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December 6, 2022
GISFQ22
Final Project

Site Scale Green Infrastructure in Cook County

Background:

As climate change progresses, the Chicago area and the Midwest in general will experience heavier precipitation in the winter and spring months, leading in higher risks of flooding (US EPA & City of Chicago, n.d.). Stormwater runoff carries chemical, biological, and physical pollutants into waterways and can damage property and infrastructure (US EPA, 2015). In urban areas, widespread impervious surfaces increase surface runoff, leading to increased flood risk (Water Science School, 2018). Additionally, in Chicago, the flow of surface runoff into the combined sewer system increases the likelihood of combined sewer overflows, sending untreated sewage into local waterways (Friends of the Chicago River, n.d.). The development of the Tunnel and Reservoir Plan reduced the volume of combined sewer overflows; however, heavy rains still increase the volume of water that needs to be treated by wastewater treatment facilities (Friends of the Chicago River, n.d.).

In response to climate change, the Chicago Metropolitan Agency for Planning (CMAP) has developed an "On to 2050" plan to improve community, prosperity, environment, governance, and mobility (CMAP, n.d.a). Part of the environment plan includes the expansion of green infrastructure to reduce urban flooding (CMAP, 2018). According to the Water Infrastructure Improvement Act (2019), green infrastructure is "the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters". On the neighborhood and landscape scale, the Green Infrastructure Vision (GIV), representing the Chicago Wilderness Biodiversity Recovery Plan works to create and manage a network of green infrastructure to support biodiversity and allow for flood protection (Chicago Wilderness, n.d.).

My final project looks to identify areas where specific types of site scale green infrastructure could be implemented to reduce urban flooding. The final form of my project is a presentation walking through the general process of visualizing the current state of neighborhood and landscape scale green infrastructure, comparing that to urban flood risk, and identifying where certain types of site scale green infrastructure could be implemented in high flood risk areas.

I selected green parking and green roofs as the types of site scale green infrastructure to implement because existing land and buildings can be reasonably retrofitted to include these. Since parking lots are often designed for peak usage during peak seasons, they have many unused spots, which can be used for bioretention rain gardens (NPDES, 2021b; NPDES, 2021a). Additionally, green roofs do not require extra land because they can be installed on commercial, multifamily residential, industrial buildings (NPDES, 2021c). Furthermore, as the size of green roofs increase, the cost of installation decreases, so larger roofs are more ideal (City of Chicago, n.d.). I also included new developments in this project because implementing green infrastructure during development benefits the development and surrounding areas without needing to retrofit after the development is complete.

Methods:

To visualize the current state of neighborhood and landscape scale green infrastructure, I used the protected lands and ecological networks datasets from the GIV. I excluded streams because I wanted to focus on reducing overland flow, not focus on stream flow. I merged the two data layers together and clipped it to a data layer of Cook County Municipalities. To calculate the percentage of each municipality with protected lands or ecological networks, I used overlap analysis and visualized the percentage with a graduated symbology.

To identify areas with high, moderate, and low risk of flooding, I used the Flood Susceptibility Index (FSI) data layer from CMAP. The FSI classifies risk based on whether there is a poor stormwater

management system, combined sewer overflow, high stormwater runoff, high impervious cover, or a low-lying depression (CMAP, n.d.b). I reclassified the raster data from a 1 -10 index into low, moderate, and high categories following 1-3, 4-7, and 8-10, respectively. I then used zonal statistics to calculate the majority classification per municipality and categorized the symbology by majority. This allowed me to identify municipalities as mostly low, moderate, or high risk.

To identify specific sites for implementing green parking, green roofs, and green infrastructure in new developments, I used the land use data from CMAP as well as the Parking Lot & Garage Operation Tax data layer. For parking lots, I initially exported parcels with parking sites*, but realized there were likely other sites that were not included in this dataset. So, I added the Parking Lot & Garage Operation Tax data layer, which was a point layer. To make sure I was not double-counting parking lots, I created a 15-meter buffer around the parcels. I selected the Parking Lot & Garage Operation Tax data layer by location and inverted the selection to create a layer that identified stand-alone parking lots and garages. I then converted the parking parcels to centroids and merged these two data layers. For green roofs, I identified commercial, multifamily residential, industrial parcels*. Since some of these parcels were very small, I filtered out parcels that were smaller than 1015 square meters, which is the average size of current green roofs in Chicago (City of Chicago, n.d.). For new developments, I identified vacant and under construction parcels and exported these as their own layer.

*For specific land use codes, see Appendix.

Conclusions:

In comparing the urban flood risk to the percentage protected lands and ecological networks, it became clear that these two are inversely related, as municipalities with high flood risk closely map onto municipalities with a low percentage of protected lands and ecological networks, and vice versa. Without this larger scale green infrastructure, site scale infrastructure is needed to mitigate flood risk, as it is not feasible to expand protected lands and ecological networks in dense urban settings.

Opportunities to implement green infrastructure are widespread throughout Cook County, but certain types may be more successful in certain areas. Green parking could be successful throughout Chicago and along the western portion of high flood risk municipalities. However, although there is a high density of potential green parking opportunities in downtown Chicago, further analysis of parking availability is needed to determine whether green parking it truly feasible at individual sites to prevent poor parking availability. Furthermore, green roofs are widely distributed and can be implemented in highly dense urban areas without requiring any extra land. The western portion of high flood risk municipalities have a substantial green roof opportunity with many large parcels available for implementing green roofs. Finally, new developments that could implement green infrastructure are widely distributed, however, they are much more prevalent in the southern portion of Cook County. Thus, northern areas of Cook County will have to rely more on retrofitting green infrastructure into individual sites rather than developing with green infrastructure in mind.

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Appendix:

Land Use Codes for Green Parking (CMAP, 2020b):

- 1540 Independent Automobile Parking
- 1250 Hotel/Motel
- 1520 Other Linear Transportation with Associated Facilities

Land Use Codes for Green Roofs (CMAP, 2020b):

- 1130 Multi-Family
- 1211 Shopping Malls
- 1212 Regional & Community Retail Centers
- 1214 Single Large-Site Retail
- 1215 Urban Mix
- 1216 Urban Mix w/Residential Component
- 1220 Office
- 1240 Cultural/Entertainment
- 1250 Hotel/Motel
- 1310 Medical Facilities
- 1321 K-12 Educational Facilities
- 1322 Post-Secondary Educational Facilities
- 1340 Prison and Correctional Facilities
- 1370 Other Institutional
- 1420 General Industrial < 100,000 sq. ft.
- 1431 Manufacturing/Processing
- 1432 Warehousing/Distribution
- 1433 Flex or Indeterminate
- 1450 Storage