# Revision of Vaccination Distribution in Hong Kong

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# A Review of Current Covid Vaccine Distribution in HK

Covid-19 has spread in the world for almost three years, yet its impact on our lives still continues. The economy is greatly affected, resulting in a shortage of almost everything. The most significant problem nowadays is the shortage of medical resources including PPE, medicine and vaccines. In this article, we mainly focus on the shortage of vaccines, and the possible solutions we would like to provide.

The majority of death cases covid are usually those patients with severe pre-existing conditions(*Causes of death and comorbidities in hospitalized patients with COVID-19*). The elderly are more likely to have pre-existing conditions hence are more vulnerable to Covid. According to data from the CDC, old people are more likely to be hospitalized and even die with the fatality rate 330 times higher than the reference group (18-29 years old) shown in figure 1.

| Rate compared to 18-29 years old[1] | 0-4 years old | 5-17 years old | 18-29 years old | 30-39 years old | 40-49 years old | 50-64 years old | 65-74 years old | 75-84 years old | 85+ years old |
|---|---|---|---|---|---|---|---|---|---|
| Cases[2] | <1x | 1x | Reference group | 1x | 1x | 1x | 1x | 1x | 1x |
| Hospitalization[3] | 1x | <1x | Reference group | 2x | 2x | 3x | 5x | 8x | 10x |
| Death[4] | <1x | <1x | Reference group | 4x | 10x | 25x | 65x | 140x | 330x |

Figure1

Starting from 2020, Covid vaccines have brought hope to fight this pandemic. According to the official government website of Canada, "Evidence indicates that the vaccines used in Canada are very effective at preventing severe illness, hospitalization and death from COVID-19".World Health Organization points out that there are still 1 billion people in undeveloped countries unvaccinated. This may result in a large impact on the healthcare system in these countries as numerous serious cases would be overwhelming. Many studies have also suggested that older people vaccinated are less vulnerable against Covid. Considering the fact that the number of fatal cases in Hong Kong is larger than many countries in this world, we look into the vaccination data of HK(figure 2)
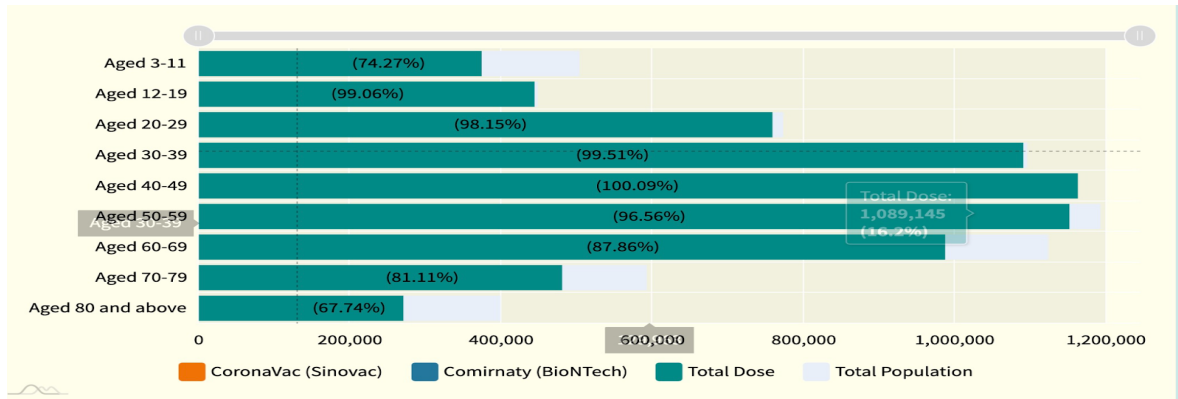
Figure 2

Despite the fact that vaccination rate is comparably high in old age groups, the vaccination rate in HK's old people is among the lowest groups. This imbalance may cause the vaccination plan to fail the duty: lower the death rate. With the purpose of increasing vaccination rate for old people, we propose that the distribution of Covid vaccines should be rescheduled.

Studies have shown that Covid-19 has the highest death rate in older adults because the side effects can be severe. From that perspective, it would be wise to prioritize vaccines to elders in order to reduce the total death rate. The figure shows that less than 80% of people over the age of 70 are vaccinated, while almost all people between the ages of 20 and 60 are vaccinated. As mentioned above, the death rate from Covid-19 increases with age. Therefore, this is an issue in vaccinae distribution.

The project aims to increase the elder people vaccination rate in Hong Kong. There are 19 districts in Hong Kong, as shown in Figure 3. However, the population density and distribution is different in each region. Therefore, it is necessary to build a model with data that can predict population distribution. From the result, multiple vaccination points can be set up to effectively improve the vaccination rate of the elderly.

# Hong Kong Districts

Historically, Hong Kong was divided into several major areas according to the stages of colonial status - Hong Kong Island and Kowloon, which were ceded to the British, and the New Territories, which were leased to the British. Hong Kong has the nickname of "Hong Kong, Kowloon and New Territories". In 1937, the government designated parts of the New Territories south of Sierra Leone as "New Kowloon" for development. However, with the development of the times, the "New Kowloon" area is now regarded as part of Kowloon. Sometimes Saigon is even considered part of "Kowloon", a far cry from colonial Kowloon.
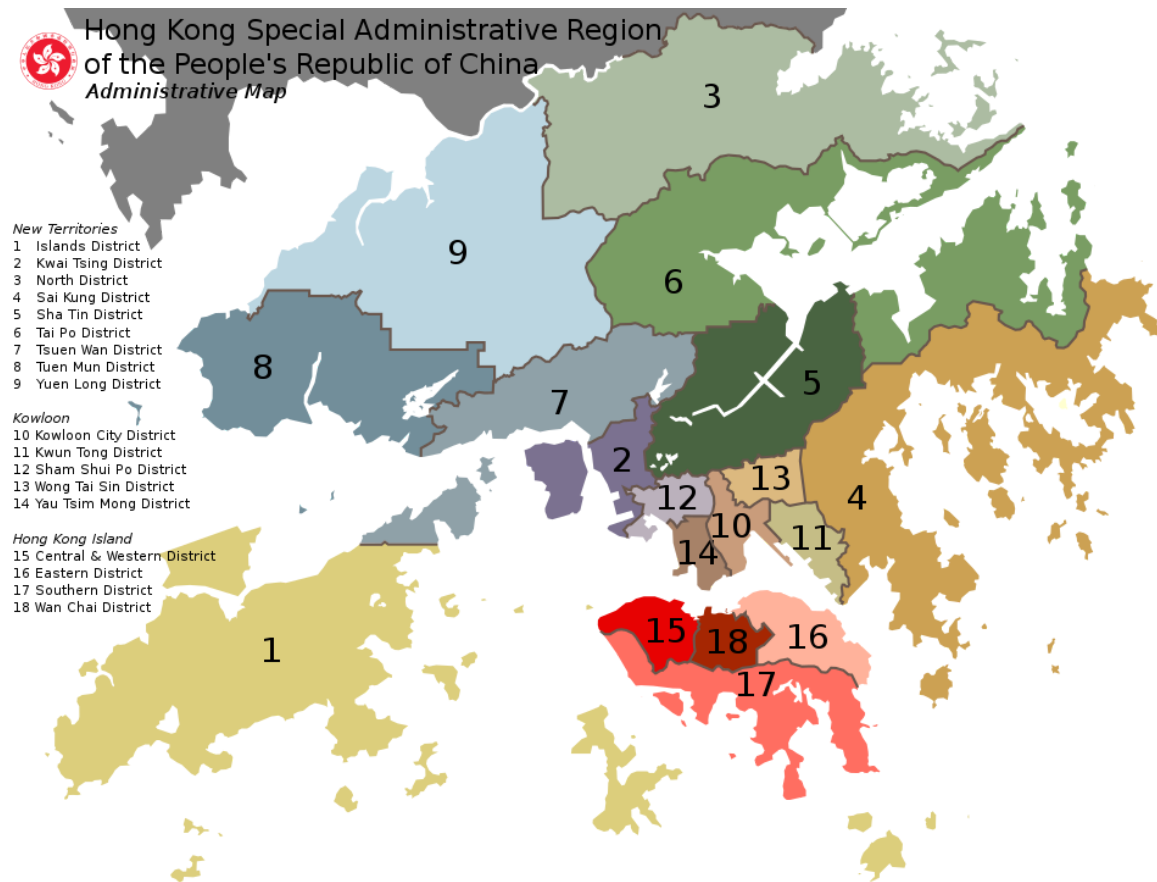


Hong Kong Special Administrative Region of the People's Republic of China
*Administrative Map*

*New Territories*
1  Islands District
2  Kwai Tsing District
3  North District
4  Sai Kung District
5  Sha Tin District
6  Tai Po District
7  Tsuen Wan District
8  Tuen Mun District
9  Yuen Long District

*Kowloon*
10 Kowloon City District
11 Kwun Tong District
12 Sham Shui Po District
13 Wong Tai Sin District
14 Yau Tsim Mong District

*Hong Kong Island*
15 Central & Western District
16 Eastern District
17 Southern District
18 Wan Chai District

Figure 3

Hong Kong is located in the mountain area, mostly surrounded by the ocean.The mountains in the territory can be considered as one with the hills of South China, and the geomorphological system is the same as that of the inland Guangdong Province. Naturally formed larger flatlands are concentrated in the northwestern part of the New Territories closest to the mouth of the Pearl River. Yuen Long and Fanling are alluvial plains naturally formed by rivers. These natural plains are fertile and suitable for farming. However, due to the low topography, in the event of heavy rainfall, the areas where drains have not been properly treated will be like a swamp. But other areas of upland does not mean that they are immune to the impact of heavy rains. In case of heavy rainfall, slopes

all over Hong Kong may have landslides, threatening the safety of the public. Therefore, it is very important for the government to fix the slopes and deal with drainage. The only remaining flat land in the territory is located on the Kowloon Peninsula and along Victoria Harbour in the northern part of Hong Kong Island, where Hong Kong first developed as an urban area, and which remains the lifeblood of the city. At the same time, the government has been gradually expanding the land available for development through reclamation projects.

Larger natural flatlands are mainly concentrated in the northwestern part of the New Territories closest to the Pearl River Estuary. Yuen Long and Fanling are alluvial plains formed naturally by rivers. These natural plains are fertile ground for farming. However, due to the low-lying terrain of the heavy rain, areas without proper drainage treatment will become "Caiji Island". But other highland areas were not immune to the heavy rain. During heavy rain, landslides may occur on the slopes of Hong Kong, threatening the safety of the public. Therefore, the government needs to renovate hillsides and manage drainage. The only remaining flat land is located along the Kowloon Peninsula and Victoria Harbour in the northern part of Hong Kong Island, which was originally developed as an urban area and remains the lifeblood of the city.

# Our Model

In this project, we use clustering as our method to redistribute the vaccination spots. Clustering is a solution that combines points that are similar to each other as a cluster. The points in the same group often share the same characteristics or have similar locations as in this case. We collected the population data of 85 years old or older in each district and assigned random points based on data. A rough example is shown below.
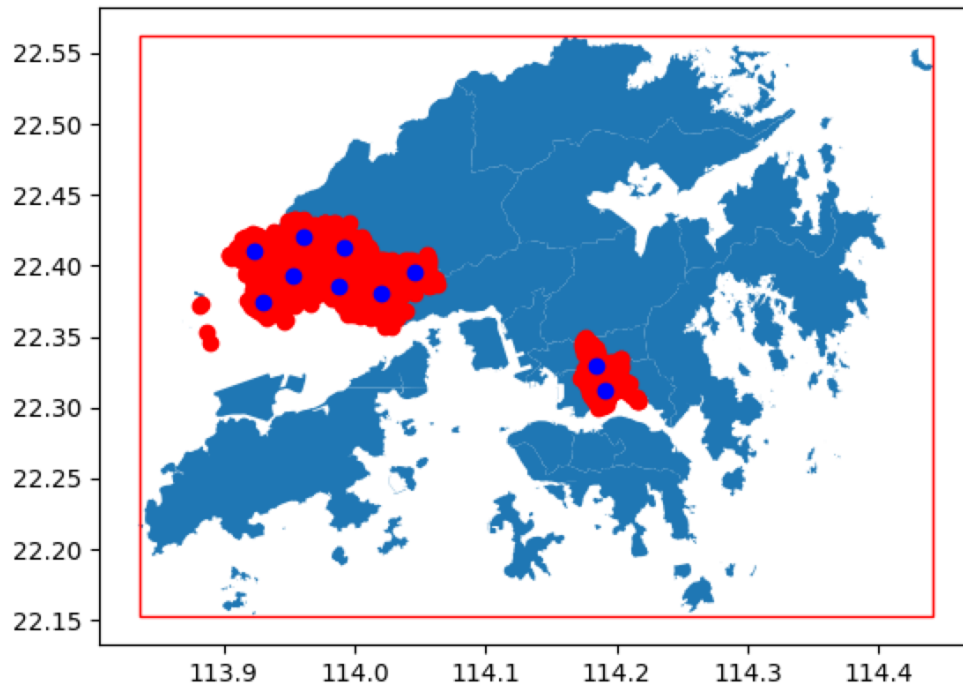


Figure 4

It has brought to our attention that assigning random points in all areas is inaccurate as there is much area where no people live. Thus, we continued looking for data of residential areas where we put our random points.Besides,It consumes too much time using the original population data, so we scale down the population by 100 times in each district. Then, we implement the k-means method to cluster all the data points in Hong Kong and generate 18 cluster points as our new vaccination spots.
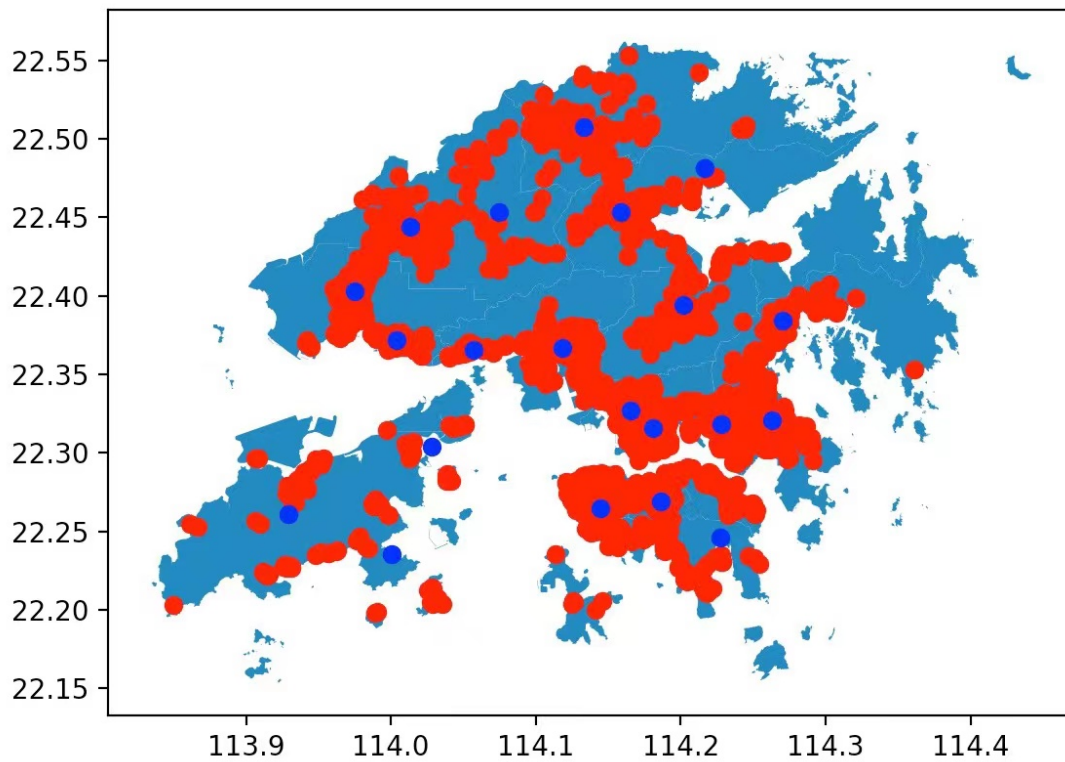
# Result



Figure 5

The resulting graph is shown above. It shows the 21 clusters of all the data points. These cluster points would be the ideal vaccination spot. By redistributing these vaccination spots, we hope the vaccination rate of old people would improve with more convenient travel plans.

# Discussion

We used "Hong_Kong_Outline_Zoining_Plans_Land_Use_Zonings.geojson" ("The Z-dataset") available from esrichina (https://opendata.esrichina.hk/) to select all the residential areas. The dataset shows the broad land use zonings and major transportation networks within the Planning Scheme Area in Hong Kong. The dataset is a subset of the Digital Planning Data made available by the Planning Department under the Government of Hong Kong Special Administrative Region at the Digital Planning Data website (https://www.pland.gov.hk/pland_en/info_serv/digital_planning_data/download.htm). The dataset has 10 attributes within two categories: the descriptive attributes and the shape-file attributes for the geojson dataset. There are six descriptive attributes: Statutory Plan No., Zone label, and descriptions of the zoning by English and traditional Chinese. The shape attributes are: shape length, shape areas, and geometry of the zonings.

We selected all the residential zonings from the Zone label. The residential zonings are labeled as "R(A)" as A indicates the types of residential areas. We selected all the residential zonings labeled as R type only. One potential problem is that our data may not include all the possible residential buildings in HongKong. As shown in the following figure, there are commercial residential buildings under the OU zoning label, which is the "other specified uses" land zones.
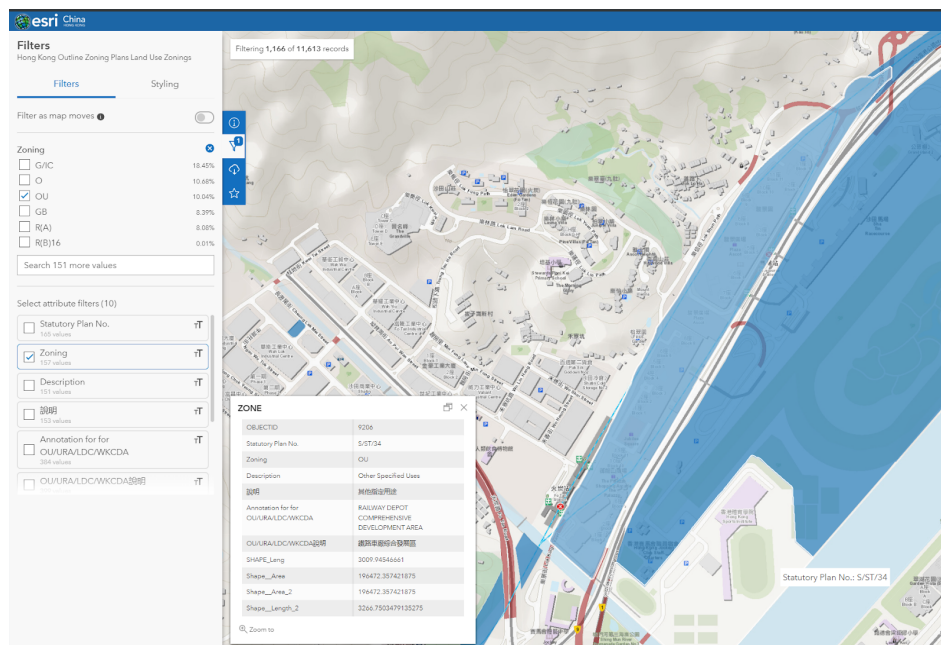


Figure 6

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