# Accessibility of Public Services in the City of Los Angeles

Chloe Clegg, Anahita Jensen, Ken Matsunaga, Anna Worgall,
Paulina Fernández, Dexter Robinson, Joshua Grumet

University of California, Los Angeles
Geography 181B - Advanced Geographic Information Systems
Professor: Yongwei Sheng
TA: Bryan Ziadie
June 2024

## Introduction

The City of Los Angeles is home to almost four million people, but the resources and services available within it are not equally spatially distributed to all of its inhabitants. To address this issue, we first conducted a large-scale network analysis of the city to determine the current state of accessibility of public services and transit routes. The specific factors we analyzed include high schools, bus stops, metro stops, grocery stores, hospitals, and parks. Additionally, we conducted a spatial analysis of the demographic factors of the county, to understand which sectors of the population are currently being served or not by the available services within the county. We used the resulting data from this analysis to identify key neighborhoods within the city for local government to target to build and place additional services to better serve their residents. Finally, to ensure that our analysis also integrates natural environment factors which impact the daily lives of residents, we performed both a temperature trend analysis of Los Angeles and a natural hazard vulnerability assessment to ensure that our final recommendations regarding public services are done so with an understanding of the impacts of climate change and natural hazards in the region. Ultimately, our analysis showed that while the majority of the identified regions in LA most in need of improved public service accessibility are in low-income areas, accessibility is also low in wealthy neighborhoods such as Bel Air, where the built infrastructure is not designed to be amenable to those without the ample resources.

## Temperature Trend and Demographic Analysis

### Introduction

To situate our analysis with an understanding of the current dynamics of the City of LA as well as the greater county, we began by creating contextual temperature trends and demographic maps. This was done to determine whether the spatial distribution of different demographics and environmental factors influence the availability and presence of resources for residents. Understanding if certain races are more likely to live in underserved regions is crucial to connecting with the community when adding new services to a neighborhood. Some neighborhoods may experience extreme heat during the summer, and will benefit more from services such as cooling shelters.

Methodology

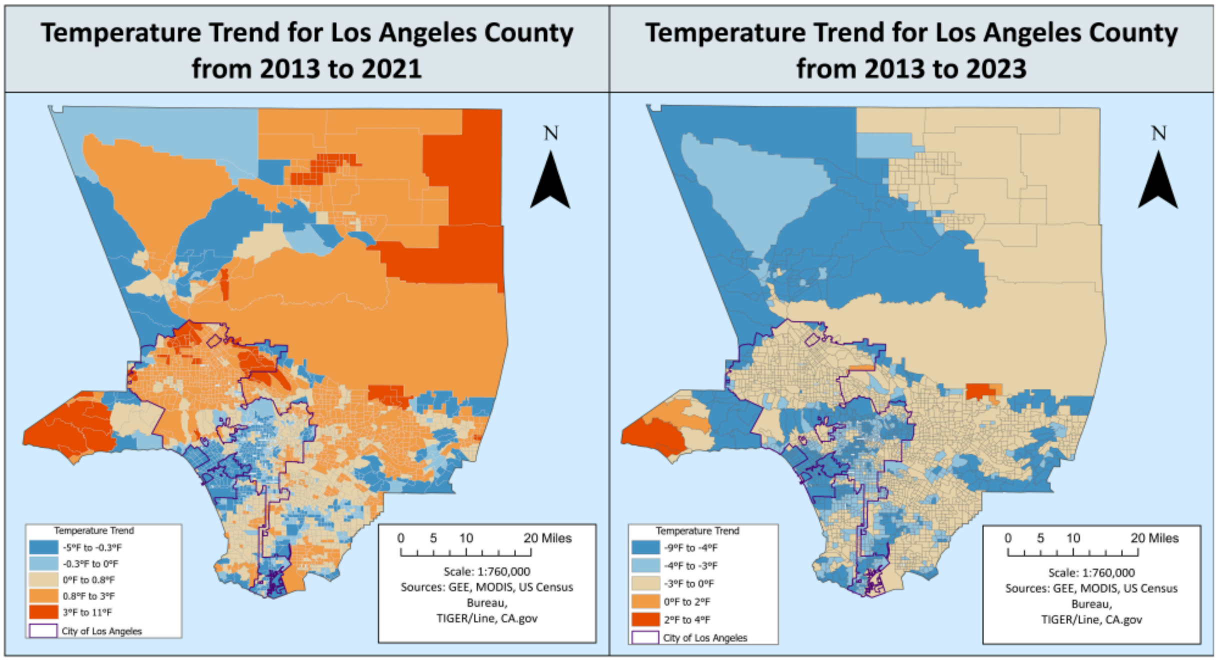
To create the temperature trend maps, we utilized geospatial tools within Google Earth Engine (GEE) and ArcGIS Pro. On Google Earth Engine, the MODIS Aqua Land Surface Temperature and Emissivity Daily Global 1km image collection was used to gather information regarding temperature. The collection was filtered from January 1, 2013 to December 31, 2021 for the first map and from January 1, 2013 to December 31, 2023 for the second map. Two different temperature trends were recorded to observe how much temperature has changed between the years 2021 to 2023. Additionally, the image collection was filtered to the boundaries of Los Angeles County using the Global Administrative Unit Layers (GAUL) administrative boundary shapefiles simplified at 500m. The linear trend was computed by utilizing the satellite's offset and scale to determine the regions that were experiencing an increase or decrease in temperature. The results were exported as a GeoTIFF from Google Earth Engine and onto ArcGIS Pro for further analysis.

On ArcGIS Pro, the raster images and TIGER/LINE shapefiles of the census tracts were clipped to the boundary of LA County, excluding the Channel Islands. We then stretched the rasters to account for any outliers in the data using the "Stretch" tool under "Raster Functions". The minimum value was equal to the mean minus the standard deviation and the maximum value was equal to the mean plus the standard deviation (mean +/- standard deviation). Following that, the "Zonal Statistics as Table" tool was used to join all statistics types of the temperature trends to the census tracts. The table was then exported and the symbology was changed so that decreasing temperatures were distinguishable by the color blue and increasing temperatures by orange-red for visual clarity.

For the demographic maps, we obtained publicly available data regarding median household income and race from Neighborhood Data for Social Change, using data from 2022 as this was the most recent year available. We exported the data into ArcGIS Pro as a .csv file and conducted a table join to join the recently downloaded data to the census tracts layer. The table join was performed by using the distinct geographic identifiers of the census tracts (GEOID). Two racial populations were shown within one map to compare and contrast their distribution across the city and county of Los Angeles.

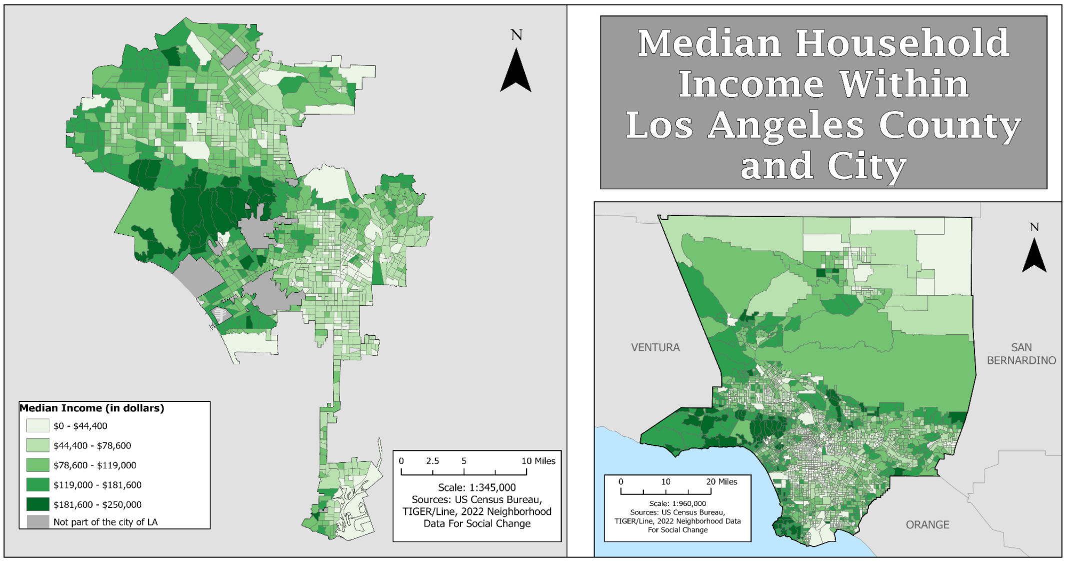
<u>Results</u>

***Map 1: Los Angeles County Temperature Trend***



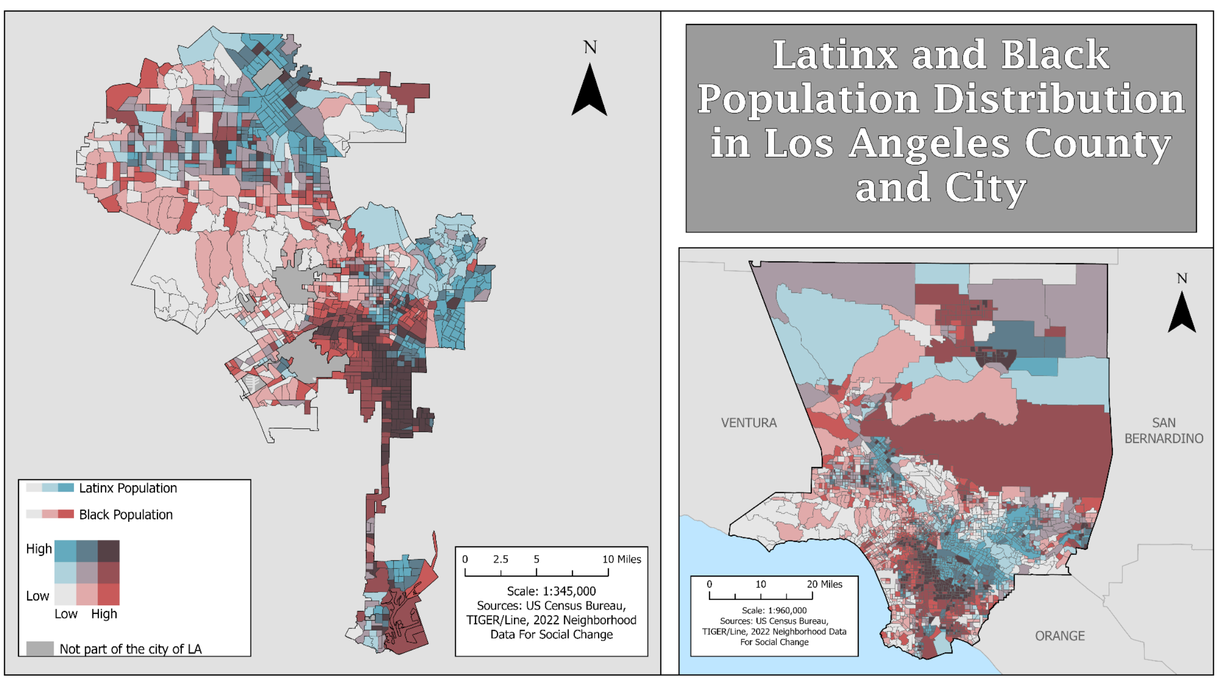

As seen in Map 1 above, temperature has generally decreased over the last decade. One contributing factor to this downward trend may be the heavy rainfall the county received in recent years.

***Map 2: Los Angeles Median Household Income***



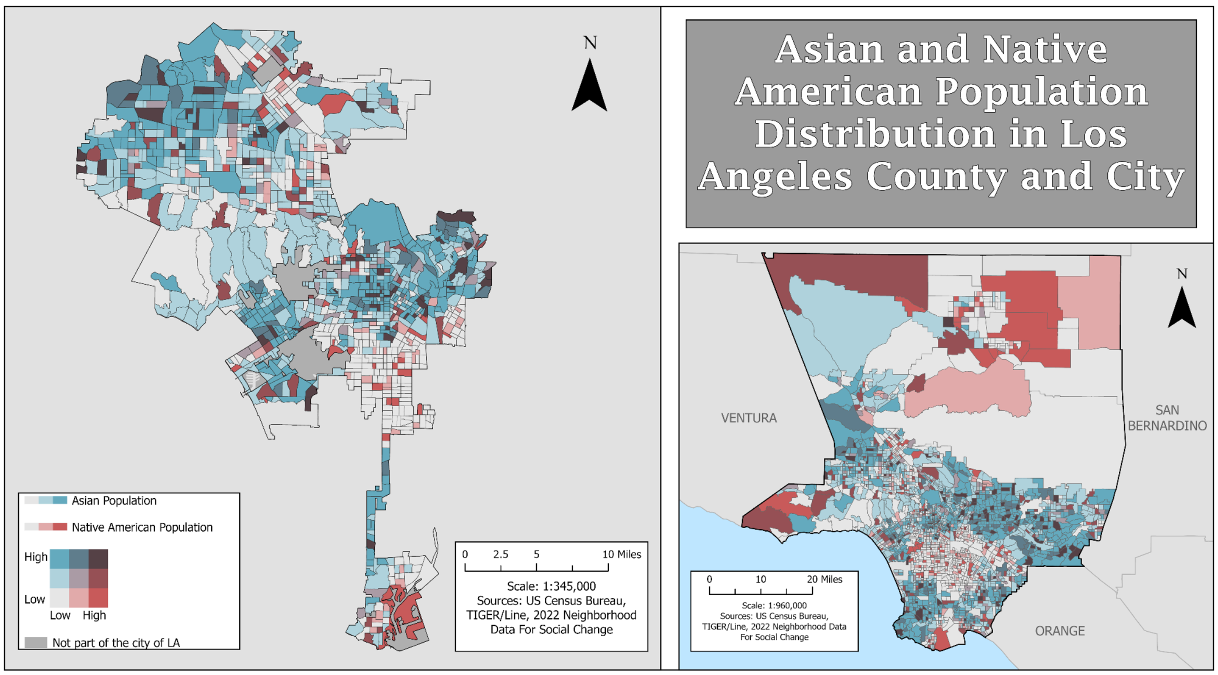

Map 2 above showcases the median household income across Los Angeles County and city. Low income households are primarily clustered in the eastern and southern portion of the city. These places include Watts, Downtown, and Boyle Heights. On the other hand, higher income households reside in the Western side of the city. Such places include Westwood, Bel-Air and Brentwood.

***Map 3: Los Angeles Latinx and Black Population Distribution***



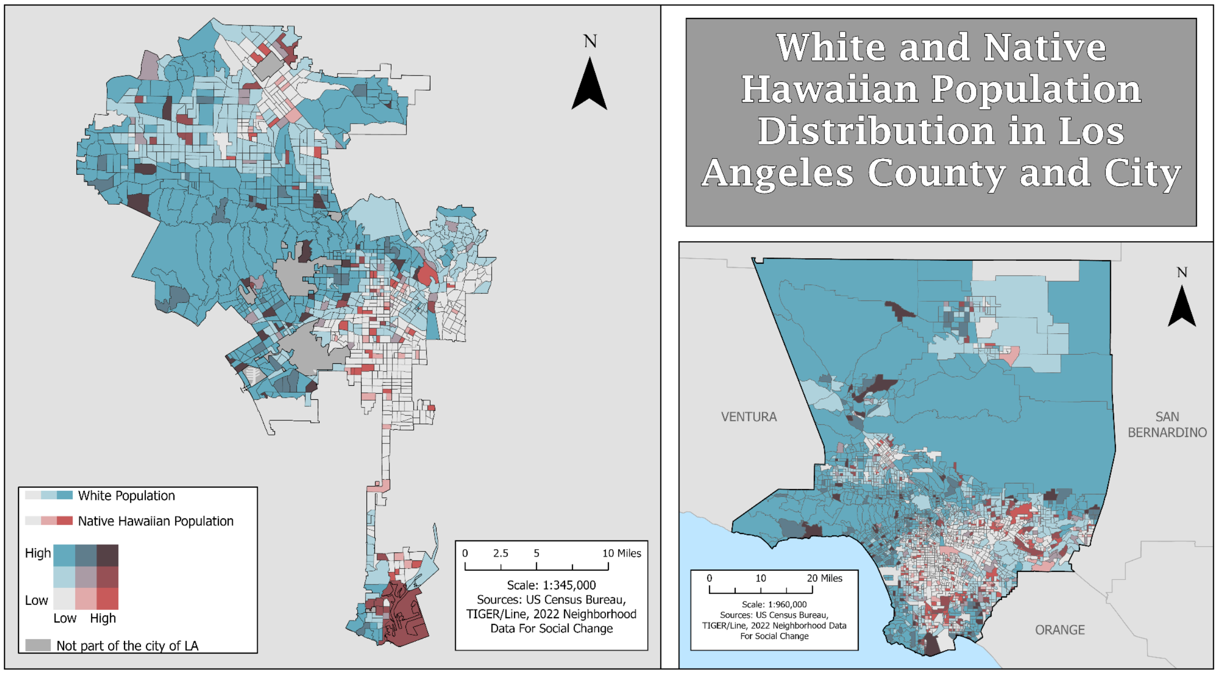
Map 3 above shows the distribution of Latinx and Black population, with high concentrations of both groups in the South Central region of the city. The Black population also has a high concentration on the West side, while the Latinx population in the Northern and Eastern regions. Crucial to note is the similarity in distribution of these racial groups' residence with the distribution of lower-income households in Map 2.

***Map 4: Los Angeles Asian & Native American Population Distribution***




As seen in Map 4 above, there is a high Asian population occupying the Northern and Eastern side of Los Angeles City. On the other hand, there is a high concentration of Native Americans in different parts of Los Angeles as well, with the majority inhabiting places in the South, like Wilmington.

***Map 5: Los Angeles White and Native Hawaiian Population Distribution***




Map 5 above showcases a huge concentration of white individuals across the city and county. On the other hand, Native Hawaiians inhabit only small sections of Los Angeles, with most of them living in the southern region of the city.

## Service Area Analysis of Public Services

<u>General Methodology</u>

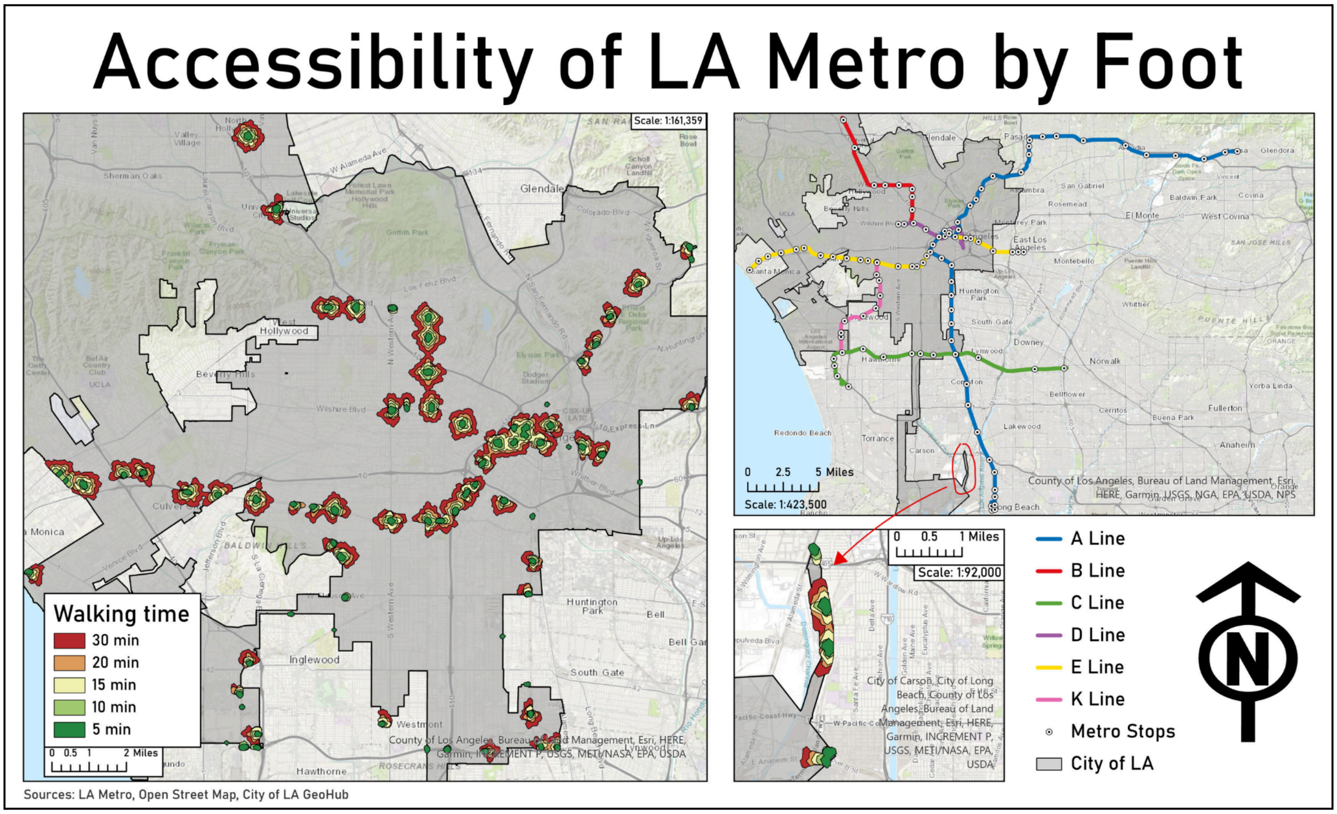
We performed service area analyses for six societally crucial public services: public transportation, public high schools, parks/green spaces, hospitals, and grocery stores. In order to perform an analysis of this scale, we created our own network dataset to handle the large amount of input data. For all but hospital services, we assessed walkability with cutoffs of 5, 10, 15, 20, and 30 minutes walking time. As using ArcGIS Pro's built in service area analysis tools for this would require more credits than we have access to, we used OpenStreetMap (OSM) data to create a local network dataset that sidesteps the need for credits. For our network dataset, walking paths were designated as the following: 'footway', 'pedestrian', 'path', 'residential', 'living_street', 'track', 'service', 'unclassified'. The "WALK_TIME" field was calculated using the following equation: (shape_length/(avg walking time in ft per minute). This gave a value of 273.403 ft/min to use when creating the cutoffs for the service area analysis. We then used the 'Create Network Dataset' tool to develop our network dataset with "WALK_TIME" as the cost/impedance.

Public Transportation

Public transportation is a crucial component to factor in when analyzing the accessibility of an urban area, as it is a mode of transport which itself can help bolster the accessibility of other services. LA is famously an extremely car-centric city, but according to 2024 American Community Survey 5-year estimates, about 8% of households in the LA metro area do not own a car, leaving them reliant on alternative modes of transportation, such as bus or rail (Valentine, 2024). Public transportation is a crucial public service: not only does it allow people without access to a vehicle to explore and traverse the city, it also serves a social good by reducing traffic congestion, air pollution, and energy and oil consumption (Federal Highway Administration, 2004).

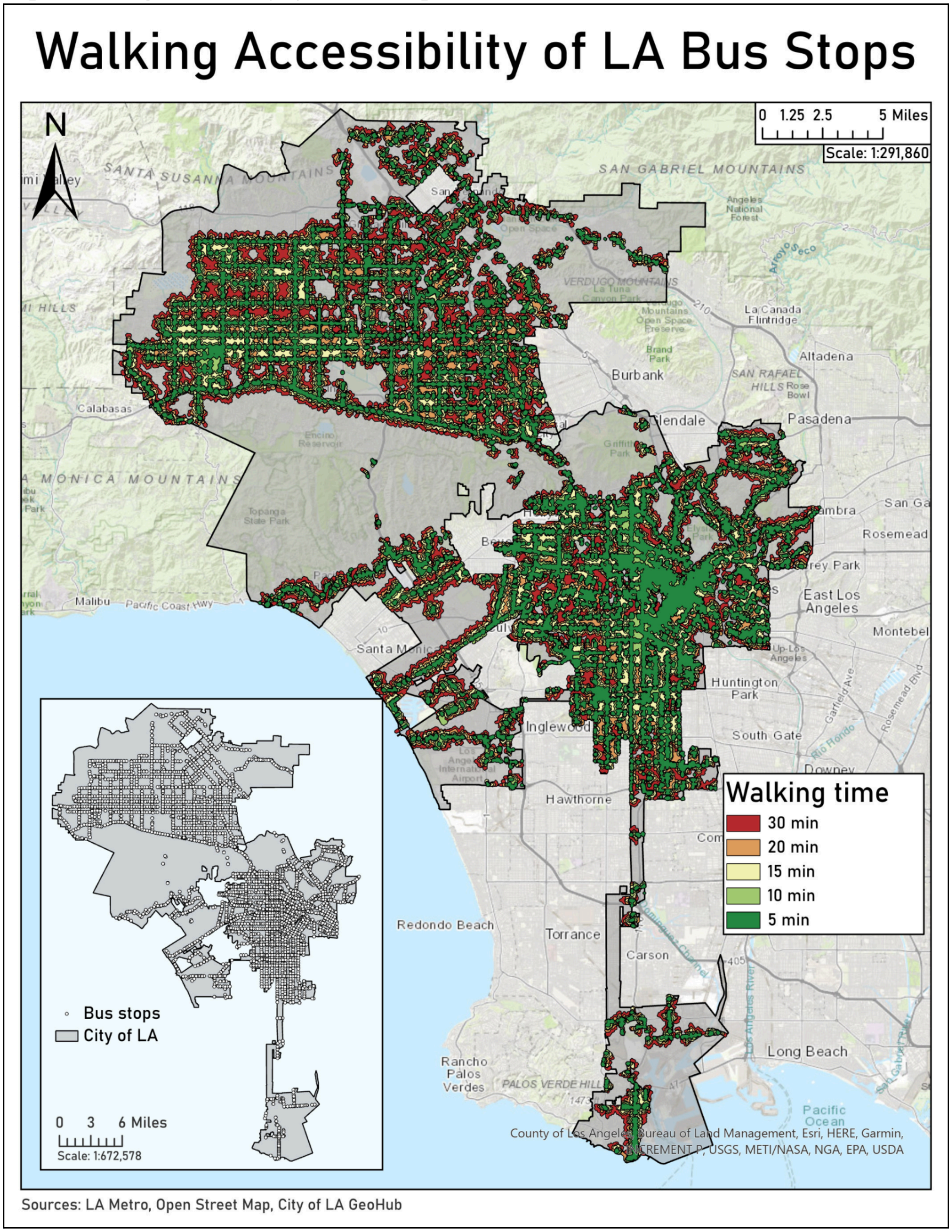
Therefore, this project decided to generate the walking accessibility of bus and metro stations in the City of LA. Facilities were imported from LA Metro, bus & metro stops/stations (LA Metro, 2024). Driving time to stops was not calculated as it is assumed that the usage of public transportation precludes the need for a car for mobility. Using the created network dataset for LA, both bus and metro accessibility were calculated using 5, 10, 15, 20, and 30 minute cut-offs. The results of these analyses can be seen in Maps 6 & 7 below.

***Map 6: Walking Accessibility of LA Metro***



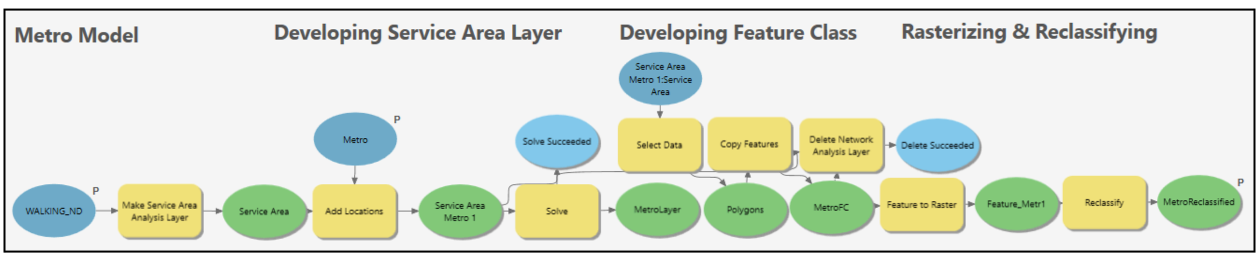

The results of this analysis show that within LA, buses provide far more coverage over the city than rail. Within the city boundary, there are 107 metro rail stations, whereas within the same area, there are 13,960 bus stops. As can be seen in Map 6, metro coverage is spotty at best, with the most accessible region of the city being concentrated around Downtown LA, where the A, D, and E lines intersect. However, the metro is largely inaccessible within the majority of the city. This is particularly true in the San Fernando Valley (which is north of the areas shown in Map 6), where there is absolutely no metro service available at all.

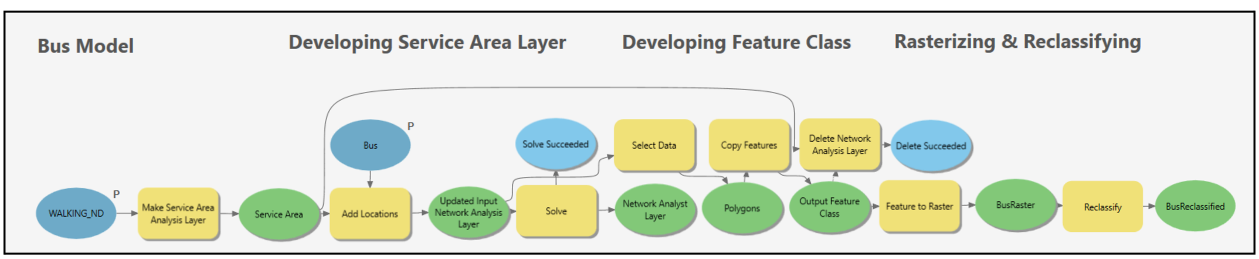
***Map 7: Walking Accessibility of LA Bus Stops***




By contrast, the bus system in the city of LA provides far greater coverage to residents than the metro. A large portion of the San Fernando Valley, as well as Central LA, is within a 30 minute walk to a bus station. Within Central LA, the large swaths of dark green in Map 7 highlight how much of the area is within a 5-minute walk to a bus station. Despite this wider coverage, there still exist areas in the city which lack adequate access to bus service. Particularly in the South Bay (at the bottom of the map, between Rancho Palos Verdes and Long Beach), bus accessibility is far more limited. Additionally, there are pockets of areas within the San Fernando Valley which are outside of a 30-minute walk to a bus stop.

While the above service area analyses were performed step by step, we also developed a model using ArcGIS ModelBuilder in order to promote ease of repeatability for other urban areas. The model will enable the user to be able to change the cutoffs if desired, or input a different region of their choice. The model, displayed below, takes our network dataset and the metro or bus stops as inputs, and outputs a classified raster. It is important to note that if this model were to be used for an area other than LA, users would have to create their own network dataset for it to be operational.




High Schools

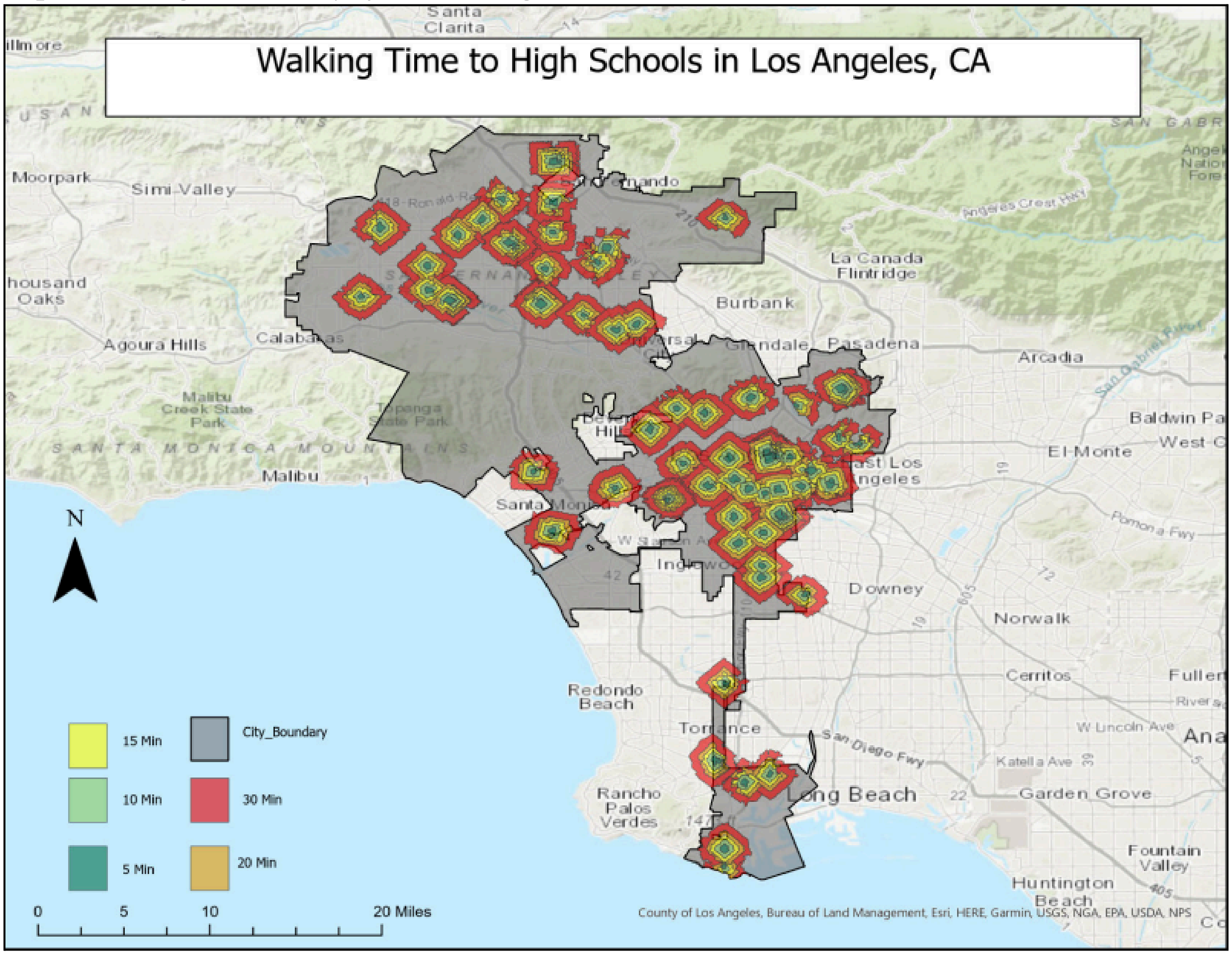
Los Angeles Unified School District (LAUSD) locations were sourced from Los Angeles GeoHub. Private and charter schools were excluded from this analysis, as the project focuses on public services accessible to all residents. Only public schools meet this criterion, as they lack the entry barriers associated with alternative schooling options. Public schools serve students from all socioeconomic backgrounds, making them more accessible to low-income households with limited car access and who are more likely to need to walk to school.

Public schools play a pivotal role in shaping the future of our country. While examining all public schools, including elementary, middle, and high schools, is important, we focused on high schools due to time and scope constraints. High school students are in their final years of schooling before entering the workforce or living independently. Therefore, it is vital for these students to receive a comprehensive and supportive education.

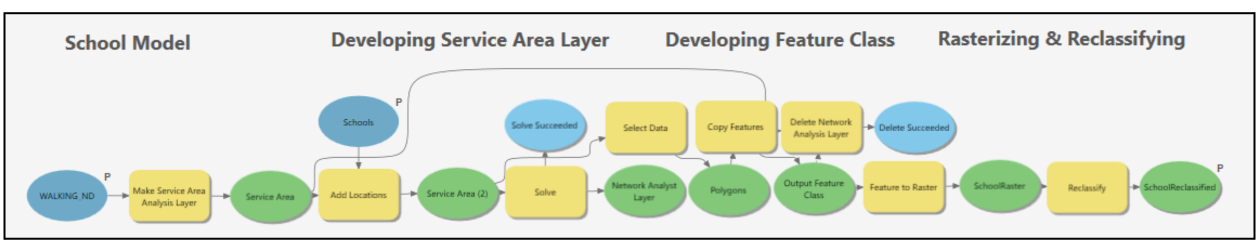
After obtaining the data from LA GeoHub, it was imported into ArcGIS Pro. We filtered the data to include only high schools in LA County and then imported the LA City boundary into ArcGIS Pro. We identified high schools within the boundaries of the City of Los Angeles using the Select by Location tool. We then created a layer showing only the selected features and included them as facilities in the service area analysis. For this analysis, we set walking times at 5, 10, 15, 20, and 30 minutes. Each layer was symbolized to show the differences between them clearly.

The analysis revealed several areas within Los Angeles that need more public schools within a 30-minute walking distance. One such area is near Beverly Hills, indicating a limitation in our project, as Beverly Hills relies on private schools and is not an underserved community. Map 8 displays the results, highlighting significant gaps in walking accessibility in the San Fernando Valley. Although other city regions also exhibit gaps, these wealthier areas likely rely more on private schools and do not require increased accessibility.

***Map 8: Walking Accessibility of LAUSD High Schools***




We also developed a model that takes schools and the network dataset as inputs and outputs a reclassified raster.

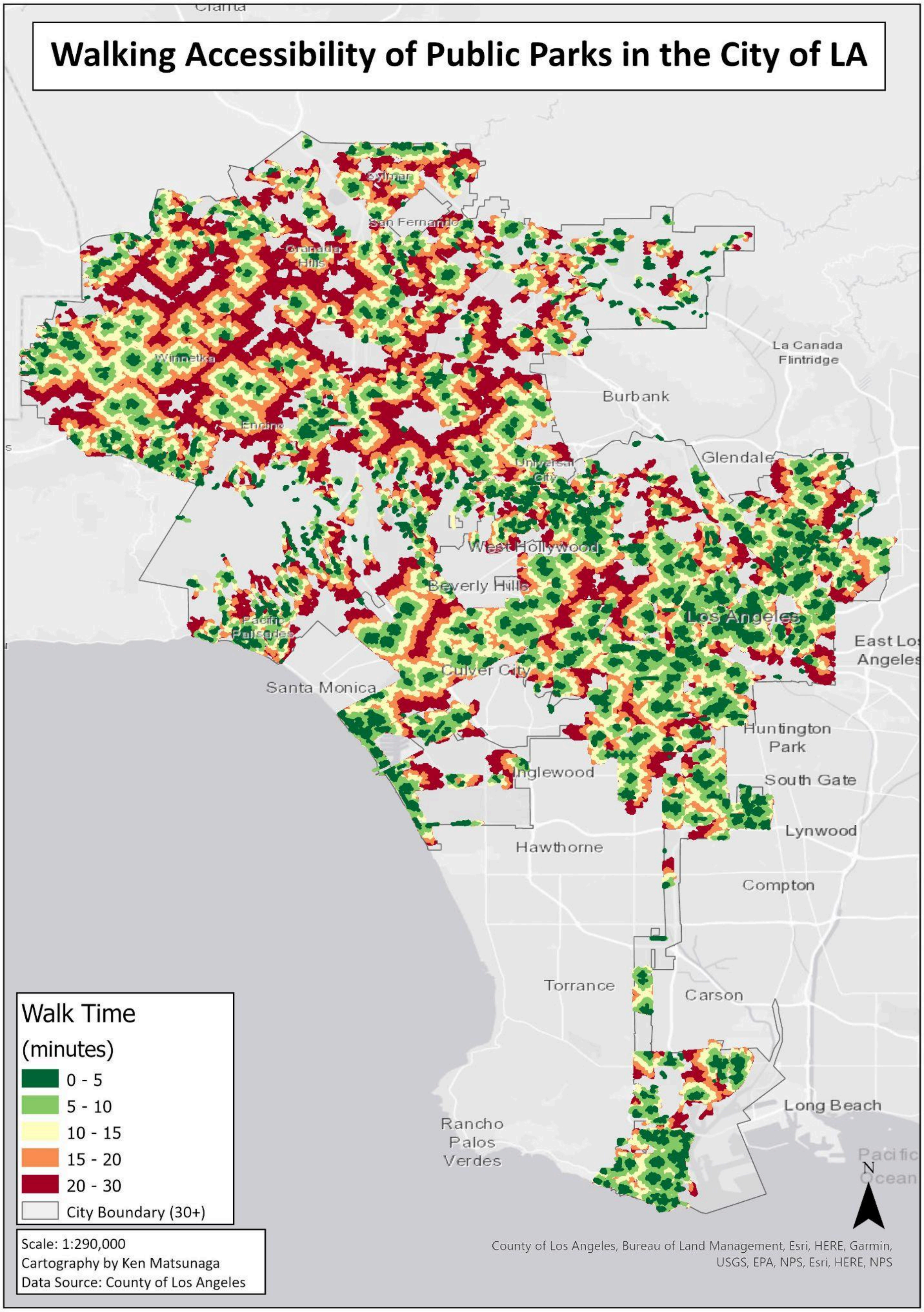



<u>Parks/Green Space</u>

Parks and green spaces are crucial public areas for the well-being of citizens, as they often serve as spaces for communities to convene, create connections, and thrive. Additionally, they provide several benefits for both mental and physical health: people who spend time in these places benefit from higher cognitive function and are more likely to report higher levels of happiness and well-being (CNR Web, 2022). These spaces also contribute to a phenomenon known as the " urban green space cooling effect": parks and green spaces not only cool their own space but also influence the area around them, combating urban heat islands (Aram 2019).

Parks and green space data was obtained from the County of Los Angeles Enterprise GIS Hub. Since the data was for the whole county of LA, data was clipped to the City of Los Angeles. To allow the useability of the data in a service area analysis, the 'Feature to Point' tool with the "inside" parameter checked was used to convert the parks and open spaces into points. Therefore, it is important to note that the walking time may be artificially inflated, as some parks cover a large area. Instead of calculating the walking time from the edge of the polygon, the time was calculated from a point near the middle of the parks' polygons. The service area analysis was performed at walking intervals of 5, 10, 15, 20, and 30 minutes, with the park points as the "facilities" input. Map 9 below displays the results.

***Map 9: Walking Accessibility of LA Public Parks***



Visual inspection of Map 9 allows for the reasonable conclusion that residents in the San Fernando Valley have less access to parks than residents who live near the center of LA (near Downtown) and areas west of the center. Additionally, Harbor Gateway North and South, the strip of the city connecting LA to San Pedro which is the southmost area on our map, are especially lacking in access to parks. It is worth highlighting that the Santa Monica Mountains and Topanga State Park are grayed out, symbolizing that people near these areas will have to walk 30+ minutes to a green space, which is untrue. This is likely a result of point symbolization of parks as mentioned above. Furthermore, the network dataset we used was based on OpenStreetMap, which also could have ignored trails and dirt roads used to access these large recreational areas.

Hospitals

Medical care is an essential service. Both emergency and non-emergency care perform life-sustaining functions for people in every age, economic, and other demographic bracket, which presents a need for abundant and accessible hospitals. Decreases in distances to and from hospitals and medical centers is correlated to increases in life expectancy for both emergency events (Nicholl et. al., 2007) and chronic health conditions (Hao et. al., 2020). To measure hospital accessibility, we calculated drive time from hospitals to surrounding areas using the service area network analysis tool in ArcGIS Pro.

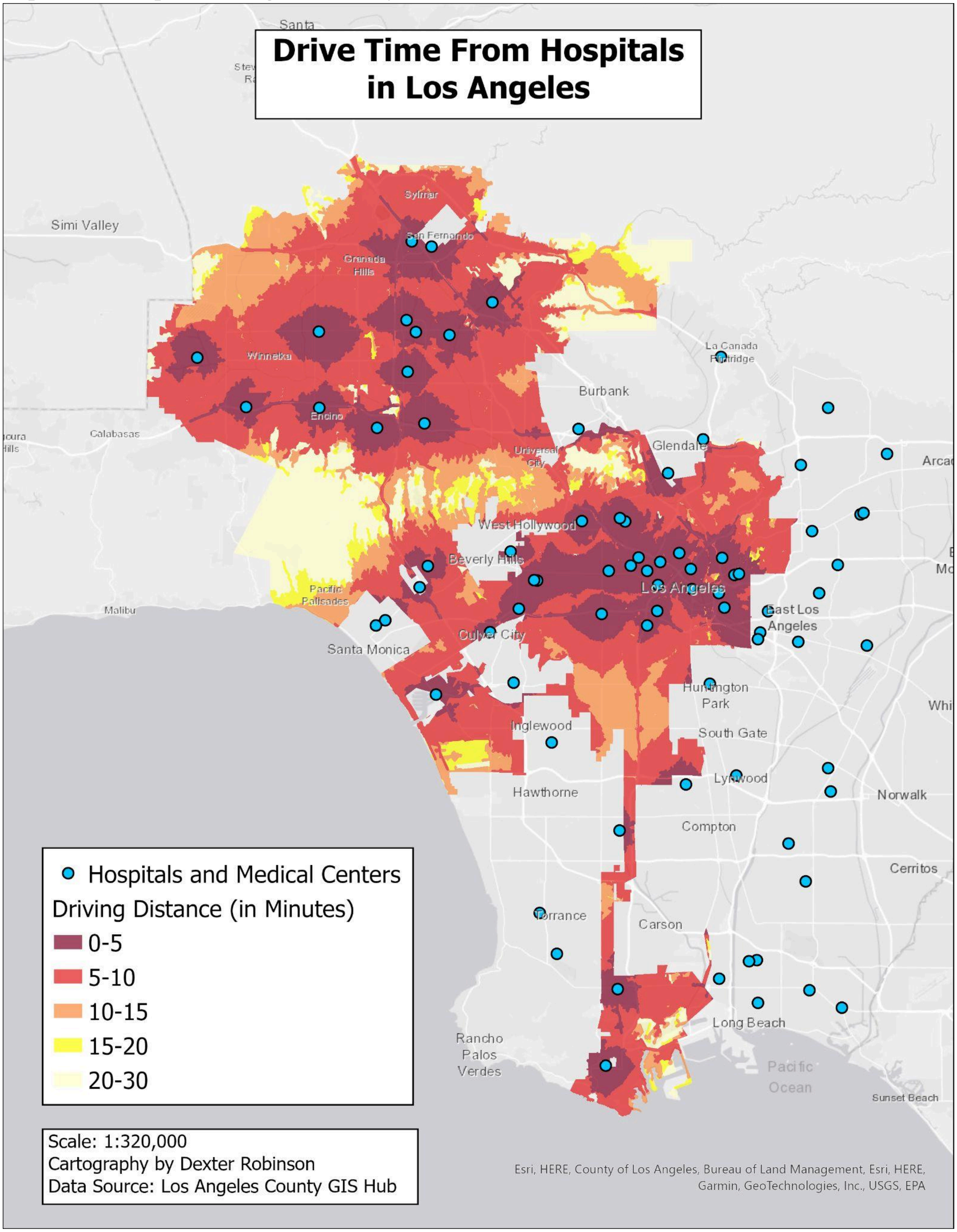
Drive time from hospitals to surrounding areas was selected as the most useful measure of hospital service area analysis. While any hospitals adjacent to a sidewalk or other footpath can be reached by foot, walking is rarely the method of transportation chosen when one is facing a dire health emergency. Instead, people are much more likely to drive to hospitals. Ambulance services also use hospitals as starting nodes, so knowing the travel time from hospitals to their surrounding areas is important for providing accurate time assessments for that service.

Hospital and medical center data was obtained from the County of Los Angeles Enterprise GIS Hub. These locations were then clipped to within ten kilometers of the City of LA, and used to create a service area layer. In addition to setting the travel direction as “Away from Facilities”, the time cutoffs were set to 5, 10, 15, 20, and 30 minutes to furnish useful analysis and to correspond with the other service area analyses used in this project. After running the service area analysis, the polygon output was converted to a raster using the “Feature to Raster “ tool and clipped to the City of LA. Finally, the values were reclassified to facilitate the final suitability analysis. Reclassification values are as follows: a value of 5 for five minutes or less, 4 for ten minutes, 3 for fifteen minutes, 2 for twenty minutes, and 1 for thirty minutes.

As can be seen in Map 10 below, most of LA has a coverage of ten minutes or less. 70.6% of the city falls within ten minutes of a hospital or medical center, while 24.7% is within five minutes. The majority of the five minutes or less coverage is concentrated in Downtown Los Angeles, central Los Angeles, and the San Fernando Valley. Coverage drops significantly in the largely residential Santa Monica Mountains and along the northern perimeter of the San Fernando Valley. Although nearly all of the Los Angeles Basin can be reached in fifteen minutes or less, two locations show suboptimal coverage (between fifteen and thirty minutes from a hospital). The first is on the tarmac at LAX. This, however, can most likely be attributed to the infrastructure and access restriction of the airport and if a health emergency were to occur there, medical services would likely be available to quickly respond. The second is in the Port of Los Angeles. Again, this is most likely due to the infrastructure of the port. Other areas with suboptimal coverage in the LA Basin are small and isolated, and are close enough to high coverage areas (less than ten minutes) to imply that they may be caused by errors in the service area analysis layer.

The biggest restriction was arguably the lack of traffic as an impeding factor. By setting the time of day, this would be somewhat resolved. However, the output raster did not appear to reflect real-world traffic. It was also difficult to decide what time of day to settle on for the final raster - an accurate traffic would show completely different results for 5:00 pm on a Monday and for 1:00 am on a Saturday. Another problem was that the shapefile did not have data on the type of hospital. Being able to run emergency care and non-emergency care hospitals separately would have shown two distinct but useful health care service analyses.

***Map 10: LA Hospital Driving Accessibility***

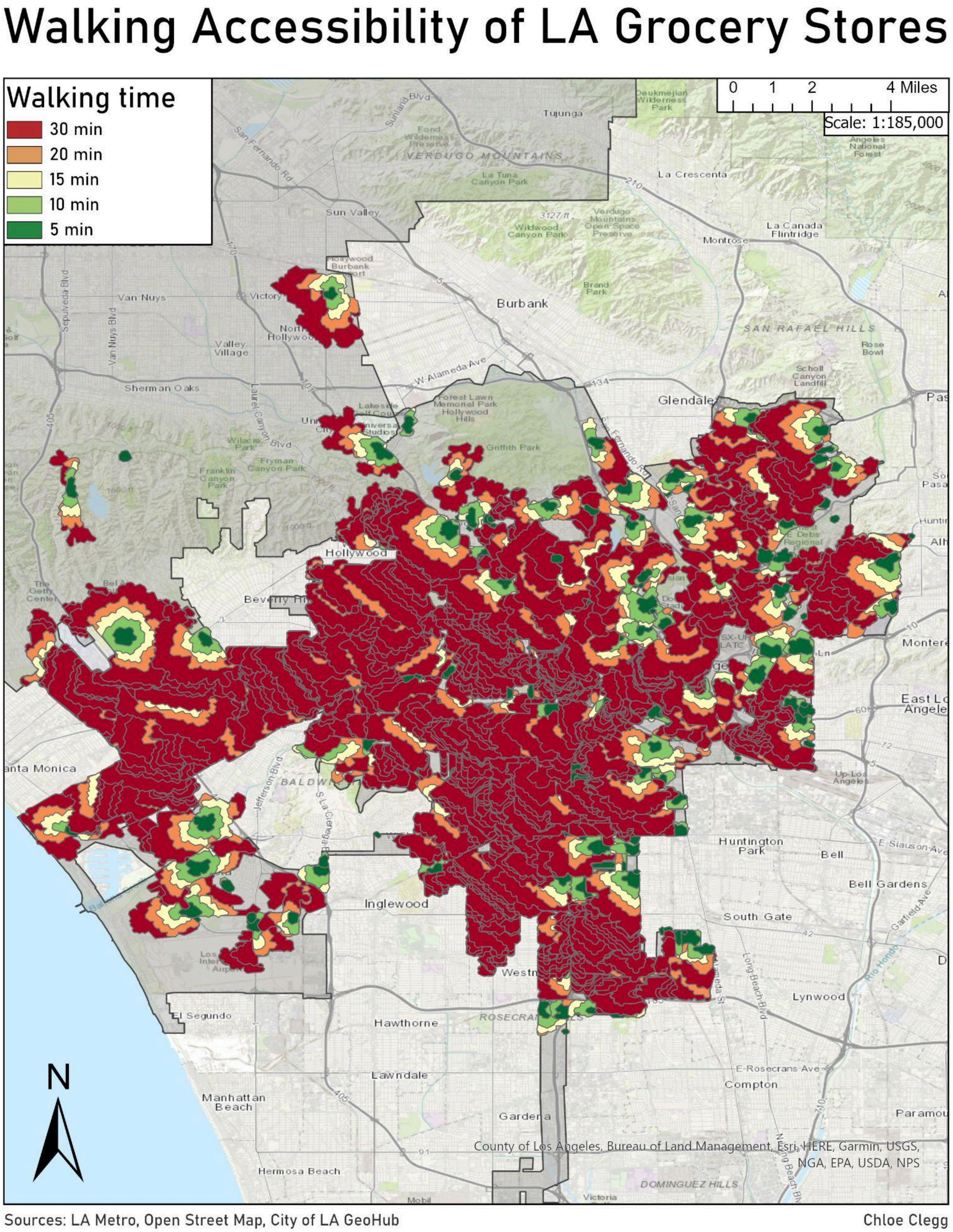


Grocery Stores

Walking access to grocery stores is critical to ensuring food justice and security. To obtain grocery store data, we downloaded a csv file from the Open Data Portal that contained businesses registered with the Office of Finance. Finding and compiling spatial data for locations of grocery stores was quite challenging since the csv file did not contain spatial data that was immediately compatible with ArcGIS Pro. To spatially encode the grocery store locations, we used the 'Geocoded Addresses' tool to create the grocery store points. These points were then added as Facilities to run the service area analysis. Similar to the previous service area analyses, we used walking time cutoffs of 5, 10, 15, 20, and 30 minutes.

Clearly, the vast majority of the grocery stores in Los Angeles are inaccessible by walking. This is especially true in Central and South Los Angeles. Given that our demographic maps show these areas tend to have a lower median household income and higher percentage of residents who identify as people of color, it is clearly an equity issue that areas do not have the same walking access to grocery stores as wealthier areas of Los Angeles. Moreover, low-income neighborhoods tend to have lower rates of car ownership and greater issues with transportation. Making Los Angeles grocery stores accessible by walking is crucial to ensuring equitable access to healthy and affordable food for all. Limitations of the analysis include potential inaccuracies in the network dataset created from OpenStreetMap data or inconsistencies present in the grocery store data obtained from the Open Data Portal.

***Map 11: Grocery Store Accessibility***



Combined Analysis

Using our six service network polygon layers, we conducted a combined analysis of accessibility for the City of Los Angeles. First, we rasterized our service area polygons with a cell size of 15 feet, as analyses were run using the projected reference system NAD 1983 StatePlane California V FIPS 0405 (US Feet). After resizing the extent of all our layers, we reclassified the six service area analyses that were based on walking and driving time on a scale of 0 to 5, using the following reclassification:

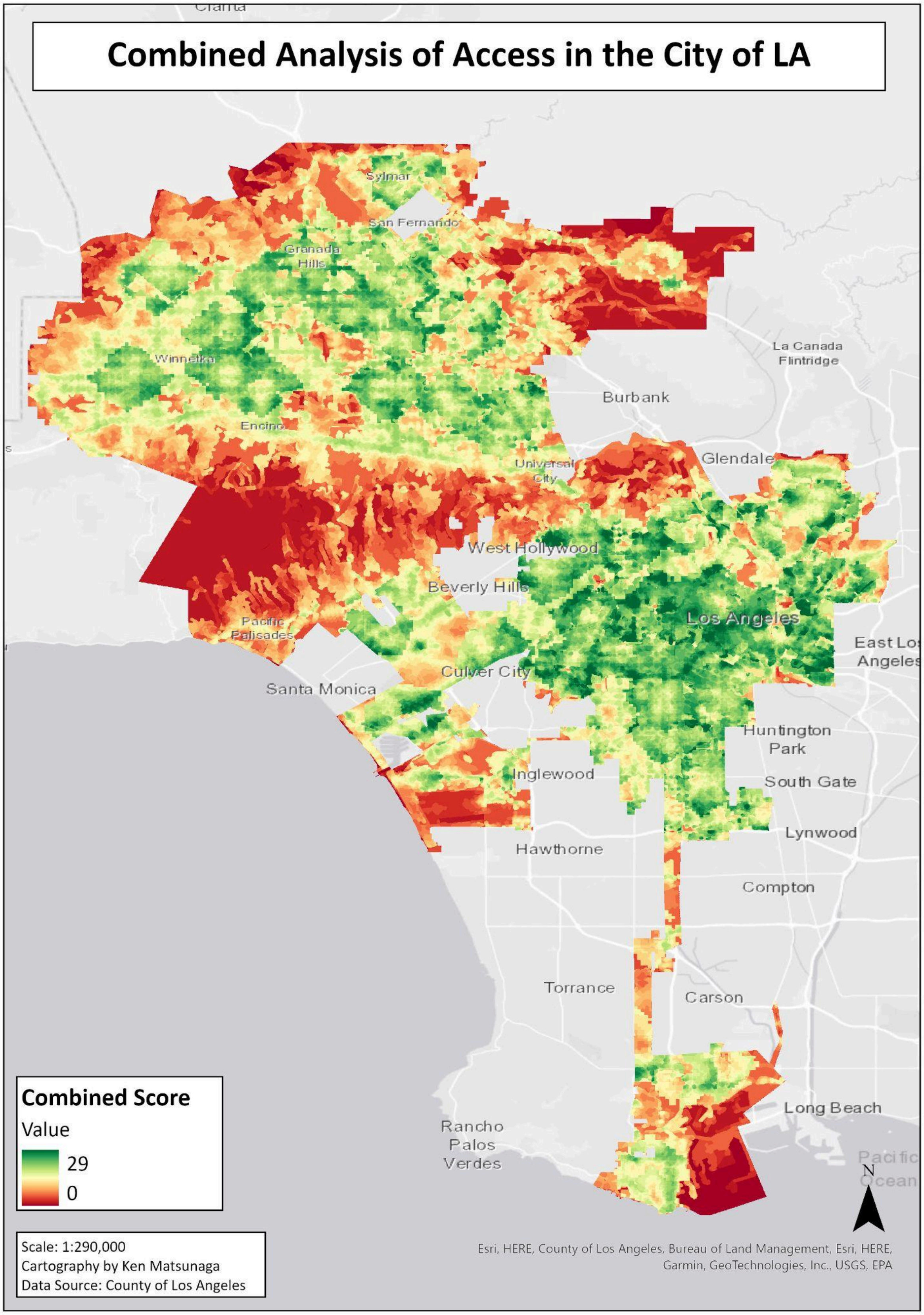
***Table 1: Reclassification Values***

| Walking and Driving* Time (Minutes) | 5 | 10 | 15 | 20 | 30 | NODATA |
|---|---|---|---|---|---|---|
| Reclassified Value | 1 | 2 | 3 | 4 | 5 | 0 |

*Driving time was only used for hospitals

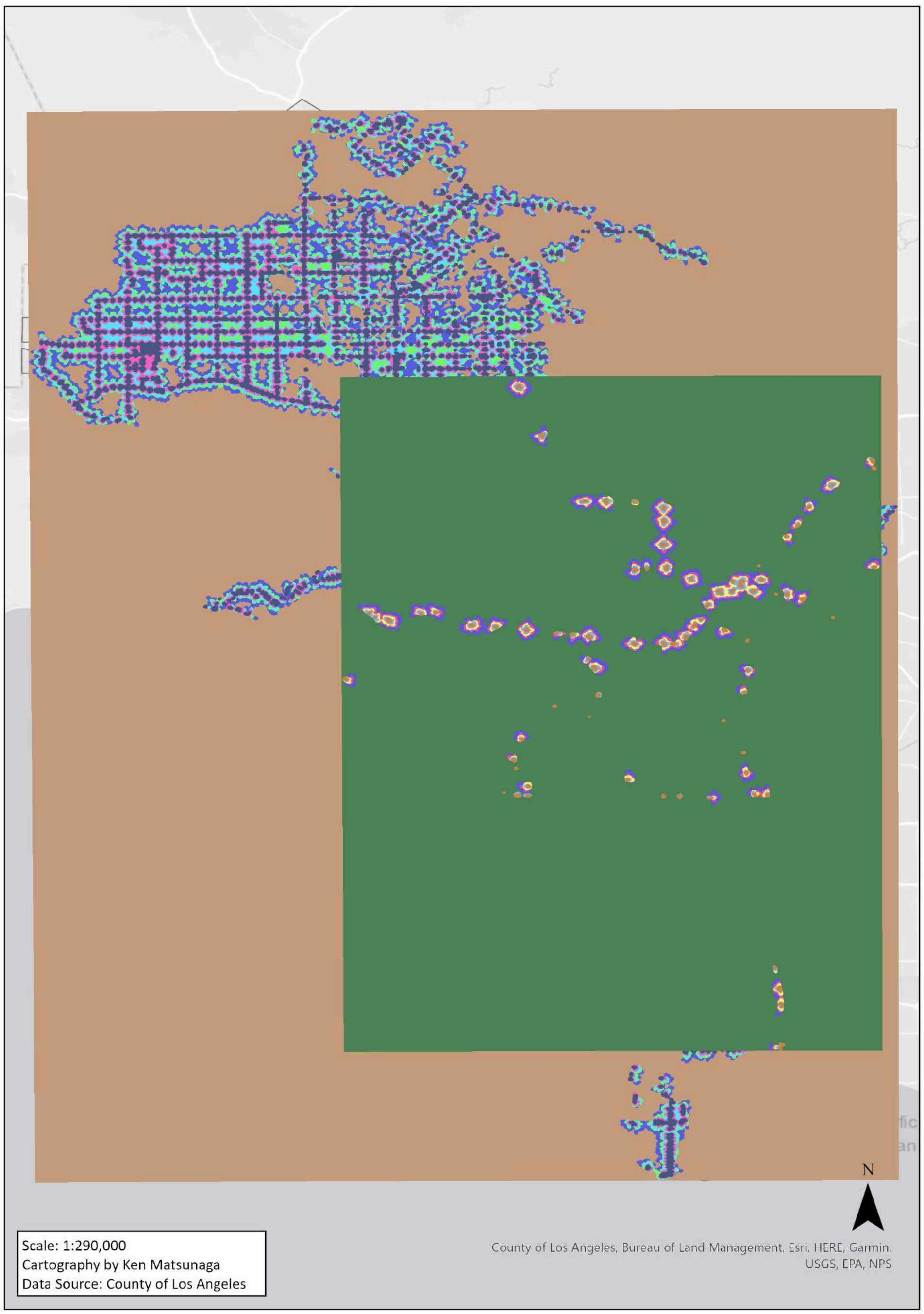
We added the reclassified rasters together using the ‘Raster Calculator’ tool, equally weighting each layer, to get our final result displayed in Map 12 below.

***Map 12: Combined Accessibility Analysis***



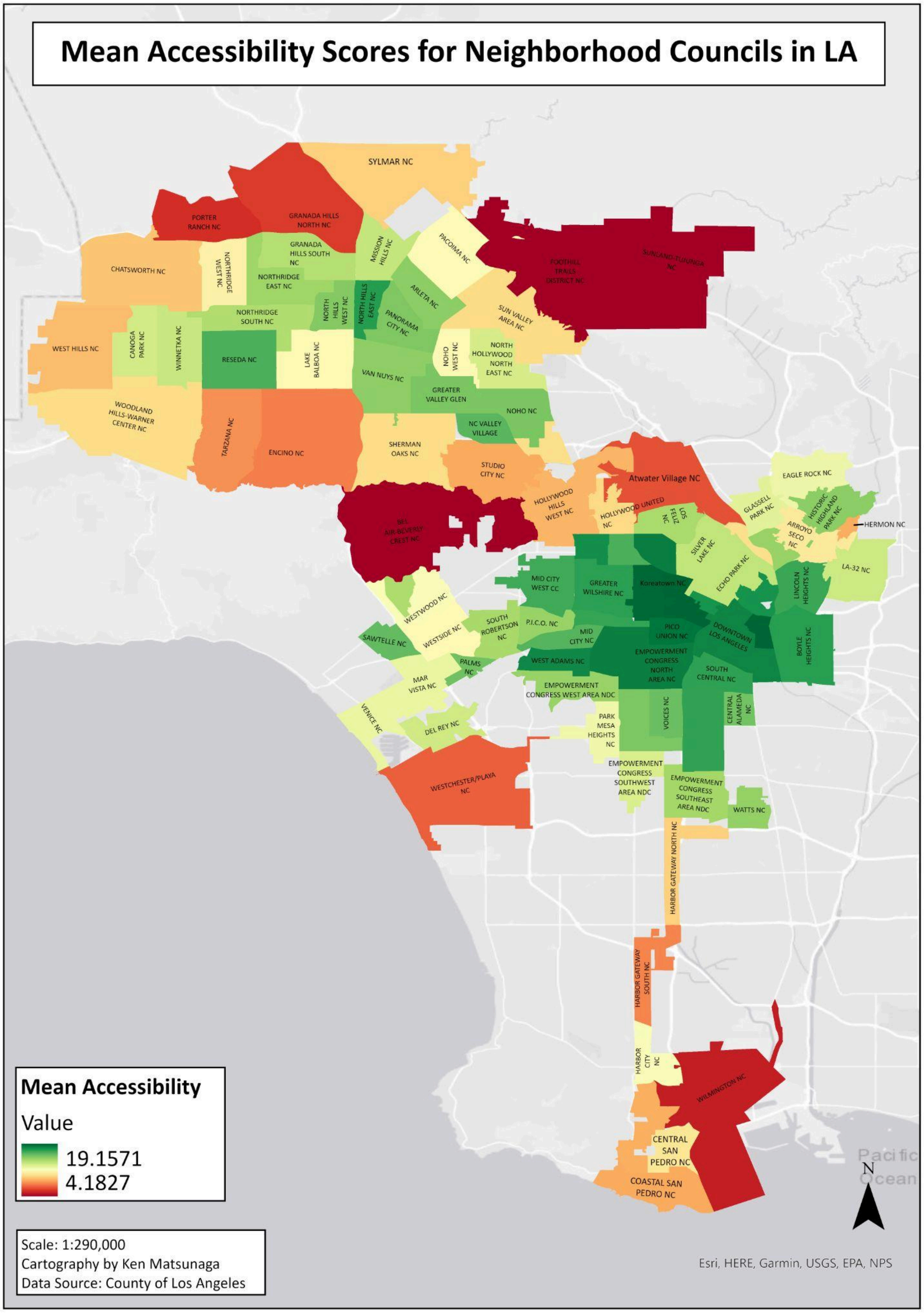
We encountered several challenges when producing this final accessibility map. Map 13 below shows how the extents of our layers are quite different, forcing us to resize the extent to the largest layer using the ‘copy raster’ tool. This was done so that the ‘Raster Calculator’ tool would apply to the whole extent of our study area.

***Map 13: Illustration of Various Layer Extents***



Using the combined analysis layer and the Neighborhood Councils layer from the City of Los Angeles GIS Hub, we used the ‘zonal statistics’ and ‘zonal statistics as table’ tools to investigate the mean accessibility scores for each neighborhood council. Map 14 below shows the final results. The neighborhood of Pacific Palisades was not included in the Neighborhood Councils layer. According to our analyses, Foothill Trails District NC, Bel Air-Beverly Crest NC, Sunland-Tujunga NC, Sunland-Tujunga NC, and Wilmington NC have the lowest combined scores in the City of LA.

***Map 14: Accessibility by Neighborhood Council***

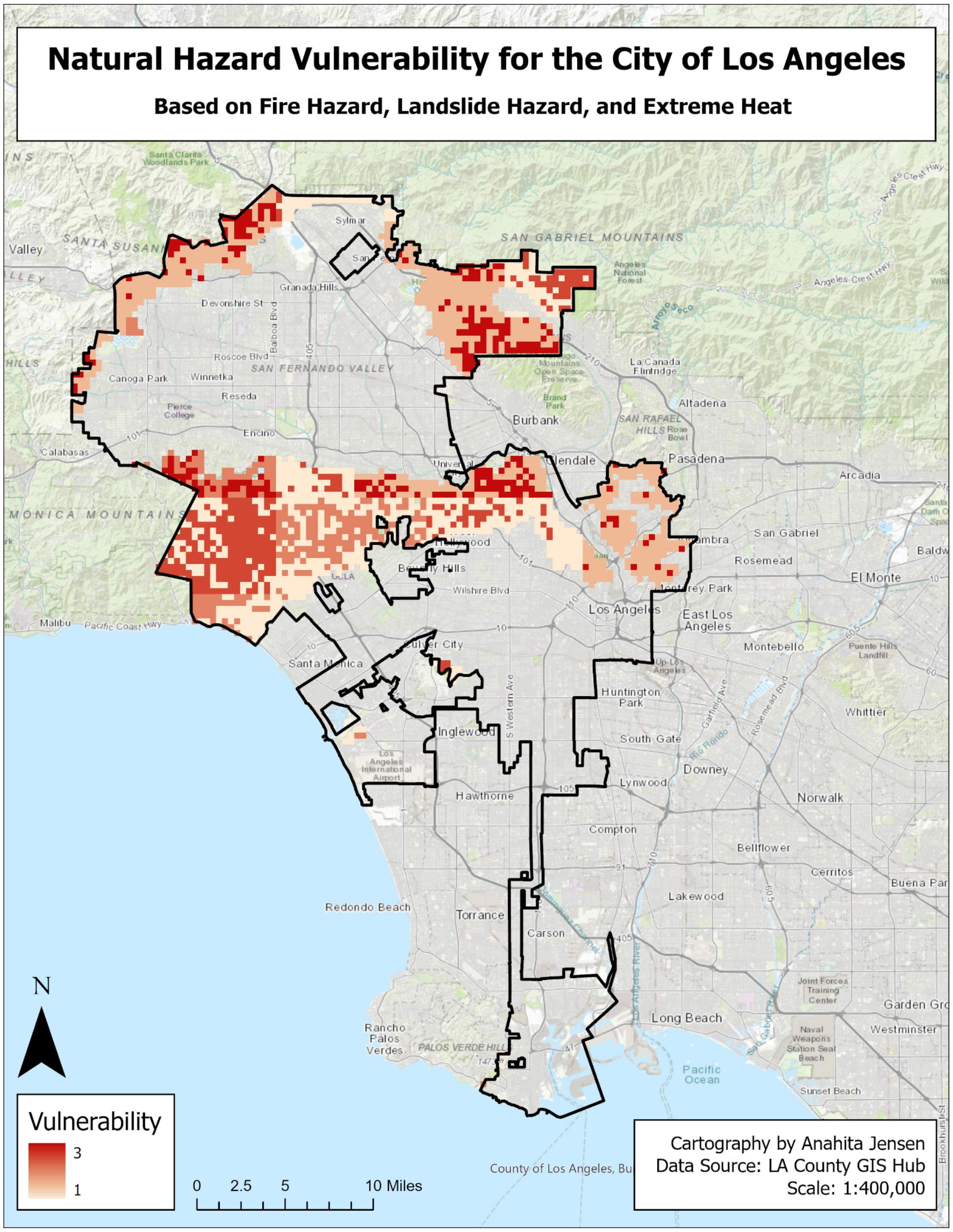


## Natural Hazard Analysis

Natural Hazard Vulnerability

In addition to conducting network analyses of public services, it is critical to understand if certain regions are threatened by natural hazards in order to ensure our recommendations for additional services are understood from all aspects. The Los Angeles region has traditionally been subject to wildfires, landslides, and extreme heat, so we took these three factors into account when developing a natural hazard vulnerability map. All three data layers were obtained from the LA County Enterprise GIS Hub, titled 'Landslide Zones', 'Fire Hazard Severity Zones', and 'Extreme Heat Low Emissions RCP 4.5'. All layers were checked and transformed into rasters to prepare for reclassification. Then, individual layers were reclassified based on the level of hazard. Finally, the reclassified layers were added together using the Raster Calculator tool to create the vulnerability map of LA County and the City of LA.

***Map 15: Natural Hazard Vulnerability***




One thing to note is that, while public accessibility is lowest in the Santa Monica Mountains, where natural hazard vulnerability is the highest, this doesn't necessarily indicate that this region needs improvements in accessibility. The Santa Monica Mountains are not densely populated, and therefore will not have many public services, simply because there is no population to service. So, natural hazard vulnerability for this region is irrelevant as there is no need to improve accessibility.

**Discussion**

Examining Table 2 below, which depicts the 4 neighborhoods that have the lowest mean accessibility, it is clear that there is one outlier. The Bel Air - Beverly Crest neighborhood is one of the wealthiest neighborhoods in Los Angeles (Map 2), and most residents within it have ample access to resources, yet according to the six factors we selected, it is designated as one of the lowest accessibility zones in the country. While one could argue that this reflects a gap in our methodology as we do not factor in median income into our final suitability analysis, this result could also show how wealthy neighborhoods are often designed in an exclusionary way which does not allow for lower income people to access them. One factor which contributed to this low score for the Bel Air-Beverly Crest neighborhood is the lack of pedestrian walkways within it. Additionally, the neighborhood has almost no public transit options within it. While the average resident in Bel Air is likely to be able to afford a car, this means Bel Air is only there for the people who can afford to live within it– not for the entirety of LA.

***Table 2: Los Angeles Neighborhoods with Lowest Accessibility Scores***

| NAME | Pixel Count | Area | Min | Max | Range | Mean |
|---|---|---|---|---|---|---|
| FOOTHILL TRAILS DISTRICT NC | 2425205 | 545671125 | 0 | 15 | 15 | 4.182704143 |
| BEL AIR-BEVERLY CREST NC | 2110805 | 474931125 | 0 | 19 | 19 | 4.479355507 |
| SUNLAND-TUJUNGA NC | 1481049 | 333236025 | 0 | 18 | 18 | 4.509975024 |
| WILMINGTON NC | 2031241 | 457029225 | 0 | 20 | 20 | 5.555618462 |

Our project aims to provide a holistic understanding of the accessibility of public services within the City of Los Angeles. We began by creating demographic maps for the city and county, to better understand the socioeconomic makeup of the area, as public services are often equally distributed across different economic and racial groups. One finding of note from this analysis was that census tracts with lower median incomes (Map 2), are also often neighborhoods with large Latinx and Black populations (Map 3). This finding echoes the exclusionary and racist history of the U.S. in general and Los Angeles in specific, where non-white groups have historically been barred from accessing resources which would facilitate upward mobility.

For further background context on the natural environment of Los Angeles county, we performed temperature trend analyses and natural hazard vulnerability analyses. The purpose of these analyses was to determine if any of the neighborhoods we identified as ideal locations for investment based on our public services suitability analysis would face any natural confounding factors which would make development in these areas difficult. However, we found no overlap between the final four neighborhoods we identified as in most need of accessibility improvements and areas identified as most vulnerable to natural hazards (Map 15). Additionally, the temperature trend map (Map 1) shows that there has been a downward trend in temperature in LA over the covered time period, which led us not to include extreme heat as a factor in our analysis. However, as the impacts of the climate crisis worsen, it would be prudent for future iterations of projects similar to this one to incorporate climate modeling and temperature projections into such calculations.

Next, we conducted a suitability analysis based on service area analyses of crucial public services. We focused primarily on walking accessibility, as, barring any mobility issues, this is a mode of transport that is not dependent on having the necessary funds required to own and maintain a car. This combined analysis allowed us to isolate four neighborhoods with the lowest accessibility rating– all of which, barring Bel Air-Beverly Crest, are low-income neighborhoods with high proportions of residents of color. This underscores the importance of an intersectional approach when determining ideal locations for public investment, which is an aim for which this project is designed.

Finally, to ensure that our workflow is clear and to allow for similar analyses to be run in different urban areas, we constructed various models in ModelBuilder to perform the suitability analysis. This ensures that other academics, residents, or simply interested parties with access to ArcGIS Pro and the relevant data layers can also discover areas most in need of improvements in public accessibility in places outside of L.A.

**Potential Contributions of Our Work**

Our analysis is best suited to be used as a guide for government investment in neighborhoods. While actual development of such a project would require more qualitative research collection– potentially in the form of resident interviews or community town halls– the analyses we conducted serve as a good baseline for identifying areas in which there is a need to improve accessibility, and then working from there most specifically to see how those living in the neighborhoods or in LA believe accessibility should be improved. Especially given that there are various services we factor into our analysis, isolating what need is most pressing to each individual community would be prudent.

Our project could also be expanded in scope to be more comprehensive. There are various methods through which this could be achieved. On the public services side, we could add additional facilities through which to measure availability and accessibility of services, such as libraries and cooling centers. On the natural environment side, we could employ climate modeling and temperature projections to better understand which neighborhoods are predicted to be most vulnerable to the impending impacts of climate change. This would be a beneficial addition to this project as it could help guide climate resilient investment.

**References**

Aram F, Higueras García E, Solgi E, Mansournia S. *Urban green space cooling effect in cities.* Heliyon. 2019 Apr 8;5(4):e01339. doi: 10.1016/j.heliyon.2019.e01339.

CNR Web. (2022, April 20). *How Green Spaces Can Improve Your Health*. College of Natural Resources News. https://cnr.ncsu.edu/news/2022/04/parks-green-spaces-improve-health/

Countywide Parks and Open Space (Public - Hosted). (2023). Internal Services Department Enterprise GIS Section. County of Los Angeles. https://egis-lacounty.hub.arcgis.com/datasets/840b3da17e844486b3bafaae6eda87d4/explore?location=34.084523%2C-118.138582%2C8.56

Demography and Employment & Income. (2022). Neighborhood Data for Social Change. https://la.myneighborhooddata.org/data/

Extreme Heat Low Emission RCP 4.5. (2021). Private Member. County of Los Angeles. https://egis-lacounty.hub.arcgis.com/datasets/24f37a4ad8764a5494c1cbed89319b57_0/explore

Federal Highway Administration. (2004). The Importance of Public Transportation. In *2004 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance* (Report No. 6, pp. 14-1 – 14-9). U.S. Department of Transportation. https://www.fhwa.dot.gov/policy/2002cpr/pdf/ch14.pdf

Fire Hazard Severity Zones. (2023). Internal Services Department Enterprise GIS Section. County of Los Angeles. https://egis-lacounty.hub.arcgis.com/search?collection=Dataset&q=fire%20hazard

Hao, L., Xu, X., Dupre, M.E. et al. *Adequate access to healthcare and added life expectancy among older adults in China.* BMC Geriatrics 20, 129 (2020). https://doi.org/10.1186/s12877-020-01524-9

Hospitals and Medical Centers. (2022). Internal Services Department Enterprise GIS Section. County of Los Angeles. https://egis-lacounty.hub.arcgis.com/datasets/e1c036f968194a979c2543481c6a4c64_81/explore?location=33.792274%2C-118.295000%2C7.63

LA Metro. (2024). *GIS data*. Metro Open Data. https://developer.metro.net/gis-data/

Landslide Zones. (2022). Internal Services Department Enterprise GIS Section. County of Los Angeles. https://egis-lacounty.hub.arcgis.com/datasets/306103cb524845368d5ae2923fbdccb3_8/explore?location=34.211616%2C-118.341005%2C8.62

Neighborhood Councils (Certified). (2020). Internal Services Department Enterprise GIS Section. County of Los Angeles. https://geohub.lacity.org/datasets/9c8639737e3a457a8c0f6a93f9c36974_18/explore?location=34.135827%2C-118.256373%2C10.00

Nicholl, J., West, J., Goodacre, S., & Turner, J. (2007). *The relationship between distance to hospital and patient mortality in emergencies: an observational study.* Emergency medicine journal : EMJ, 24(9), 665–668. https://doi.org/10.1136/emj.2007.047654

Schools (LAUSD). (2016). Los Angeles GeoHub. City of Los Angeles Hub. https://geohub.lacity.org/datasets/lahub::schools-lausd/about

Valentine, A. (2024, June 7). *Car ownership statistics 2024*. Forbes. https://www.forbes.com/advisor/car-insurance/car-ownership-statistics/#ownership_statistics_section