Proposing new Hospital Locations to Provide better Medical Service to Minorities in the Greater Toronto Area

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Introduction

This project proposes new sites for the hospitals in the Greater Toronto Area (GTA) using Drive-time Analysis and Multi-Criteria Analysis. It further looks into the visible minority ratios in the Greater Toronto Area, and analyzes how the addition of the new hospitals will help the welfare of these communities. Immigrant communities have frequently taken the brunt of the diminished hospital resources in the region. A study shows, some people spent as much as nine years finding a suitable family doctor (Asanin & Wilson, 2008). The services were being used more frequently by the immigrants and minority groups on a more frequent basis from at least 3 decades back. A study shows that the nature of work amongst the minorities led them to seek the medical services more than the institutionalized populations of Ontario in 1990 (Wen et al., 1996). Multiple cases of social inequality have been reported, and people from minority groups were denied proper healthcare according to a report presented at the Annual meeting of the Canadian Political Science Association (Good, 2004).

Conducting this study on the GTA is significant for numerous reasons. A majority of the population of Canada lives in and around Toronto. To put things into perspective; it is known that Canada receives a high volume of immigrants each year. This population is mainly concentrated in large cities like Toronto (Anise & Lanphier, 2003). In the next two decades, Toronto alone is projected to hold the country's highest count of immigrants in its population. It is expected to reach 46% to 52.8% (Grant, 2017). Within Canada, Toronto is one the largest and quickest growing census metropolitan areas. This is not only the result of immigration, but a steady population growth rate (Xinhua, 2020). This further explains why most hospitals in Ontario are concentrated in this area. The limited number of hospitals in the area are required to provide a service for an immense number of people. This leads to an overwhelming amount of patients in these facilities, which has proven to result in absurdly high wait times, high stress for nurses and doctors, and an increased duration of stay for patients (Bond et al., 2007). Given that Canada's population is highly concentrated around the GTA and the long-drawn-out hospital wait times, the study area is appropriate as a great number of people would benefit from new hospitals.

Healthcare is universal and everyone in the world needs it. Recently, the healthcare system has been under a great deal of stress, especially with rising COVID-19 cases. The latest hospital built in the GTA is the Cortellucci Vaughan Hospital. It was opened in 2021 to assist with COVID relief. This new addition helped, but hospitals in the area were still experiencing an overload of patients. This was the first corporation hospital built in Ontario in over 30 years (Mackenzie Health, 2021). Until recently, the government has not funded or paid much attention to the GTA's healthcare system. In 2016, Ontario's government decided to expand and build new hospitals in Ontario. However, only the Vaughan hospital was built and some were expanded or modernized (Government of Ontario, 2016). Finally on December 1rst of 2021, the Ontario government announced that they will be investing billions of dollars to modernize and expand hospitals within the GTA, more specifically the Trillium Health Hospitals. These are located in and around the Toronto area. The demand for health care services in this area is already high and it is projected to increase by almost seven times in comparison to an average hospital in Ontario (Queen's Printer for Ontario, 2021). Modernizing the current hospitals is a major step as the need for innovation is crucial. Many hospitals are designed around departments and specialties as opposed to patient needs which leaves large areas of the hospitals to be inactive and other areas to have high patient traffic (Rachel et al., 2010). This research is significant as it aims to expand the healthcare system in some of the largest and fastest growing regions in Ontario. Another study shows how an institutional change in the health care system in the early 2000s has already

brought about a huge shift in the services that were being provided. It suggests that the universal health care system has made the system more inclusive for the immigrants and minority groups (Hutchison et al., 2011). This study looks further into the flaws of the health care system in the GTA, and proposes the possible changes.

The type of analysis used in this study is multi-criteria decision analysis using 7 different criteria and weightings taken from a previous paper on hospital allocation. Drive-time analysis is also used in both the criteria of the multi-criteria decision analysis, and the evaluation of the resulting proposed hospital locations.

The research questions are listed below. There are two sets of questions that the project will be looking after. This project hopes to answer the following questions:
- Are the current hospitals in the GTA capable of providing service to the population of the study area?
- How would the addition of new hospitals benefit the minorities?

The objectives of this course are framed to achieve the optimal outcomes for the questions asked above. The research questions are listed below:
- ☐ **Objective 1:** Determine whether the current hospitals in the GTA are capable of providing services to the region's current population using Weighted Multi-Criteria Analysis.
- ☐ **Objective 2:** Propose new locations and examine the increased medical services coverage for the minorities in the Greater Toronto Area.

Methods
Study Area
This study will be conducted for the GTA, otherwise known as the Greater Toronto Area. This is located in Southern Ontario and its extent can be seen in the figure below. Within these boundaries, there are 5 regions; Halton, Peel, York, Toronto, and Durham region. This study area is important given the population density of these regions. Within the GTA, there are 7.1 million residents as of 2020 and this number is projected to grow. By 2046, the GTA is predicted to nearly reach 10 million residents. This is the result of a 40.9% growth in the next 15 years (Ontario Ministry of Finance, 2021). Concurrently in 2020, Ontario's population was just under 15 million, at around 14.7 million people (Government of Ontario, 2021). This means that the Greater Toronto area accounts for nearly half of the population in Ontario. With that in consideration, there are 33 non-specialized hospitals within the study area. These are hospitals that are open 24 hours a day and are not restricted to specific care. The hospitals considered in this analysis are within a 7125 km^2 area (Reddy, 2002).

Recently, the healthcare system has exceeded the number of patients that it can and should handle. This leaves the hospital no choice but to transfer patients to other facilities, which wastes time and resources. A study found that in the first 9 days of April 2021, during the pandemic, 130 adults who had critical illnesses were forced to be transferred out of the overflowing hospitals (Yang & Ogilvie, 2021). This issue of long wait times and exceeded capacities has been a problem even pre-pandemic. Various hospitals and doctors have revealed this issue as a concern of theirs in the past. A study done in 2018 found that hospitals operating at over 100% capacity and overcrowding in Ontario has become a normal occurrence (Gillies et al., 2018). Even more recently, but still pre-pandemic, Etobicoke General Hospital and Brampton

Civic Hospital were handling more patients than they should handle. In the first 6 months of 2019, the emergency department at Etobicoke General Hospital was operating at 106% capacity while Brampton Civic Hospital was running at 104%. Concurrently, their medical and surgical beds were both working at 106% capacity (CBC News, 2019). OHA, or the Ontario Hospital Association, defines the international standard that a hospital should be operating at is about 85% to leave extra room in case there is a sudden spike in patient volumes (Ontario Hospital Association, 2018). Currently, the health care system in the GTA is not struggling to serve its residents at a reasonable rate. Within the study's boundaries, the number of patients will certainly continue to grow as population increases. It will begin to spread further outside of Toronto and surrounding areas. As seen in figure 2 below, a majority of the hospitals are within the Toronto region, and the southern part of all other regions. This is due to the high population concentration in that area. It is notable that the hospitals in that area are under more stress because of the high population density. These hospitals are undoubtedly operating at a concerning level. Delaying the construction of new hospitals may be harmful to the patients that have to wait a significant amount of time to be admitted. Population density is a major factor in determining optimal locations for new hospitals.
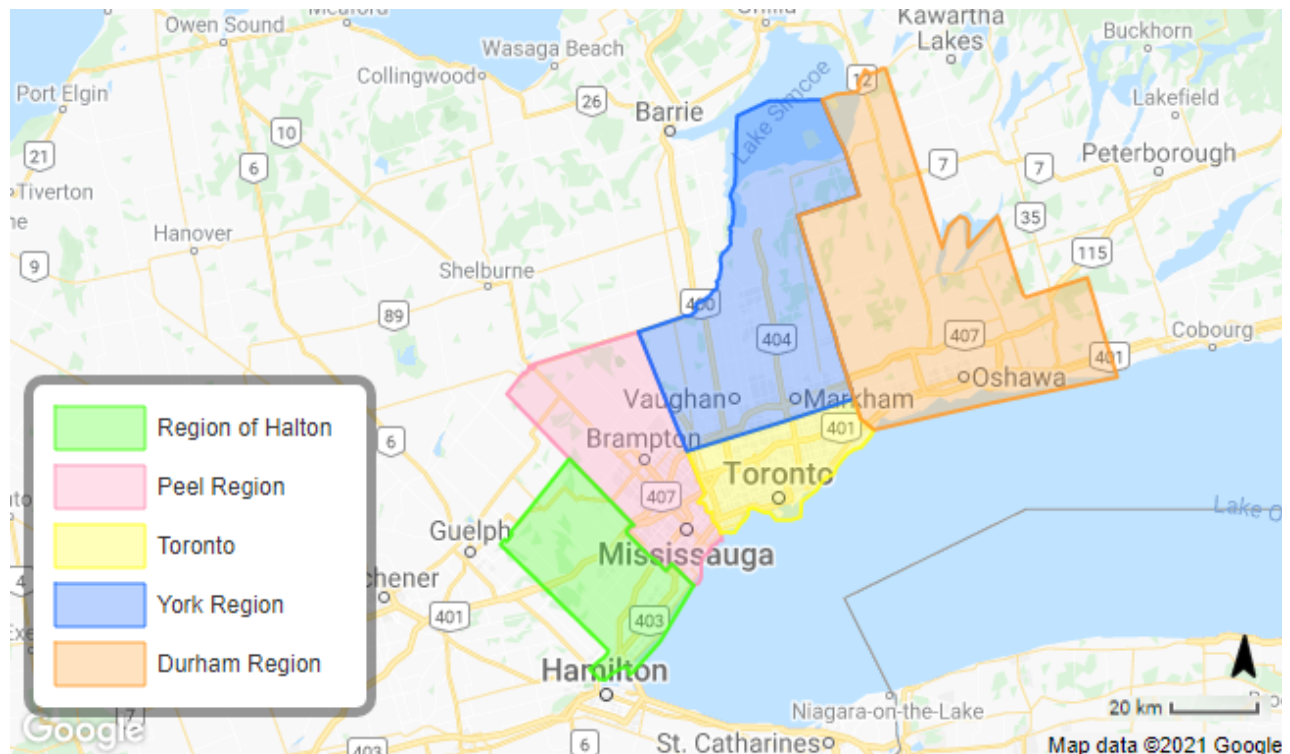

Figure 1: Map of the Greater Toronto Area and the Regions within it, located in Southern Ontario
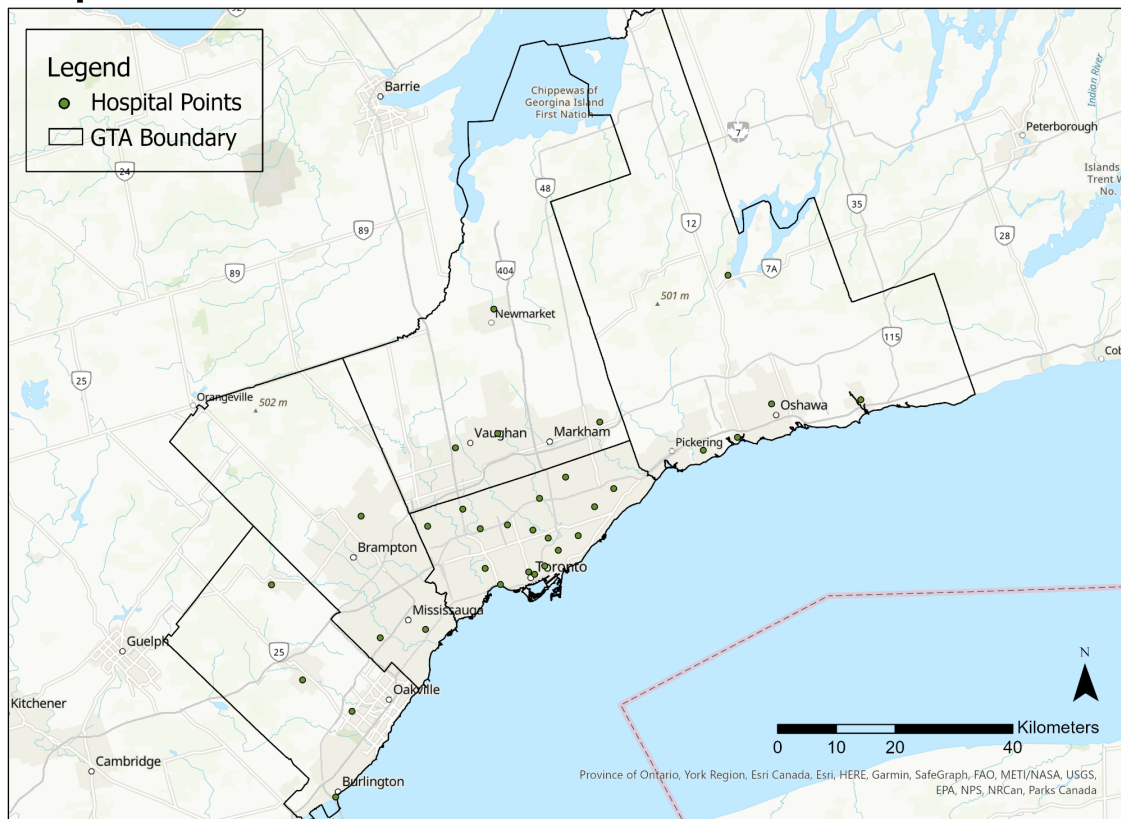
Hospital Locations within the GTA

Figure 2: Hospitals within the GTA Regions

Data

The main focus of this analysis is to find beneficial locations for new hospitals in the Greater Toronto Area. Naturally, the existing hospitals within the GTA boundaries will be considered in the final result to ensure the new proposed locations are not too close to current facilities. The most recent operating hospital built is the Cortellucci Vaughan Hospital. Nearly all the data gathered for this research was obtained from official Ontario government websites in order to ensure high quality and accuracy. As mentioned before, 33 hospitals were included for this analysis. This point data was downloaded from Ontario's Official GeoHub and it was last updated in 2021, meaning the most recent hospital in the area was included in the analysis. Another crucial dataset that was taken into account is population densities organized geographically by forward sortation area (FSA). FSA is a geographical way of -splitting areas by the first 3 characters of Canadian postal codes. This population data is from 2016, which is the most updated census available and it is gathered from Statscan. Statistics Canada is another highly trusted government website. Other data that was considered in the weighted analysis and were retrieved from Ontario's GeoHub were airports, and water bodies. The road network, and minority FSA data were both taken from Statistics Canada. Finally, the residential areas and industrial centres data were not publicly available off of a government website. This data ended up being retrieved from the UWaterloo Geospatial Centre. All the data was downloaded as a polygon, point, or line shapefile. Data included in the analysis are up to date with any major changes. The only two exceptions are the population and minority census being from 2016.

All the data that was gathered and used for this study was kept inside the GTA's political boundary, except for some polygons that were incredibly close to the border. This is because factors that were near enough to the border would still have some impact on the final result and decision. For example, an airport near the North West border of the GTA was considered since it was close enough to the border. Much of the raw data had to be changed before using it for the analysis. For example, the hospital data comes with over 60 hospitals within the study area. The raw data comes with specialized hospitals which are not considered for this analysis. Thus, using the attribute table and definition queries, only 33 corporation hospitals were left.

Analysis

The specific criteria and weights used in this multi-criteria decision analysis are taken from a previous paper regarding hospital allocation using multiple criteria decision analysis in Shiraz performed in 2016 which can be seen in figure 3 (Rahimi et al., 2017). This specific paper was chosen due to the data availability of the Greater Toronto Area, and the similar goal of the study.

Original Criteria	Original Weight	Priority	New Weight	New Priority
Proximity to the main roads	0.2234	1	0.3240	1
Population Density	0.1986	2	0.2880	2
Proximity to fire stations	0.1710	3	0.0000	NA
Area of Land plot	0.1395	4	0.0000	NA
Fair Distribution all over the city	0.0912	5	0.1323	3
Not being located on the river path	0.0691	6	0.1002	4
Fast and easy accessability	0.0440	7	0.0638	5
Being far from airports	0.0406	8	0.0589	6
Being far form industrial centers	0.0226	9	0.0328	7

Figure 3: Table of criteria and respective weights used for Hospital location-allocation (Rahimi et al., 2017)

The raster layers of all 7 criterion maps which can be seen in figure 4 are to be created using the following methods:

1. Proximity to main roads: Roads with 4 or more lanes are selected as main roads. A euclidean distance layer will then be calculated; areas closer to main roads are given priority.
2. Population density: Population density will be calculated through dividing the population of an area by the area of the forward sortation area; higher population densities will be prioritized.
3. Fair distribution throughout area: Drive time areas will be calculated from each hospital, areas farther away from a hospital will be given preference.
4. Proximity to water bodies: Euclidean distances of water bodies will be calculated, giving preference to areas further away from them.
5. Fast and easy accessibility: Euclidean distances of residential areas will be calculated, giving preference to areas closer to them.
6. Proximity to airports: Euclidean distances of airports will be calculated, giving preference to areas further away from them.

7. Proximity to industrial centers: Euclidean distances from industrial areas will be calculated, giving preference to areas further away from them.

There were two criteria in the original study that were not used in this study, namely: area of plot size, and proximity to fire stations. The area of plot size was used in the original study as it was a significant factor in purchasing the land to build a hospital in Shariz (Rahimi et al., 2017). In the Greater Toronto Area, there are multiple other factors which would likely further affect the ability for purchasing land, and constructing hospitals which would make this factor not as relevant to the Greater Toronto Area (Payne, 2016). Proximity to fire stations was not used in this study due to the limited data availability of active fire stations in the Greater Toronto Area. To compensate for the missing criteria, the weightings were redistributed to the rest of the criteria.

Once the data had been gathered, raster maps were created for each criterion. Criteria regarding proximity were calculated using the "Euclidean Distance" tool in ArcMap, with a processing extent set to the boundaries of the Greater Toronto Area.

For the criteria of "Fair distribution throughout area", network analysis was performed, creating drive-time areas of 3, 5, and 8 minute areas from each hospital. These duration of 3, 5, and 8 minutes were selected based on paramedic response time goals shared by multiple municipalities within the Greater Toronto Area (Granger, 2020).

Once the raster layers were created, they were all then reclassified using the "Reclassify" tool in ArcMap to values ranging from 1 to 9 (least to most suitable) based on natural breaks. Natural breaks were chosen as the classification method in order to show separability between each criterion.

The "Weighted Overlay" tool in ArcMap was then used to create the resulting suitability map using the reclassified rasters, and the weightings taken from figure 4. The resulting suitability map will provide a suitability value for each cell ranging from 1 (least suitable) to 9 (most suitable).

A site selection was then performed based on the resulting suitability map, preferring areas with higher suitability values. The suitability values for areas of current hospitals were then taken, and evaluated.

The proposed hospitals will then be evaluated based on drive-time analysis of the existing, and proposed hospitals, and how they will affect the population of minorities in the Greater Toronto Area.

Multi-criteria decision analysis has commonly been used for decision analysis for varying issues ranging from the selection of wind farm facilities (Noorollahi et al., 2016), evaluating flood risk (Rahmati et al., 2015), evaluating landslide risk (Kavzoglu et al., 2013), and allocation of hospitals (Kaveh et al., 2020). Multi-criteria decision analysis consists of determining the criteria for a specific issue, determining the weights for the criteria, and then evaluating the study area based on the criteria (Cegan et al., 2017). Usually to determine the weights for a set of criteria, a process known as "Analytic hierarchy process".

Figure 4: Data flow diagram

Analytic hierarchy process or AHP is a method of systematically making pairwise comparisons by a group of experts to determine the relative importance of each criteria in regards to a specific issue (Vaidya & Kumar, 2006). As there was not enough time, or the resources to consult experts in healthcare, construction, or urban planning to create weightings specific to the Greater Toronto Area, weightings from an existing hospital analysis were used.

Results

Proposed Hospital Locations

Figure 5 shows the suitability based on the multiple criterias mentioned earlier. It is noticeable that the current hospitals for the most part are not situated in the most ideal locations. In some cases, the suitability is as low as 4 out of 9. In other cases, most of the hospitals have a suitability of 6/9. This shows that the GTA requires the addition of new hospitals to provide a good coverage of the health service to the residents. There are a total of four new proposed locations around the GTA that improve the health services in the region. The proposed hospitals all have a suitability of 7 out of 9 respectively.
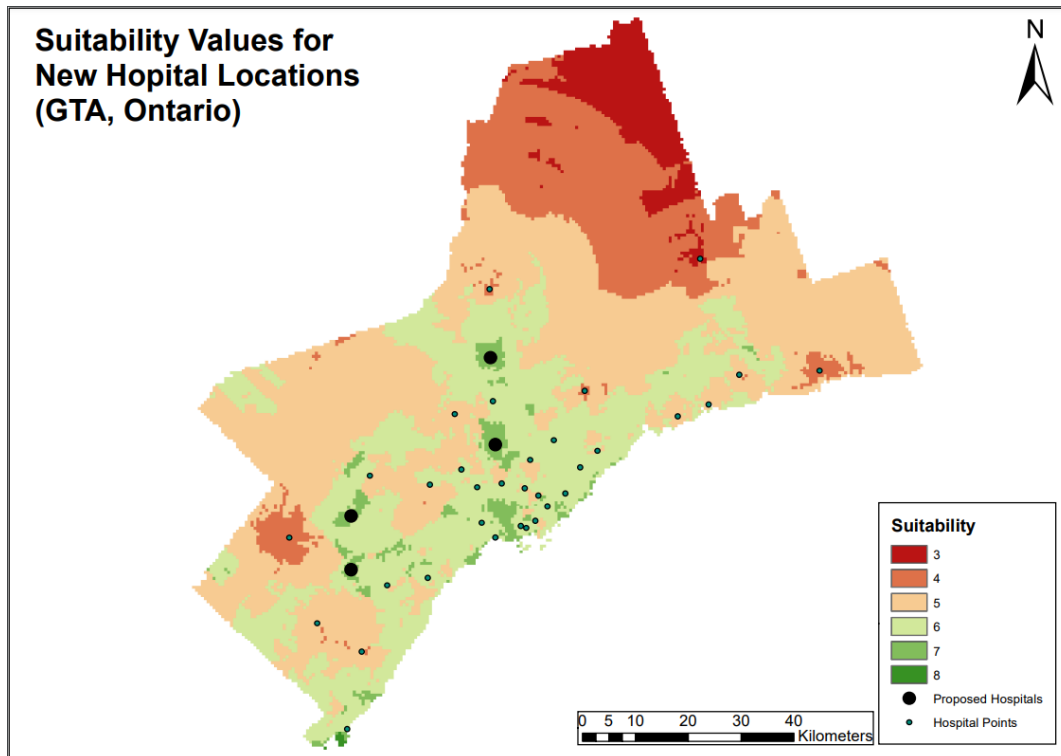
Figure 5: Suitability Values for New Hospital Locations (GTA, Ontario)

The proposed hospitals shown in figure 5 are located in Richmond Hill, North York, Brampton, and Mississauga. These locations are classified as optimal because they have a high suitability under all or nearly all of the weightings used. The main factor that makes them great is the high population with a low number of hospitals. For example, the Brampton location is known to be highly populated and growing. However, there are only 2 other major hospitals in the area. Similarly, the other 3 locations are great as they are just outside of the Toronto borders. This is where the population growth rate is rapidly increasing and where there are minimal healthcares centres to service the area. Additionally, all these locations are extremely close to major roads. The Mississauga location was recently proven to be an optimal location. The Ontario Government stated on December 1rst of 2021 that a new "state-of-the-art" hospital will be built in Mississauga. (Queen's Printer for Ontario, 2021)

Another multi criteria analysis (with equal weightings) provided with the following result shown in figure 6. The weightings of the major roads and population density did not outweigh the rest of the criterions, therefore, a contrasting suitability map was created. Northern Ontario now has a higher suitability, while the suitability in the city of Toronto dropped drastically. The reason behind this is the population in northern Ontario is low and it also lacks major roads. Therefore, in the earlier scenario, Toronto, having more population density and more major roads, had higher suitability, which has now shifted evenly across the study area. Even with the equal weightings, the proposed locations are situated very well based on the suitabilities.
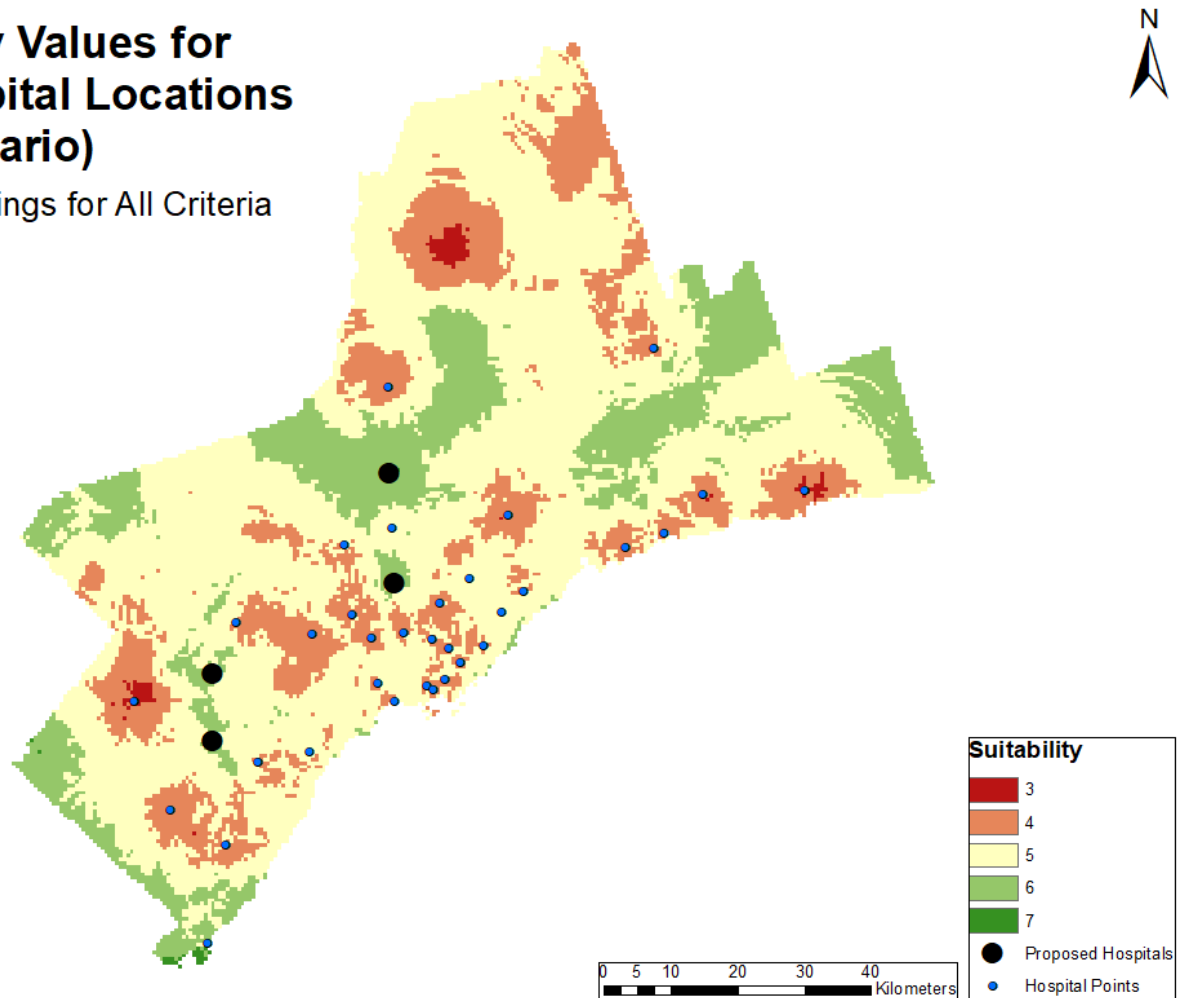
Figure 6: Suitability Values for New Hospital Locations (GTA, Ontario)

The following figure shows a comparison between the service areas within a 8 minute drive time of the current hospitals and with the addition of the proposed locations. Furthermore, it shows the percentage of minorities based on the FSAs. A major objective of this project was to answer if the addition of the hospitals would improve the services provided to the minorities in the GTA. Figure 8 shows the population densities along with the 8 minute service areas. After looking at the two figures, it shows that the addition of the new proposed locations will highly benefit the minorities. As seen in figure 7, all the four locations, specially, Mississauga and Brampton, have fairly high minority populations. Approximately 40% of the population in the 8 minute service areas is minorities. This shows the lack of coverage that is currently experienced by these communities. Looking at figure 8, it can be interpreted that the proposed locations provide services to fairly densely populated areas. New locations tend to ease the loads on the existing hospitals. This overall results in a better quality of service being provided to the minorities situated in the high density population areas.
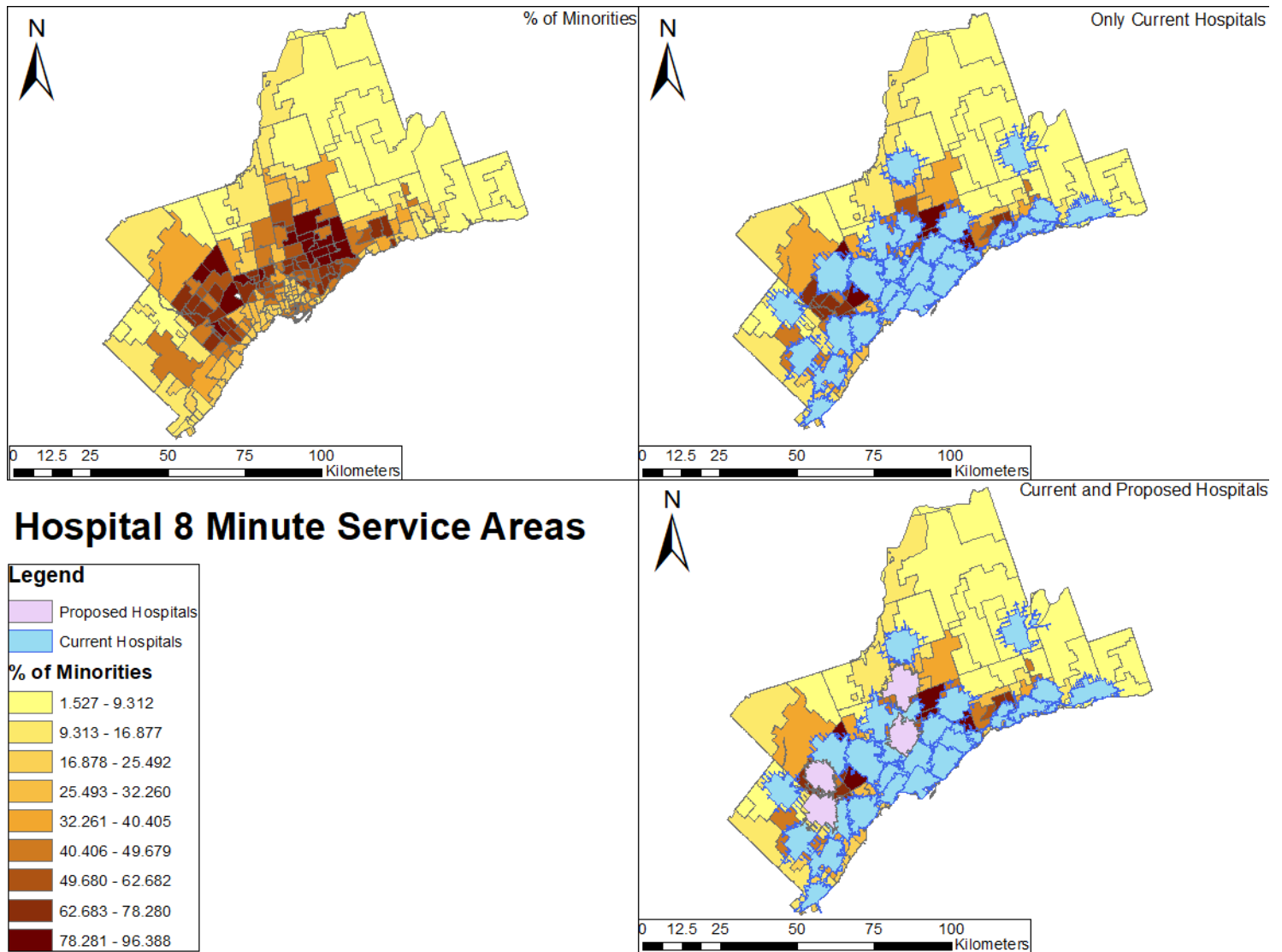
Hospital 8 Minute Service Areas

Legend

Proposed Hospitals
Current Hospitals

% of Minorities

1.527 – 9.312
9.313 – 16.877
16.878 – 25.492
25.493 – 32.260
32.261 – 40.405
40.406 – 49.679
49.680 – 62.682
62.683 – 78.280
78.281 – 96.388

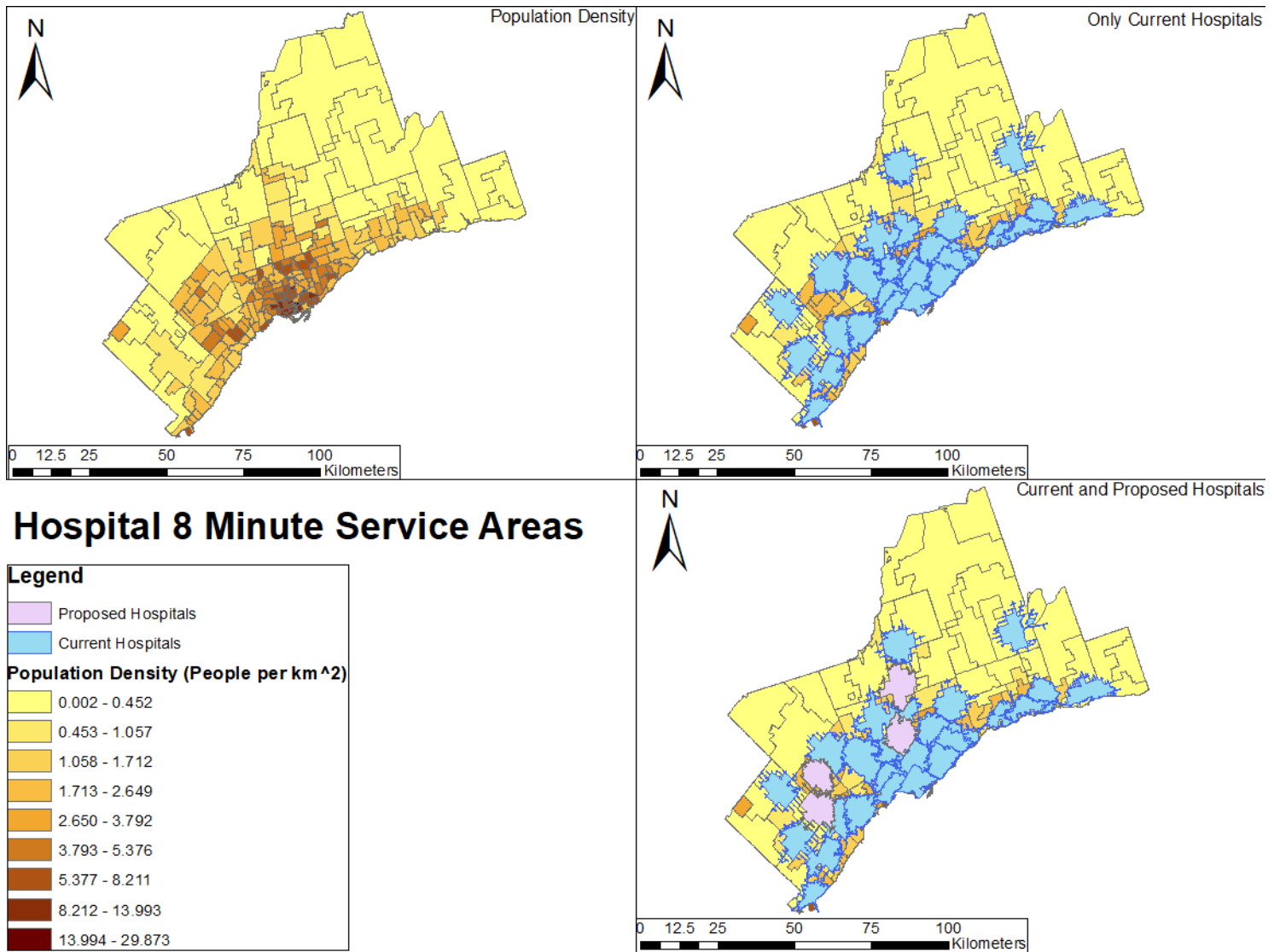*Figure 7: 8-Minute Service Areas of Proposed and Current Hospitals on Minority Percentages*

Figure 8: 8-Minute Service Areas of Proposed and Current Hospitals on Population Density

The figure below (9.1) displays the suitability value of the hospitals with regards to proximity to airports. There are several airports, large and small, in Ontario. The proposed locations are nearly perfectly between airports in order to ensure that no hospital is built too close to any runway.
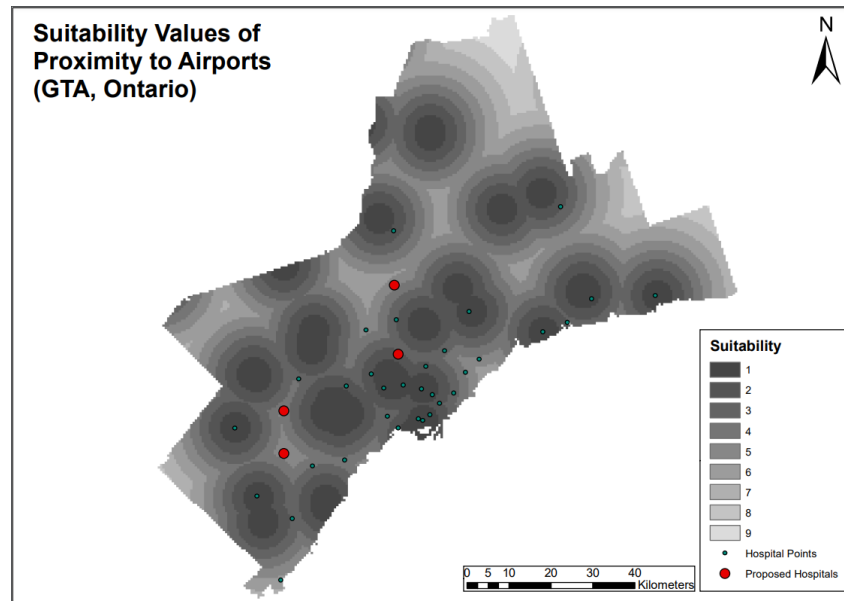

Figure 9.1: Suitability Values of Proximity to Airports (GTA, Ontario)

In this next figure (9.2) the hospital locations suitability can be seen in terms of residential areas. The closer the hospitals are to urban areas the better since that is where a majority of the population is. This further explains why there are not many hospitals in the northern part of the GTA since there are not many major urban areas.
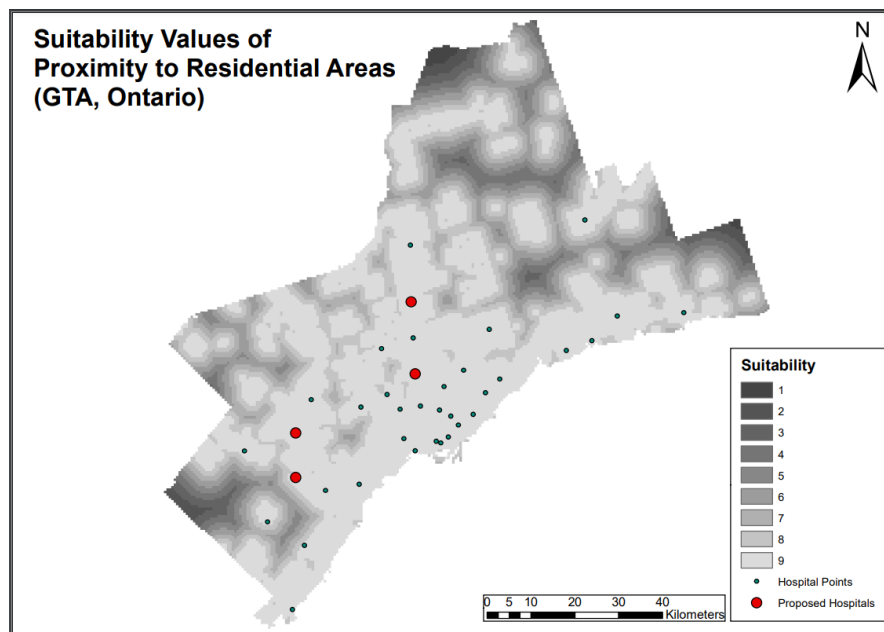

Figure 9.2: Suitability Values of Proximity to Residential Areas (GTA, Ontario)

Figure 9.3 is one of the heaviest and most influential with regards to the weighted analysis. It shows the suitability of the proposed hospitals based on the population densities. One of the major criterias of this study was to ensure that the new hospitals would benefit as many residents as possible. The figure below shows that the proposed locations are optimal in terms of population as they are either in extremely close to highly dense areas.
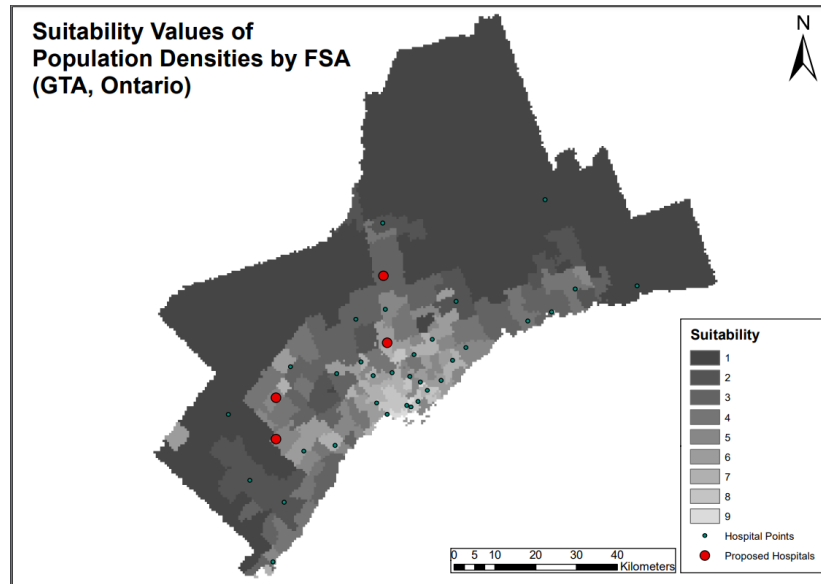

Figure 9.3: Suitability Values of Population Densities by FSA (GTA, Ontario)

The figure below (9.4) is another suitability map that had a heavy influence on the final decision of the new locations. As expected, the major roads were mainly near the Toronto area as it is the heaviest populated region. On the contrary, the northern and eastern parts of the GTA have no major roads. All the proposed locations are within the cluster of major roads to ensure that they are easily accessible.
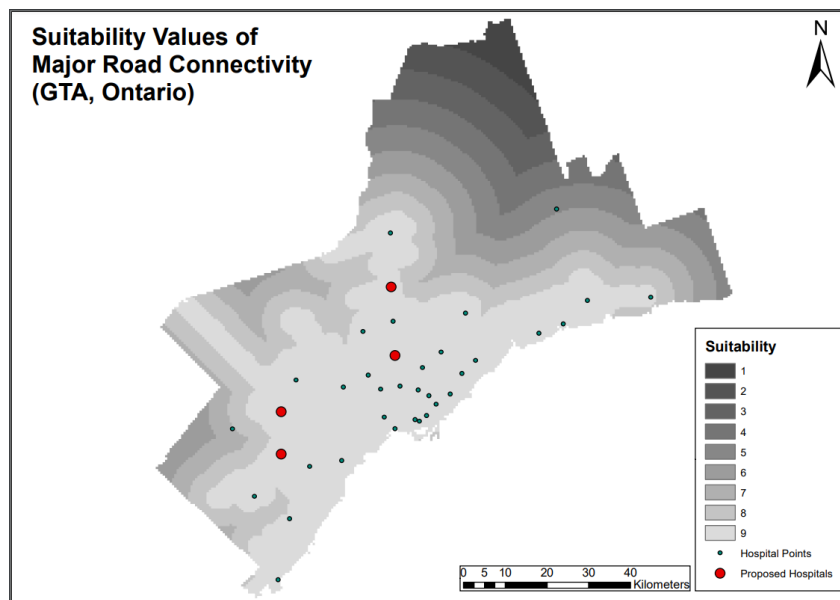
Figure 9.5 shows the suitability of the proposed hospital locations based on the rivers in the GTA. This is a crucial and strict criteria since building a hospital on a body of water introduces new implications. As shown below, all 4 proposed hospitals are comfortably away from any river.
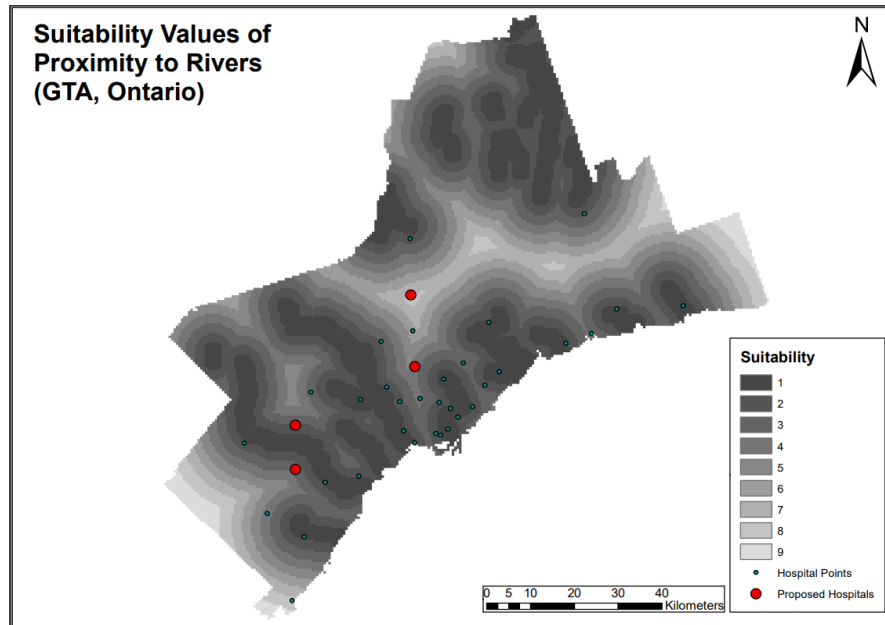

Figure 9.5: Suitability Values of Proximity to Rivers (GTA, Ontario)

This last figure (9.6) shows the suitability values of the proposed hospital locations based on the existing hospitals service areas. This criteria was created to ensure that no two hospitals are too close to each other. The hospital in North York (right above Toronto) perfectly fills the gap between existing hospitals. The other 3 are placed near other service areas but not within them. This leaves some space for even more hospital locations in the future to fill in the gaps.
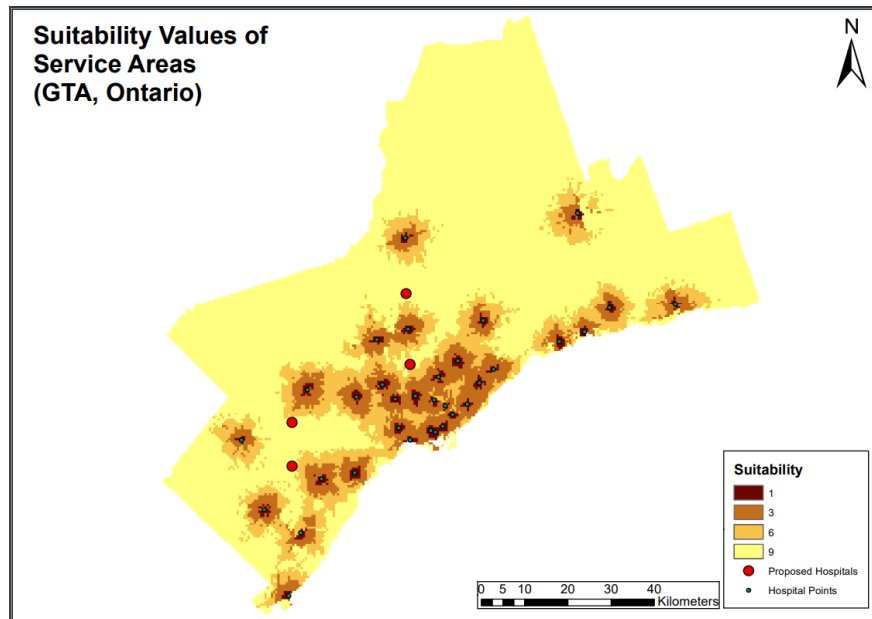

Figure 9.6: Suitability Values of Service Areas (GTA, Ontario)

Discussion
Limitations & Constraint

The main limitation encountered throughout this project was the lack of access to data. This research was compelled to not account for certain objectives; some aspects of the research that were originally planned were not explored in as much depth as initially drafted or they were entirely dismissed due to data insufficiency. Absence of data was generally an issue observed within different emergency services in the region.

The most limiting example of this was the lack of hospital specific data. As originally planned, this research aimed to explore the impacts of the COVID-19 pandemic on hospitals around the Greater Toronto Area; this included looking at number of patients being hospitalized due to COVID-19 at each location, a comparison between the number of other patients to previous years and other similar analyses. This was one of the main objectives of the research due to the timing of it. Due to a lack of access to such data, this aspect of the research was dismissed. Similarly, other data in terms of response times for other emergency services within the region such as fire stations within the GTA were also unavailable.

While this project suffered from data scarcity, there were also other non-data related limitations. In terms of the literature review for this research, no similar research has been conducted on this topic within the GTA or any other region with similar conditions. Most of the literature found within the context of multiple-criteria decision analysis with emergency services

in mind, was done on regions with much different circumstances compared to the GTA. For example, a similar paper that was selected for review was *Hospital location-allocation in Shiraz using Geographical Information System* (Rahimi et al., 2017). While these projects share a lot of common traits in terms of their objectives, the respective study areas of these two papers are very different in terms of demographics and urban planning. Per example, the GTA has a population density of 900.4/km^2 while Shiraz has a population density of 6,670/km^2 (Statistical Center of Iran, 2017; see also Statistics Canada, 2021).

When considering the results of this research, it is important to note the lack of accountability for construction viability and land availability for proposed locations due to a combination of limitations of the GIS environment and a lack of expertise within this subject. While the 4 proposed locations are ideal for new hospitals in the region in theory, these positions may not be quite feasible for the physical construction of new facilities due to a variety of factors such as land ownership, zoning, etc. In a real-life application, the proposed locations of these hospitals may be forced to be adjusted based on such factors.

Discussion & Broader Implications

When selecting the 4 proposed locations for new facilities, an important factor that was considered within the analysis outside of the GIS environment was the implications these new facilities would have for visible minority groups at each location. It is important to remember the proposed placements of these facilities, they are located within the following regions: Brampton, Mississauga, North York, and Richmond Hill. The region of Brampton has a visible-minority population percentage of 73.3%, Mississauga with 57.2%, while North York has 53.0% and Richmond Hill consists of 60.0% visible minorities (City of Richmond Hill 2017; see also City of Toronto, 2019; Region of Peel, 2017). As evident, all these regions consist of high visible-minority population percentages. It is also key to keep in mind these regions have relatively high population densities, especially within the Peel region (Brampton and Mississauga). This implies that minorities would benefit highly from the construction of these 4 new facilities, as it would increase their access to healthcare. The reason this is highlighted is due to the historical discrimination against visible minorities within the healthcare system; with the COVID-19 pandemic shining a light on this controversial topic very recently. While being the most diverse region in the GTA, Brampton's healthcare system is also the lowest funded in Ontario. As of 2016, Brampton received $611.35 in funding per capita, compared to the city of Toronto receiving almost $2,964.11 per capita (Brown, 2018).

While the focus is not on the Greater Toronto Area specifically, a research done in 2012 at the Department of Community Health and Epidemiology in Dalhousie University located in Halifax stated that attributes that appear within visible minority groups that are not euro-centric may lead to unfair treatment within the healthcare industry. These attributes include both visible and audible attributes such as skin colour, accent, appearance, tone of voice and other qualities that may reveal a visible minority background within the patient (Weerasinghe, 2012). It is worth noting this study only focused on immigrant women who had moved to Canada within the past 5 years at the time this study was conducted.

In another study done on the city of Toronto, in an effort to understand how the current healthcare policies and practices affect the experiences of visible minorities within the city's healthcare system, it was concluded that racialized users experienced everyday racism when receiving health care. It is relevant to mention that the participants selected for this study were all located within communities in Toronto and the Greater Toronto Area. These participants reported

racial discrimination as the main challenge when receiving health care (Mahabir et al., 2021).

When considering the results of this paper, there is an important aspect to consider; these results may not be the most accurate when looking at areas close to the boundaries of the GTA. This is due to the analysis not taking nearby hospitals outside of the outlined region into account. When looking at the results, these regions may appear as they may have long drive-times to their respective nearby hospitals, while this may not be the case due to a facility being located outside of the boundaries. An example of this would be the city of Guelph; when looking at Halton & generally the left side of the GTA, while these regions may have high suitability values, this may not actually be the case as there is a hospital located within the city of Guelph. Due to these facilities not being accounted for, regions close to the boundaries may have higher suitability values than they should. In order to compensate for this effect, the 4 new proposed locations were selected within regions that were farther away from the boundaries.

A major broader implication of the construction of 4 new proposed hospitals around the region is the implication it would have within the context of COVID-19. Due to the timing of this research, an entirely new aspect was introduced when considering purposes and locations for the construction of these new facilities. As evident throughout the past 2 years, dealing with COVID-19 and sharp rises in case counts has been a major challenge for hospitals around the globe; this has also been an issue within the Greater Toronto Area. According to a recent report, at the peak of wave 3 of COVID-19 in Ontario, the number of patients requiring ventilators was over 180% of historical averages before the pandemic. The Ontario critical care system has only been able to deal with the influx of patients by transferring patients within hospitals in the region, creating temporary emergency care units (such as setting up tents within parking lots) and most importantly deferring surgeries and procedures (Barrett et al., 2021). A depletion of hospital resources was noticed throughout the Greater Toronto Area, because of the increased Covid-19 caseloads (Barrett et al., 2020). The construction of these 4 new facilities would increase the healthcare system's overall capacity, adding the ability to take care of more patients and it would reduce the number of deferred surgeries due to unpredicted circumstances. While the construction of these hospitals would take time, it is important to note the uncertainties that experts still have regarding COVID-19 and its variants. Despite high vaccination rates throughout the country, COVID-19 cases have been on the rise recently, which is worrisome especially considering the recent variants and reports that vaccines may be less effective against them (Abu-Raddad et al., 2021). Similarly, according to recent studies, annual booster vaccine shots may be necessary in coming years; this implies the virus may stay in our communities for at least the next few years (Rubin, 2021). While this is not for certain due to a lack of time and familiarity with the behavior of this virus, the construction of new hospitals would only increase the region's ability to support more patients (including non-COVID cases) especially considering the growing population of the GTA.

Conclusion

In conclusion, this study highlights the demand for more hospitals within the Greater Toronto Area because of the region's growing population. This research proposes 4 ideal sites for new facilities to be built around the region. While these locations would work in theory, it is important to note real-life factors that may complicate the physical construction of facilities at these exact locations.

The construction of new hospitals would increase the region's overall patient capacity, while improving overall wait-times which has been a challenge within the Canadian healthcare

system. The region's growing population has been calling for expansion within the healthcare system, this has been highlighted in the past 2 years due to the recent COVID-19 pandemic. These 4 new hospitals would have an important implication for visible minorities within the region, as these locations would increase their access to healthcare which has been a controversial topic in the Greater Toronto Area in the past.

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Appendices:

Table A: Description of group member contributions to project proposal			
Section	**Group Member(s)**	**Specific Tasks**	**Contribution**
Introduction			
	P. Singh	Wrote on the State of Knowledge. Incorporated 8 citations. Worked on revising questions and objectives	50%
	G. Diniz	Wrote the relevance of the study area and proposed work. Incorporated 4 citations. Worked on revising questions and objectives	50%
Methods			
	G. Diniz	Wrote the text for the Study Area, and Data, as well as created figure 1 and 2. A total of 7 citations were incorporated.	40%
	E. Chow	Drew the Process-flow diagram, and wrote the Analysis. Incorporated 9 citations.	60%
Results			
	E. Chow	Worked on finalizing the maps.	30%
	P. Singh	Worked on designing and assisted in making the maps. Wrote part of the text for Results.	40%
	G. Diniz	Wrote part of the text for Results. Incorporated 1 existing citation.	30%
Discussion			
	Siavash Pourdeilami	Wrote all the text for the discussion section and incorporated 12 citations.	90%
	P. Singh	Added to the discussion and incorporated 1 citation.	10%
Conclusion			
	S. Pourdeilami	Wrote the conclusion.	100%
References			
	Everyone	Cited Sources.	25% each
Appendices (a.k.a this table)			
	Everyone	Each person filled in their part.	25% each