[Demographics and Fire Department Response Times]

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Abstract

The purpose of this research is to determine whether there is a correlation between firefighter response times in medical situations and demographics such as race, income, and non-English speakers in the city of Seattle. Our research questions were "How does the response time for fire emergencies compare from actual response times to predicted response times based on the location of fire stations and the road network?" and "How does availability of emergency response vary in different areas across Seattle?"

We take a look at response times from the Seattle Fire Department and demographic data for the last three months of 2017 and compare them using GI Hot Spots. Upon examining the maps created, there seems to be slight to no correlation between demographics and response times. Most of the slower response times are in areas such as Greenwood and West Seattle while some of the faster response times are in areas such as downtown Seattle and the Industrial District. We would need to create more or relocate fire stations in order to decrease response time for areas with slower times.

Introduction

In an emergency situation, the difference between a person living or dying could be only a matter of seconds. The distance between the fire station and the incident can affect how quickly firefighters can respond to these incidents. The purpose of our research is to determine if there is a discrepancy between the predicted time it should take for firefighters to arrive at a destination and the actual time it takes them. We based our research on the city of Seattle for the months of October through December of 2017. “Optimising the Spatial Location of Urban Fire Stations” by Murray A, will help us explain the proximity of fire station placement in Seattle. We will then use this data to determine whether there is a discrepancy in times based on areas that are of lower income, of larger minority, and have more non-English speakers.

To reduce the amount of data we would need to analyze, we looked through each of the incidents and decided on using aid and medical responses as our data source. We chose this incident because out of all the incidents, aid and medical responses were the highest responses out of all the data. It also insured that we have data not only from public spaces but homes as well. Using North Shore Fire Rescue’s “Firefighter’s role in a Medical Response”, we will explain the reasoning behind firefighters responding to medical situations.

The Environmental Justice Tool was used to referred to the percentages of the population to help us with our analysis. “Mapping fires and American Red Cross aid using demographic indicators of vulnerability” by Evan Lue and John P. Wilson given ideas as well for how to use household income and non-English speaking population to map out and analyze how the two factors may affect medic response times. It help led to our idea of our low-income map (Figure 1), but instead of having income tiers we decided to focus on the low-income group figuring it would be easier to analyze.

What we hope to obtain from the research was determining whether there was a discrepancy in the times for certain areas based on race, income, or non-English speakers. Using the “Seattle Fire Department Annual Report 2016” to explain fire station building and costs, we would then be able to determine whether we need to relocate fire stations to better suit the location or create more based on this.

Data Sources

For all the maps, we used data from both “census.gov” and the Seattle Fire Department. As the main point of interest, we used a “neighborhood shapefile” from the U.S. Census for the city of Seattle. We also used data from the Seattle Fire Department that contained incident reports from October-December 2017.

For the three demographic maps Figure 1, 2, and 3, we used census data from the Environmental Justice and Screening Tool. This data is comprised of 2010 Census Tract Information. We focused on the percentage of population for each of the datasets since it would be better for analysis over the total population in that census tract.

For the map “GI Hot Spot” and “Local Moran’s I” we used data obtained from the Seattle Fire Department. The Seattle Fire Department data contained information on (x, y) coordinates for destinations where each of the calls were made. This helped plot the data onto the Arc Map, but we still had to change the coordinate system itself because the neighborhood data we used and the plots were in separate coordinate systems. So we set both of our data in State Plains for Washington North side. This was not the end of the conversion for our data because we then had to join the datas together with excel first since our data came in “strings”. We used the times for “when the first unit was notified” and for “when the first unit has arrived” as the starting and stopping point of our response times. We then created an “elapsed time of response” by finding the difference in the two amounts, right after obtaining the value for the “elapsed time of response” we then had to create another column where we did predicted time minus

actual time and used this data as our main source for the data clusters of the map (Seattle Fire Department).

Going through the different situations that we want to analyze for firefighter response times, we decided to work with medical response data. We chose this data over fire emergencies not only because most of the calls that were given from Seattle Fire Department data were medical emergencies but we needed data that was focused on public and private areas. “In fact, 75% of our calls are for medical emergencies” (North Shore Fire Department). People may think that Hospitals are the only ones who respond to medical emergencies but more frequently, firefighters respond. This is because there aren’t that many hospitals in Seattle. In total, there are only 8 hospitals in Seattle compared to the 33 fire stations. Meaning that if hospitals were the only ones to respond to medical emergencies, not only would they be overloaded with requests but it would take them a large amount of time to arrive at each destination. Not only that, but firefighters have the ability to perform a number of actions such as “administering an electric shock and drugs to restart a heart, inserting a breathing tube, or extricating an accident victim, from a crushed vehicle while simultaneously treating their injuries” (North Shore Fire Department).

Methods

For the demographic maps we created percentages of the people who are low income, non-english speaking and minority. We did this by dividing the population of interest by the total population. Then we mapped these by percent on a census tract level with Natural Jenks as our classification method. Natural Jenks allows us to map the areas where the data is clustered in. We used 5 classes. We chose to use five classes so the readers would be able to see the variation in data while not being overwhelmed by it having too many classes. 5 was a good medium. We then layered point data of the locations where the incidences happened. We chose to do this because it specifically showed readers where the calls were made. This would allow readers to see a underlay of low income/non-english/minority while also being able to see the calls on top. We also chose to do an inset of the map in places where there was a dense concentration of calls being made so users could see the data in those areas without it being covered up by the point data. Our reasoning behind mapping non-english speakers was to see if people who were unable to speak the language did not call the fire department.

For the map “GI* Hot Spots”, we used the cluster and outlier analysis in order to determine GI* Hot Spots. We used this data in order to determine where different clusters of data are occurring. If there are clusters of data, we will determine if there is a pattern of times that are very fast or very slow. This will allow us to determine if there is sufficient coverage for fire stations in each area. For the Blue colored dots in Figure 4,

those are times where the respondents were slower and red are where the cluster of respondents were faster.

For the map “Local Moran’s I, We used local Moran’s I to determine whether the clusters of data from the map “GI Hot Spots” are just random occurrences or if there are patterns occurring. When we did the Local Moran’s I test we did find out that the data was clustered.

Findings

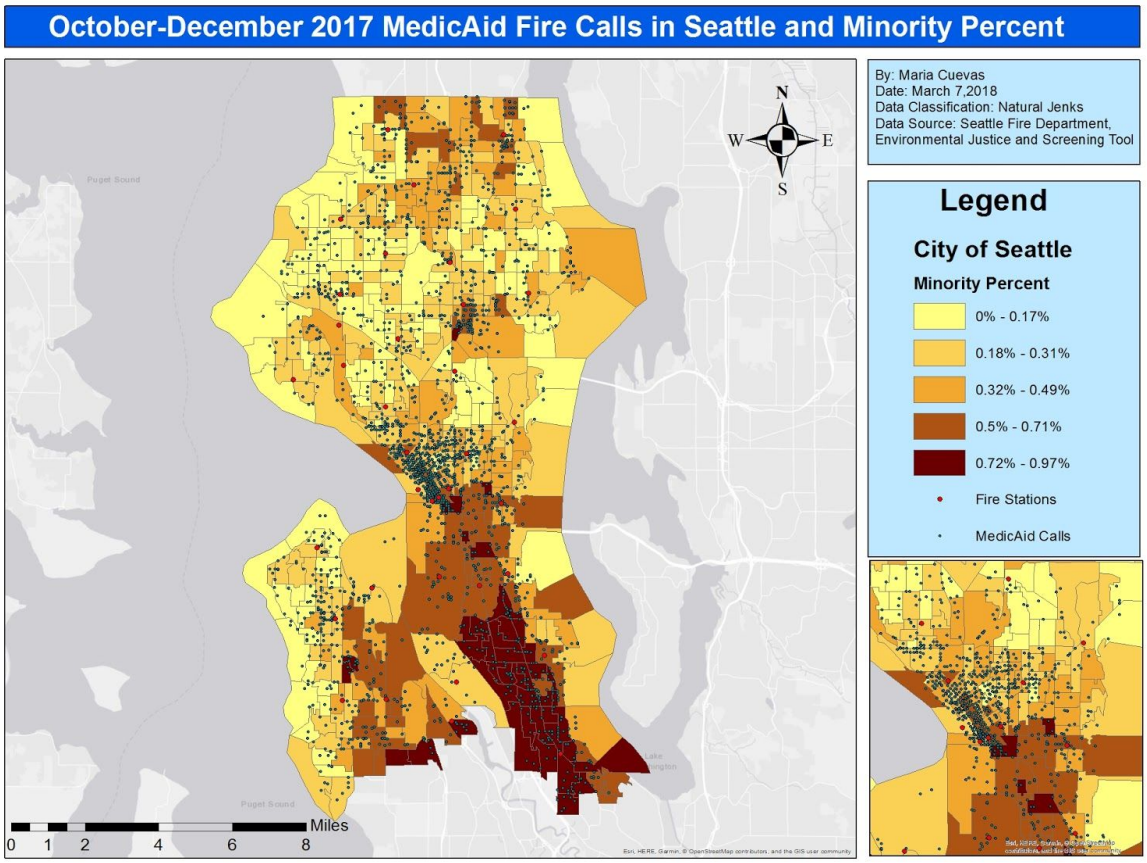
Comparing the three maps showing each of the demographics to the map “GI Hot Spot”, there seems to be “low” clusters in the areas of Seattle, Northgate, and the Industrial District meaning there are much faster response times in those areas. There seems to be hot spots in areas such as Greenwood, South Rainier Valley, and West Seattle meaning there are much slower response times in those areas. Comparing the hot and cold points, there seems to be larger and more frequent hot spots than cold spots. But cold spots are much more spread out throughout Seattle.

We can conclude comparing the maps together that there is a slight to no correlation between the three demographics and fire station response times. When comparing the areas of hot and cold clusters compared to “October-December 2017 Medicaid Fire Calls in Seattle and Low Income Percent”, there are areas that are of low income that have some of the fastest response times in Seattle and some of the slowest times. Northgate is an area that has a very high low income percentage but has some of the fastest response times and is surrounded by fire stations while Greenwood which is right next to Northgate and has a very high low income percentage has some of the slowest response times. There are also areas that don’t have a high low income percentage that have slower response times. Downtown and the industrial district have some of the fastest response times but have the highest low income percentages. The only difference between downtown and other large low clusters is that downtown has the highest amount of calls that come in compared to other areas. But an area like

West Seattle, has a slow response time but has a lower low income percentage compared to other areas of Seattle.

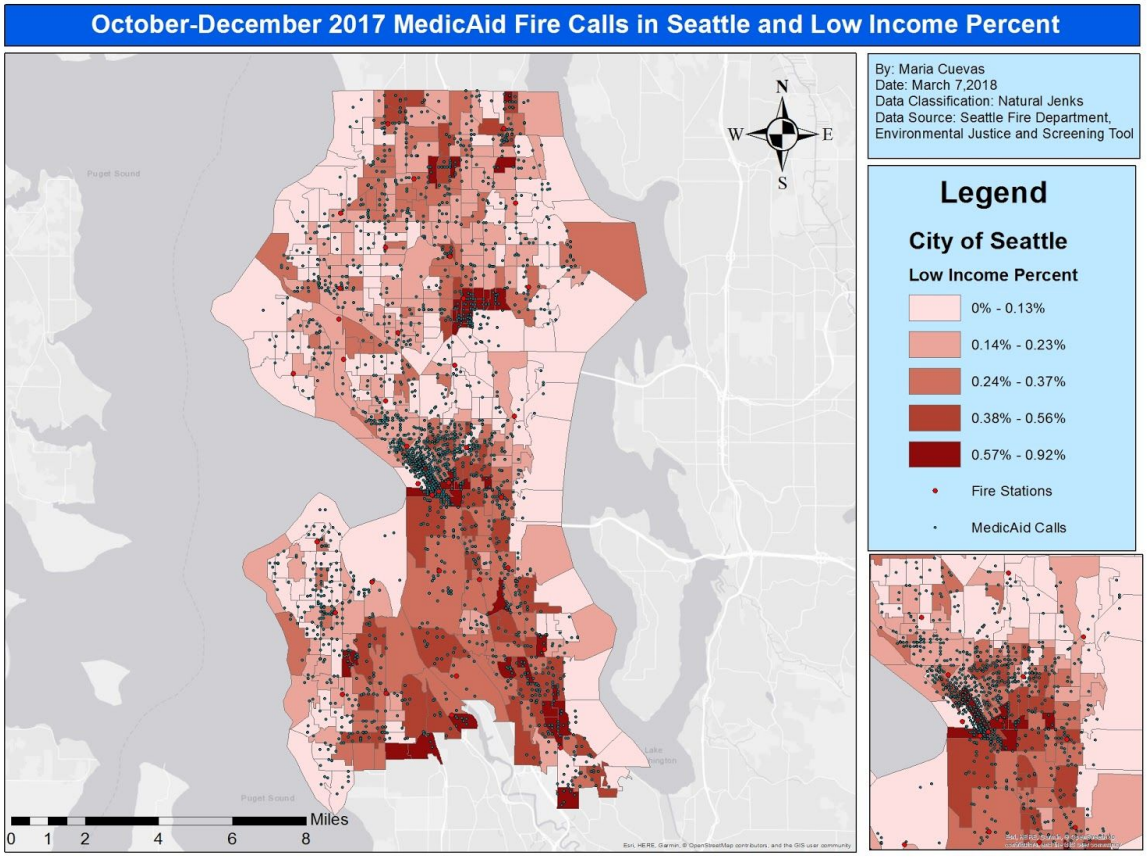
The same could be said about the other two demographic maps. There is a very similar correlation when relating the other two maps to the GI Hot Spot Map. The areas with the highest minority rate and Non-English speakers are Beacon Hill and downtown. Beacon Hill has no significant response times except in small areas but no clusters while downtown has faster response times.

Figure 1: MedicAid Fire Calls in Seattle and Minority Percent



As seen in Figure 1, there is a large amount of minority population in the Beacon Hill area vs up north near Pinecrest etc. There seems to be a concentrated amount of calls which occur where there are minorities, this could be because people who are minorities often are low-income and cook at home because its more affordable than eating out. This could cause minorities to use their stoves more often. Often times the heat source from this is from gas as these are the older models. Leading to heat being used more and making it more likely that a fire medical aid to be called. In addition there could also be the possibility that minorities live where there are not fire alarms that function which could turn a small fire they could put out into a big fire they they need firefighters for.

Figure 2: MedicAid Fire Calls and Low Income Percent



As seen in Figure 2, there are a large amount of calls which occur in the downtown Seattle area. This area in downtown seems to have some census tracts which have a mixture of both high and low income populations. This could be because of the large amount of homeless people which live in the downtown area. There is also a cluster of large amount of calls in South Seattle. There is a correlation among where the fire calls happen and being low-income. This could be possibly due to how people in low-income areas may not be living in places where they are equipped with fire extinguishers.

Figure 3: MedicAid Fire Calls and Non-English Speaking Percent

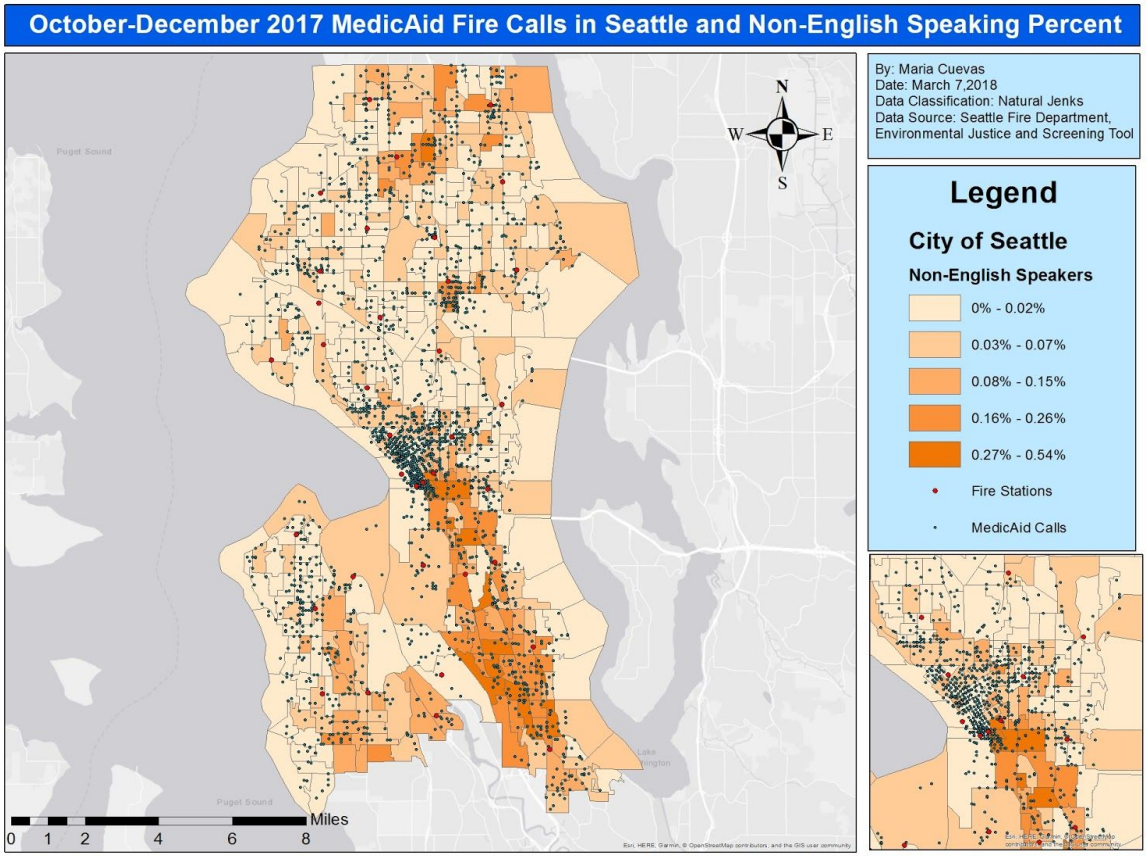


Figure 3, shows the percent of people who do not speak English very well compared to the total population of each area along with an overlay of places where fire calls were made. As seen in the inset map, in the downtown area there seems to be a place south where there seems to be a drop in calls which are made. This shows that because people are not english speakers its likely they didn't call during a fire emergency. A possible reason why people do not call is because they could be undocumented and fear calling the fire department because they could be deported. In addition it could also be that they don't call because they know they won't be understood. Also, it could be that non-english speaking parents ask their children or neighbors to call for them. Perhaps that is one the ways that non-english speaking families are still able to overcome that language barrier and still have fire medicaid be contacted.

Figure 4: GI* HotSpot Clusters

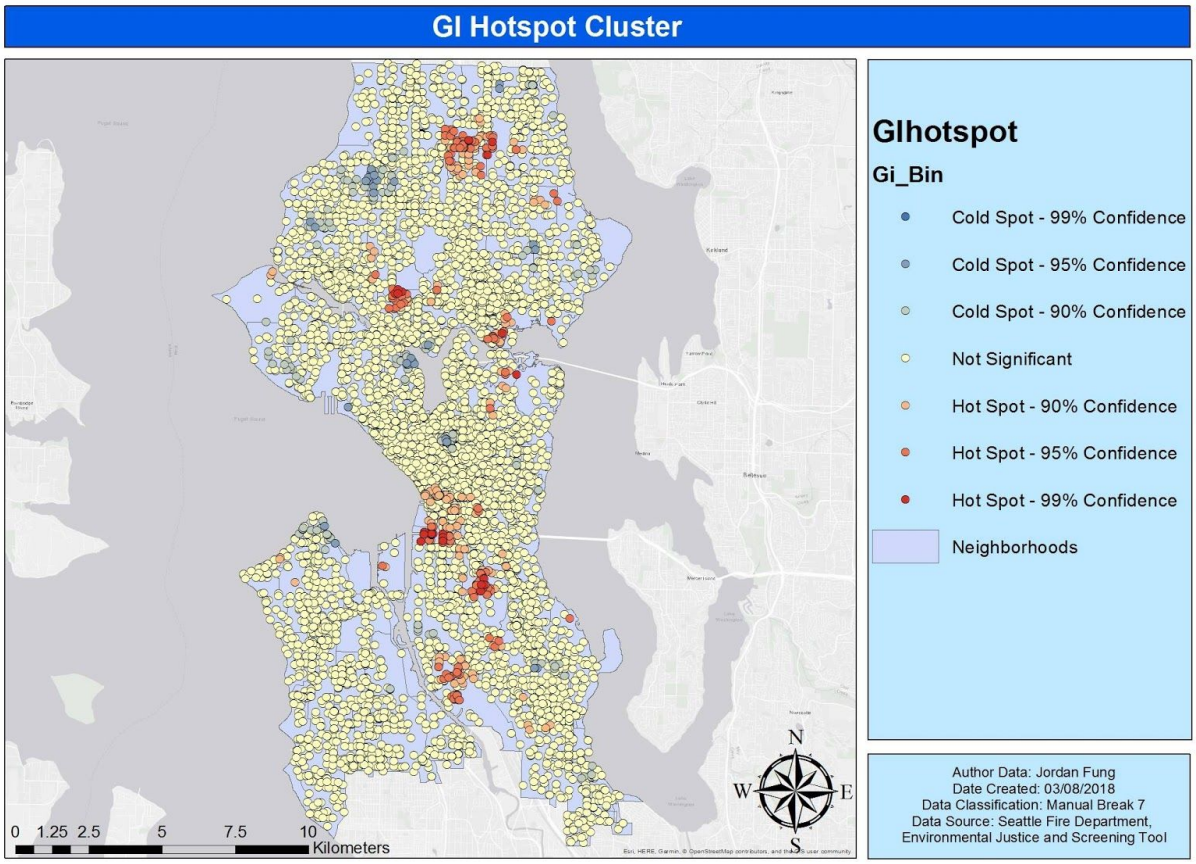


Figure 4, shows hot and cold clusters of data points for the area of Seattle. The hot clusters of the map represent areas that have a much faster response times than other areas. The cold clusters of the map represent areas that have much slower response times than other areas. The confidence level represents how likely this cluster of data is a pattern and not just a random occurrence. Since in this project we are interested only in the 95% of confidence and it does show that our clusters are not random at all. It also seems that we are serving areas where there are higher levels of minorities, this shouldn't be a surprise since King County or even the Seattle Area we do try our best to serve those who are less fortunate.

Figure 5: Local Moran's Is Analysis of Predicted Time

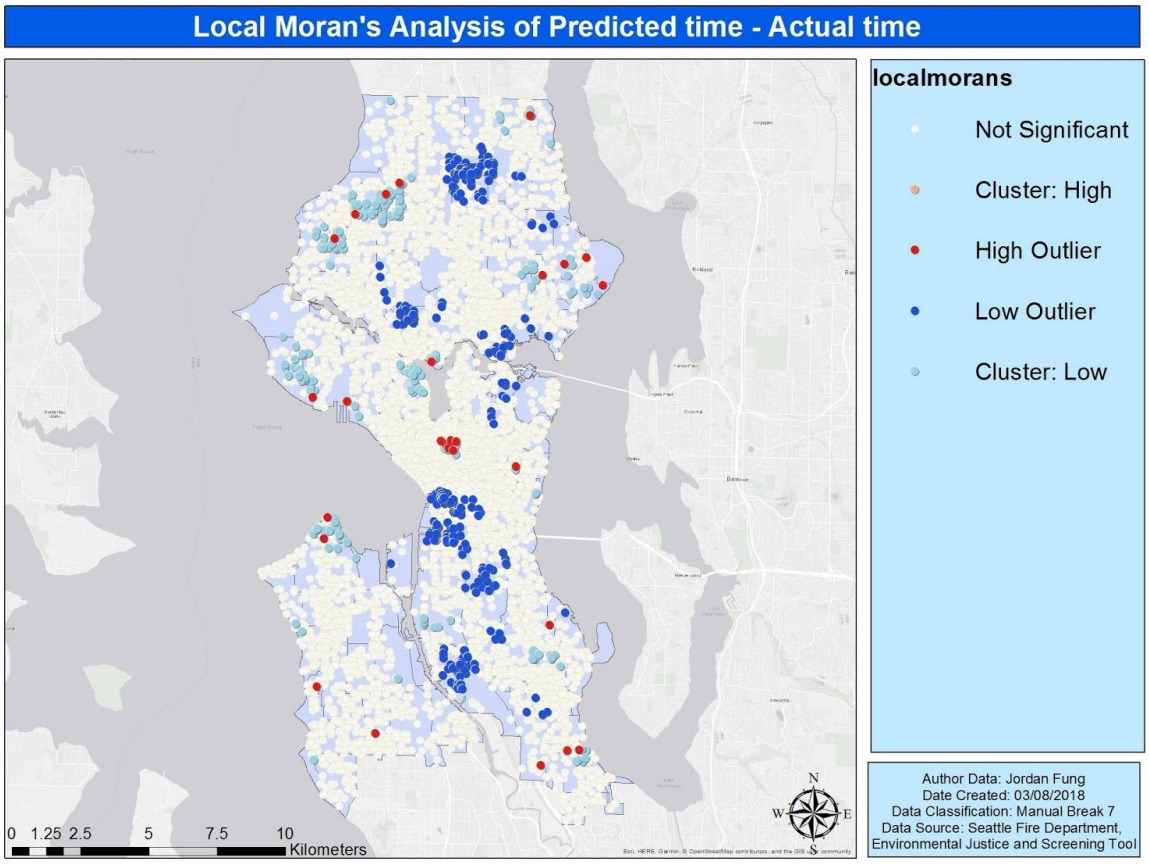


Figure 5, represents areas that have much higher z scores compared to the standard deviation than other areas in Seattle. Low outliers are areas that have much lower z-scores than other areas and represent areas that have a much faster response time. High outliers are areas that have much higher z-scores than other areas and represent areas that have a much slower response time. These differences in z-scores represent less than a 1% chance lower or higher of being a random occurrence. Also in my map I used a fixed distance and threshold band of 0 and where the Moran's I calculated 3465.0569 US feet for neighboring dots in each census block of the king county neighborhood shapefile. I chose a fixed distance because I wanted the data to leave out more insignificant data so we can focus more on the data that we find more significant.

Figure 6: MedicAid Fire Calls with Total Population per Census Tract

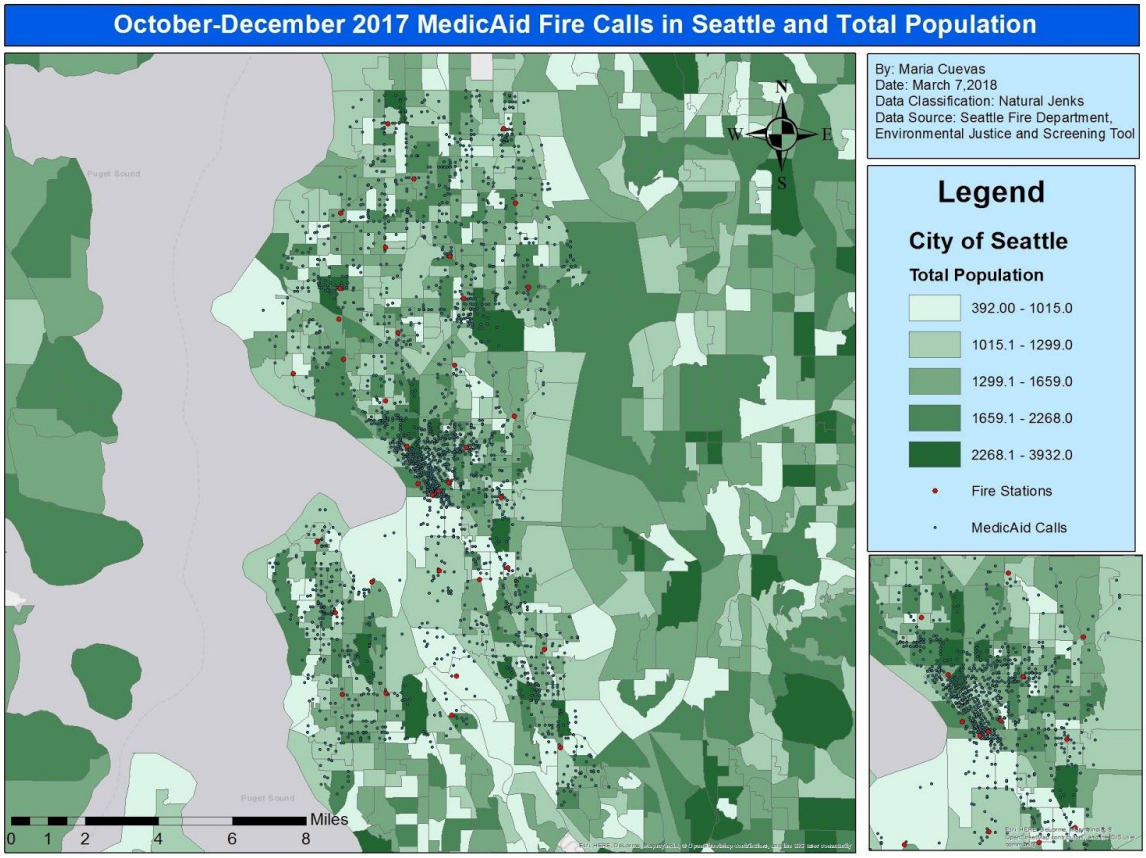


Figure 6, shows the total population of each area in the city of Seattle. In areas such as Northgate and downtown Seattle where response times are faster, there is a much larger population. While areas such as upper West Seattle and Greenwood where response times are slower, have a smaller population.

Conclusion

The research shows that there is no correlation between demographics and response times for each of the neighborhoods. In fact, several areas that have high minority, low income, and non-English spoken rates have some of the faster response times. But there are certain areas that have much slower response times. In order to fix this problem, we would need to relocate one of the fire stations next to Northgate and create a fire station near the edge of West Seattle. “The cost of creating a new fire station is roughly 2 million dollars and the cost of relocating one is roughly the same. This does not include the cost of maintaining them early which is roughly 2 million as well” (Seattle Fire Department Annual Report, pg. 14) The cost of this would be roughly 4 million in creation and movement, with an increase in cost of about 4 million annually. So whether or not, the state fixes this problem is based on the amount of finances they are willing to put in to fix this, especially since some of the areas have high low income rates.

Although the places which have minorities in them are served, its important to note that there are a larger amount of fire medicaid calls in areas where there are a large amount of minorities, low-income and non english speakers. There needs to be more research done on why these areas have a large amount of calls vs area where whites and higher income people live.

Even though it is a relief that demographics are not involved, the areas that have slow response times should be resolved, since the difference between saving a life is only a few seconds.

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