THE NEW SCHOOL
URBAN SYSTEMS LAB

ENVIRONMENTAL JUSTICE OF URBAN FLOOD RISK AND GREEN INFRASTRUCTURE SOLUTIONS

METHODOLOGICAL CONSIDERATIONS AND MODELING ASSUMPTIONS

Introduction

The Urban Systems Lab's research project, "Environmental Justice of urban flood risk and green infrastructure solutions" has two primary goals. The first aims to understand the distributional justice of flood risk by researching who is more exposed? Second, the project also aims to analyze and reflect on the distributional justice of the benefits provided by green infrastructure, hence asking who benefits? In order to answer these questions, the Lab's research team developed maps of urban flood risk using a modeling approach. By modeling flood risk, we have been able to identify the areas that are likely to be exposed to flooding in four case study cities including Syracuse, NY, Yonkers, NY, Milauwakee, WI, and Elizabeth, NJ. In several of the cities researched, the preliminary results reveal disproportionate flood risk affecting low-income and minority communities.

However, despite these results, it is important to keep in mind the limitations of our methods. As a simplification of a complex reality, models rely on assumptions that make it feasible to simulate the processes studied. In our case, some of the assumptions and limitations of our approach are temporary choices that we aim to improve in the future. Other assumptions, such as the storms simulated, constitute decisions that could be adapted to new needs in the future. Some limitations and assumptions, on the other hand, are unavoidable decisions that need to be acknowledged in order to have a clear understanding of what the model represents, and what it does not. For example, the resolution of the simulation is limited by the availability of topographic data developed by a third party (in this case, the U.S. Geological Survey).

An awareness of the uncertainties of any modeling process is critical to ensure the public does not draw inaccurate conclusions that would undermine the core objective of supporting local planning to adapt to climate change. In the sections below, we identify the main assumptions and limitations of our methodology. By doing this, we aim to remain transparent about the reach of our work, as well as to detail plans to improve our approach in future research efforts.

Modeling tool used: CityCAT

CityCAT is a fully hydrodynamic flood risk modeling tool that simulates the circulation of water in real time using the full shallow water equations. The model considers the effect of buildings in rerouting surface runoff and infiltration in pervious areas, making it especially suitable for urban environments. In addition, the model requires a very simple set of inputs, which are usually publicly available and require little processing.

CityCAT was provided by Vassilis Glenis, the model's developer and a researcher at Newcastle University. Vassilis Glenis also provided guidance in the setting up and troubleshooting of our simulations.

Drainage networks

The modeling of the project has so far not included the drainage and sewer networks of the cities studied. The reasons for this are data availability, computational costs, and the time needed to set up the infrastructure in the model. By not accounting for the drainage infrastructure, our modeling methods are likely to overestimate flood risk in areas that are supported by a dense network of stormwater inlets. More importantly, overlooking the role of drainage systems may mask the injustices linked to a maldistributed infrastructure that fails to perform properly in low income and minority communities. Because of this, our work should not be seen as a substitute for more technically detailed studies, nor be used to inform individual decisions such as the purchase of flood insurance.

Future iterations of this work aim to include the effect of drainage networks in moderating flood risk by incorporating missing data or the results of other studies.

Storms modelled

In every case study city, we have so far simulated two storms with a duration of one hour (10 and 100 years return periods). The storms were generated using data provided by NOAA Atlas 14, and are considered to be spatially homogeneous.

While each storm is 1 hour long, the simulations were run for 2 hours in order to allow for surface runoff to circulate through the system once the precipitation has stopped. This allows for the model to account for high flood depths that may be caused by the accumulation of water in bottlenecks such as creeks and narrow streets in lower lying areas. In large cities like Milwaukee, even longer simulations will be considered in the future to ensure that the concentration times of surface runoff are considered.

Spatial resolution of the simulations

The default resolution of the simulations was 2x2m (~6x6 ft). In Milwaukee, however, computational needs required us to reduce the resolution to 10x10m (~30x30 ft). Because of this, buildings were not taken into consideration in the city of Milwaukee because their inclusion in the model requires a higher resolution.

Soil textures

In order to capture the role of different soils in encouraging or limiting water infiltration, we included soil texture data provided by the US Department of Agriculture's SSURGO (Soil Survey Geographic database). Because this consideration was added at an intermediate stage of the project, not all the cities consider differential soil textures across space. A city factsheet developed for the project provides details about the soil texture considerations of each city.

Surface roughness

Surface roughness plays an important role on the velocity of surface runoff. The project's simulations considered constant roughness for all the impervious surfaces, and a higher constant roughness coefficient for pervious surfaces. Future iterations of this work aims to incorporate different roughness parameters for different land cover categories.

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