# Evaluation of urban drainage and stormwater management in the development of the Assentamento 26 de Setembro in Brazil's Federal District

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## Highlights

- Urbanization and its effects on water resources.
- Application of SWMM for the simulation of environmental impacts and the interface with urban planning.

## Introduction

The irregular change of land use in agricultural areas causes urban and environmental consequences in Brazil's Federal District region (Fileni et al., 2019). In Vicente Pires, one of the Federal District administrative regions, rural farms were allotted and converted into urban areas, with low population density, a high degree of soil imperviousness and recurrent flooding problems. The present study evaluated the hydrological impacts of the irregular occupation of the Assentamento 26 de Setembro, located near Vicente Pires, in different scenarios, detecting the evaluation of land use and occupation based on the development of the Vicente Pires area and using the USEPA Storm Water Management Model (SWMM) implemented on Personal Computer Storm Water Management Model (PCSWMM).

## Methodology

Surface runoff in the Assentamento 26 de Setembro was evaluated under 3 scenarios: C1, of current occupation; C2, of consolidated occupation and equivalent land use to that established in the Master Plan of Territorial Planning of the Federal District (Federal, 2009); C3, characterized by stablished urbanization with characteristics similar to those observed in Vicente Pires.

Supervised classification was performed in the QGIS program using multispectral bands from the 2020 LANDSAT 8 satellite, with a spatial resolution of 30 meters. The classification of CN for each class was done according to the values proposed by Tucci (2001). For the formulation of the future occupation pattern of the study area, a section of the urban area of Vicente Pires was used.

Assentamento 26 de Setembro does not have stormwater drainage networks. Preliminary tracing was carried out to compare the occupation scenarios of the study area following the guidelines of Novacap's Term of Reference (NOVACAP, 2019). The pre-dimensioning of the network was carried out in order to accommodate the flows generated by Scenario C3.

The same network was used for the other scenarios for the purpose of comparing. The networks were subdivided into 8 subcatchments with their own outfall.

The design rainfall was determined using the intensity-duration-frequency curve (IDF) of Brasilia, presented in presented in the Urban Drainage Master Plan (Federal, 2009), with a duration of 24 hours and a return time of 10 years. The hietogram was obtained using the alternating block method, with blocks discretized at 5-minute intervals.

Housing lots similar to those found in Vicente Pires were delimited, based on the road design and occupation already observed in the region. Admitting that each condominium system presents

convergence of stormwater runoff, the limits of the lots were considered coincident with the limits of the urban subcatchments.

## Results and discussion

The percentage of areas observed in the land use study for each class in scenarios C1 and C3 was obtained. A high value was recorded for the exposed soil class in C1. There was small variation in the low urbanization class and a large increase in the high urbanization percentage, as well as a decrease in vegetation from C1 to C3. The variations point to a tendency of highly impermeable occupation of the available areas. By crossing information of soil type and land use in C1 and C3, it was possible to define the curve-number (CN) parameter. For the study of C2 an average CN of 55 was applied for all urban subcatchments, equivalent to cultivated areas with soil conservation and pastures in good conditions (TUCCI, 2001), land use indicated in Master Plan of Territorial Planning (DF, 2009).

In C1, the maximum flow values obtained exceeded, in 6 of the 8 points of discharge, the maximum value allowed of flow by the Adasa resolution (ADASA, 2011), which regulates stormwater discharges in the Federal District. The values obtained for C2 were below the limit established by the regulatory agency. The result indicates that the occupation originally planned for the area would present acceptable additional runoff.

Comparing C1 and C2, it is evident the distance that the region already presents in the impermeabilization process and increase of runoff pattern in relation to what was proposed by the Master Plan of Territorial Planning. It was verified that, for C1, at some of the points of discharge, the runoff flow already presents an excess close to that obtained in C3.

For all outfalls, C3 presented flows that exceed the limits established by Adasa (2011), with effluent flow up to approximately five times higher than that set by the regulatory agency. One C1 outflow had a maximum value that exceeded the indicated flow by 4.5 times, which confirms the high potential for increasing flows when considering the situation of occupation with high soil imperviousness.

Table 1 shows the maximum values reached at the outlets for the different scenarios and the maximum flow rate admitted by Adasa (2011). It is important to note that the values were obtained by modeling without calibration. The performance of all the drainage subsystems presents the same trend. Thus, only hydrographs of the different scenarios for the outflow OF1 are shown in Figure 1, while the other results are presented in tabular form in Table 1.

**Table 1.** Maximum flows of the proposed subsystems ($m^3/s$).

| | OF1 | OF2 | OF3 | OF4 | OF5 | OF6 | OF7 | OF8 |
|---|---|---|---|---|---|---|---|---|
| C1 | 3.82 | 2.07 | 7.49 | 11.06 | 1.93 | 0.51 | 6.03 | 4.78 |
| C2 | 1.01 | 0.30 | 1.51 | 2.07 | 0.79 | 0.48 | 1.77 | 2.26 |
| C3 | 11.04 | 3.02 | 13.82 | 21.45 | 6.68 | 4.39 | 15.97 | 24.32 |
| Q regulated | 2.50 | 0.95 | 4.15 | 4.68 | 2.01 | 1.20 | 4.08 | 4.86 |

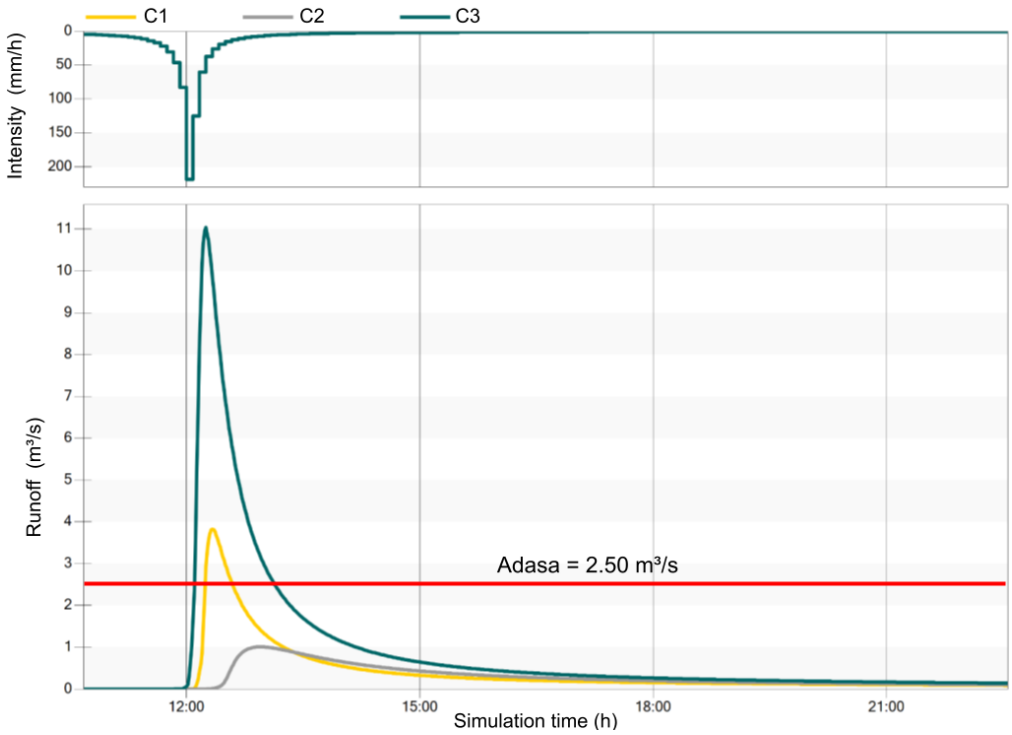


**Figure 1.** Hydrographs of the outflow OF1.

## Conclusions and future work

The study analyzed the characteristics of the runoff surplus produced in the area for a 10-year return period rainfall generated from the IDF curve of Brasilia. It was possible to verify the tendency of the increase in flows for the proposed scenarios. The comparison of scenarios C1 and C2 makes explicit the difference that the study area already presents with respect to the foreseen use. The comparison between C1 and C3 shows that the effects of imperviousness are accentuated in the study area and may reach even higher levels in a short timeframe. The study shows that there is a need to anticipate the irregular occupation, either by restricting the parcelling of the small farms or by projecting the occupation in an organized way according to a sustainable urban plan with attention to basic sanitation infrastructure. Based on this study, it is suggested that future studies verify the effect of distributed compensatory measures and low-impact solutions in order to enhance infiltration and reduce the flood peaks.

## References

ADASA. Resolução no 9, de 8 de abril de 2011. Agência Reguladora de Águas, Energia e Saneamento Básico do Distrito Federal, 2011.

Costa, Maria Elisa Leite, et al. Modelagem hidrológica e hidráulica usando o SWMM - Storm Water Management Model na bacia urbana do Riacho Fundo I - Distrito Federal. Research, Society and Development, vol. 10, no 1, janeiro de 2021, p. e6010111458. DOI.org (Crossref), https://doi.org/10.33448/rsd-v10i1.11458.

Federal, Distrito. Plano Diretor de Ordenamento Territorial do Distrito Federal (PDOT) – Lei Complementar Nº 803, 25 de abril de 2009. 2009.

Federal, Distrito. Plano diretor de drenagem urbana (PDDU-DF). Secretaria de Obras do Distrito Federal, 2009.

Fileni, Felipe de Mendonça, et al. The application of LIDs in Savanna region for mitigation of flooded areas. RBRH, vol. 24, 2019, p. e40. DOI.org (Crossref), https://doi.org/10.1590/2318-0331.241920180177.

NOVACAP. Termo de Referência e Especificações para Elaboração de Projetos de Sistema de Drenagem Pluvial no Distrito Federal. Brasília, DF, 2019

Tucci, C. E. M. Hidrologia: Ciência e Aplicação. 2. ed. Porto Alegre: Associação Brasileira de Recursos Hídricos - ABRH, 2001. ISBN 8570252986.