



**SMU**

**SINGAPORE MANAGEMENT  
UNIVERSITY**

**SMT201 – Geographic Information Systems for Urban Planning**

**Theme2, Sub-theme 1: Impact of closures or mergers of education institutions on equity  
of access**

**AY 2022/23, Term 1**

**Instructor: Professor Kam Tin Seong**

**Team: G1 - Team 5**

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<b>1. Introduction &amp; Project Motivation</b>	<b>3</b>
1.1 General Information on the Closure and Merger of Primary School and Junior College (JC)	3
1.2 Project Motivation	3
1.3 Project Objective	4
1.4 Project Data	4
1.5 Scope of Work	5
1.6 Project schedule	7
<b>2. Methodology, detailed discussions of the GIS Analysis process and functions used</b>	<b>7</b>
<b>3. Results and Discussion, Comprehensive Equity of Access Analysis</b>	<b>8</b>
Primary School	8
Accessibility:	9
Service area using Voronoi Polygon:	13
Junior College	15
Accessibility:	15
<b>4. Lesson learned and recommendation</b>	<b>19</b>
<b>5. Collection of Analytical Map</b>	<b>21</b>
<b>References</b>	<b>28</b>
<b>Appendix</b>	<b>30</b>
Gantt chart	30

# 1. Introduction & Project Motivation

Github link: <https://github.com/jkpok/GISProject.git>

QGIS project link: [SMT\\_Group5 \(Final\).zip](#)

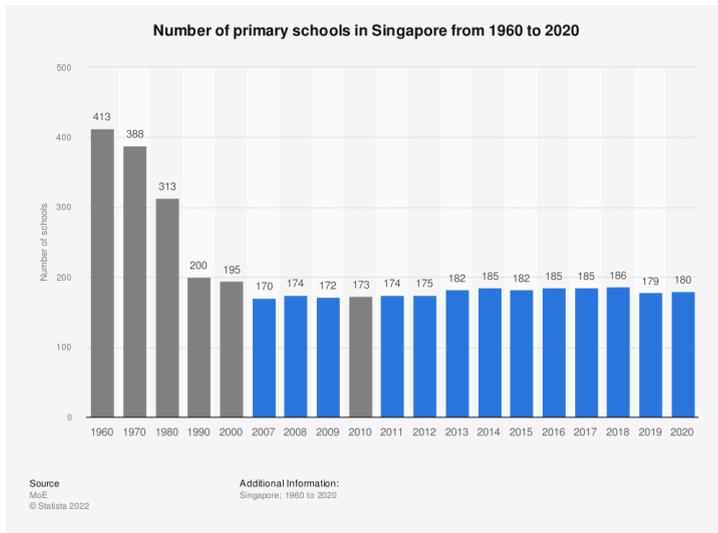
## 1.1 General Information on the Closure and Merger of Primary School and Junior College (JC)

Singapore is widely known for its people having the 2nd highest IQ population in the world (Worlddata.info, n.d.). In recent years, due to an increase in the standard of living and quality of life in Singapore, and with the pressure of inflation that has affected people all around the world, the cost of living has been increasing significantly and this has caused many Singaporeans to avoid having offspring which caused Singapore's population to decline.

Therefore, with a decline in birth rate and a decrease in the population size for younger generations between the age of 0 to 6, the Ministry of Education of Singapore released a statement in 2018 that there will be 11 primary schools and 6 JC that will be closed between 2018 to 2025 as per our data preparation link (Ministry of Education Singapore, 2022). This is to ensure that the resources that the Ministry of Education have deployed will not be under-utilized while all students in primary schools will still have equal and high-quality access to education.

## 1.2 Project Motivation

Singapore has long been regarded as a success story about a small island without natural resources turned world-class metropolis in one generation. However despite the boon we experienced, or perhaps because of it, the birthrate has been declining to the extent where schools have to be closed. Our team is incredibly concerned about the consequences of Singapore's low birthrate which thus, led us to assess the impact of closures or mergers of education institutions on equity of access. The chart below shows us that the number of primary schools has more than halved since 1990, which is incredibly concerning news.



### 1.3 Project Objective

To determine and measure the impact of closures/merges of primary schools and JC in Singapore from 2018 to 2025 towards Primary School and JC students and the equity of access to the remaining Primary Schools and JC in Singapore.

### 1.4 Project Data

File name	Description	Source
Master Plan 2019 Subzone Boundary (No Sea)	Polygon layer of Singapore categorised by various sub-zones.	<a href="https://data.gov.sg/dataset/master-plan-2019-subzone-boundary-no-sea">https://data.gov.sg/dataset/master-plan-2019-subzone-boundary-no-sea</a>
Malaysia, Singapore, and Brunei	Vector layers from Open Street map, which were used to identify the roads and traffic of Singapore	<a href="https://download.geofabrik.de/asia/malaysia-singapore-brunei.html">https://download.geofabrik.de/asia/malaysia-singapore-brunei.html</a>
Education	A csv file containing the names of schools in Singapore and their locations	<a href="https://elearn.smu.edu.sg/d2l/learn/content/328735/viewContent/2062006/View">https://elearn.smu.edu.sg/d2l/learn/content/328735/viewContent/2062006/View</a>

Location of Primary School as at 2017	A csv file containing the names of primary schools in Singapore and their locations	<a href="https://data.world/hxchua/primary-schools-in-singapore">https://data.world/hxchua/primary-schools-in-singapore</a>
Location of JC	A website to search for existing and closed JC	<a href="https://geo.sg/gmaps/singapore-schools/show_data?utf8=%E2%9C%93&amp;search=innova&amp;button=#">https://geo.sg/gmaps/singapore-schools/show_data?utf8=%E2%9C%93&amp;search=innova&amp;button=#</a>
Primary Schools Closure and Mergers	An article from MOE containing the annex of Primary Schools that are affected by the closure or merger.	<a href="https://www.moe.gov.sg/-/media/files/news/press/2022/annex-names-of-schools-merging-between-2022-2025.ashx?la=en&amp;hash=99BC8F6A971058F4AF09F1DEB1A16A1F0D9AB195">https://www.moe.gov.sg/-/media/files/news/press/2022/annex-names-of-schools-merging-between-2022-2025.ashx?la=en&amp;hash=99BC8F6A971058F4AF09F1DEB1A16A1F0D9AB195</a>
Geographic Distribution	Geographic Distribution of the Population Trends.	<a href="https://www.singstat.gov.sg/find-data/search-by-theme/population/geographic-distribution/latest-data">https://www.singstat.gov.sg/find-data/search-by-theme/population/geographic-distribution/latest-data</a>

## 1.5 Scope of Work

Theme	Person in Charge
Selection of project focus and conducting literature review	Chevy, Swinnerton, Andrew
Preparing proposal and project website	Chevy, Swinnerton, Andrew
Data collection, extraction, integration, transformation and wrangling	Chevy, Swinnerton, Andrew

Designing and building GIS model and database	Chevy, Swinnerton, Andrew
Performing GIS analysis	Chevy, Swinnerton, Andrew
Preparing poster and project webpage.	Chevy, Swinnerton, Andrew

Others

<b>Theme</b>	<b>Person in Charge</b>
School closure for Primary School	Chevy, Swinnerton
School closure for Junior College	Chevy, Andrew
Road network	Chevy, Swinnerton
QGIS, Report clean up	Chevy, Swinnerton, Andrew
Poster clean up	Chevy, Swinnerton, Andrew
Metadata	Chevy, Swinnerton, Andrew

## 1.6 Project schedule

Start Date	3/10/2022						
Week	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
Date	3 Oct	10 Oct	17 Oct	24 Oct	31 Oct	7 Nov	14 Nov
<b>Phase 1: Discussion and select themes to work on</b>							
Theme selection							
Collate and download data							
Data compilation, extraction and integration							
Understand the data, data cleaning, preparation and wrangling							
Create Github							
Create Website							
<b>Phase 2: Analysis of school type, schools that are close down</b>							
Analysis of population							
Analysis of roads							
Design of GIS Map and GeoPackage							
Update project website							
<b>Phase 3: Selection of schools</b>							
Discussion of school closure							
Equity of access for closure and merger of education institutions							
Design of GIS Map and GeoPackage							
<b>Phase 4: Report</b>							
Content layout discussion							
Introduction and project motivation							
Equity of access report content and layout							
Write up equity of access analysis report							
Finalise project reports							
Report submission							
Update project website - Project report							
<b>Phase 5: Poster</b>							
Edit poster content							
Finalise poster							
Poster submission							
Update project website - Project poster							
<b>Phase 6: Finalising project materials</b>							
Finalise project website, report and poster							
Project artifacts and website submission							

## 2. Methodology, detailed discussions of the GIS Analysis process and functions used

### Creating a Grid (Hexagon) using Singapore's MP19 Subzone No Sea

For our team's network analysis, we have developed a grid using a hexagon shape which covers Singapore's subzone at 500m by 500m. For each hexagon, it will be utilized to depict the shortest distance to reach the nearest Primary School and JC. The shorter the distance, and if it falls under the category of a shorter distance (e.g., 0 to 100m) that is classified using Symbology, the denser the colour (e.g., Green) which will be highlighted on the hexagon.

### Creating a centroid for each hexagon present in Singapore's Subzones

Using the hexagon grid that is developed based on Singapore's subzones, a centroid will be generated for each hexagon to depict the centre point. This centroid will eventually be utilized to determine the distance between each individual Primary School and JC in Singapore.

### Filtering out the existing Primary Schools and JC in Singapore

As our group is performing the network analysis for Primary Schools and JC in Singapore, we will be filtering out Primary Schools and JC in Singapore and excluding the other schools that do not fall under the category that meets the criteria.

### Filtering out the Primary Schools and JC that will be affected by the closure or merger

For this section, as our sub-theme solely focuses on the closure and merger of schools in Singapore, and with our group's goal to focus on Primary Schools and JC, apart from filtering out all Primary Schools and JC in Singapore, we will also be filtering out schools that will be closing soon and there will be 2 point layers where one will depict all primary schools before the arrangement to close the 11 primary schools, 6 JC, and another layer will depict the Primary schools and JC that are still available even after the closure of the schools.

### Generating OD Matrix

In order to obtain the distances between the schools and centroids across Singapore, we used the QNEAT3 plugin's function to generate an OD matrix. This was a very computational intensive task as we had many data points and the road layers were unfiltered, furthermore we even had to run it 4 times. The 4 OD matrices generated were to obtain the distances from centroids in Singapore to Primary Schools in 2018, distances from centroids in Singapore to Primary Schools after closures, distances from centroids in Singapore to Junior Colleges in 2018, and distances from centroids in Singapore to Junior Colleges after the closures.

### Filtering out shortest distances

After the matrices were obtained, we had to filter out the shortest distances as the matrices contained all the possible ways to get to the destination. We accomplished this by using the execute SQL function.

## 3. Results and Discussion, Comprehensive Equity of Access Analysis

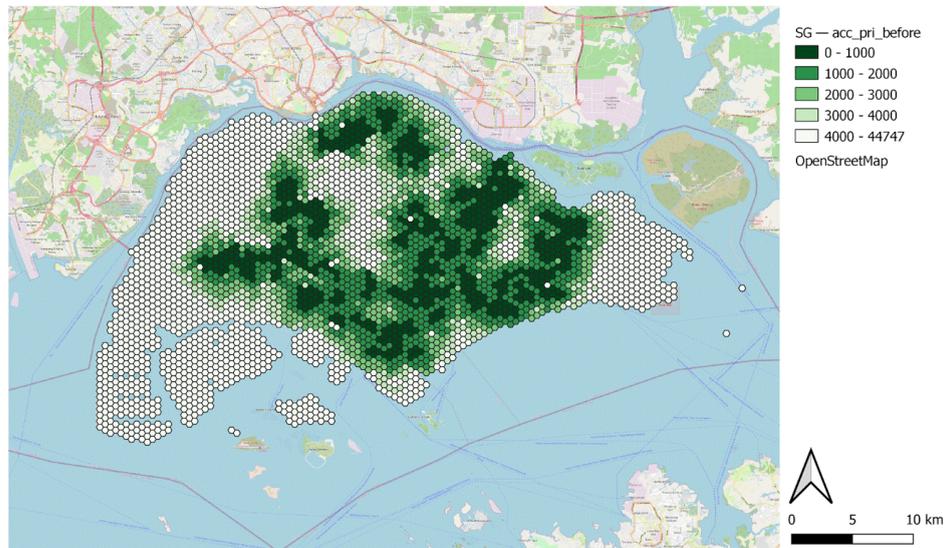
### Primary School

Closed Primary Schools:

- Balestier Hill Primary School
- Coral Primary School
- Da Qiao Primary School
- East Coast Primary School
- East View Primary School
- Eunos Primary School
- Guangyang Primary School
- Loyang Primary School
- MacPherson Primary School
- Pioneer Primary School
- Stamford Primary School

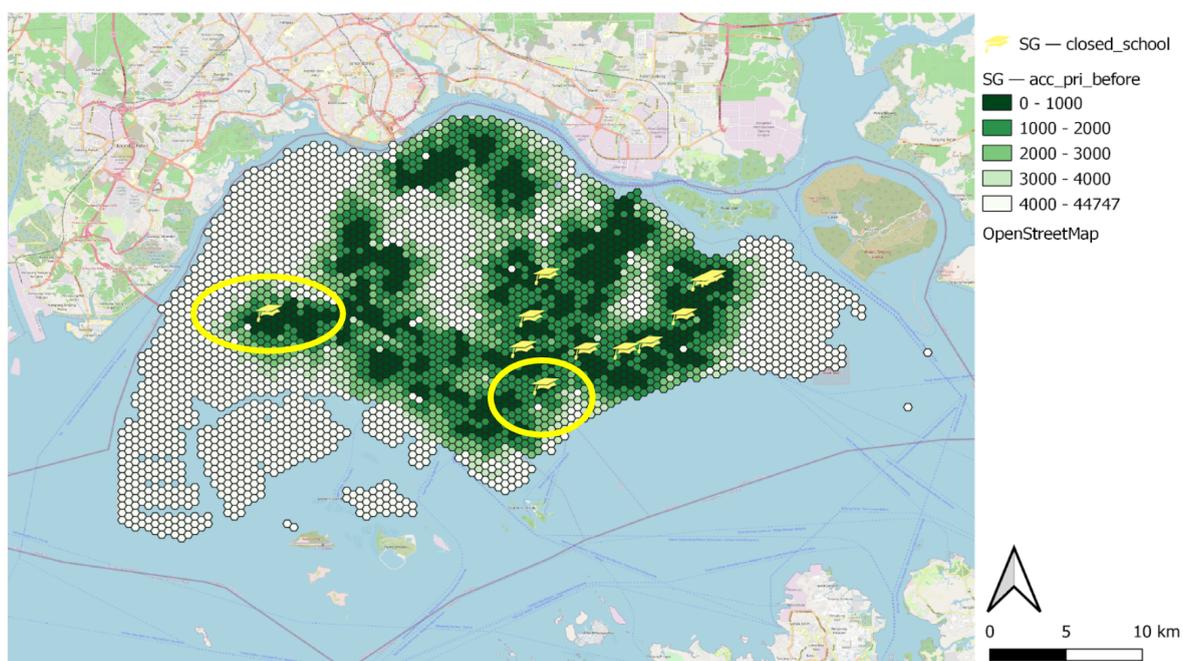
## Accessibility:

### Accessibility Primary Before



The gif above shows the change in accessibility before and after the closure of the primary schools. Upon further analysis, we notice that the central/southern subzone has turned to a lighter shade which indicates that residents of that area would have to travel further assuming they would commute to the nearest school. However, the change seems very minor as there are numerous other primary schools clustered together in those areas. Let us now analyse each map in closer detail.

## Accessibility of Primary Schools before closures



The map shows that the majority of Singapore Primary Schools in 2018 are highly accessible. There are some areas which are completely white/ inaccessible, namely the North-Western planning area of Lim Chu Kang, which holds farmlands and cemeteries, and the Western planning areas of Pioneer and Tuas. However, the accessibility of these areas is inconsequential to students as they are not residential areas but rather industrial areas which also explains the inaccessibility to the primary schools (we will go into more detail on the residential population in the later section later).

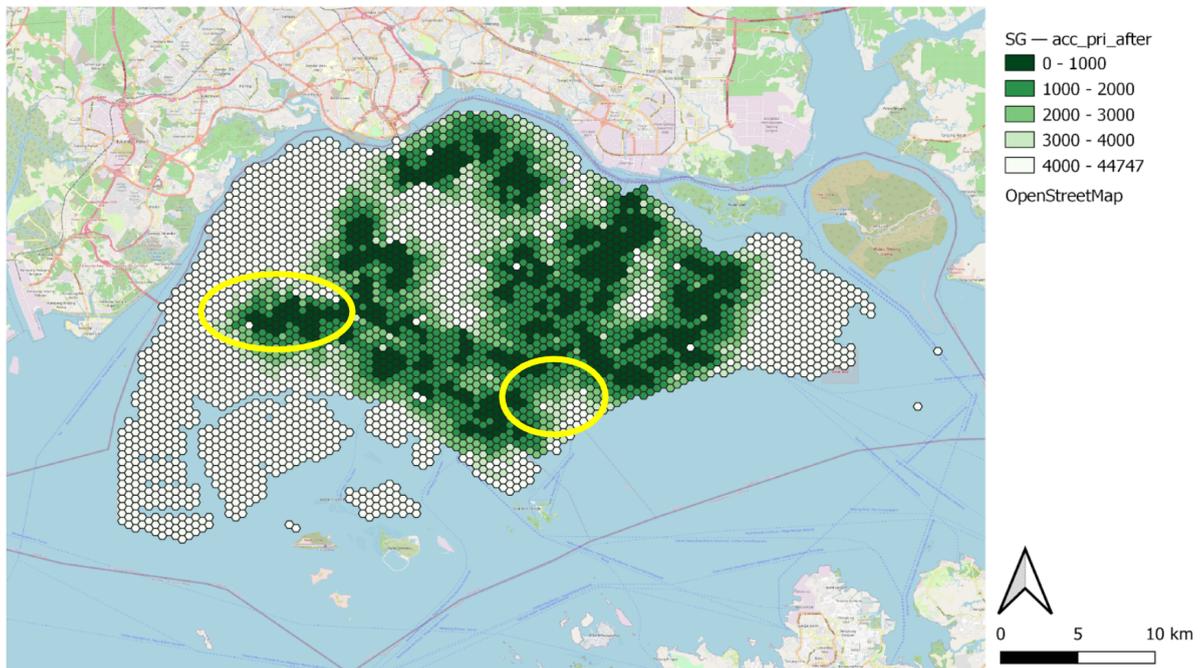
Furthermore, the map has 11 yellow icons which denote the schools which will close or have already closed.

These schools are namely:

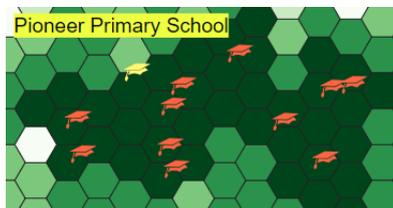
- Balestier Hill Primary School
- Coral Primary School
- Da Qiao Primary School
- East Coast Primary School
- East View Primary School
- Eunos Primary School
- Guangyang Primary School
- Loyang Primary School
- MacPherson Primary School
- Pioneer Primary School
- Stamford Primary School

We have to monitor the areas around these schools closely as they are the main subject of our analysis and would definitely impact the equity of access.

## Accessibility Primary After

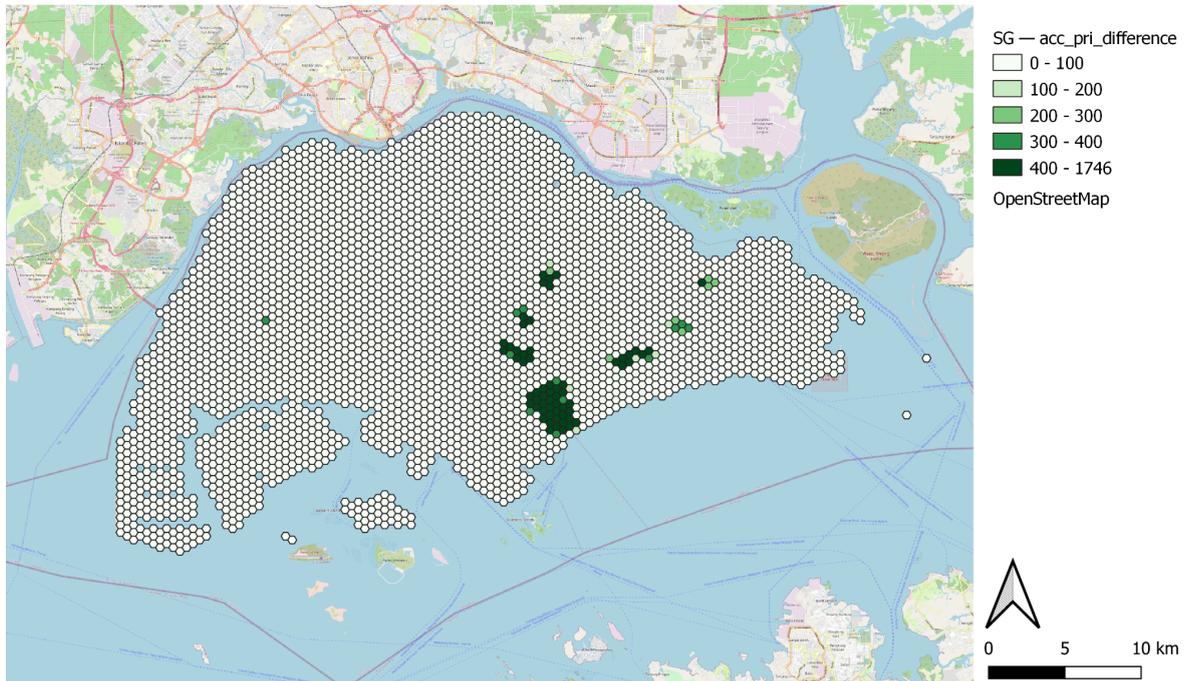


The map above shows the accessibility of primary schools after the closure of the aforementioned 11 primary schools. Regarding the area circled in the central/southern region which encompasses Stamford Primary School, its closure has caused the colour density to decrease, meaning that the residents living within the subzone will have lower accessibility, should students choose to commute to the nearest primary school.



On the other hand, in the western region also denoted by a yellow circle, we can see the closure of Pioneer Primary School does not have much impact on accessibility. We discovered that the reason for this was the existence of numerous other primary schools in close proximity to Pioneer Primary School, which prevented the significant loss in accessibility around the region.

## Accessibility Primary - Difference



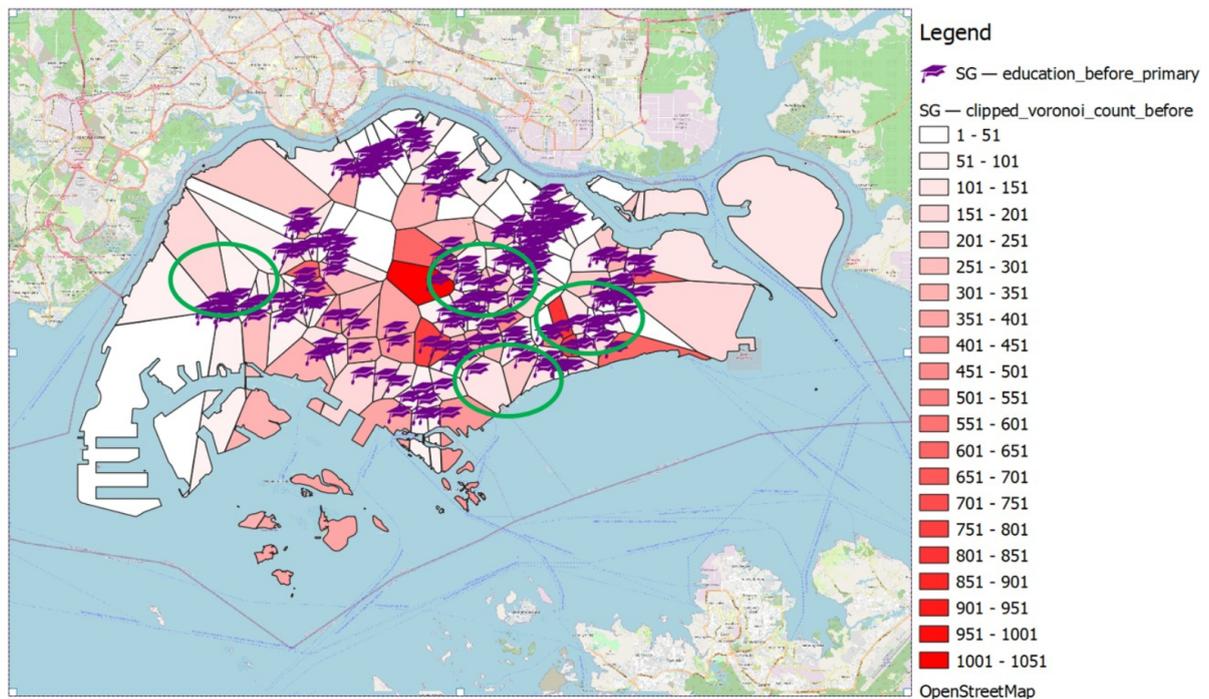
The map above shows the change in accessibility after the closure of primary schools. Based on our analysis, the darker the colour in green, the greater the change in accessibility. For the analysis of the change map, where we calculated the difference in the shortest distance, we take the shortest distances after the school closures **minus** the distance pre-closure/merger. We have derived the change map and can analyse the areas where the distance has increased, such that the primary school student will need to travel in order to reach the next nearest Primary School or inequity of access to Primary Schools in the subzones or planning areas located in the central/southern area where Stamford Primary School resides on, and it is represented by the darker shades in the map (positive value). Based on the before and after choropleth maps for Primary Schools that we have analysed previously, we can identify similar areas that were circled in yellow (central/southern region) which were deemed as being denser in colour in general. Hence, the closure of primary schools within the subzone or planning area has generally decreased the accessibility for the residents living in the area.

In addition, if we try to deduce why some primary schools close down, we can take reference from Stamford Primary which is one of the schools that closed down, and based on the number of residential buildings that it would potentially service, we will notice that it is proportionally less compared to the number of residential buildings serviced by other schools as seen from the Voronoi Diagram below.

## Service area using Voronoi Polygon:

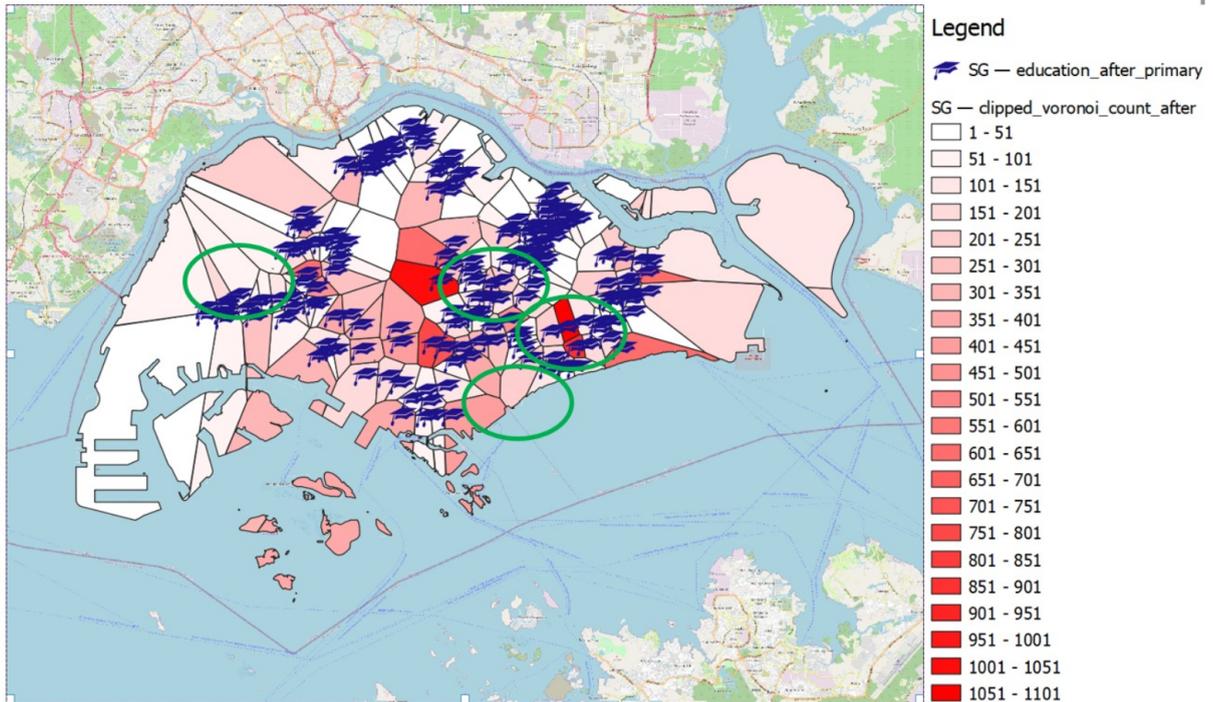
To further complement our previous analysis with the Choropleth Map (shortest distance), we have used Voronoi polygons to identify the difference between the flying distance to validate our Choropleth map analysis of the number of the residential building serviced before and after the closure of the primary schools. We will now look into each of them shortly. The Voronoi polygons delineate the areas which each school would most likely service as any point within the area of a certain school would have that school as the closest one in terms of flying distance.

### Voronoi of Primary School Service Areas before Closure



Before the primary schools close down, we identified 4 areas that are circled in green that will potentially change due to the closure and it will cause the Voronoi Polygon to shift or change and even cause the colour density to lighten.

## Voronoi of Primary School Service Areas after Closure



After the closure of the primary schools, we can delineate that the shape of the Voronoi Polygon shape has shifted and changed, causing the colour to tone down as the nearby schools have taken up the count of residences to service those that are affected and the total count of residential buildings that were once assumed to be serviced by the closed school would be split up and becomes reassigned with the next nearest existing Primary School and it will be assigned to that Voronoi Polygon of the nearest school. One example is towards the central/ southern of Singapore, Stamford Primary School has been closed down which explains the shift in the Voronoi Polygon being lighter, causing the Voronoi Polygon that serves both Cantonment Primary School and Farrer Park Primary School density to be changed.

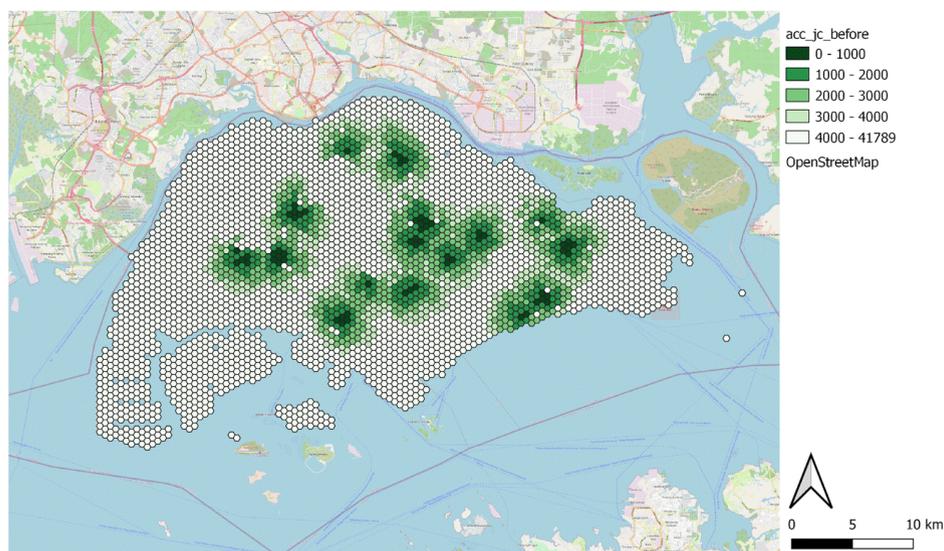
# Junior College

Closed JCs:

- Innova Junior College
- Jurong Junior College
- National Junior College
- Serangoon Junior College
- Tampines Junior College
- Temasek Junior College

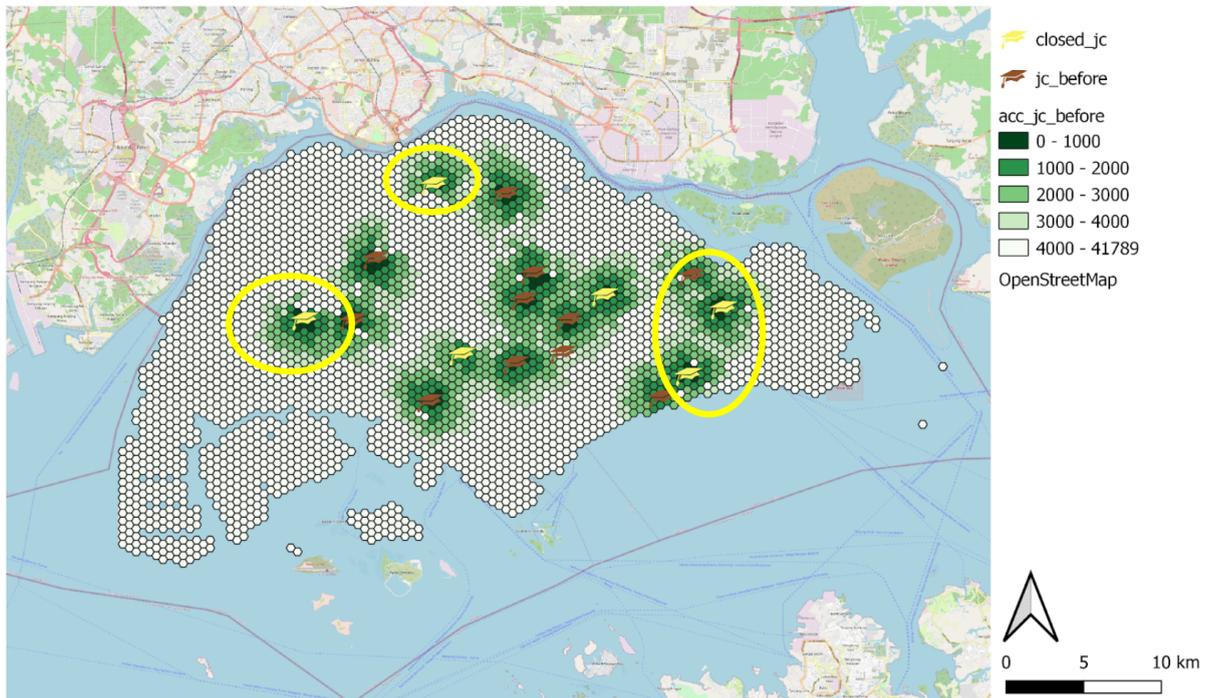
Accessibility:

Accessibility of JC Schools before closures



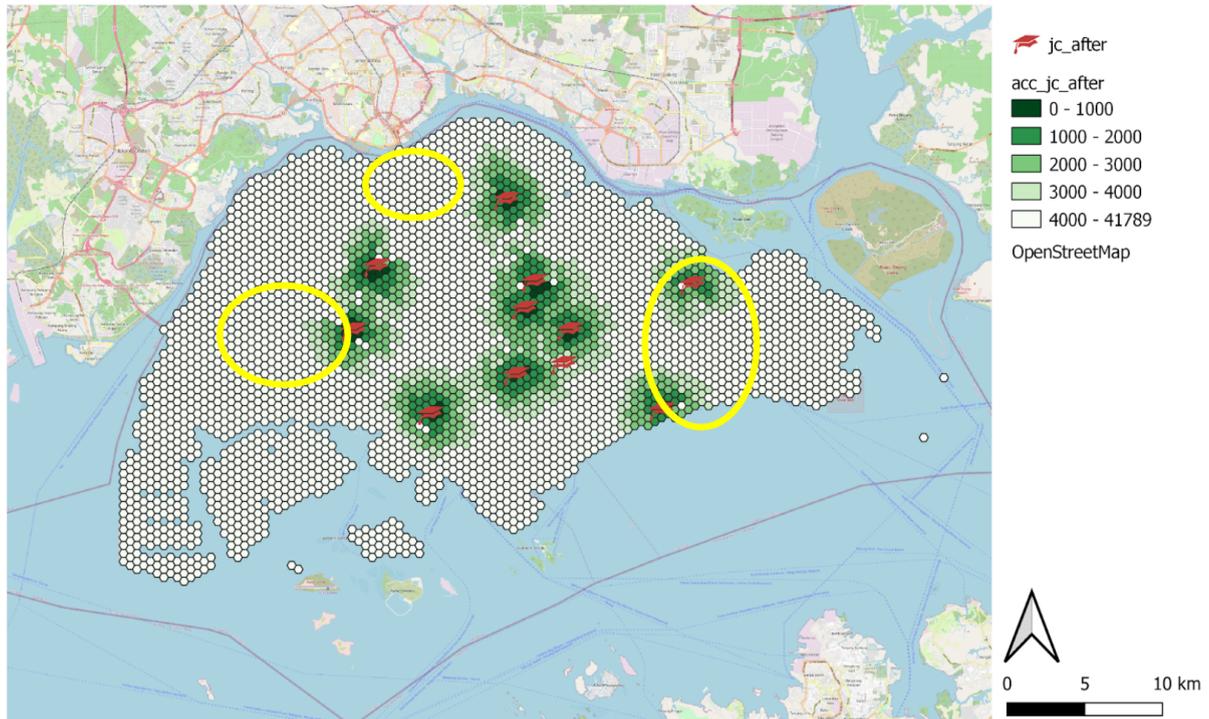
Moving onto the analysis of the impact of Junior Colleges(JC), similar to the primary schools, the gif above shows the change in accessibility before and after the closures of the 6 JCs. Immediately, we notice that a significant amount of areas have turned to a lighter shade, indicating that students who are residents of that area would now have to travel further to the next nearest JC. Additionally, the areas that are most heavily impacted are the northern and western residential areas such as Woodlands and Jurong West. Let us now analyse each map in closer detail.

## Accessibility of JC Schools before closures



The map above shows the accessibility of JCs in Singapore in 2018. The denser the colour (dark green), the shorter the travel distance between the points in Singapore to their nearest JC. Notice that there are 6 yellow icons for the closed JC, we will monitor the difference especially those in the yellow circle to see how the closure of these schools affects the equity of access.

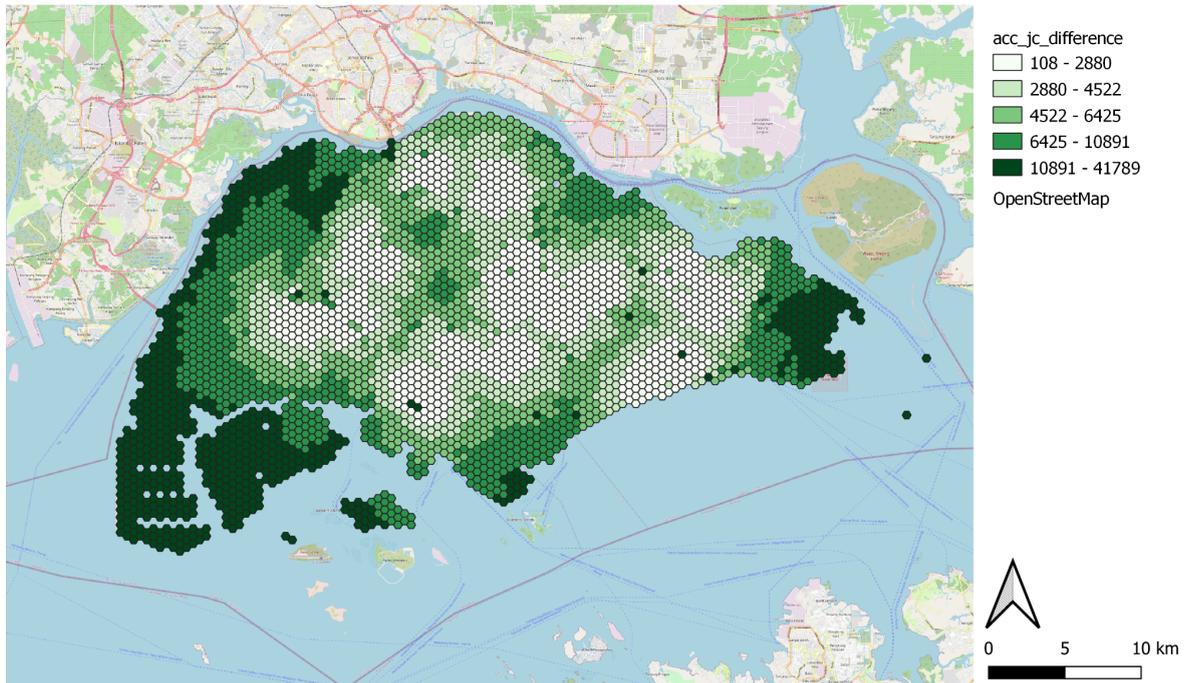
## Accessibility of JC Schools after closure



After the closure of the 6 JCs, the closure of Jurong JC within the western yellow circle has significantly lowered the equity of access for residents living within the subzone, reflected by the decrease in colour density. Due to the closure of the JC, the residents who are existing or potential JC students will have to travel further to JC which causes a decrease in the accessibility and an increase in inconvenience as they will have to travel a longer distance to school. Similarly, for the yellow circle towards the north, the closure of Innova JC has decreased the accessibility of students living in northern regions such as Woodlands and Kranji.

Furthermore, the closure of Tampines and Temasek JC has caused a decrease in accessibility in the east area, making the equity of access to other JCs decrease and resulting in the existing JC students travelling to the merged JC that was announced. In addition, it also affects potential students who would prefer to study in a JC and would need to seek alternative JCs of their preference which is significantly further from their residential area.

## Accessibility Junior College - Difference



Similar to the analysis of primary schools, we have again derived a change map showing the areas impacted by the closures of JCs. Further complimenting our analysis, the map above shows the change in accessibility after the closure of the 6 JCs. Basically, the darker the green colour, the greater the change in accessibility, and in this case, a denser green hexagon shows lower accessibility and a lighter green hexagon shows a lesser impact on accessibility. The region with a darker colour density shows the greater distance needed for residents in the region to travel to the nearest JC. The greatest change comes from the closure of Innova JC in the north, as students from the area would have to travel at least 8 kilometres to the next nearest or the merged JC such as Yishun JC, and this portrays an inequity of access to JC for existing or potential students living in the north area.

In addition, based on the map for differences in accessibility, areas involving Pioneer, Pasir Ris, and Woodlands were affected the most by the closure or merger of JC schools. While the JC schools are clustered nearer to the middle of the island for an even spread to enable potential and existing students to have an equity of access, some students might be living at the edge of Singapore such as Pioneer, Joo Koon and Pasir Ris (closure of Tampines and Temasek JC) and a longer travelling time and distance is required to travel to the next nearer JC that is outside the subzone (E.g., Travelling from Woodlands to Yishun JC due to the closure of Innova JC).

Based on the map layout as shown above, we are able to observe that the **changes** to the color density of the JC closure are **significantly more than** the Primary School although there are only 6 closure. The reason being, compared to the Primary School, each JC are further from one another unlike Primary School where different Primary School are clustered around each other example Pioneer Primary have West Wood Primary and Juying Primary

School around it. The JC are evenly distributed across Singapore and are further from each other hence with the closure of the 6 JC the resident around it will significantly decrease in accessibility example the closure of Innova JC in Woodlands, students who stay around there will have to travel all the way down to Yishun, Yishun JC.

Furthermore, the map shows that the majority of Singapore JC is accessible. Similarly, there are some areas which are completely white/ inaccessible, namely the North-Western planning area of Lim Chu Kang, and the Western planning areas of Pioneer and Tuas. However, the accessibility of these areas is inconsequential to students as they are not residential but rather industrial areas which also explains the inaccessibility.

## 4. Lesson learned and recommendation

Based on our team's observation, based on the closure of the selected primary schools, in some subzones such as North Bridge road and Crawford where Stamford Primary School is located, there are residences residing in the area. As a result, the decision to close Stamford Primary School will have an impact on both existing and potential students who are studying or planning to study there, as existing students will be required to travel to the planned merged school, while potential new primary school students will be required to either enrol in the merged school or enrol in another available Primary School that is closer to their home. The arrangement to close or merge primary schools will decrease accessibility and the equity of access will prove to be imbalanced (inequity) for the students affected by the closure of their Primary School that is due to be merged with another school.

Therefore, we realised that in order to provide equity of access for all existing and potential primary school students in Singapore, our group finds that the Ministry of Education could plan to relocate or open more schools within a 1-2km buffer range so that the primary school students will still be able to gain access to quality education without the fear of travelling a long distance and this includes those areas that are lighter in colour in terms of the density to ensure that it's evenly distributed across the island. In addition, it will be advisable to close down the schools that are clustered together as the schools that are spread around will be able to service the students living and studying in the area.

As for the recommendation for JC, considering the limited number of JC schools that are available in Singapore, the closure of the 6 selected Junior Colleges will affect students who are studying or would potentially be studying in a Junior College in the future as the distances required to travel to the next nearest JC would increase significantly. For instance, the closure of Jurong JC may have an adverse impact on the residents living in the western areas of Singapore (Tengah) in terms of the time taken to travel to the JC, especially if there is a growing demand for students wanting to study in a JC at the west side. As there are existing residential areas located in the west area such as Boon Lay, Pioneer and Joo Koon, there will still be demand for students who would eventually want to study in a JC. Hence, we firmly believe that the JCs that are servicing the student population living at the edge of Singapore should not be closed down.

With that being said, this brings us to our next point we have highlighted an example of a subzone where there has been an increase in the number of residential areas over the years

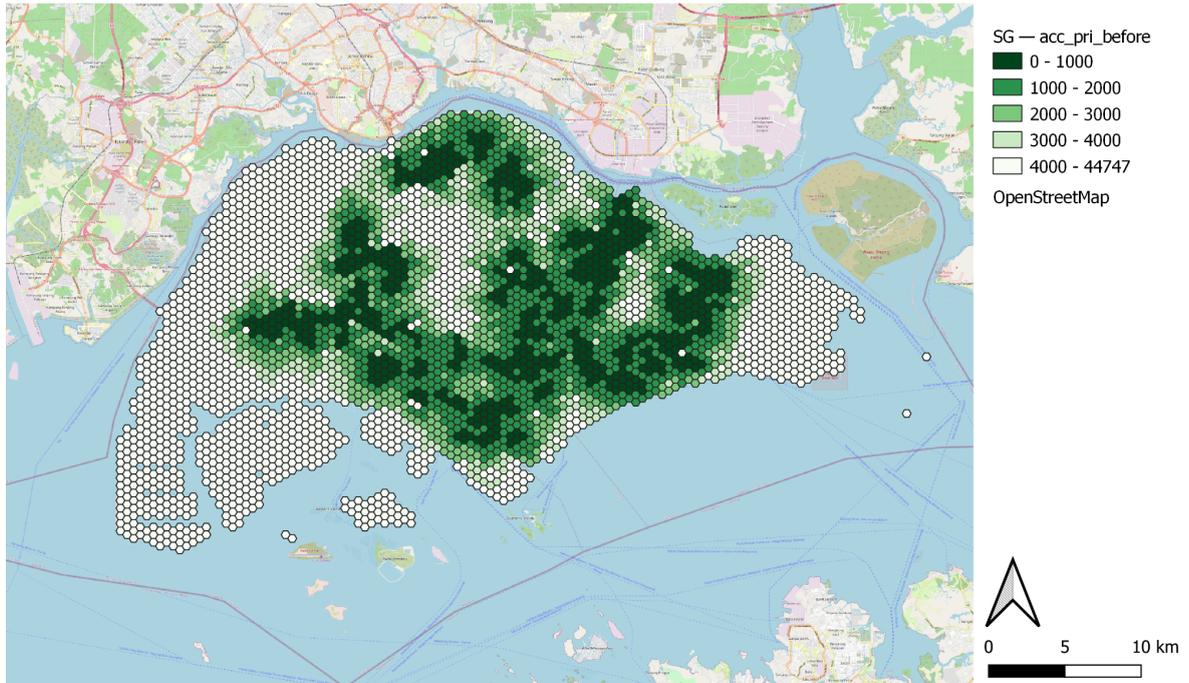
in Punggol. Currently, there are about 693 residential buildings (num points) which is a substantial amount. However, due to the lack of sufficient planning for future changes that might occur (e.g., a Steep increase in residents living in developing subzones such as Punggol since the development of residential buildings in the area), there has not been an increase in JCs in Singapore to accommodate the demand in that area. Based on this scenario, if there is no appropriate planning made for developing subzones such as Tengah, the future residents that will be living in the area may face a similar issue in the near future due to the closure of Jurong JC ahead of time and they might need to travel to the next nearest JC such as Jurong Pioneer Junior College.

Count — Features Total: 7, Filtered: 7, Selected: 0

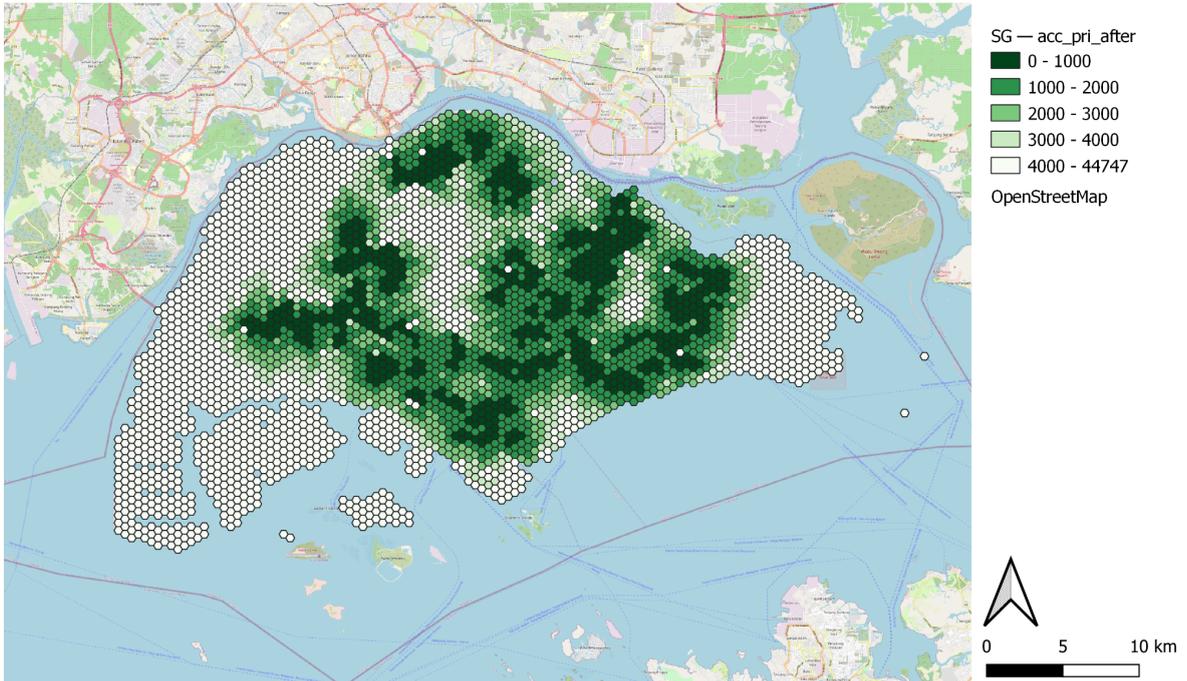
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3	4	PUNGGOL FIELD	PGSZ04	N	PUNGGOL	PG	NORTH-EAST R...	NER	7462F6141FA74...	20191223152313		183
4	3	MATILDA	PGSZ03	N	PUNGGOL	PG	NORTH-EAST R...	NER	DE257E21D72C...	20191223152313		192
5	5	WATERWAY EAST	PGSZ05	N	PUNGGOL	PG	NORTH-EAST R...	NER	A9E7E4A7DEE0...	20191223152313		179
6	2	PUNGGOL TOW...	PGSZ02	N	PUNGGOL	PG	NORTH-EAST R...	NER	C88176A77BAB...	20191223152313		71
7	6	PUNGGOL CANAL	PGSZ06	N	PUNGGOL	PG	NORTH-EAST R...	NER	90CACDCDAB5...	20191223152313		0

## 5. Collection of Analytical Map

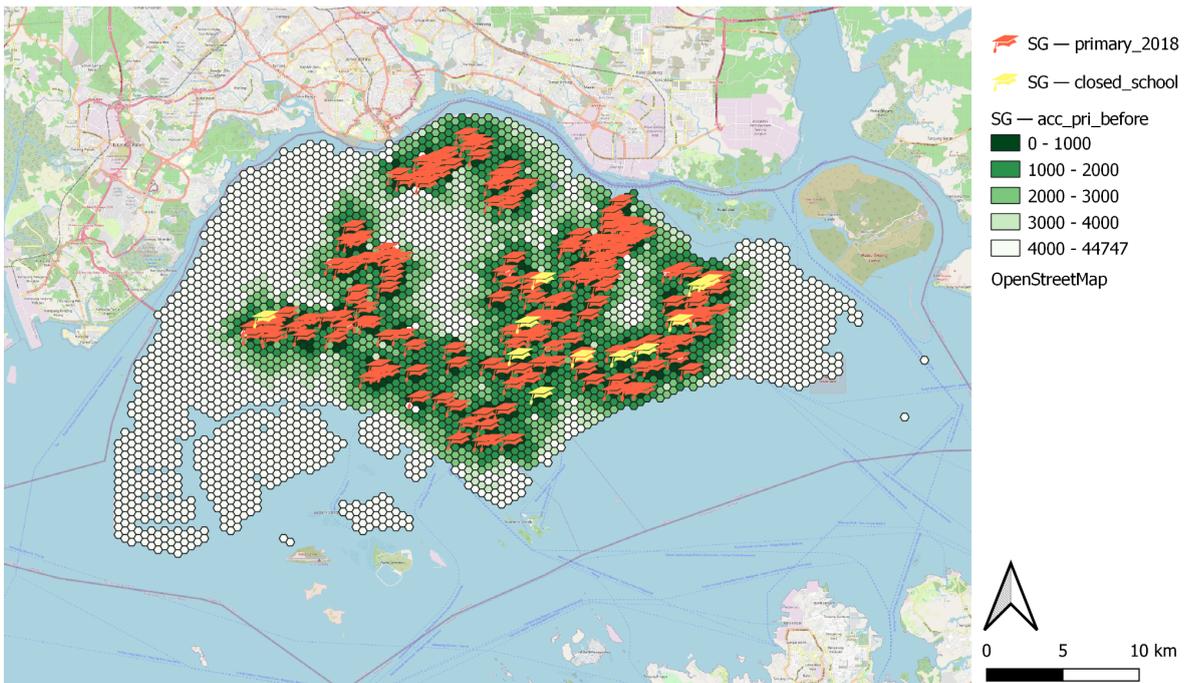
### Accessibility Primary Before



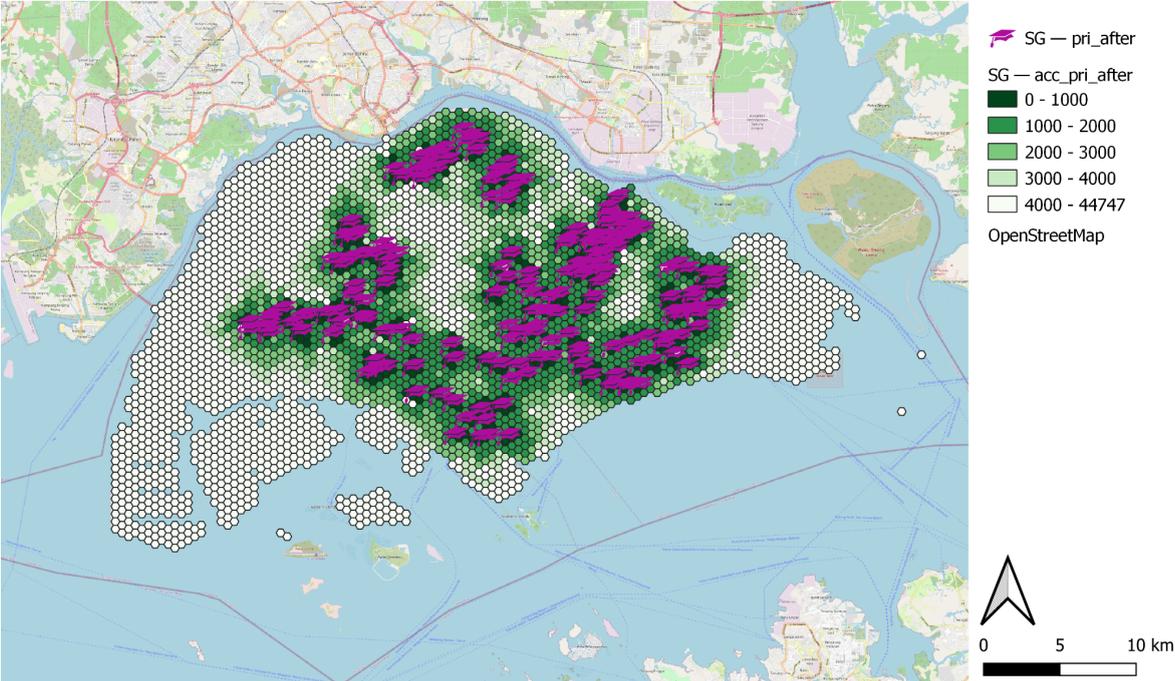
## Accessibility Primary After



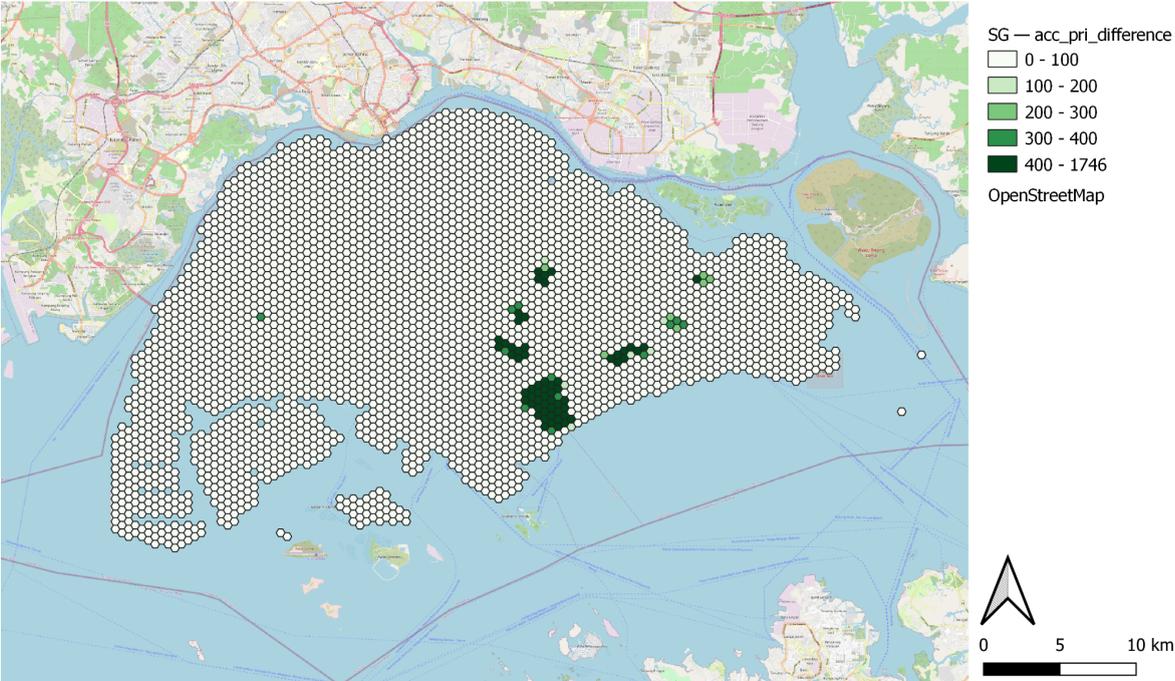
## Accessibility of Primary Schools before closures



# Accessibility of Primary Scools after closure



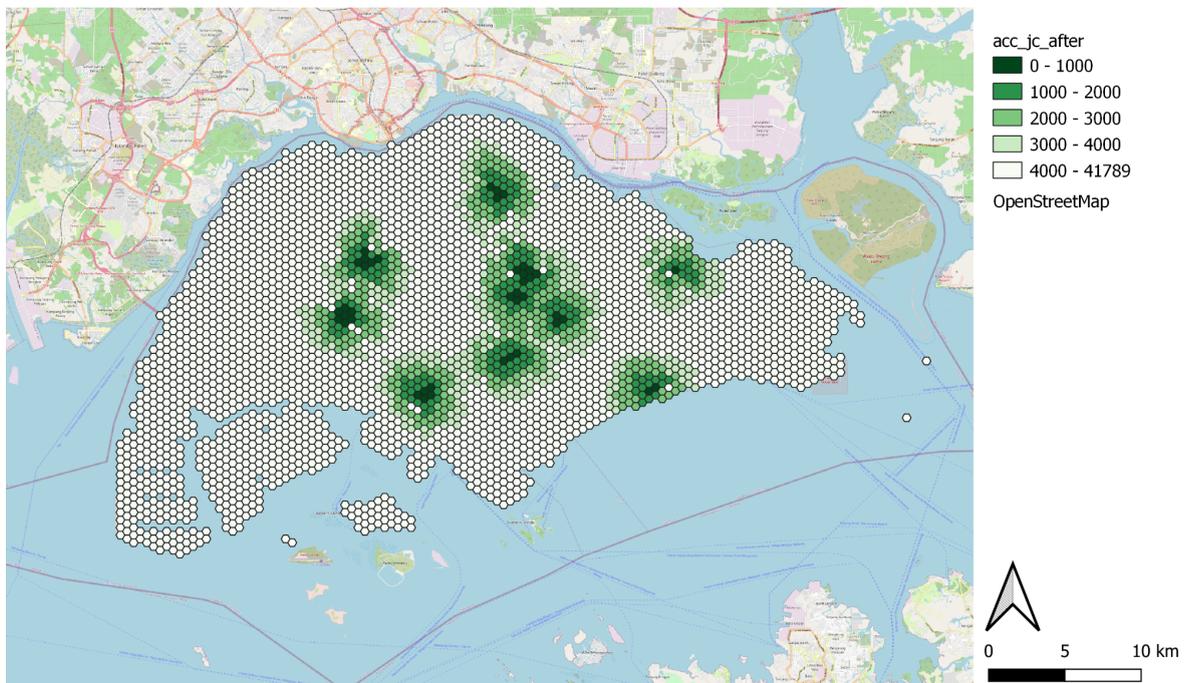
# Accessibility Primary - Difference



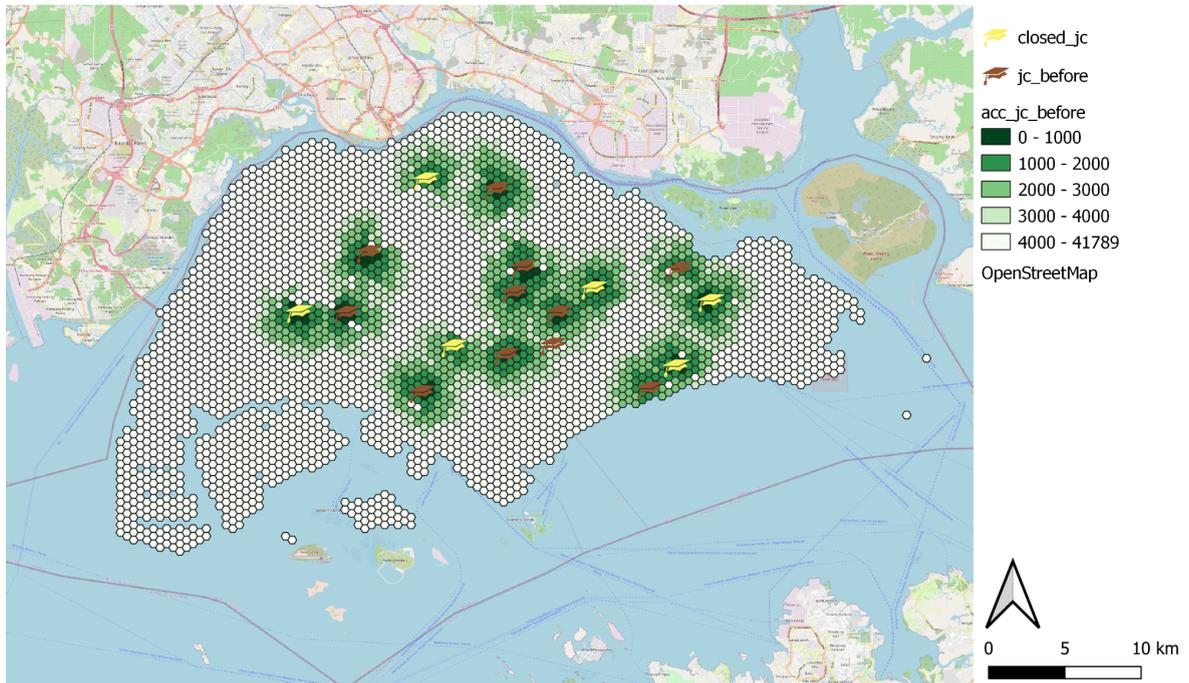
## Accessibility of JC Schools before closures



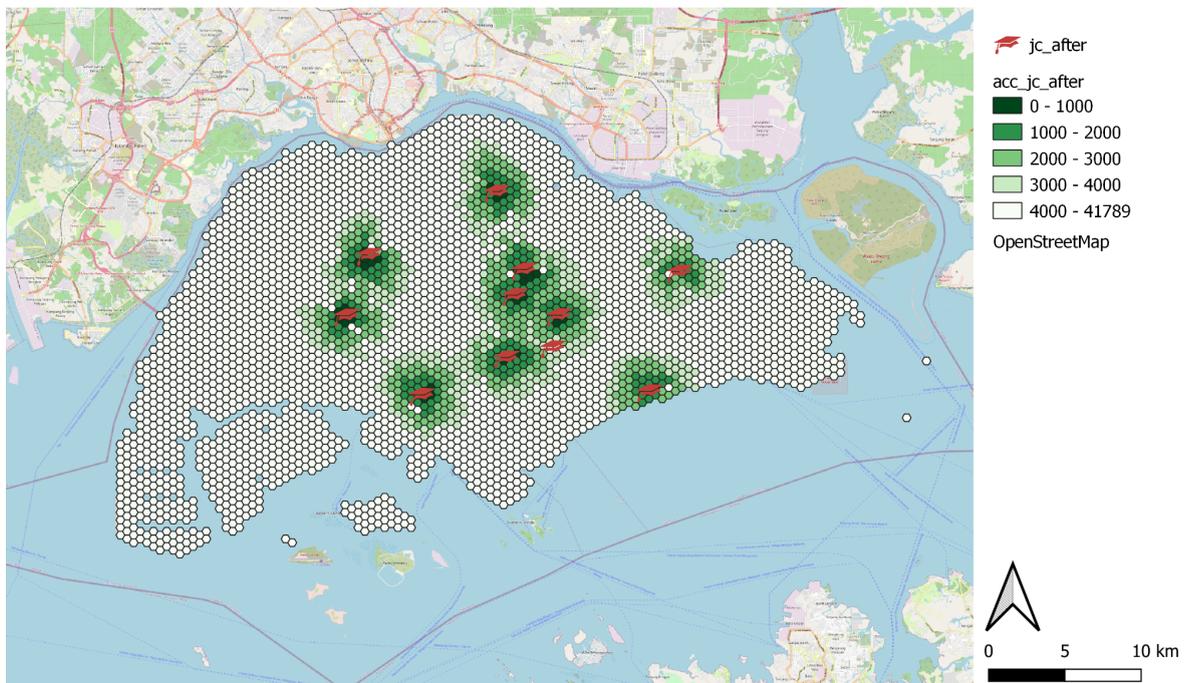
## Accessibility of JC Schools after closure



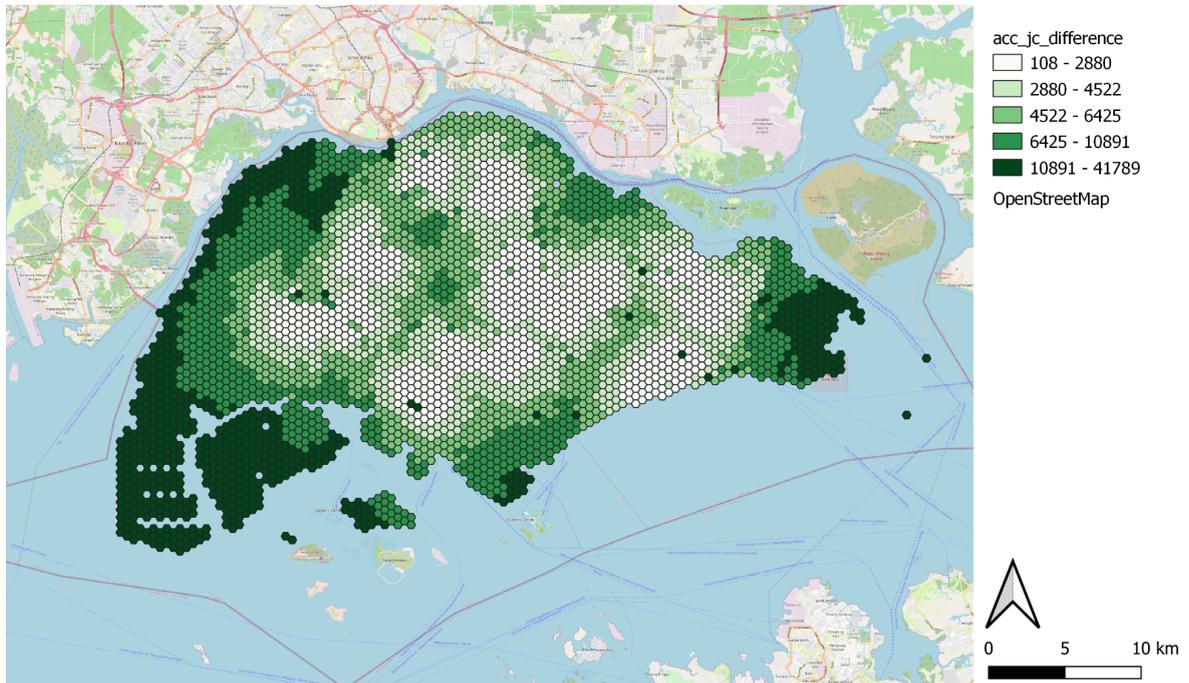
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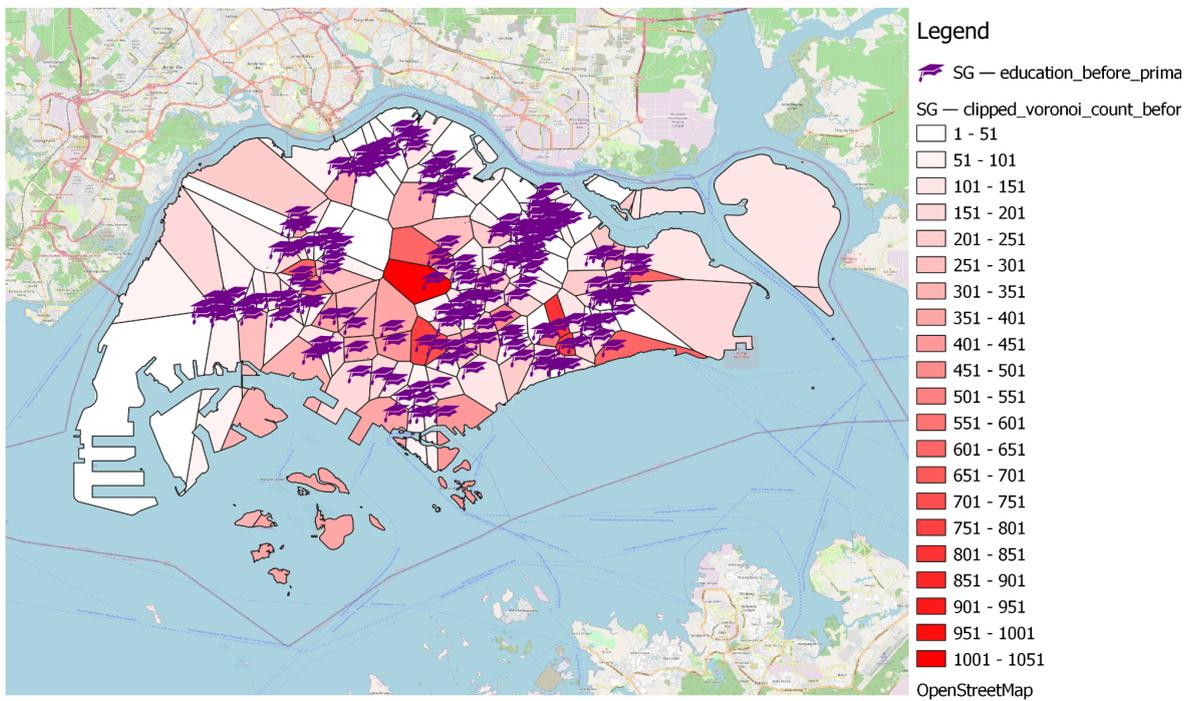
## Accessibility of JC Schools after closure



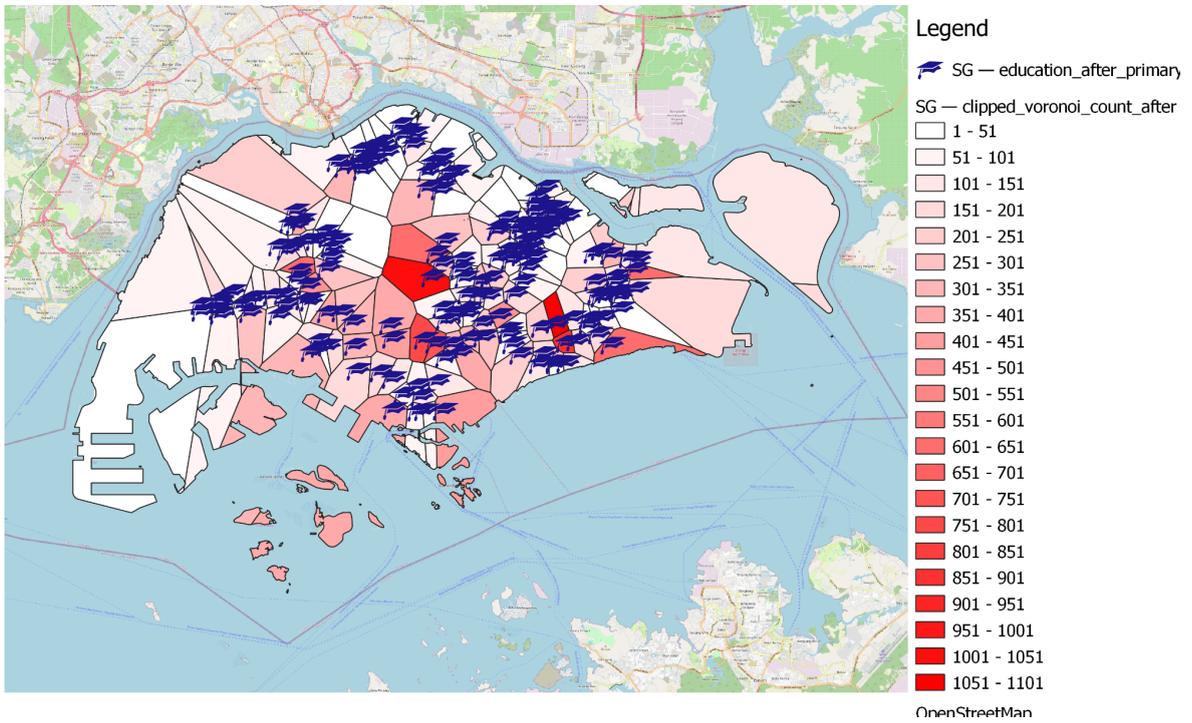
## Accessibility Junior College - Difference



## Voronoi of Primary School Service Areas before Closure



# Voronoi of Primary School Service Areas after Closure



# References

Ministry of Education Singapore. (2022, April 6). Names of primary and secondary schools merging between 2022 and 2025.

<https://www.moe.gov.sg/news/press-releases/20220406-names-of-primary-and-secondary-schools-merging-between-2022-and-2025>

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## Names of Primary and Secondary Schools merging between 2022 and 2025

### Primary Schools

S/N	Merging Schools	Merged School Name	Location of Merged School
1	Eunos Primary & Telok Kurau Primary	Telok Kurau Primary School 友诺小学 Sekolah Rendah Telok Kurau தெலுக் குராவ் தொடக்கப்பள்ளி	Site of Telok Kurau Primary School
2	Farrer Park Primary & Stamford Primary	Farrer Park Primary School 华苑小学 Sekolah Rendah Farrer Park ஃபேரர் பார்ட் தொடக்கப்பள்ளி	Site of Farrer Park Primary School
3	Guangyang Primary & Townsville Primary	Townsville Primary School 光洋小学 Sekolah Rendah Townsville டவுன்ஸ்வில் தொடக்கப்பள்ளி	Site of Townsville Primary School
4	Juying Primary & Pioneer Primary*	Pioneer Primary School 聚英小学 Sekolah Rendah Pioneer பயனியர் தொடக்கப்பள்ளி	Site of Juying Primary School (To be relocated to new school site in Tengah tentatively in 2025)

\*Merged in 2022.

# Appendix

## Gantt chart

Start Date	3/10/2022						
Week	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
Date	3 Oct	10 Oct	17 Oct	24 Oct	31 Oct	7 Nov	14 Nov
<b>Phase 1: Discussion and select themes to work on</b>							
Theme selection							
Collate and download data							
Data compilation, extraction and integration							
Understand the data, data cleaning, preparation and wrangling							
Create Github							
Create Website							
<b>Phase 2: Analysis of school type, schools that are close down</b>							
Analysis of population							
Analysis of roads							
Design of GIS Map and GeoPackage							
Update project website							
<b>Phase 3: Selection of schools</b>							
Discussion of school closure							
Equity of access for closure and merger of education institutions							
Design of GIS Map and GeoPackage							
<b>Phase 4: Report</b>							
Content layout discussion							
Introduction and project motivation							
Equity of access report content and layout							
Write up equity of access analysis report							
Finalise project reports							
Report submission							
Update project website - Project report							
<b>Phase 5: Poster</b>							
Edit poster content							
Finalise poster							
Poster submission							
Update project website - Project poster							
<b>Phase 6: Finalising project materials</b>							
Finalise project website, report and poster							
Project artifacts and website submission							