Evaluation of conductivity as surrogate water quality parameter for urban storm water studies in central Brazil

Evaluation de la conductivité comme paramètre de subbstitution de la qualité des eaux urbaines au centre du Brésil

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RÉSUMÉ

Le processus d'urbanisation affecte directement les eaux réceptrices sur les plans qualitatif et quantitatif, c'est l'environnement hydrique qui est le plus affecté par l'urbanisation, car toute activité qui modifie l'utilisation des sols dans un bassin hydrographique aura un impact direct sur les caractéristiques de qualité de l'eau. Dans cette étude, les paramètres considérés comme «faciles à mesurer», la conductivité électrique (CE) ont été évalués lors de dans trois points de surveillance (ETE Riacho Fundo, Iate et CO bassin), tous se trouvaient dans le bassin versant du Lac Paranoá, qui est le plus récent réservoir d'approvisionnement en eau de Brasilia - DF. Les résultats montrent que le comportement de la CE change pendant les inondations et souligne l'importance de paramètres faciles à mesurer car ils peuvent servir de paramètres de substitution, tels qu'ils sont évalués avec des solides et des nutriments dissous, qui peuvent fournir des résultats satisfaisants corrélation avec ces paramètres de qualité de l'eau, sans avoir à mener des expériences de laboratoire. Les résultats ont montré que les eaux usées irrégulières pourraient modifier la valeur de la CE, et ce paramètre est une corrélation plus forte dans ETE Riacho Fundo, probablement parce qu'il n'y a pas de rejets d'égout dans le système de drainage.

ABSTRACT

The urbanisation process affects directly the receiving water in qualitative and quantitative aspects, it is the water environment that is most adversely affected by changes in the existing land use in a watershed due to the direct impact of diffuse pollutants release. In this study, we evaluated a parameter considered "easy-to measure", electrical conductivity, in three monitoring points located at the downstream end of the stormwater drainage mains at Paranoá Lake watershed, planned to be the next main water supply source for the Brazilian Capital. The results show that the behavior of electric conductivity (EC) during the flood events showed acceptable correlation with dissolved solids and nutrients. The continuous measurement at the discharge points showed the possible existence of irregular sewage connections to the drainage system could change the EC value, and this parameter is greater correlation in ETE Riacho Fundo than other monitoring sites, probably because there is not evidenced sewage discharges in the drainage system. The importance of easy-to-measure parameters for stormwater quality studies, without having to carry out resource intensive laboratory experiments was evidenced, indicating that EC can be used as alert system in drainage systems where sewage should not be present.

KEYWORDS

Automatic probes, diffuse pollution, easy to measure parameter, stormwater monitoring, water quality

1 INTRODUCTION

Urbanisation changes the release and delivery of chemicals naturally produced in the watershed, resulting in increase of nutrients for some time after disturbance, because the streams usually receive a mix of chemical contaminants produced by human activities (House et al, 2013). The impacts of urbanisation on the water environment must be recognized for an effective urban resource planning and management (Setlle et al, 2007).

In Brazil the increase of the urban population represents 84% of the country's population, according to the Brazilian Institute of Geography and Statistics (IBGE, 2010). Between 2012 and 2017, the Federal District, where this study was carried out, was the state with the highest population growth in the country.

These migrations affect directly the water resources, and in the Federal District we observed a water supply crisis due to the lack of investment in water supply sources for a decade, leading to the needs of a water supply suspension once a week (Aguiar et al, 2018).

The Riacho Fundo River is a Paranoá Lake tributary and the lake reach formed by its waters, presents the worst water quality comparing with the other four reaches (Menezes, 2010), and also where most frequently algae bloom were observed (Pinto et al., 1999). The Paranoá Lake is the most recent water supply source in the Federal District and it is very important to improve the knowledge about the nutrients and sediment loads. Moreover, reliable modelling in simulating non-point source pollution, requires data. Hence, considerable effort has been dedicated to test parameters “easy-to-measure” as surrogate parameters for water quality indicators, such as pH, turbidity and electric conductivity (EC) (Miguntanna et al, 2010), to evaluate parameters such as sediments and nutrients (Kim et al, 2012).

Thus, the objective of this study is to compare the EC measurement as surrogate to water parameters such as nutrients during flood waves in three points of stormwater monitoring in Paranoá Lake watershed, Iate sub basin, CO sub basin and Riacho Fundo sub basin, all located at the downstream end of drainage galleries.

2 MONITORING STRATEGIES

Electric Conductivity probes *HACH sension 5* -200mS/cm rang were used to measure EC of samples in laboratory Nutrient concentrations (nitrogen and phosphorus) were also analyzed in more than 600 samples collected at the three monitoring stations (Figure 1). Monitoring at Iate and CO galleries were carried out in 2012 and 2013, during the rainy season, and at ETE Riacho Fundo gallery in 2017 and 2018. In all stations automatic sampler ISCO 6400 equipment were used to collect the samples each 5 minutes during the flood passage inside the drainage system.

The impact of urban discharges on waters resources need an extensive study to identify and calculate the pollution diffuse loads (House et al, 1993) and this research is being developed to understand the relation of nutrient concentration and EC in order to allow continuous monitoring of the most important drainage contribution, considering that more than 100 urban drainage galleries discharge their water directly into the Paranoa Lake.

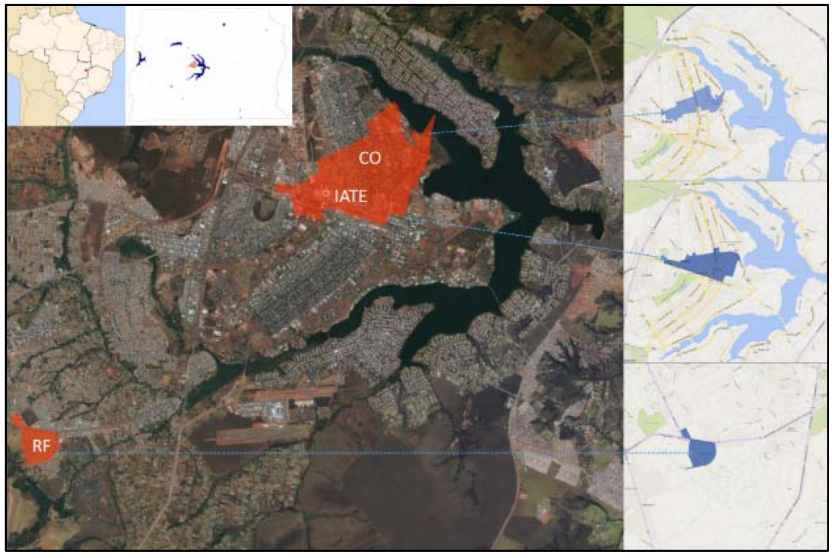

Figure 1. Study areas.

3 ELECTRIC CONDUCTIVITY (EC) RESULTS

The EC can be correlated with the nutrients and dissolved solids (DS), as it is widely demonstrated in several studies (Walton, 1989; Stevens et al, 1995; Thomson et al, 1997; Setlle et al, 2007; Miguntanna et al, 2010; Ali et al, 2012; Costa, 2013; Souza, 2014; Mitsuko, 2018, Taylor et al, 2018). However, the uncertainty in using only conductivity measurements for this purpose is high, but this parameter is a good indicator of the presence of sewage and slurry (Ali et al, 2012; Costa, 2013).

The value of EC found in the analyzed samples varied between 18 and 436 µS/cm, 18,5 and 138,7 µS/cm and 16,7 and 209 µS/cm, for ETE Riacho Fundo gallery, CO gallery and Iate gallery, respectively. The results for linear regression between conductivity and nutrients are shown in Table 1.

Table 1 – Correlation between Conductivy, Nutrients and Dissolved Solids.

Sub basin	Nutrients	Dissolved Solids
ETE Riacho Fundo	0,77	0,50
Iate	0,64	0,14
CO	0,47	0,3

At ETE Riacho Fundo gallery was found that during the rainy season the EC values decreased, after a higher value observed in November 2017, (values up to 400 µS/cm) , while in March 2018 the values ranged around 30 µS/cm. At this site, the best results for correlation among EC, nutrients and DS were found.

At Iate and CO galleries, the best correlations between EC and nutrients were found, while correlation with DS was smaller. One of the possible reason could be the method used to analyses the DS (gravimetric method). Another reason was that in these galleries irregular sewage discharge were detected, which change significantly the EC value ranges. In CO and Iate result evaluation, strong correlation between EC and nutrients were found for low flows. The worst results happened when the number of dry antecedent days were higher than 7 days.

Miguntanna et al (2010) found the good correlation between EC with dissolved solids in the water. Souza (2014) simulated the EC in SWMM model in an Iate sub basin in Brasilia she also obtained good results for R^2 and NSE for the events analyzed. For these reason, studies about the conductivity are important to correlate EC with some water quality parameter, because the easy to measure parameter can be easily purchased.

4 CONCLUSION AND RECOMMENDATIONS

Results show that the behavior of EC varies following nutrient concentration during the flood events and it highlights the importance of easy-to-measure parameters to be used as surrogate parameters in evaluation of dissolved solids and nutrients. This kind of measurement can enhance the generation of urban stormwater quality databased on on-site measurements for define monitoring strategies and modeling approach.

The results showed that sewage presence can strongly change the EC values, and only in the ETE Riacho Fundo gallery no evidence of sewage discharges in the drainage system were found.

In future work, more statistics evaluation will be investigate, such as principal component analysis (PCA) of parameters and the correlation matrix should be study in order to show the relationship of conductivity and water parameters with illegal sewage dumping in these galleries.

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