Mike Urban+ modeling to support urban drainage management at Meio river watershed, Florianópolis-SC

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Highlights

- The Mike Urban+ is a promising tool to support urban drainage management and planning.
- Calibration procedure is necessary to adjust the simulated to the observed hydrogram.
- Time-area method can be used while infiltration parameters are scarce.

Introduction

The urban sprawl and people concentration associated with climate change effects tends to augment the challenges of water resources management, in urban drainage systems it can increase flood risk according to the increase of flood vulnerability (Kourtis and Tsihrintzis, 2021).
Since 1980s many approaches to reach an integrated urban water management system have been developed and applied around the world, e.g., Best Management Practices and Low Impact Development in the United States; Water Sensitive Urban Design in Australia; Compensatory techniques in French (Fletcher et al. 2014).
In view of these challenges, the modeling is an important tool for planning, designing and evaluating different mitigation devices scenarios. Models 1D hydrodynamic such as SWMM, InfoWorks and Mike Urban are already used for planning purposes, focused in investigate the impacts of system alterations and the frequency of flooding occurrences (Lund et al, 2019).
The Meio river watershed, located at Florianópolis-SC, is part of the Itacorubi basin where the outfall is located in the Itacorubi mangrove, a very sensitive environment (Souza et al. 2018). The Meio river has been extensively studied since the 2000s mainly because it comprises one of the Federal University of Santa Catarina (UFSC) campus where floods and low water quality indexes are frequently observed (Tasca et al. 2019 and Mulungo, 2012). Studies highlight that the problems are the effect of disorderly urban growth added to underestimated and poor maintenance of urban drainage networks (Laurenti et al. 2018). Such problems are likely to become more frequent in face of the effects of climate changes.
The main objective of this study is to model the Meio river watershed, using the Mike Urban+ model to generate the runoff seeking for some predictions about the floods and, after calibration and verification, to simulate sustainable devices scenarios.

Methodology

The Meio river watershed cover an area of 448.89 ha, where approximately 18.85% is occupied by impervious areas (Figura 1). The network system time of concentration is 18.9 min and the average slope is 0.05 m/m. The impervious areas were obtained from buildings and roads provided by Florianópolis Municipality (Laburb, 2012) and updated from Open Street Map and Google Satellite images.
The network system was provided by Florianópolis Municipality, georeferred and provided by Caprario (personal communication, 10th May 2021), however the data only presented 2961.482m of pipes and channels, Therefore, it was necessary to collect data in the field to get more information about the urban drainage network.

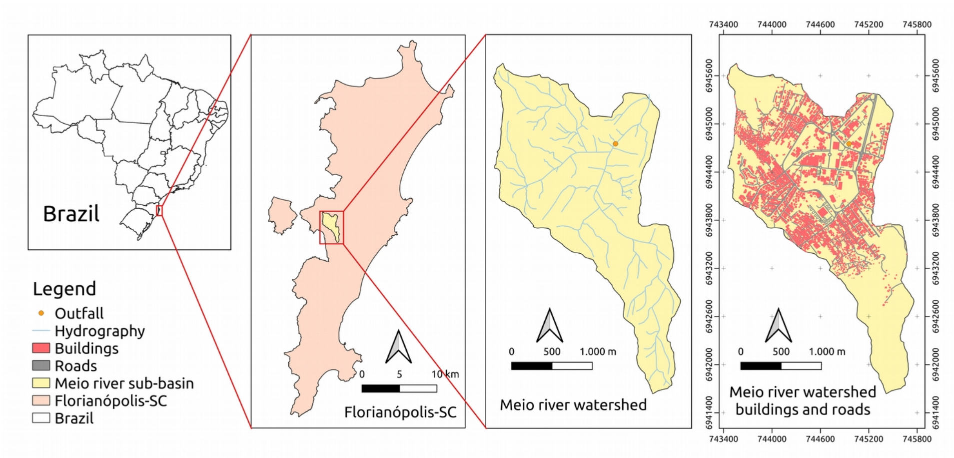

Figure 1. Meio river watershed hydrography and land occupation, in the Florianópolis and Brazil context.

The simulations were carried out using the rainfall registered by the rain gauge located at UFSC Campus and the water level was collected from the monitoring station located at "outfall" showed at Figure 1. Due to the data scarcity (very common in Brazil) mainly about infiltration parameters, the time-area method was chosen as rainfall-runoff routine. The simulated watershed was modified to coincide the "outfall" monitoring station with the watershed outfall. The studied area was divided into 361 catchments by Thiessen decomposition, and the impervious percentage was attributed to each catchment.

Results and discussion

The impervious area percentage attributed to each sub-catchment are shown in Figure 2(a), where also is possible to see the network system used in the modeling, the pipes and channels length summed 24060.45 m (Figure 2(b)). The simulation with Mike Urban+ was performed for rainfall occurred in 1st January 2018, the comparison between the flows observed and simulated also are shown in Figure 2(c).

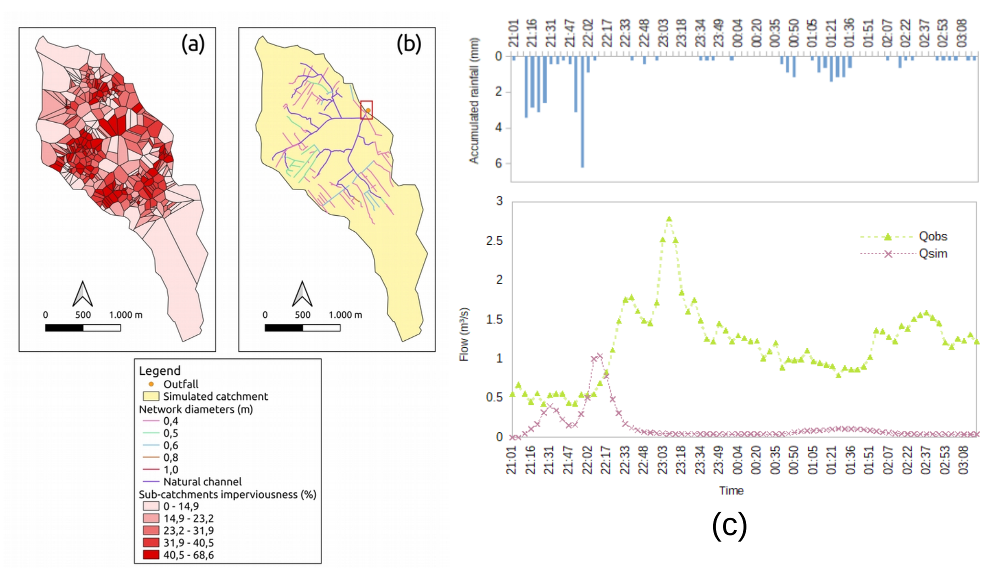

Figure 2. (a) The sub-catchments imperviousness percentages, obtained from buildings and traffic zones polygons; (b) The simulated catchment and the pipes and channels diameter; (c) The observed (Qobs) and the simulated (Qsim) hydrograms for 1st Jan 2018 precipitation event.

The maximum flow observed was 2.782 m^3/s at 11:08 PM, while the maximum simulated was 1.038 at 10:12 PM, as can be seen in Figure 2 (c) the flow simulated was underestimated although, is important to highlight that the model are not calibrated yet and it is expected that the simulated hydrograms come closer to the observed.

Conclusions and future work

The results can be improved with calibration and verifying process and for future works, the infiltration parameters should be surveyed to simulate using kinematic wave model. The Mike Urban+ model is a good tool to simulate the urban stormwater with many tools to make the modeling process easier and faster. The modules which allows devices such as LIDs, is an useful tool for urban stormwater planning and management.

Acknowledgement

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