belo Horizonte (Vieira 2008), can be noticed a considerable increase in the COD, solids and turbidity discharges in the floody events, which indicate the washup phenomenon, important to the diffuse pollution analysis. Interpreting the hydrograms and pollutograms, were able to identify the first flush phenomenon in these parameters. In both results could be observed high levels of nutrients in water bodies that presented sewage discharges in it.

Conclusions and future work

In this work it is very notable the differences between EMC in dry and rainy season. In the dry season can be observed a considerable decrease in the values of the concentration of the parameters, except nitrate, which probably is caused because of clandestine sewage discharges are not diluted because there are not flows in high measurement. It was also noticed a stability in some parameters, such as reactive phosphorus and nitrite. Analysing the great results of COD and solids discharges, we can assume that, in rainy events, the superficial flow carries the pollutants to the water body, that becomes a great contributor to the increase of diffuse pollution, that may cause eutrophication and silting up in the final receptor that a Paranoá Lake. Utilizing the data acquired in this study, and continuing analysing the pollutants discharges in water basins, it will be possible to obtain more detailed and accurate results, in order to recommend the better mitigation solutions to reduce the impact of diffuse pollution in basins.

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