

## Daycare Center Shortage Problem in Seoul, Korea

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### I. Background

These days, daycare center shortage is a serious problem in Seoul, Korea. Seoul is a huge city whose population is over 10 million, but the number of daycare centers is not enough to satisfy the young parents who have kids of age 0 to 5. Some daycare centers are so popular that you should get on the waiting-list as soon as you give a birth to a baby.

Recently, Seoul City announced that they will open 600 new public daycare centers within 2020 to reduce the shortage problem. The new daycare centers should be allocated effectively, considering the relevant factors such as the population of children by districts. In this project, each area's level of demand for public daycare center will be analyzed.

### II. Gathering Data

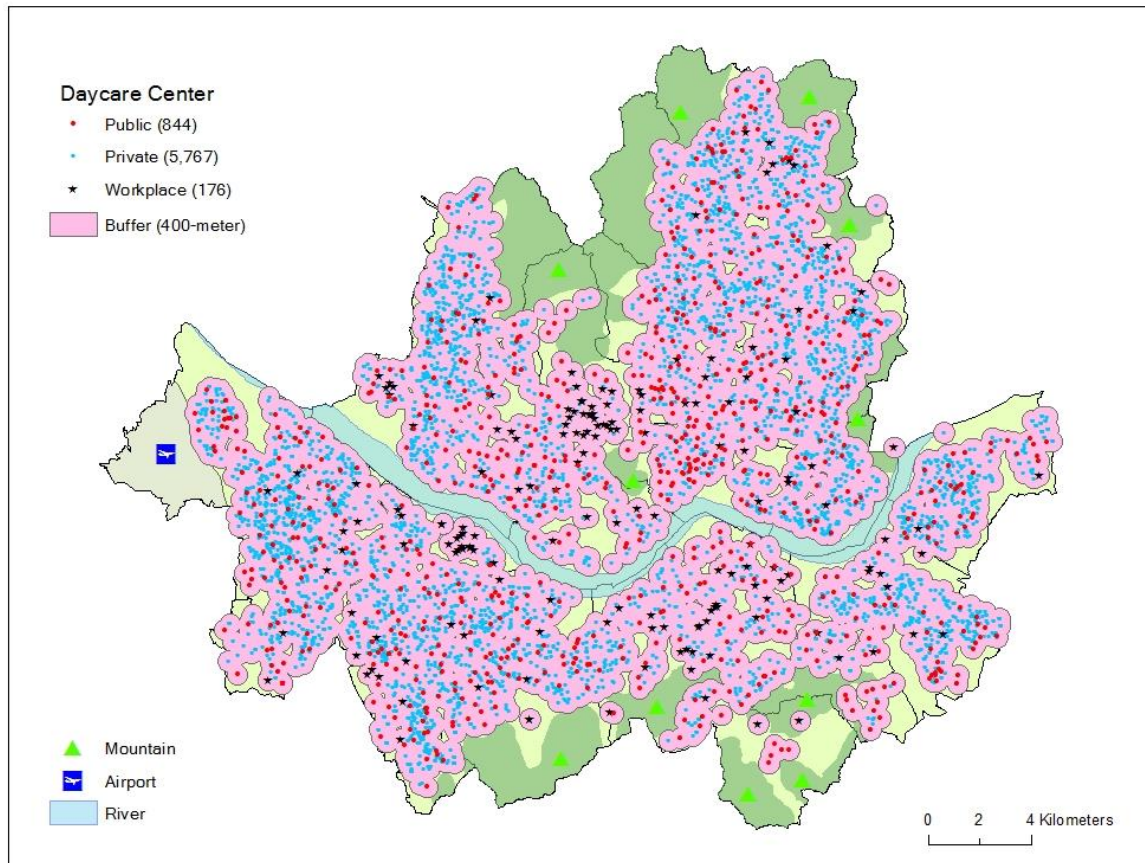
For this project, I collected data from different sources as shown in the Table 1.

Type	Name	Source
Shapefile	Map of Seoul	<a href="http://www.arcgis.com/">http://www.arcgis.com/</a>
Shapefile	Location of Daycare Center (2015)	<a href="http://map.seoul.go.kr/">http://map.seoul.go.kr/</a>
Excel File	List and Capacity of Daycare Center (2015)	<a href="http://iseoul.seoul.go.kr">http://iseoul.seoul.go.kr</a>
Excel File	Population, Birthrate, and Average Income of Each District (2015)	<a href="http://kosis.kr/">http://kosis.kr/</a>
Excel File	Area of Each District	<a href="http://stat.seoul.go.kr/">http://stat.seoul.go.kr/</a>

Table 1. Used Data List

### III. Process

#### 1. Idea Flows



**Map 1. Location of Daycare Centers and the Buffers**

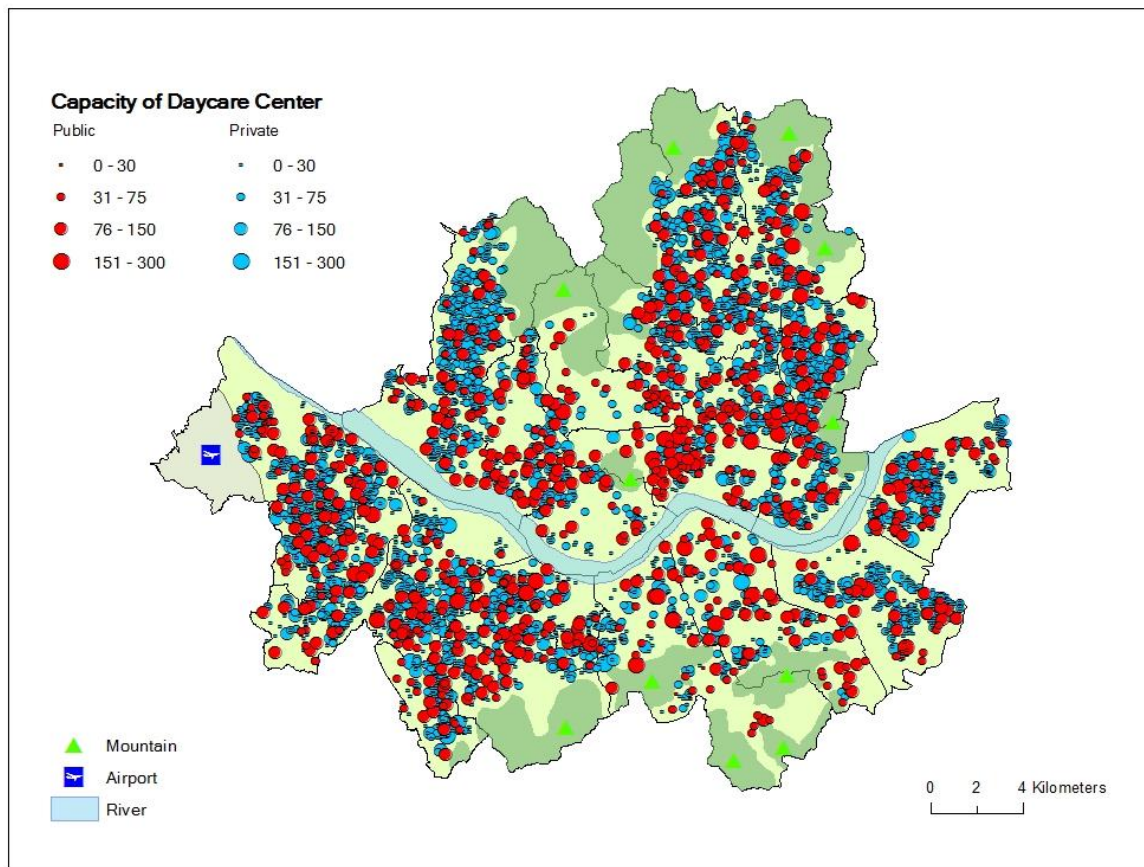
The Map 1 shows the location of daycare centers and the 400-meter buffers around them. There are three types of daycare center; public daycare centers (red points), private daycare centers (blue points), and the daycare centers operated by companies for their employees (black stars). The buffers show the areas where a daycare center is located within walking distance (400 meters).<sup>1</sup> From this map, you can see that most parts of Seoul are covered by the buffers except for the areas where the airport, river, and mountains are

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<sup>1</sup> There is no standard for 'walking distance'. In this project, I assume that 400 meter is the maximum walkable distance for the parents who take their kids to the daycare center on foot.

located.

However, the Map 1 does not reflect many relevant factors related to such as the capacity of each daycare center. In addition to that, it ignores the fact that people usually prefer public daycare center than private daycare center due to their lower price and higher quality. Thus, it is possible that in some areas, residents demand for more public daycare centers even though they have enough private daycare centers nearby.



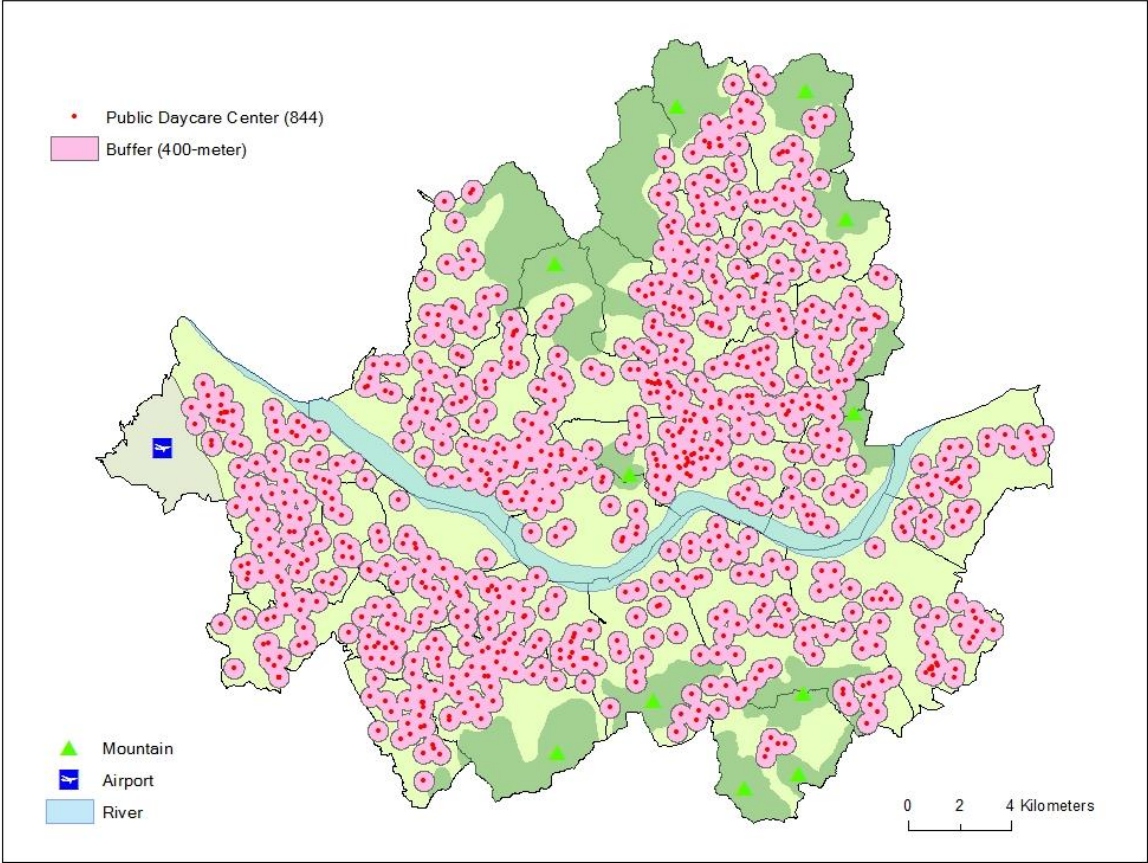
**Map 2. Capacity of Daycare Centers**

The Map 2 shows the capacity of daycare centers.<sup>2</sup> As shown in the map, the capacity differs for each daycare center; the minimum is 5, and the maximum is 298. It shows that we should not ignore the capacity when determining demand for public daycare center. The

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<sup>2</sup> The capacity means the maximum number of children that a daycare center can accommodate.

capacity matters; even though there are many daycare centers in an area, if their capacity is not enough, demand for public daycare center can be high.



**Map 3. Location of Public Daycare Centers and the Buffers**

Now, let us focus more on public daycare centers. The Map 3 shows the location of public daycare centers and the 400-meter buffers around them. You can see that some areas are not covered by the buffers, unlike the Map 1. Considering that most people prefer public daycare centers than private daycare centers, we may anticipate that some areas might desperately want more public daycare centers. Now, a question arises: *Which area will demand for public daycare center the most?*

## 2. Assumptions

To answer this question, I assumed that there are ten factors that affects the demand for public daycare center. The factors and their impact on the demand are assumed as follows.

No.	Factor	Impact
1	Density of population (All age)	+
2	Density of population (Age 0-5)	++
3	Birthrate	++
4	Average income	-
5	Sum of capacity of the public daycare centers within walking distance (400 meters)	-
6	Distance to the nearest public daycare center	++
7	Capacity of the nearest public daycare center	-
8	Sum of capacity of the private daycare centers within walking distance (400 meters)	-
9	Distance to the nearest private daycare center	+
10	Capacity of the nearest private daycare center	-

Table 2. Relevant Factors on the Demand

I did not consider the workplace daycare centers in this project because they are operated for their employees only; and they are not usually located in residential areas. I assumed that the three factors – population density of age 0-5, birthrate, and distance to the nearest public daycare center – have stronger impact than other factors. I assumed that the average income and demand for public daycare center have a negative relation because wealthy people are more likely to have an alternative such as hiring a baby sitter.

## 3. Standardization of Value

Seoul is divided into 25 districts. The Korean Statistical Information Service (KOSIS) and the City of Seoul provide various data in district level. In this project, I used population density data, birthrate data, and average income data. For analysis, I standardized these values using the formula below.<sup>3</sup>

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<sup>3</sup> Or, you can just use the 'Standardize' function in Excel.

$$\text{Standardized Value} = \frac{\text{Original Value} - \text{Average}}{\text{Standard Deviation}}$$

The purpose of standardization is to make a value comparable with another one. A standardized value falls around zero, in accordance with how far it deviates from the average. Let us see the standardization result shown in the Table 3.

District Name	Population Density (Per Sq. Kilometer)	Standardized Population Density	Average Income (10,000 KRW)	Standardized Average Income
Dobong	8,545.34	-0.99	290.8	-0.54
Dongdaemun	14,231.68	-0.40	320.7	0.01
Dongjak	16,651.23	-0.15	316.7	-0.06
Eunpyeong	11,408.66	-0.70	292.3	-0.52
Gangbuk	10,678.19	-0.77	278.5	-0.77
Gangdong	25,685.87	0.78	337.3	0.32
Gangnam	26,494.09	0.87	453.6	2.48
Gangseo	43,200.31	2.60	292.6	-0.51
Geumcheon	6,374.10	-1.22	241.8	-1.45
Guro	19,573.68	0.15	317.3	-0.05
Gwanak	34,876.85	1.74	266.7	-0.99
Gwangjin	21,467.46	0.35	297.9	-0.41
Jongno	6,129.15	-1.24	299.0	-0.39
Jung	6,701.93	-1.19	281.2	-0.72
Junngang	8,457.17	-1.00	264.0	-1.04
Mapo	21,938.02	0.39	360.2	0.75
Nowon	22,712.37	0.47	297.8	-0.41
Seocho	12,210.60	-0.61	479.8	2.97
Seodaemun	17,112.70	-0.11	332.4	0.23
Seongbuk	18,170.00	0.00	290.9	-0.54
Seongdong	13,037.81	-0.53	330.8	0.20
Songpa	21,050.34	0.30	376.2	1.04
Yangcheon	19,224.80	0.11	336.2	0.30
Yeongdeungpo	35,891.97	1.84	337.5	0.33
Yongsan	11,469.68	-0.69	307.8	-0.23

**Table 3. Standardization Result**

You cannot simply compare Gangseo's population density with its average income, because they are in different scale. The standardized values, however, are comparable with each other. From the standardized values, you may know that Gangseo's population density is above average and its average income is below average.<sup>4</sup> Furthermore, you can say that Gangseo's population density deviates from the average farther than its average income does.<sup>5</sup> You can even add or subtract two or more standardized values because they have the same scale; this is what I will do in **6. Formula for the Calculation of Demand**.

#### 4. Fishnet Map

To display each area's demand for public daycare center, I chose to use a fishnet map. A fishnet map divides the whole area into uniform, square grid cells. It enables us to create cell-level data from point data. It also makes it possible to analyze demand for public daycare center at a lower level than the district-level.

The fishnet map that I used for this project divides the whole area of Seoul into 1,815 uniform, square grid cells of width 600-meter and height 600-meter. There are two reasons for choosing 600-meter as the width and height. Firstly, a 600-meter square cell is not too small; and not too big. If a fishnet cell is too small, it will rarely contain a daycare center in it. If a cell is too big, the fishnet analysis will lose its meaning.

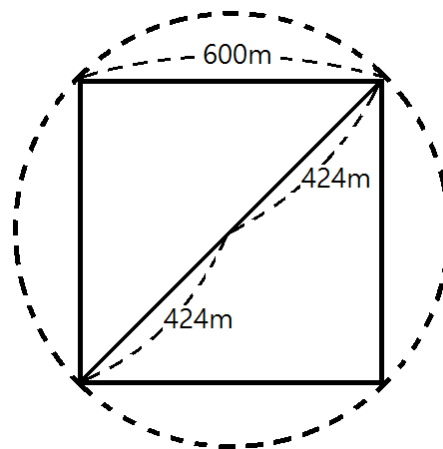


Figure 1. 600-Meter Square Cell

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<sup>4</sup> Because 2.60 is above 0; and -0.51 is below 0.

<sup>5</sup> Because 2.60 is bigger than 0.51.

The second reason is related to the walking distance. As shown in the Figure 1, the distance between the center of the square and its edge is 424-meter, which means that almost every point in the square is within the walking distance<sup>6</sup> from the center of the square. Thus, a 600-meter fishnet cell is appropriate for as a unit of analysis.

## 5. Data Assignment

Each fishnet is assigned two types of data. The first type of data is from the point feature of daycare center; each fishnet cell is assigned data about the nearest daycare center and the daycare centers located in the cell.

The second type of data is from the district-level data. The standardized data of each district are assigned to each fishnet cell based on its location. For example, the cells inside Gangseo District have a standardized average income of -0.51 and a standardized population density of 2.60. On the other hand, the cells which are located on the boundary of two or more districts have the average value of the districts' standardized value.

## 6. Formula for the Calculation of Demand

Based on the assumptions in **2. Assumptions**, I created a formula to calculate each fishnet cell's demand for public daycare center. The formula is as follows.

$$\begin{aligned} \text{Demand} = & \text{Standardized density of population (All age)} \\ & + \text{Standardized density of population (Age 0-5)} * 2 \\ & + \text{Standardized birthrate} * 2 \\ & - \text{Standardized average income} \\ & - \text{Standardized sum of capacity of the public daycare centers in the cell} \\ & + \text{Standardized distance to the nearest public daycare center} * 2 \\ & - \text{Standardized capacity of the nearest public daycare center} \\ & - \text{Standardized sum of capacity of the private daycare centers in the cell} \\ & + \text{Standardized distance to the nearest private daycare center} \\ & - \text{Standardized capacity of the nearest private daycare center} \\ & + \text{Correction value} \end{aligned}$$

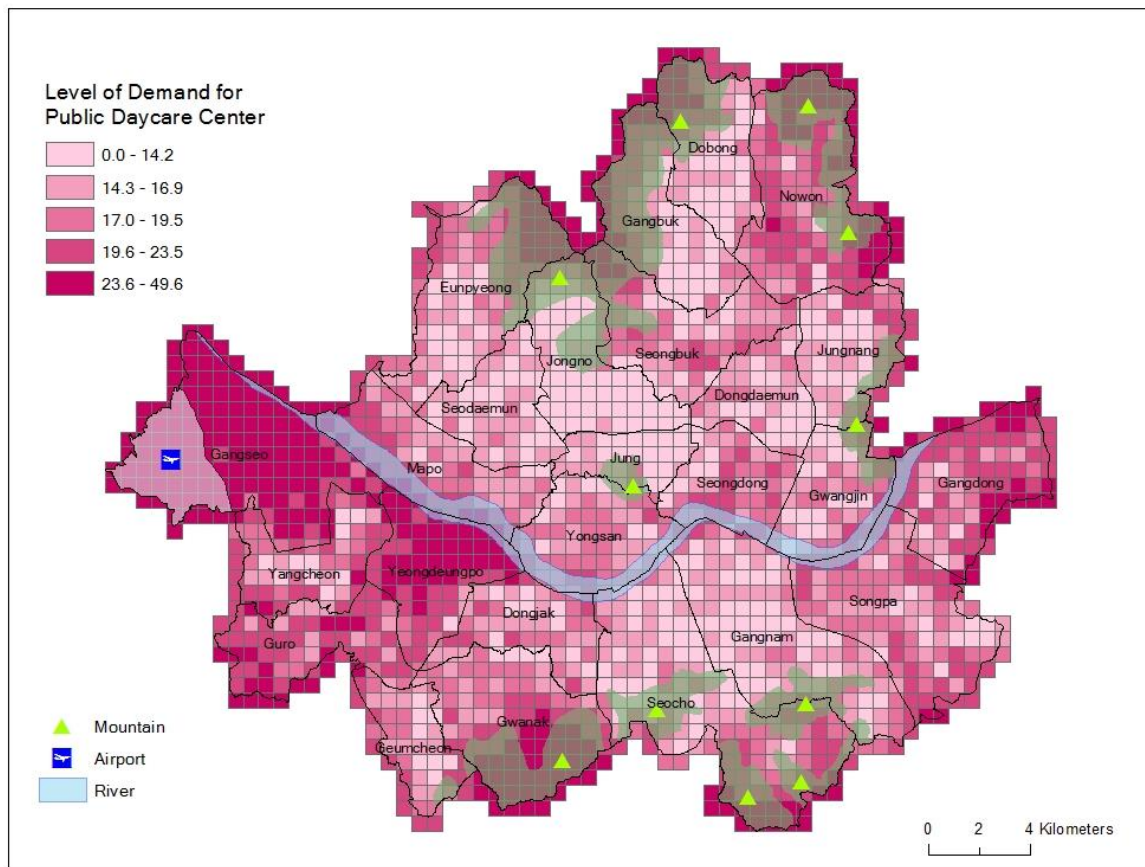
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<sup>6</sup> I assumed that the walking distance in this project is 400-meter.



The factors which are assumed to have a positive impact on demand are added, and the factors which are assumed to have a negative impact on demand are subtracted. The three factors which are assumed to have a stronger impact are doubled. Lastly, I added 18.70 as a correction value to make each cell's demand have a positive value.<sup>7</sup>

#### IV. Outcome & Analysis

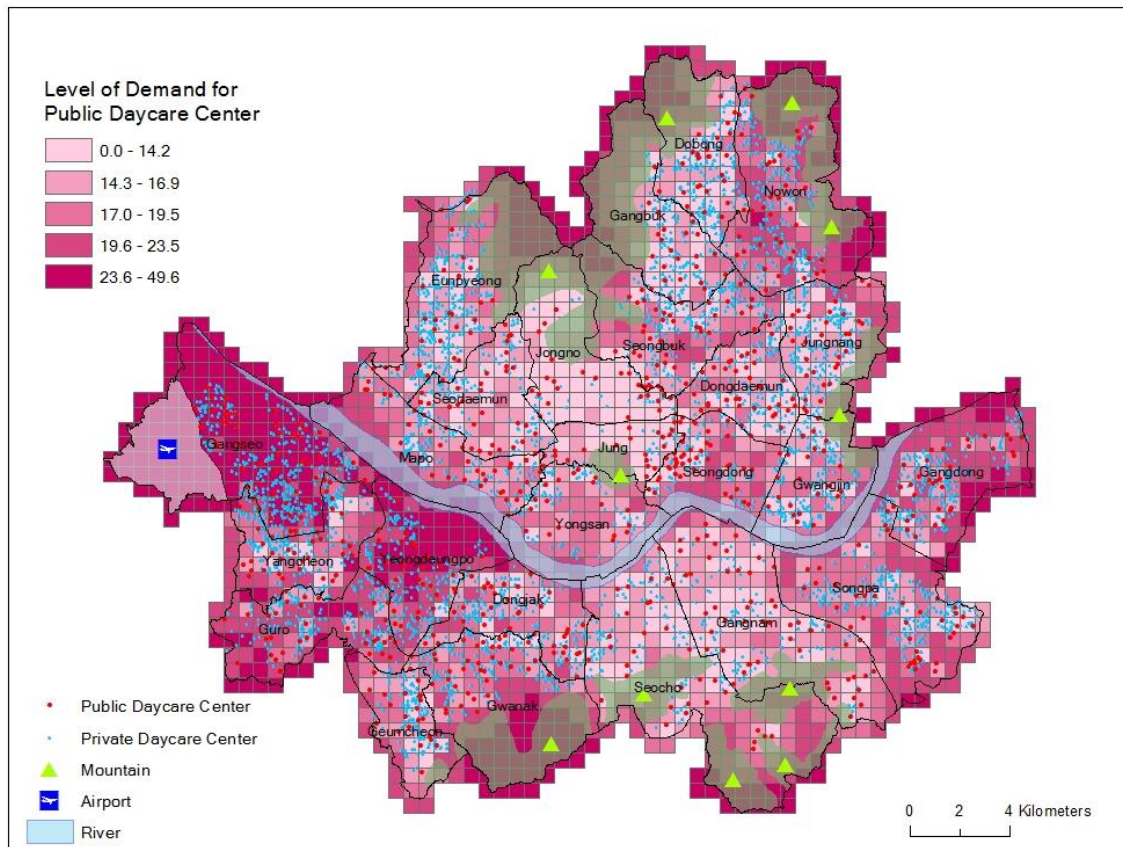


Map 4. Demand for Public Daycare Center

<sup>7</sup> If 18.70 was not added, some cells would have a minus value for its demand. Adding 18.70 does not change the order of demand; it only makes demand have a positive value.

The Map 5 is the choropleth map which shows each fishnet cell's demand for public daycare center. The level of demand is divided into five classes based on Quantile Method. Lighter color means lower demand; and darker color means higher demand.

The cells in the lightest color have lower demand for public daycare center. Most of them are the ones which have one or two public daycare centers and/or two or more private daycare centers in it, as shown in Map 6 below. Some cells have a totally different reason, however. For example, the cells in Jung District and Jongno District (in the upper-central area of Seoul) are mostly in the lightest color, even though they rarely have a daycare center. This is because Jung District and Jongno District are the commercial areas which have few residents. Due to their low population density, these two district turn out to have lower demand for public daycare center.



**Map 5. Demand for Public Daycare Center & Location of Daycare Centers**

The cells in the darkest color have higher demand for public daycare center. There can be several reasons for higher demand; higher population density, lower average income, poorer accessibility to the nearest daycare center, and so on. For example, the cells in Gangseo District (in the western part of Seoul) are mostly in the darkest color even though they have some public and private daycare centers. This is because their high population density and low average income.

Some cells have the darkest color because of their geographical characteristic. The cells located on the boundary of Seoul usually have the darkest color because the daycare centers outside Seoul are not considered in this project. The cells in the areas where the airport, river, mountains are located have the darkest color because there are no daycare centers.

Other than the cells with 'special' reasons mentioned above, most fishnet cells show demand for public daycare center well. The Map 5 shows that Gangseo District, Yeongdeungpo District, Songdong District, Seongbuk District, Nowon District, and Guro District are running out of public daycare centers more than other districts. Considering that these districts are the ones which have relatively lower average income, we may conclude that the current allocation of public daycare center is somewhat problematic in terms of equality.

## V. Limitations

This project has some limitations as follows.

1. The statistics data is provided in district level, which is too broad to be used in analyzing a 600-meter x 600-meter fishnet cell.
2. The assumptions are subjective.
3. The formula which is used for calculating demand is not supported by statistics or academic research.
4. The cells located on the boundary of Seoul should have been treated differently from other cells.
5. Individuals who prefer daycare centers near their workplace are not considered.
6. Individuals who drive to the daycare center are not considered.

## VI. Conclusion

The shortage problem of public daycare center is severe in Seoul, Korea. It frustrates many young parents who have kids of age 0 to 5. Recently, Seoul City announced their plan to develop more public daycare centers. The allocation of new public daycare centers should be based on the residents' demand for them. Otherwise, it will just amplify the frustration. In this sense, it is meaningful to analyze demand for public daycare center.

There is no exact standard in calculating demand for public daycare center; it must be subjective to some extent. For this, these questions should be answered: "What are the relevant factors related to demand for public daycare center?", "How can we combine the factors to draw a conclusion?". In this project, I assumed that there are ten relevant factors. The data values were standardized, and then added or subtracted in accordance with its impact on demand.

The resultant map (the Map 5 and 6) displays each fishnet cell's demand for public daycare center. Most cells show their demand well; while some cells show higher or lower demand due to their geographical characteristics. From the map, we could see that Gangseo District, Yeongdeungpo District, Songdong District, Seongbuk District, Nowon District, and Guro District are running out of public daycare centers more than other districts. Considering that these districts have relatively lower average income, we may conclude that the new public daycare centers must be allocated in accordance of equality.