Mitigating Flood Risk with Strategic Tree Planting in Long Beach, California

Samantha Duzy

PPD 631

Spring 2024

Introduction

Long Beach, California, is a city situated 20 miles south of Los Angeles with a population of approximately 492,000 (California State University Long Beach, 2023). The city is located on a flood plain between the Los Angeles and San Gabriel rivers, which used to flow freely, forming wetlands along their routes and changing in size and course based on floods. (Historical Society of Long Beach, 2024). The two rivers are now channelized with manmade concrete banks. The city's proximity to the ocean and its location between the draining points of both the Los Angeles and San Gabriel rivers makes it highly susceptible to flooding. Urban development has greatly decreased soil permeability with pavement coverage, "constraining natural infiltration and evapotranspiration and converting rainfall into runoff" (Qin, 2020). 35% of properties in Long Beach are at risk of flooding, as compared to 20.6% of properties nationwide (RiskFactor, n.d.). As the climate changes, the city is "expected to be subject to sea level rise increases between 0.5 and 1.0 feet by 2050, which will likely increase coastal flood elevations" (FEMA, n.d.). Long Beach will need to prepare for this increased risk, and strategic tree planting could play a large role in this preparation.

Tree Planting

The complex and multifaceted nature of flood risk mitigation has led to a newfound appreciation for "soft" engineering techniques such as increasing green cover (Carrick et. al, 2018). Studies have shown that trees can reduce up to 60% of stormwater runoff by intercepting rainfall with their canopies, storing water in their trunks, and improving soil permeability with their root systems (Quin, 2020). Tree planting is an aspect of "natural flood management" (Chappell et. al, 2017) that, when used in combination with other interventions, could significantly reduce the impact of flooding on Long Beach communities.

The City of Long Beach Office of Climate Action and Sustainability offers a free tree planting program to city residents, aiming to prioritize assisting SB-535 Disadvantaged Communities by planting trees in city parkways. SB-535 Disadvantaged Communities are those most heavily impacted by climate change, and have been designated to receive funding from the Greenhouse Gas Reduction Fund for local projects designed to promote clean air and sustainable energy use (Magavern et. al, n.d.). This analysis will aim to identify high-priority areas for tree plantings based on the alignment of elevation, flood risk, and community need.

Data Sources

ArcGIS is an appropriate tool to analyze this issue because it will scope the various neighborhoods of Long Beach through different perspectives: elevation, vacant tree sites, flood risk, and SB-535 Disadvantaged Community designation.

I used seven different layers for this project, outlined below.

Source	Data	Summary
City of Long Beach	LBTrees2018 feature layer	ZIP file containing all information regarding all tree sites, both filled and vacant, in the city
City of Long Beach	Elevation raster	Raster dataset demonstrating the elevation contours of Long Beach
Federal Emergency Management Agency (FEMA)	National Flood Hazard Layer	Geospatial database that contains current flood hazard data
MapsLB	City Boundary Feature Layer	City of Long Beach unofficial city boundary layer
MapsLB	Neighborhoods Feature Layer	Geographically localized communities within the city
MapsLB	Waterways Feature Layer	All waterways in the city

California Office of Environmental Health Hazard Assessment	SB 535 Disadvantaged Communities 2022 Feature Layer	Delineates disadvantaged communities as identified by Senate Bill 535

Analysis

Using the City Boundary and Neighborhood layers from Maps LB, in combination with the SB 535 Disadvantaged Communities 2022 feature layer, I first identified the neighborhoods and disadvantaged communities in Long Beach (Figure 1). This allowed me to scope the rest of the data, and confine other layers to within the Disadvantaged Communities using Pairwise Clip. However, the Pairwise Clip was not available for the Elevation layer as it was raster data. I only wanted to focus on Disadvantaged Communities, as they are prioritized for environmental projects by the city.

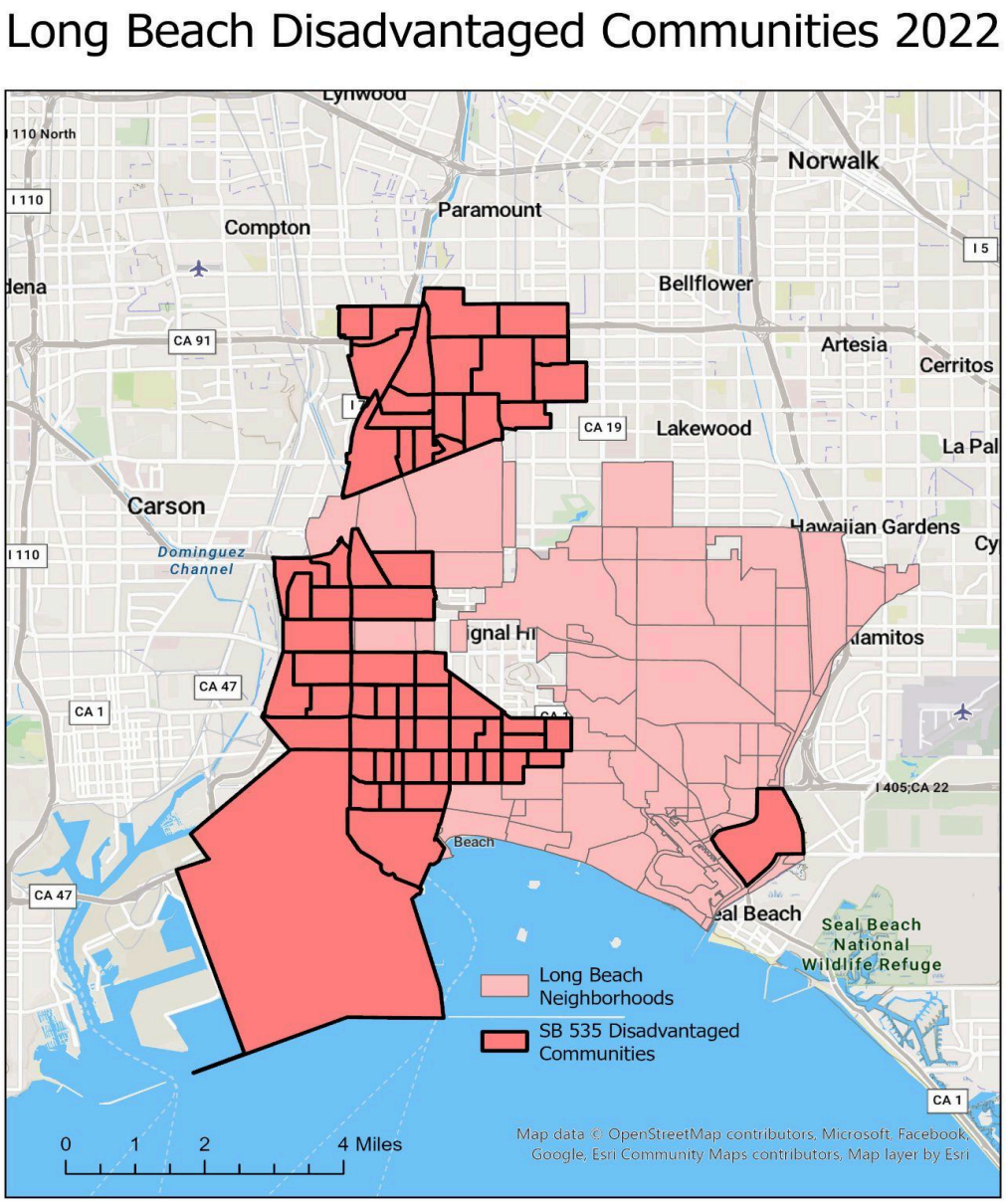
Long Beach Disadvantaged Communities 2022
Lynwood
I 110 North
I 110
Compton
Paramount
Norwalk
I 5
Bellflower
CA 91
Artesia
Cerritos
CA 19
Lakewood
La Pal
Carson
Dominguez Channel
Hawaiian Gardens
I 110
CA 47
CA 1
I 405;CA 22
Beach
CA 47
Seal Beach National Wildlife Refuge
Long Beach Neighborhoods
SB 535 Disadvantaged Communities
CA 1
0 1 2 4 Miles
Map data © OpenStreetMap contributors, Microsoft, Facebook, Google, Esri Community Maps contributors, Map layer by Esri

Figure 1

Next, I used the Waterways layer from MapsLB, the Disadvantaged Communities layer, and the Elevation raster layer from the County of Los Angeles to identify the areas of the city with higher elevation (Figure 2). Then, I added the National Flood Hazard layer from FEMA, to identify areas with a higher flood risk (Figure 3). Strategically planting trees in the light blue, green, or red-colored areas will help to retain rainwater before it can reach the lower-elevation areas. I have circled in red the areas highest in elevation, where storm runoff will likely move towards an area with high flood risk. These circled areas are potential zones to prioritize tree planting (Figure 3).

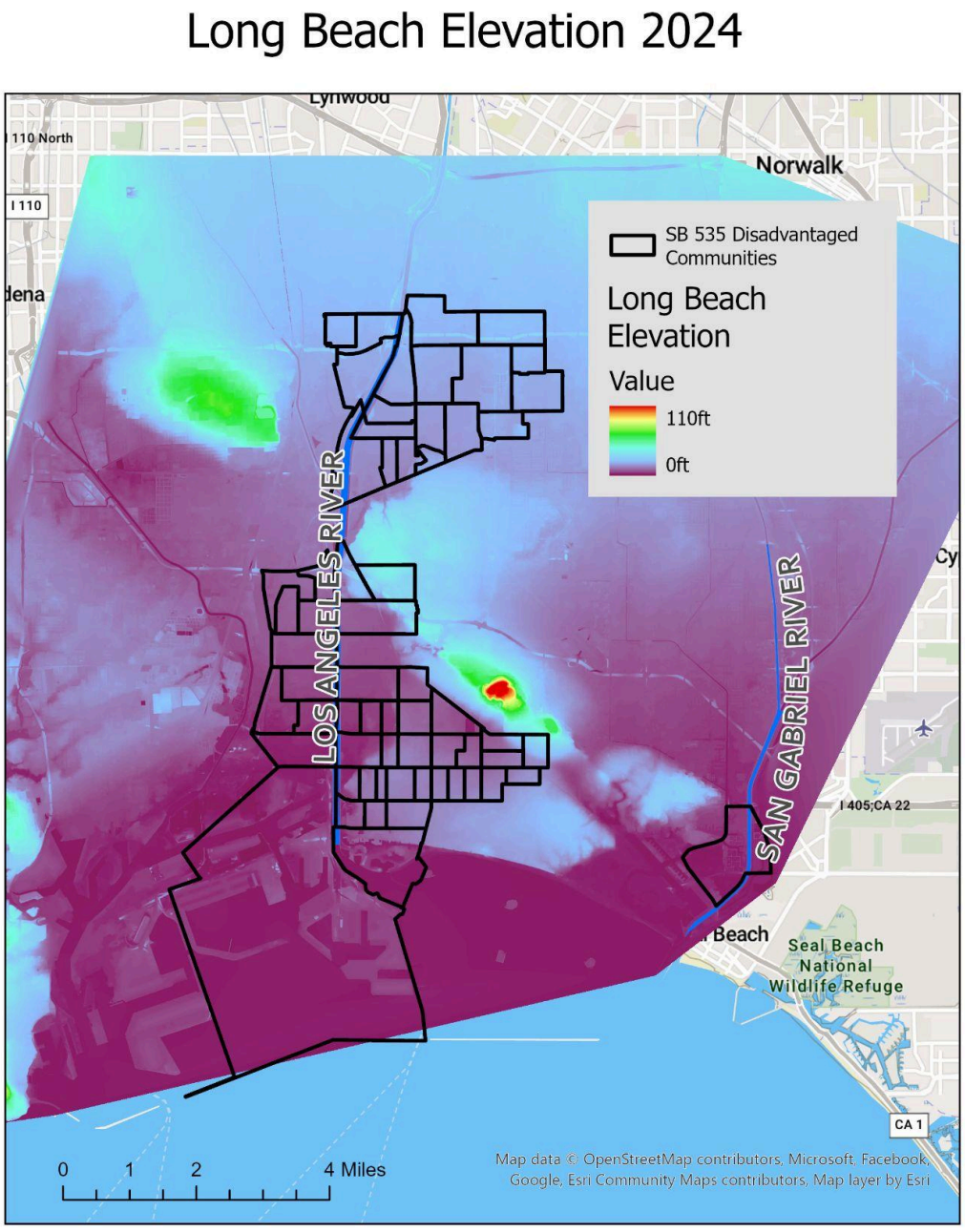
Long Beach Elevation 2024
Lynwood
110 North
I 110
Norwalk
SB 535 Disadvantaged Communities
Long Beach Elevation
Value
110ft
0ft
LOS ANGELES RIVER
SAN GABRIEL RIVER
I 405;CA 22
Seal Beach National Wildlife Refuge
CA 1
0 1 2 4 Miles
Map data © OpenStreetMap contributors, Microsoft, Facebook, Google, Esri Community Maps contributors, Map layer by Esri

Figure 2

Elevation and Flood Risk in Long Beach, 2022

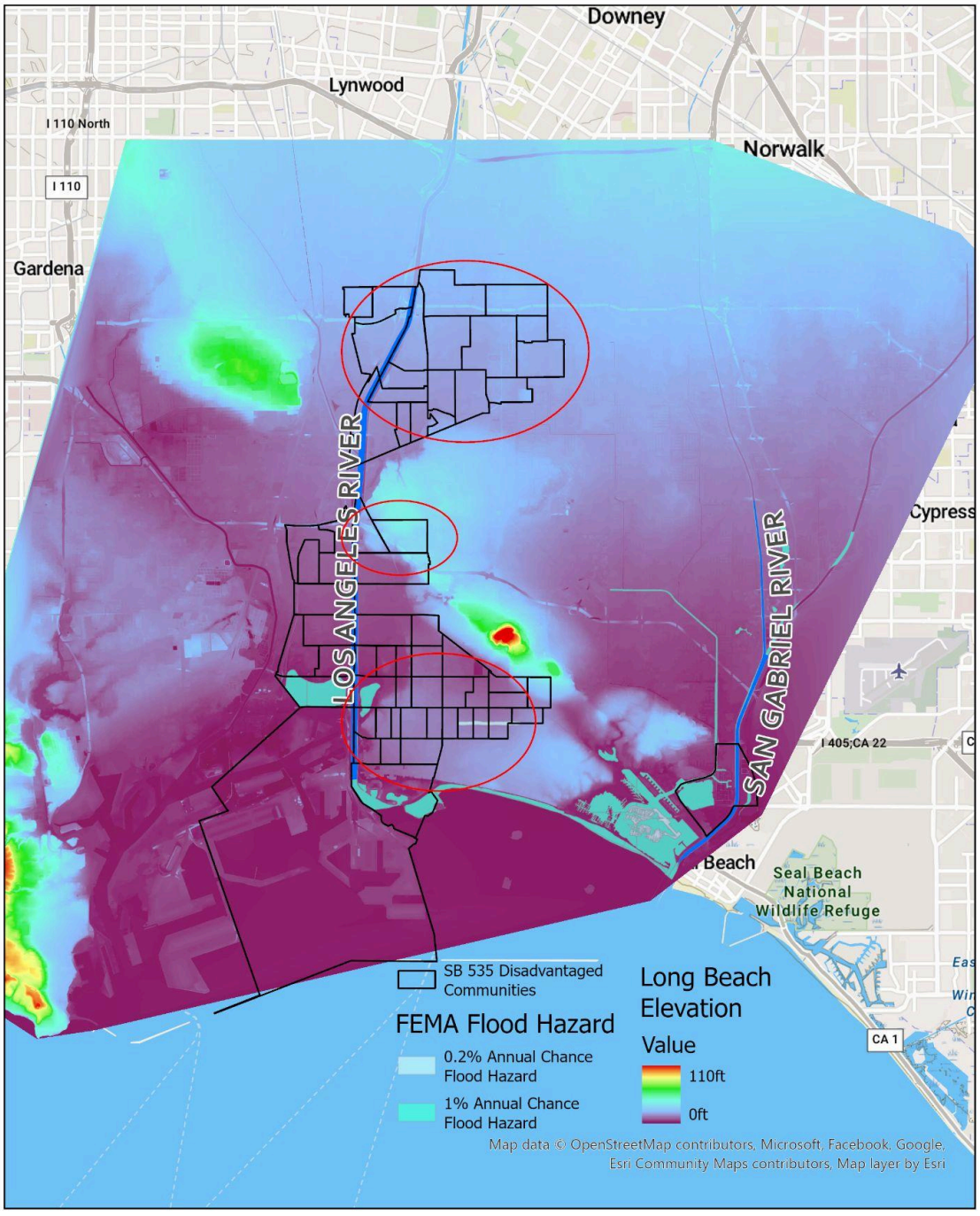

Figure 3

Finally, I downloaded Long Beach's 2018 data on all trees throughout the city. This data included all vacant tree sites. To get an idea of where the most opportunity for tree planting in the city is, I filtered the data to only mark vacant tree sites with a parkway width of 5 feet or more, as these parkways can fit the largest trees that will offer the most benefit. Then, I conducted a Hotspot Analysis to determine the locations of the highest concentrations of vacant tree sites throughout Disadvantaged Communities (Figure 4).

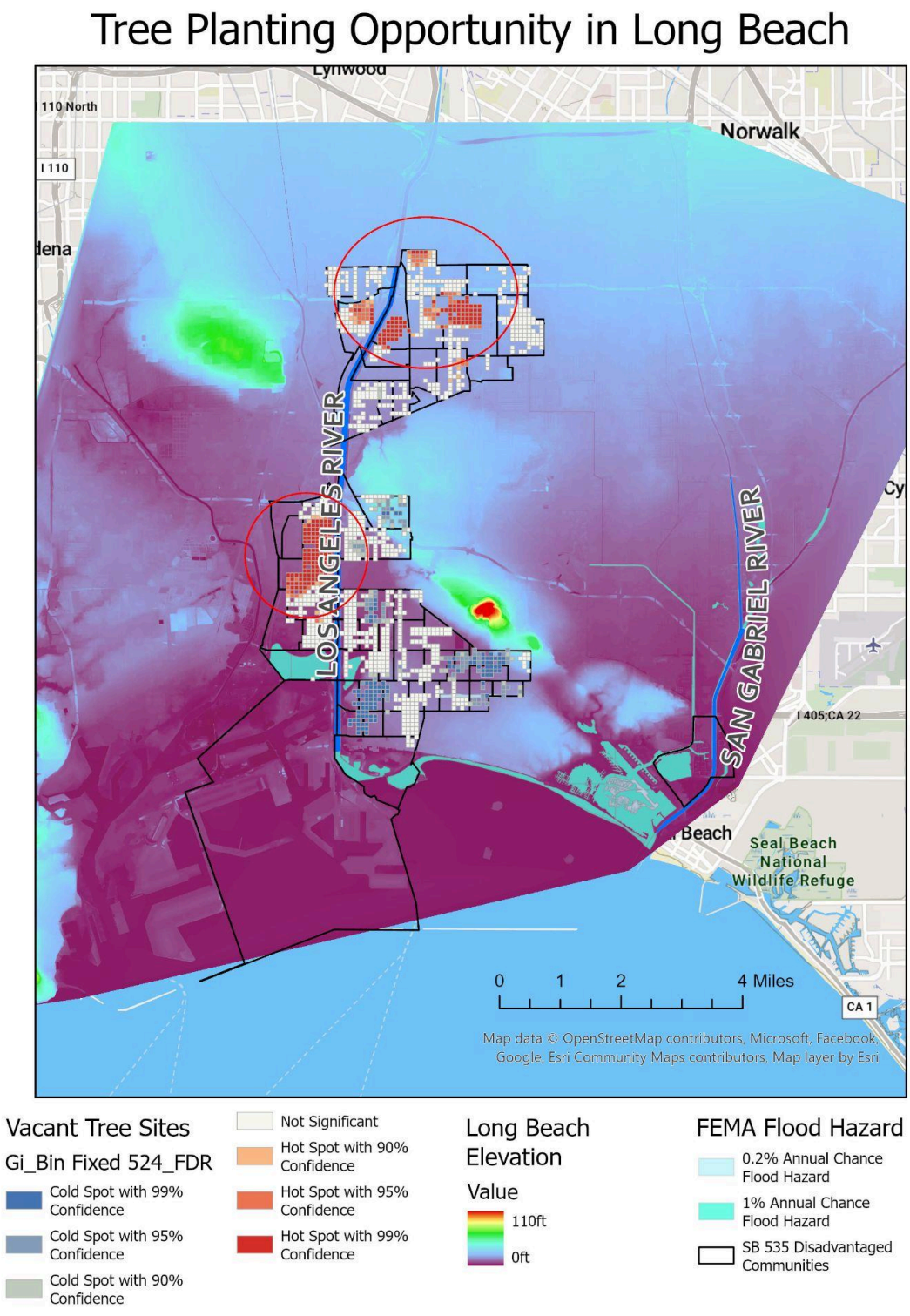
Tree Planting Opportunity in Long Beach
Lynwood
110 North
I 110
Norwalk
dena
LOS ANGELES RIVER
SAN GABRIEL RIVER
I 405;CA 22
Beach
Seal Beach National Wildlife Refuge
0 1 2 4 Miles
CA 1
Map data © OpenStreetMap contributors, Microsoft, Facebook, Google, Esri Community Maps contributors, Map layer by Esri
Vacant Tree Sites
Gi_Bin Fixed 524_FDR
Cold Spot with 99% Confidence
Cold Spot with 95% Confidence
Cold Spot with 90% Confidence
Not Significant
Hot Spot with 90% Confidence
Hot Spot with 95% Confidence
Hot Spot with 99% Confidence
Long Beach Elevation
Value
110ft
0ft
FEMA Flood Hazard
0.2% Annual Chance Flood Hazard
1% Annual Chance Flood Hazard
SB 535 Disadvantaged Communities

Figure 4

The area with the combined highest elevation and the highest concentration of vacant tree sites is the circled area in North Long Beach. This would be the first area to prioritize as it will provide an impactful amount of flood risk mitigation, as it lies further up the Los Angeles river and would help to reduce the amount of storm runoff into the river. Though the second circled area of West Long Beach is lower in elevation, it would also be a beneficial area as there is an especially high concentration of vacant tree sites, demonstrating a higher need. We can see these two areas in more detail in Figures 5 and 6.

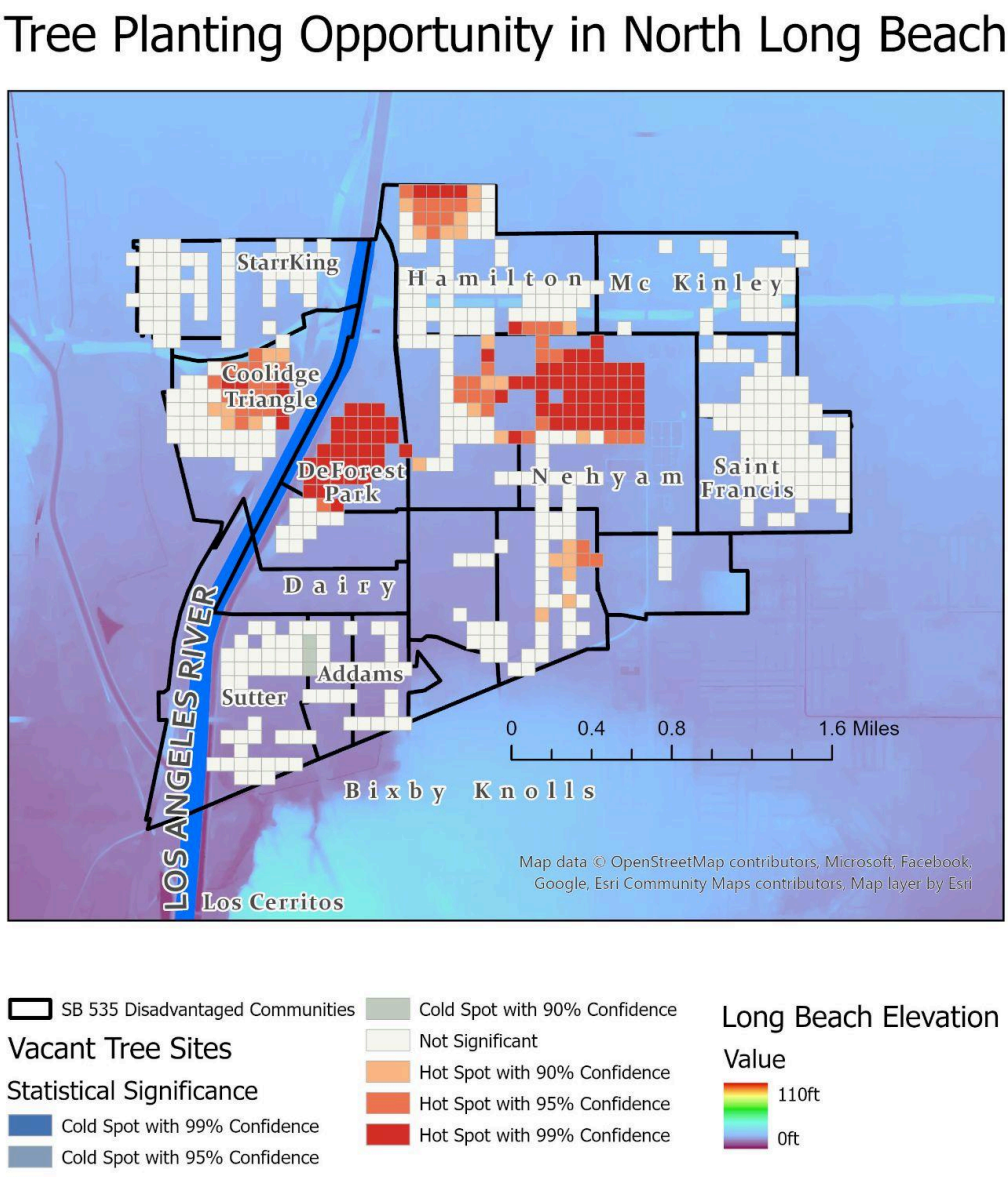
Tree Planting Opportunity in North Long Beach
StarrKing
Hamilton
Mc Kinley
Coolidge Triangle
DeForest Park
Nehyam
Saint Francis
Dairy
LOS ANGELES RIVER
Addams
Sutter
0
0.4
0.8
1.6 Miles
Bixby Knolls
Map data © OpenStreetMap contributors, Microsoft, Facebook, Google, Esri Community Maps contributors, Map layer by Esri
Los Cerritos
SB 535 Disadvantaged Communities
Vacant Tree Sites
Statistical Significance
Cold Spot with 99% Confidence
Cold Spot with 95% Confidence
Cold Spot with 90% Confidence
Not Significant
Hot Spot with 90% Confidence
Hot Spot with 95% Confidence
Hot Spot with 99% Confidence
Long Beach Elevation
Value
110ft
0ft

Figure 5

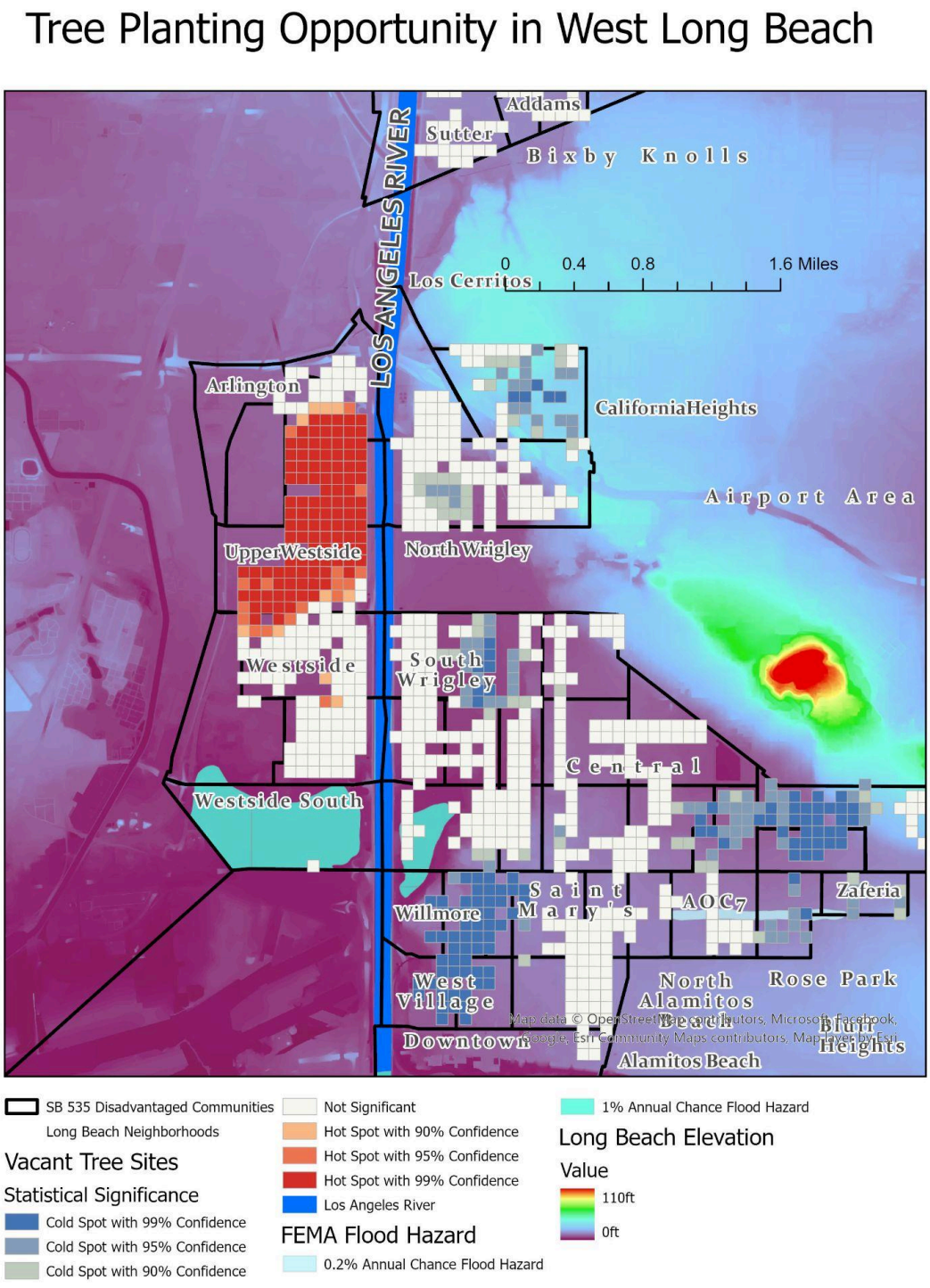
Tree Planting Opportunity in West Long Beach
Addams
Sutter
Bixby Knolls
LOS ANGELES RIVER
0 0.4 0.8 1.6 Miles
Los Cerritos
Arlington
CaliforniaHeights
Airport Area
UpperWestside
North Wrigley
Westside
South Wrigley
Central
Westside South
Saint Mary's
AOC7
Zaferia
Willmore
West Village
North Alamitos Beach
Rose Park
Downtown
Alamitos Beach
Bluff Heights
Map data © OpenStreetMap contributors, Microsoft, Facebook, Google, Esri Community Maps contributors, Map layer by Esri
SB 535 Disadvantaged Communities
Long Beach Neighborhoods
Vacant Tree Sites
Statistical Significance
Cold Spot with 99% Confidence
Cold Spot with 95% Confidence
Cold Spot with 90% Confidence
Not Significant
Hot Spot with 90% Confidence
Hot Spot with 95% Confidence
Hot Spot with 99% Confidence
Los Angeles River
FEMA Flood Hazard
0.2% Annual Chance Flood Hazard
1% Annual Chance Flood Hazard
Long Beach Elevation
Value
110ft
0ft

Figure 6

Limitations

The tree data obtained from the City of Long Beach archives is not recent, as it is from 2018. Many more trees have been planted since then, so the data is not a reflection of Long Beach's tree canopy in 2024. Young city trees are also often vandalized or underwatered, so there could be a significant number of new vacant tree sites that are not represented by this data.

It is also important to note that the flood hazard data from FEMA is merely a prediction based on historical flood events, and does not predict future trends. As the climate changes, Long Beach will experience more severe flooding, and it is difficult to predict what this will look like. As with all kinds of risk mitigation infrastructure, the recommendations I make in this analysis are an estimation of the most likely areas that will reduce flood risk.

Finally, this data set does not take into account all empty parkways in the city, and community initiatives. Planting trees in the areas I recommend may not be in the best interests of those neighborhoods. It is important to take community needs and desires into consideration and build a relationship with local groups before diving into such a large-scale project.

Conclusion

Based on this analysis, the North Long Beach neighborhoods of Neyham, Deforest Park, Hamilton, and Coolidge Triangle should be prioritized first for planting trees, as they demonstrate a high need for tree canopy and are situated at a higher elevation, which will reduce the amount of runoff during storms and help prevent flooding. The Arlington, Westside, and Upper Westside neighborhoods should be prioritized second. Though these neighborhoods sit at a lower elevation, they demonstrated the highest need for trees of any other SB-535 Disadvantaged Community.

The City of Long Beach should continue to analyze this subject further through updating its tree canopy data and reaching out to neighborhood leaders or community groups from the six priority neighborhoods. Trees can be planted on an individual basis by city staff, or on a larger scale through volunteer tree planting events. Once trees have been planted and established in these neighborhoods, the City should create a plan to keep track of the flooding trends in nearby, lower-elevation areas to measure the benefits of these trees.

References

Carrick, J., Rahim, M. S. a. B. A., Adjei, C., Kalee, H. H. H. A., Banks, S. J., Bolam, F. C., Luna, I. M. C., Clark, B., Cowton, J., Domingos, I. F. N., Golicha, D., Gupta, G., Grainger, M., Hasanaliyeva, G., Hodgson, D. J., López-Capél, E., Magistrali, A., Merrell, I., Oikeh, I., . . . Stewart, G. (2018). *Is planting trees the solution to reducing flood risks?* Journal of Flood Risk Management, 12(S2). https://doi.org/10.1111/jfr3.12484 https://riskfactor.com/city/long-beach-ca/643000_fsid/flood

Chappell, N. A., Hankin, B., Bielby, S., Tych, W., & Leeson, P. (2017). *Quantifying flood mitigation benefits of tree planting and related interventions in Wasdale.* In The Woodland Trust, JBA Consulting, & Lancaster University, Technical Report EAA7518/2 [Report]. Woodland Trust Uplands Planting Research Programme. http://www.es.lancs.ac.uk/people/nickc/Wasdale_report_EAA7518_2.pdf

FEMA Flood Hazard and Risk Data Viewer (n.d.). Retrieved April 20, 2024 from https://experience.arcgis.com/experience/e492db86d9b348399f4bd20330b4b274#data_s=id%3AdataSource_1-SeaLevelRise_7537-0%3A673

Historical Society of Long Beach. (2024, January 9). *Water changes everything - Historical Society of Long Beach*. https://hslb.org/water/?v=f24485ae434a

Long Beach, California. (2023, July 25). California State University Long Beach. https://www.csulb.edu/international/life-at-the-beach/long-beach-california.

Long Beach, CA flood map and climate risk report. (n.d.). RiskFactor.com. https://riskfactor.com/city/long-beach-ca/643000_fsid/flood

Magavern, B., Taruc, M. R., Sanchez, A. S., & The Greenlining Institute. (n.d.). *SB 535 FACT SHEET*. https://upliftca.org/wp-content/uploads/SB535-Fact-Sheet-Final.pdf

Qin, Y. (2020). *Urban Flooding Mitigation Techniques: A Systematic Review and Future Studies*. Water, 12(12), 3579. https://doi.org/10.3390/w12123579

Singgih, P., & Gqlshare. (2022, February 2). *Long Beach flood-prevention efforts to be bolstered by FEMA grant.* Press Telegram. https://www.presstelegram.com/2022/02/01/long-beach-flood-prevention-efforts-to-be-bolstered-by-fema-grant/

Data References

City Boundary (January 2023). MapsLB. Retrieved April 21, 2024 from https://maps.longbeach.gov/datasets/LongBeachCA::city-boundary/explore?location=33.809156%2C-118.156254%2C12.23

LBTrees2018. City of Long Beach. Retrieved March 21, 2024 from city archives.

National Flood Hazard Layer (n.d.) FEMA. Retrieved April 21, 2024 from https://www.fema.gov/flood-maps/national-flood-hazard-layer

Natural_cont1. City of Long Beach. Retrieved April 9, 2024 from city archives.

Neighborhoods. MapsLB (October 2023). Retrieved April 21, 2024 from https://maps.longbeach.gov/maps/6d554418275b4ce69d342adb8e1b9f4a/explore?location=33.809131%2C-118.156100%2C11.26

SB 535 Disadvantaged Communities 2022 (2012). Retrieved April 21, 2024 from https://oehha.ca.gov/calenviroscreen/sb535

Waterways. MapsLB (September 2022). Retrieved April 21, 2024 from https://maps.longbeach.gov/datasets/b624d9b62bdd4824ba1a707eebf61cc0_0/explore