# COVID-19 in Brazil

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INTRODUCTION

- Brazil is currently one of the countries with greatest number of cases and deaths due to the Covid-19 pandemic;

- The president of the country is constantly denying the gravity of the pandemic and can be considered the greatest responsible for the fast increase of the number of cases and deaths in the country;

- New politics must be adopted in a national level in order to slow down the spread of the disease in Brazil and the country recovers the economy and the public health situation.

Brazil is the greatest country of Latin america and is divided in five regions: North, Northeast, Midwest, Southeast and South.

It has a total of 26 states and its population increases with the proximity to the litoral.

In this work, I analyze the gravity of accumulated number of cases and deaths for each region of Brazil.
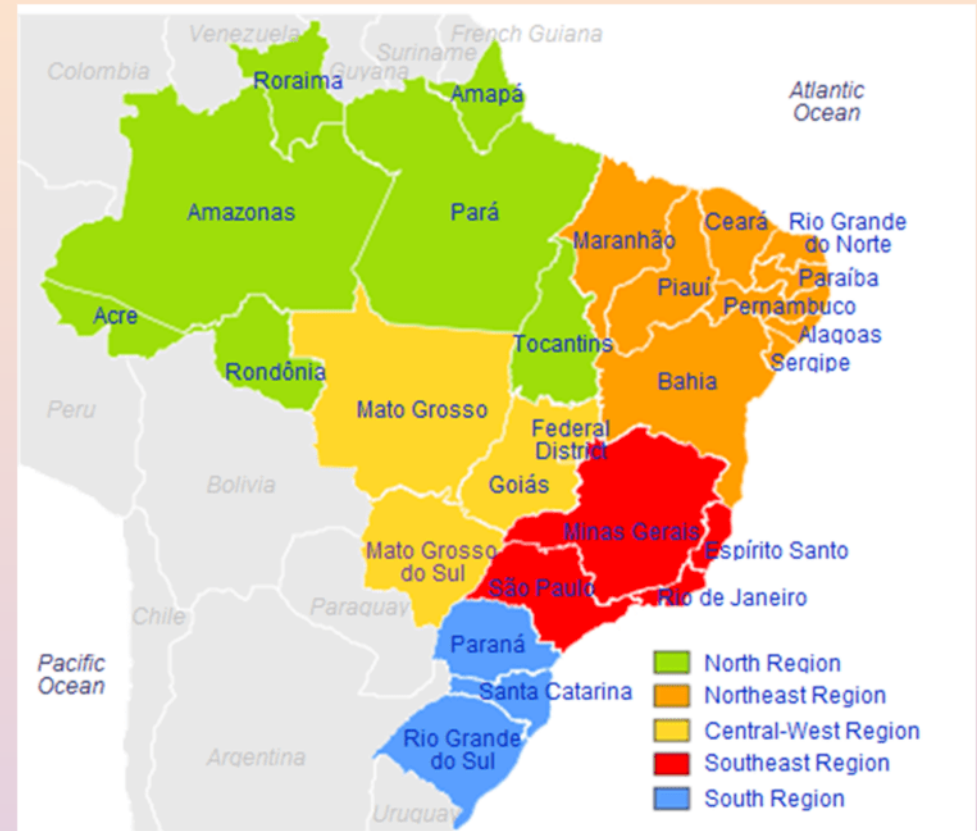
METHODOLOGY

- The data file used contains historical accumulated absolute numbers of cases and deaths, and historical daily numbers of cases and deaths for almost every city in Brazil, from March 27 to July 1st;

- The data also contains information about the population of each city. The numbers were replaced by the rate of the the numbers per 100,000 inhabitants of the corresponding city;

- I plotted some graphs with the historical accumulated numbers of cases/100,000 inhabitants for each region and then plotted for different states in each region. This gives an initial notion of the gravity of cases in the country.

- For the main result, I use the K-means clustering algorithm. I apply the algorithm once for each region according to the accumulated number of cases and once according to the accumulated number of deaths. I set three clusters everytime, so that the cities are divided by lower, intermediate and high intensity of number of cases or deaths.

Accumulated number of cases per day in different regions/100,000 inhabitants

Accumulated cases of Covid-19 in each region.
The most grave situation, according to this data, is northeast, followed by north, southeast, south and midwest.
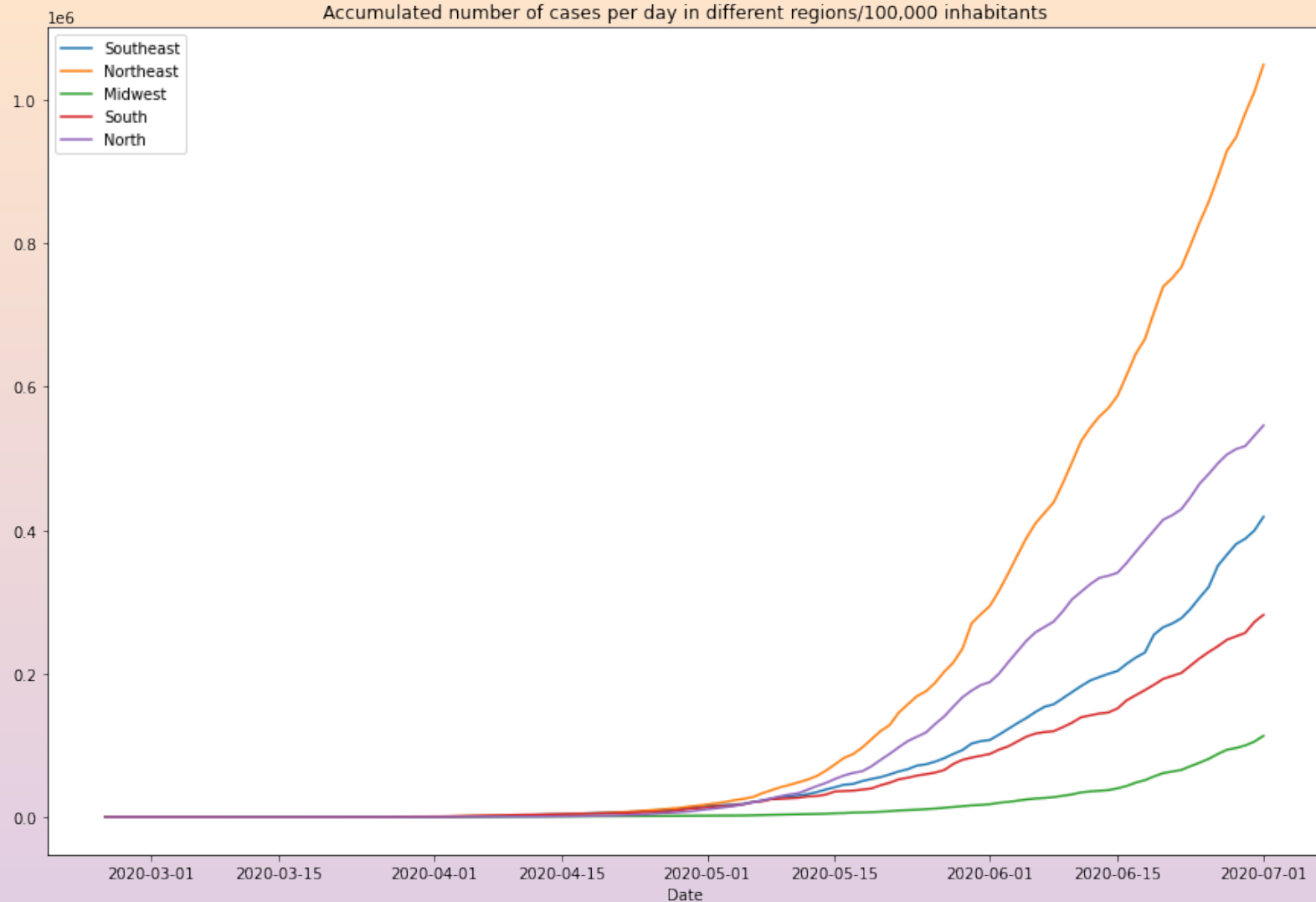
Accumulated number of deaths for each different region. The trend for southeast and north becomes inverted in comparison to the accumulated number of cases. The tip in the north's line indicates wrong data in that point.

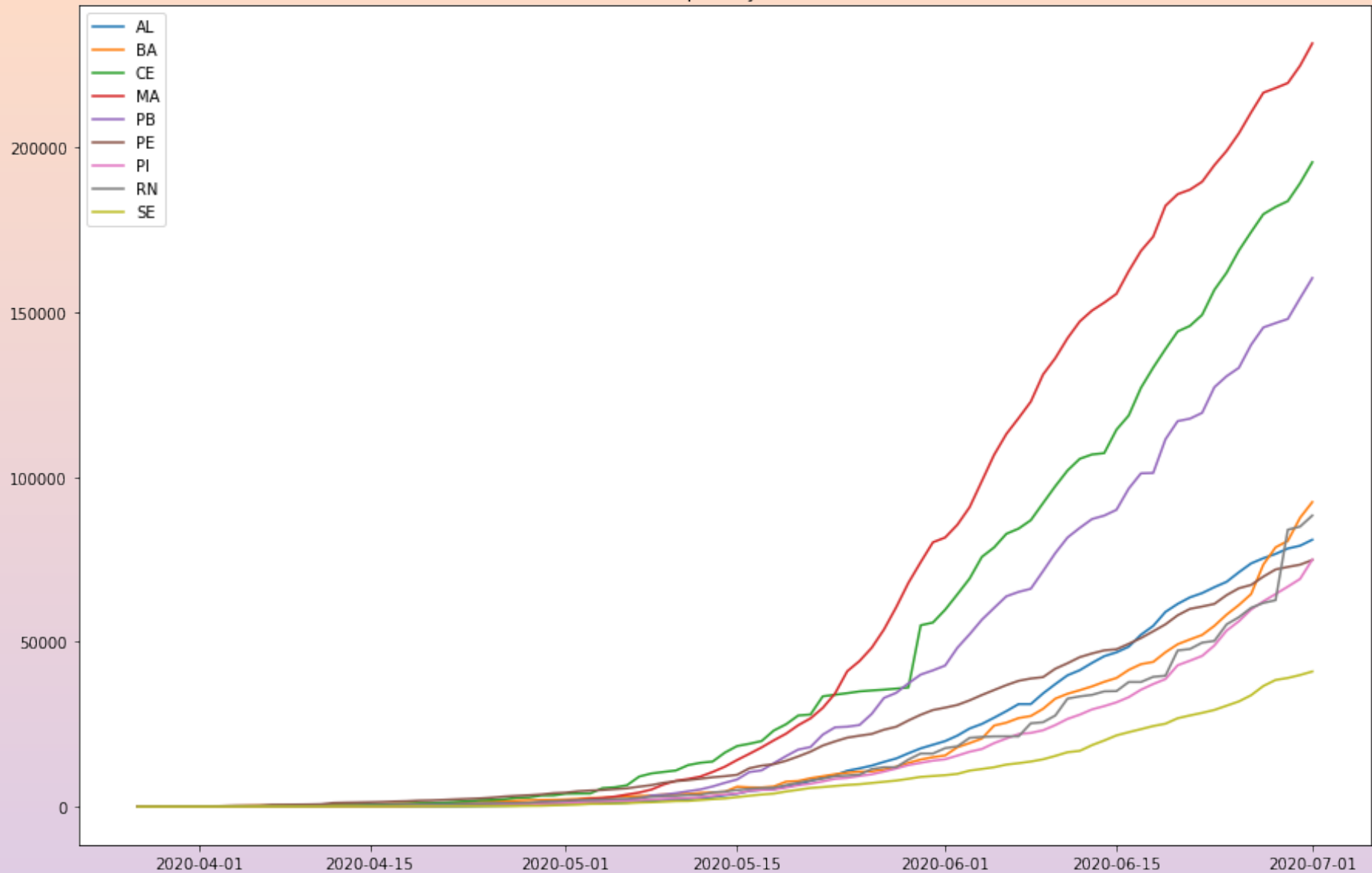Accumulated number of deaths per day in different regions/100,000 inhabitants
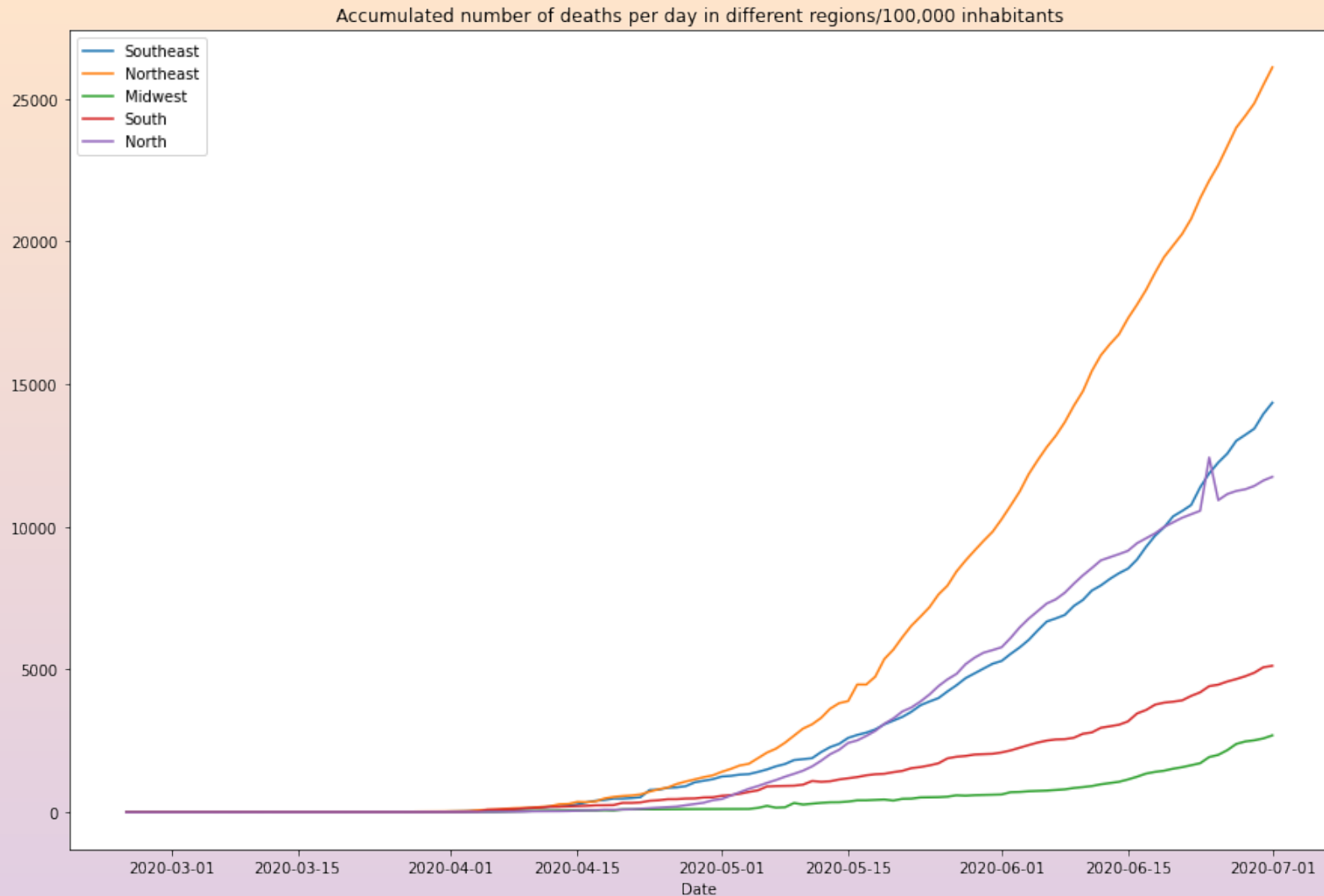
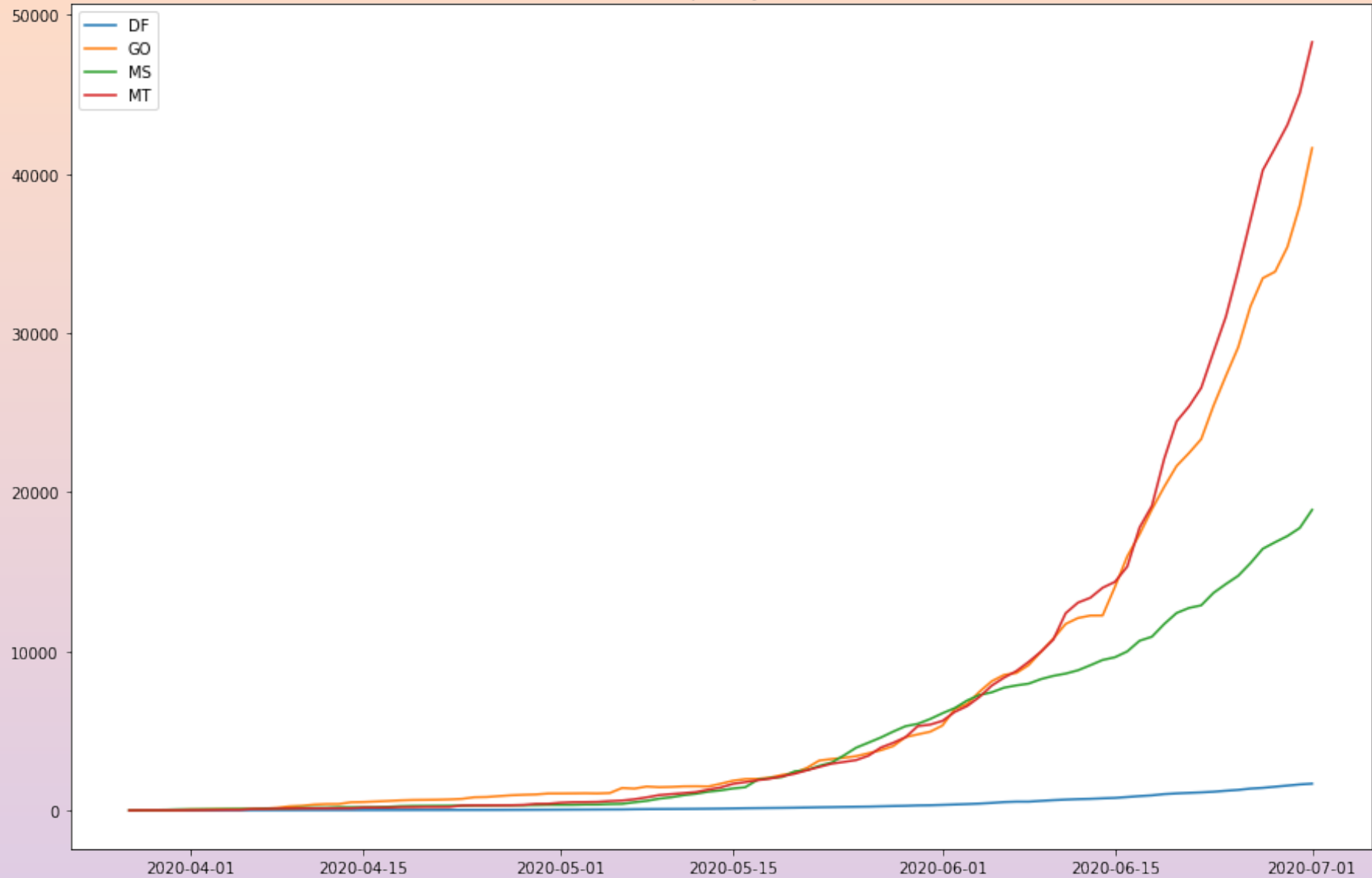# Accumulated cases of individual states in each region

Accumulated number of cases per day in different states of North
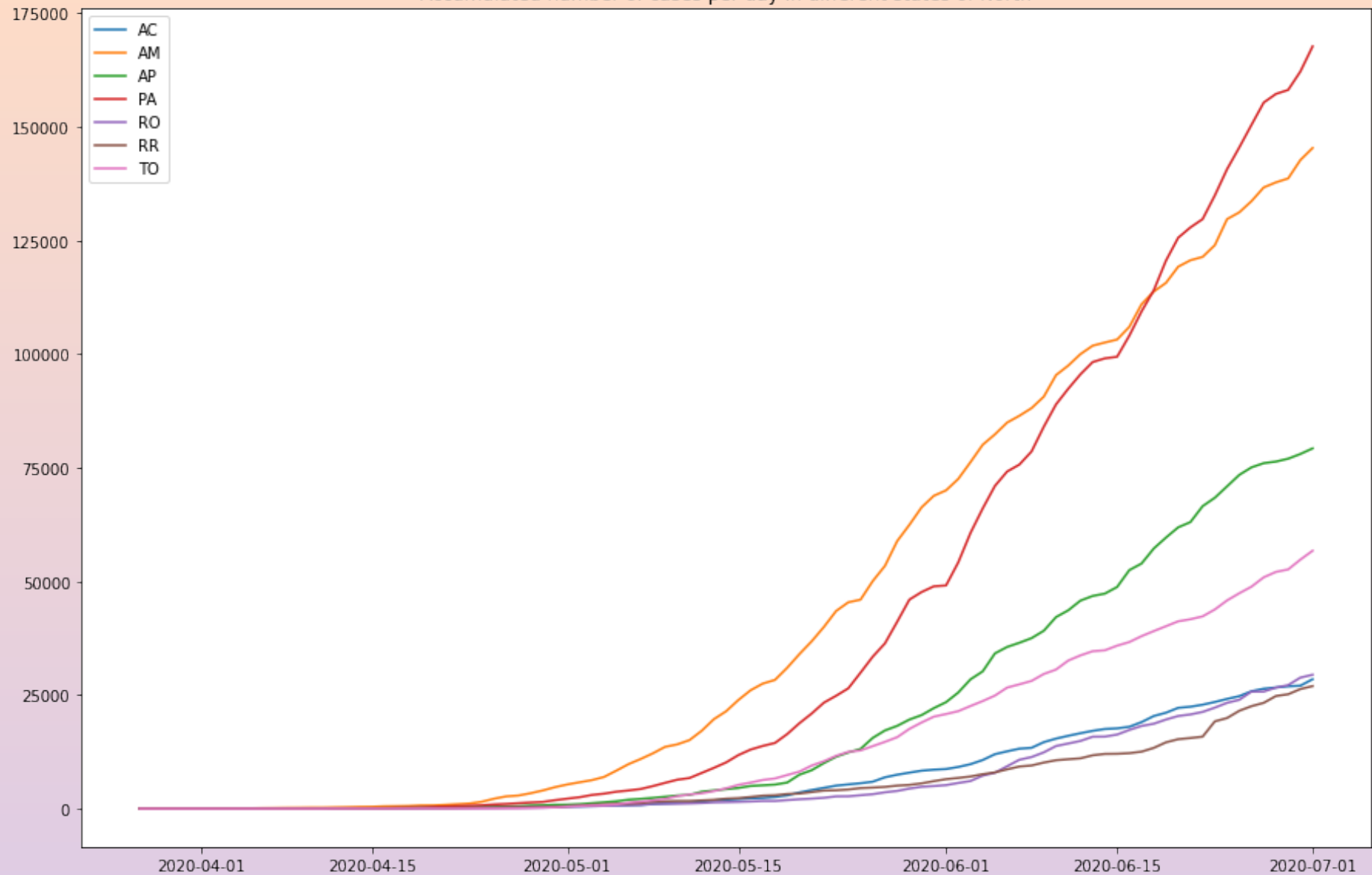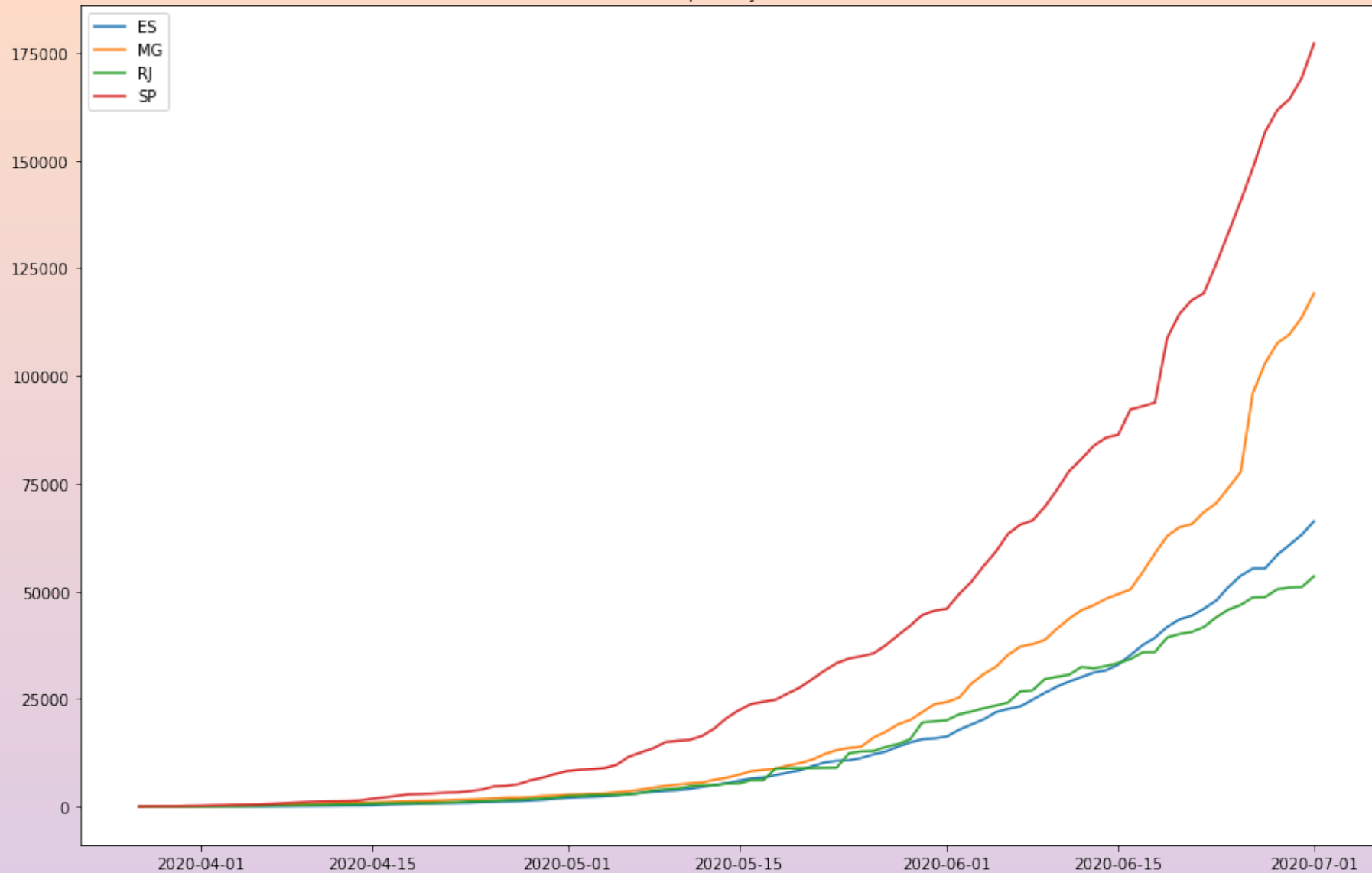
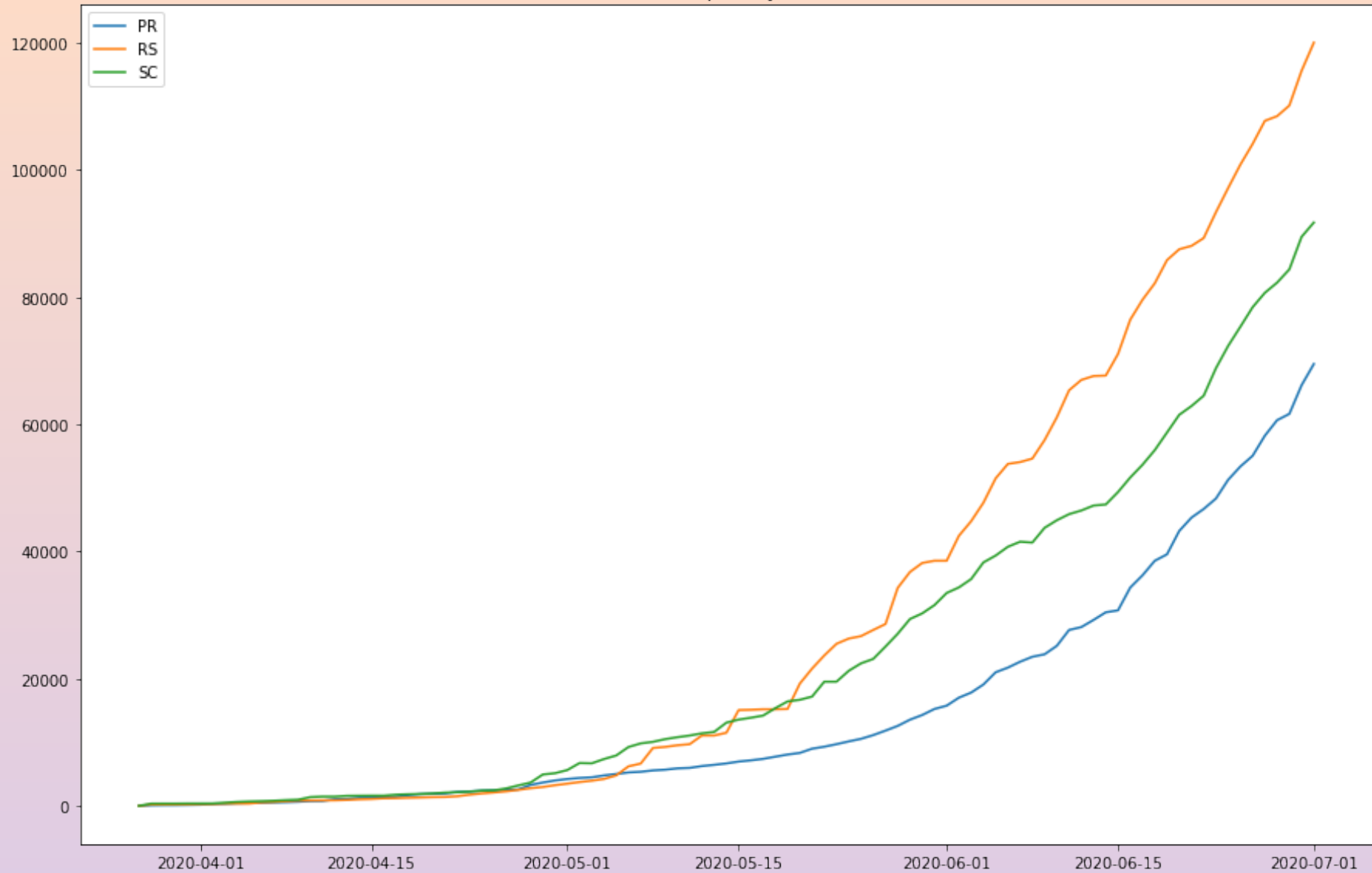Accumulated number of cases per day in different states of Northeast

Accumulated number of cases per day in different states of Midwest

Accumulated number of cases per day in different states of Southeast

Accumulated number of cases per day in different states of South

# Classification of cities by accumulated number of cases

Classification: Average accumulated number/100,000 inhabitants on July 1st*

	Low intensity cluster	Intermediate intensity cluster	High intensity cluster
North	623.6	2,625	6,884
Northeast	283.2	1,162	2,710
Midwest	180.4	883.2	2,526
Southeast	112.6	516.2	1,220
South	181.5	982.4	7,069

* The K-means clustering algorithm considers not only the date of July 1st for the classification, but all the days in the data. The numbers presented here are consequence of the algorithm, used here for having some intuition about the classification.
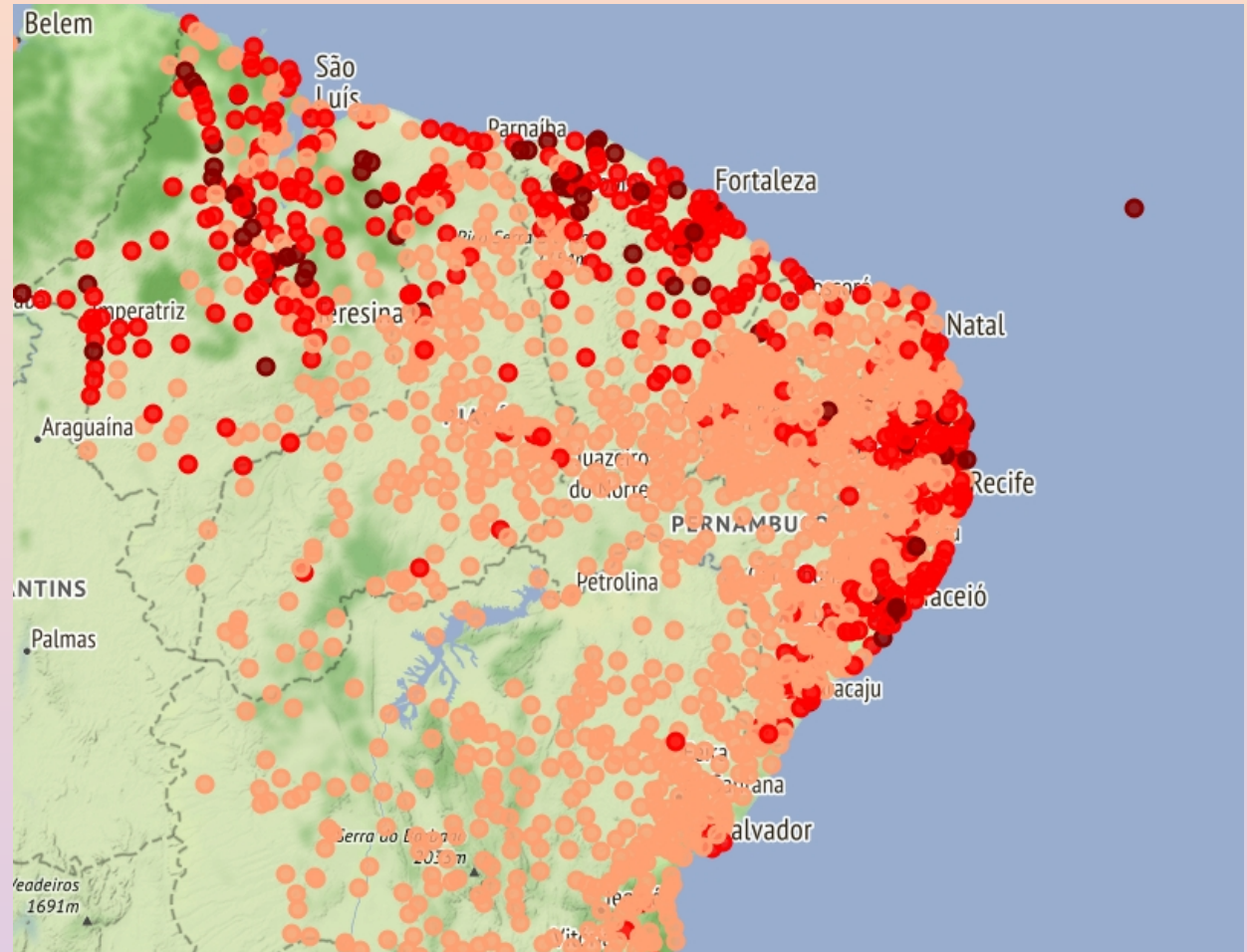
North

The north region has 450 cities officially, and the data contains 434 of them. The markers' colors are darker as high is the intensity of the accumulated number of cases. Only the state of Pará and Amazonas have cities with high intensity of number of cases. The great majority of cities in the north region is in the group of cities with low intensity of cases.
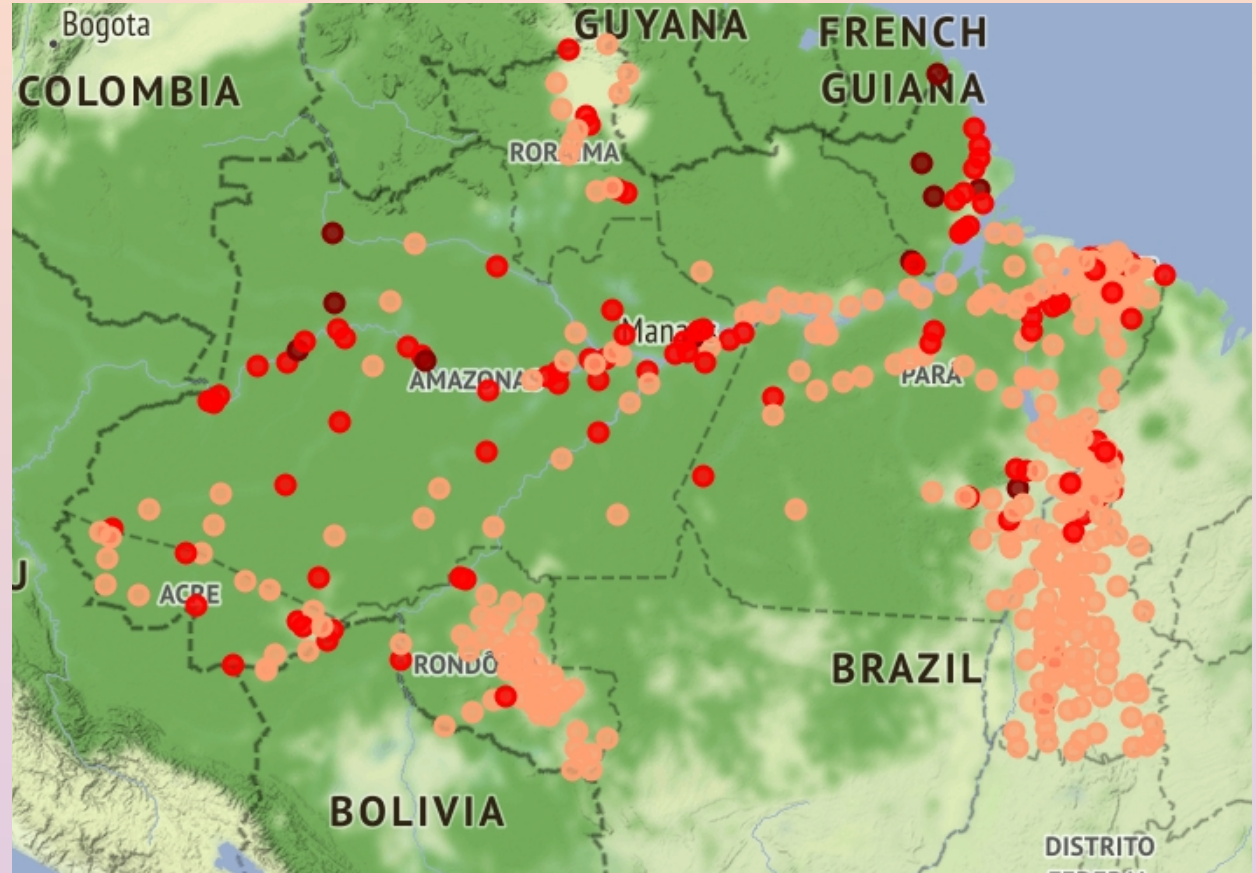
Northeast

The northeast region has 1,794 cities officially, and the data contains 1,759 of them. As it has much more cities than the north, there are much more occurrences of cities with high intensity of cases, more concentrated in the litoral, as the main cities are there. The exception is the state of Maranhão (top left), with more even distribution of cities with high intensity of Covid-19 cases.

Still in the northeast region, as we move down to the south, to the state of Bahia, the occurrences of cities with intermediate or high intensity of covid-19 cases is much smaller than in the upper part of the region.
The state of Bahia adopted a great number of measures for controlling the spread of the disease.

Northeast
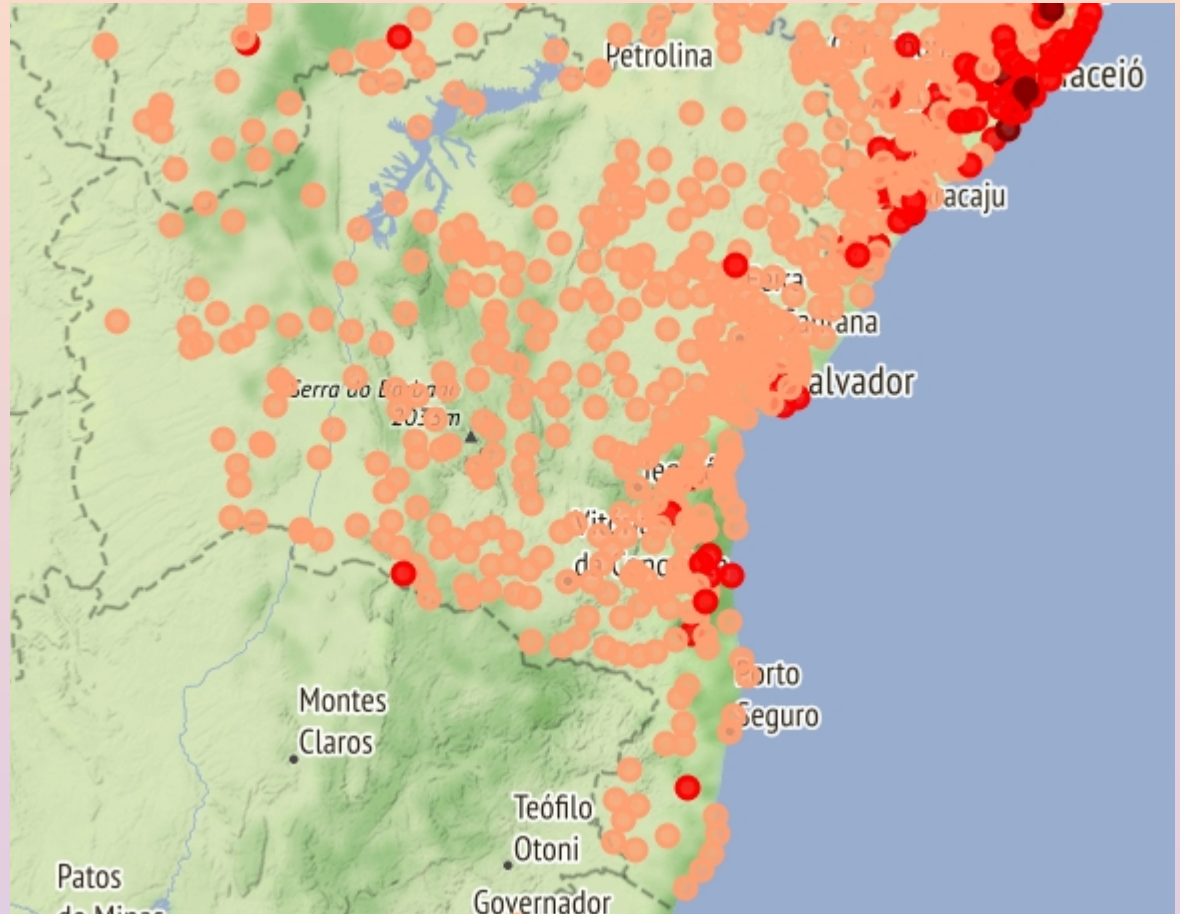
Midwest

With officially 466 cities and 424 cities in the data, in the midwest, there is only one city with high intensity of number of cases, which is Guia Lopes da Laguna, MS. The cities with intermediate level of occurrence are spread near the states capitals: Brasília, DF; Goiania, GO; Cuiabá, MT, with some few occurrences in cities far from the capitals.
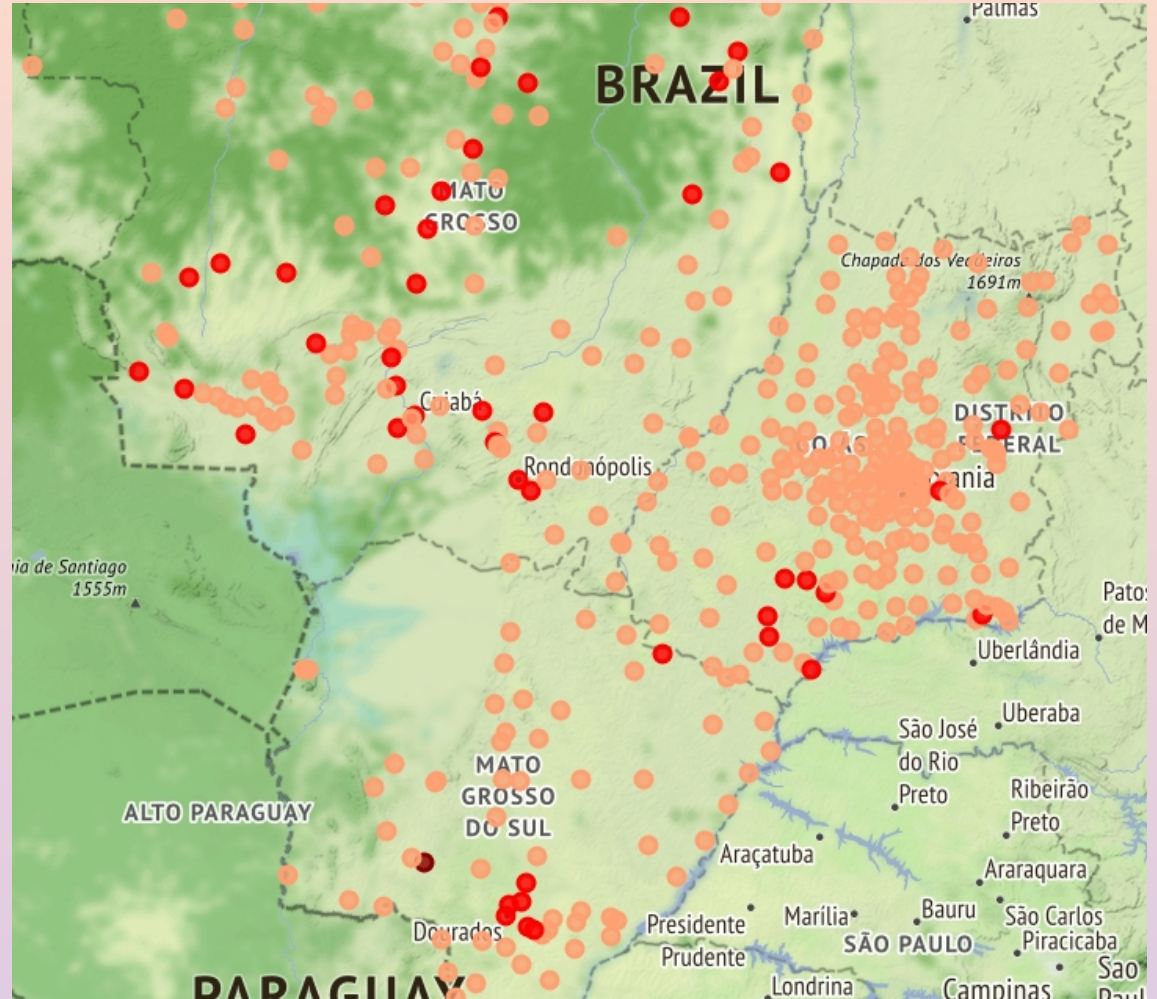
Midwest

Still in the midwest, just few cities in the state of Mato Grosso do Sul have intermediate intensity of accumulated number of cases. The capital of the state, Campo Grande have low intensity of number of cases, so are the cities near it, in the geographical center of the state.
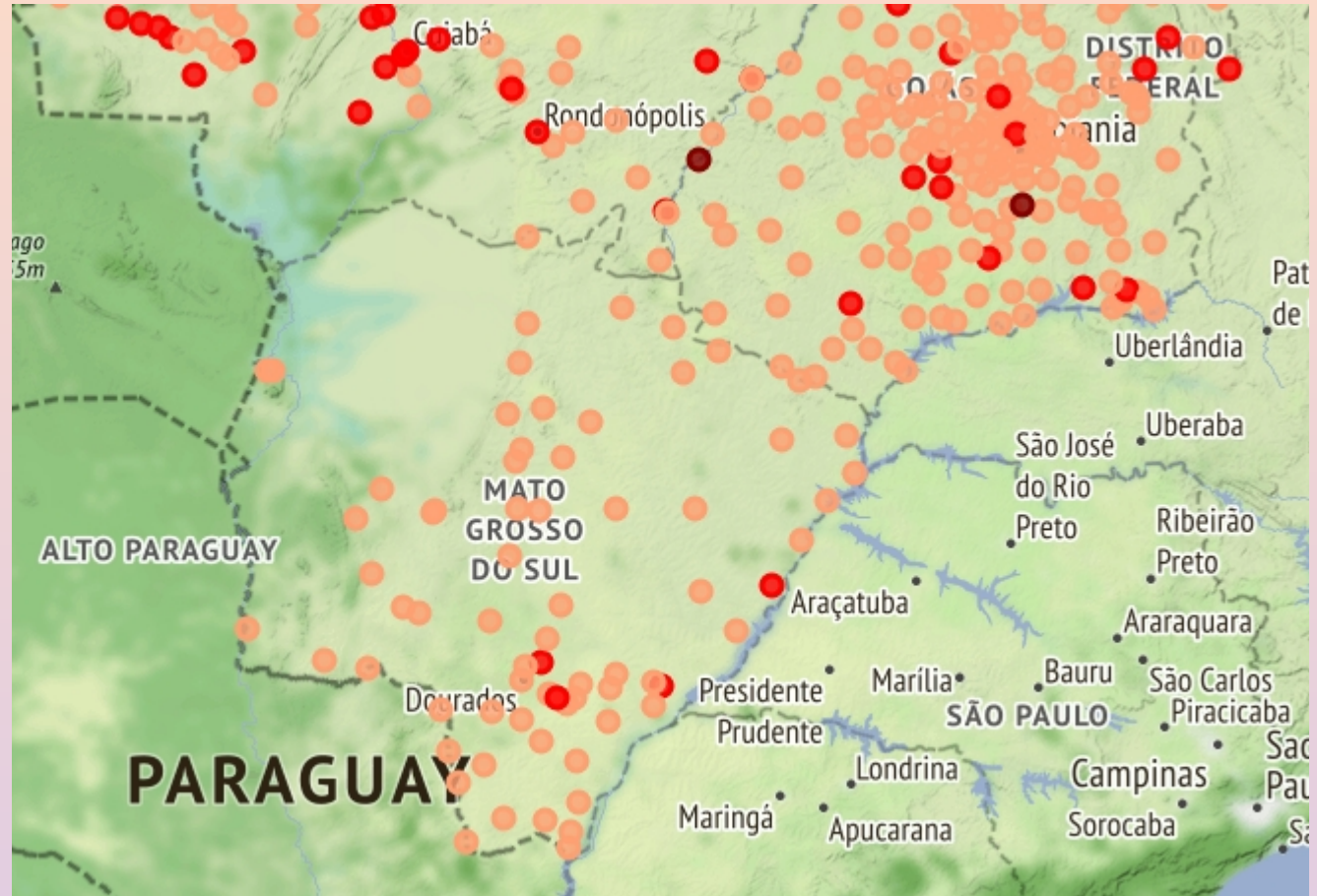
Southeast

The southeast has officially 1668 cities and 1649 of them are present in the data. The southeast was the first region to present a confirmed case, in February, in the city of São Paulo, SP. The cities with high intensity of accumulated number of cases are more concentrated near the littoral as well as in northeast, but there is a great number of cities with intermediate intensity also in regions far from the littoral. Despite being the second state with higher number of cases, as presented in a previous graphic, the state of Minas Gerais is very huge and has a great number of cities, being the state with fewer cities classified as intermediate or high intensity compared to other states in the southeast.
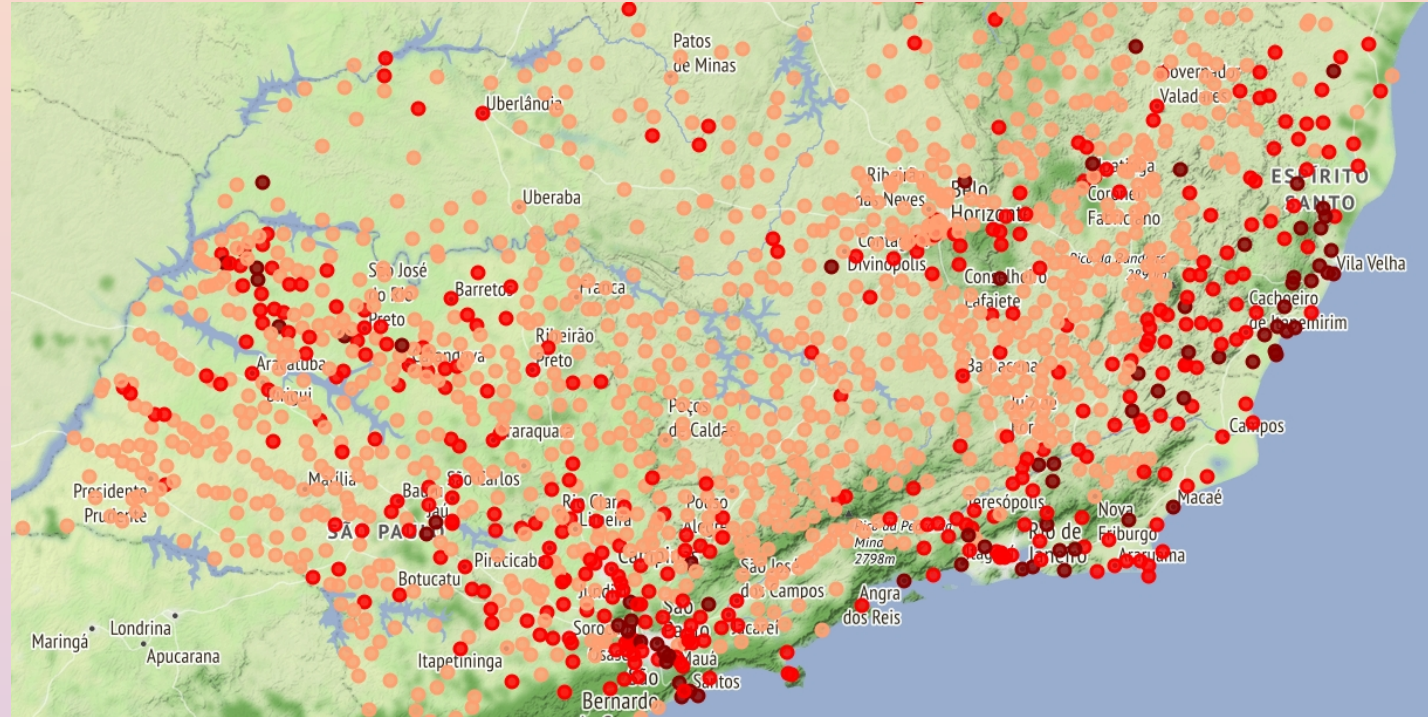
South

The south has officially 1,191 cities and 1,067 of them are present in the data. Only two cities belong to the group of cities with high intensity of number of cases, which are Entre Rios, SC and Nova Araçá, RS, both of them are cities from the rural area. The cities with intermediate intensity of number of cases are concentrated more in the center of the region, in constrast with the pattern appearing in northeast and southeast, where cities of litoral are the ones with higher intensity of cases. Also, the cities with intermediate number are not the ones near the capitals of the states.
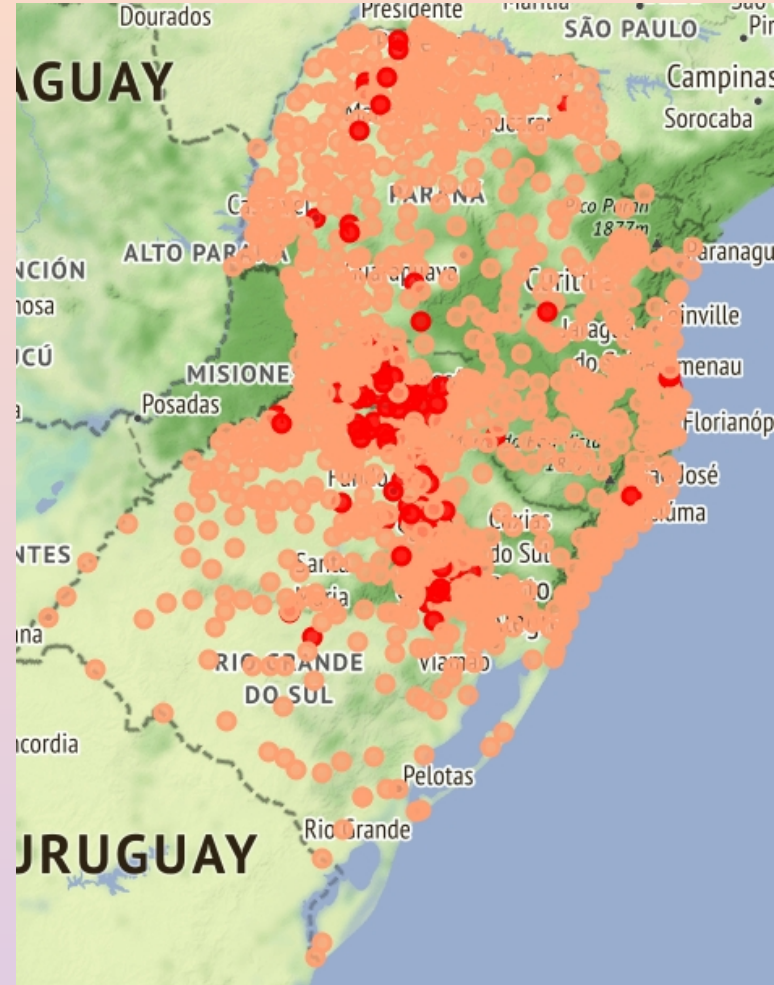
Classification of cities by accumulated number of deaths

Classification: Average accumulated deaths/100,000 inhabitants on July 1st

	Low intensity cluster	Intermediate intensity cluster	High intensity cluster
North	0	13.6	67.4
Northeast	5.08	31.1	68.6
Midwest	3.46	26.4	62.7
Southeast	2.90	25.9	61.7
South	2.81	35.5	151

North

Once again, the markers' colors are darker as high is the intensity of the accumulated number of deaths. Differently from the analysis of the number of cases, the cities with greatest number of occurrences are the ones with intermediate number of deaths. There is only one city with low number of deaths, which is Oliveira de Fátima, TO, with no deaths.

The average number of deaths for each cluster is 0, 13.6 and 68.6. The average number of the second cluster is much smaller than the average number of the other regions. Because of that, the best thing to do is to consider the clusters of low and intermediate intensity as only one cluster, with low intensity, and the high intensity cluster really represent cities with high intensity of numbers of deaths, as its average number is similar to the ones of high intensity clusters in the other regions.

Northeast

In the northeast region, the distribution pattern of cities is a bit different from the distribution for accumulated number of cases. This is due to two reasons:

- In the state of Maranhão, the cities are more frequently cathegorized as low or intermediate intensity of number of deaths than for the number of cases;
- The cities with high intensity of number of deaths are less frequent than the ones with high intensity of number of cases, for the whole region.
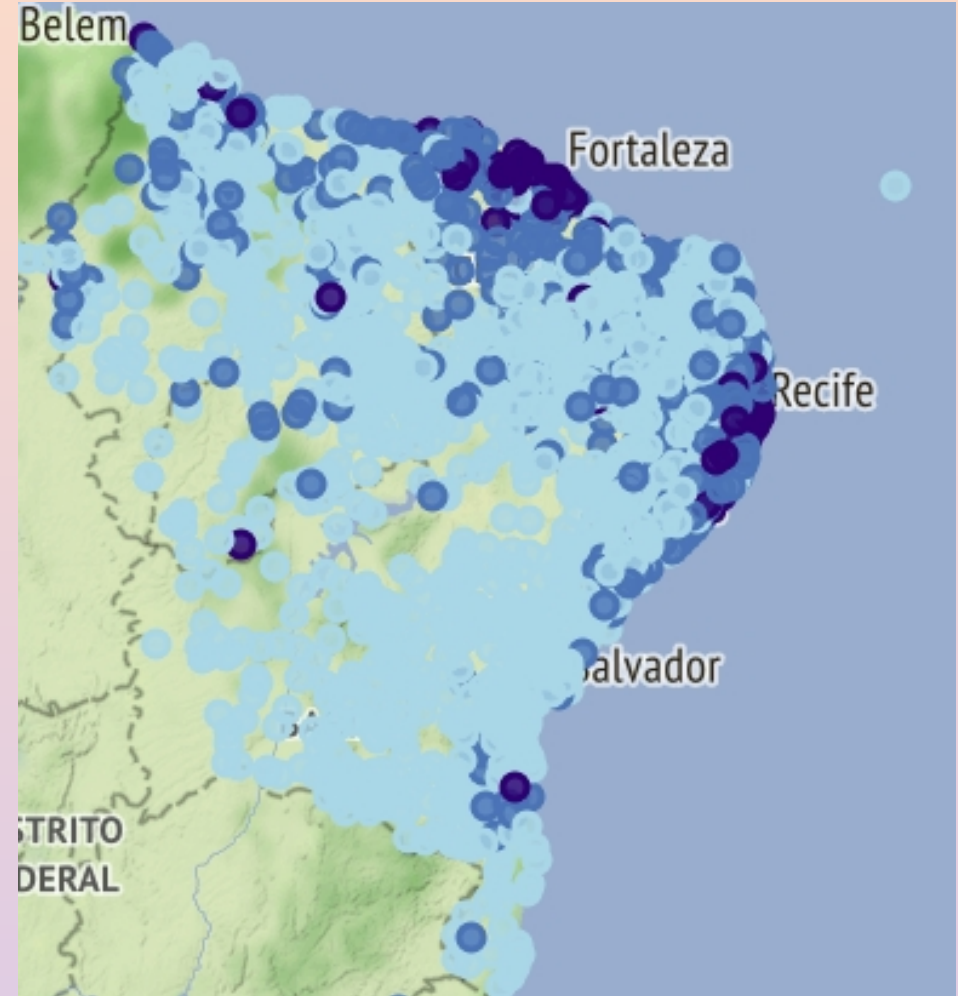
Midwest

There are only two cities with high intensity in the number of deaths, which are Ponte Branca, MT and Professor Jamil, GO.
These cities are different from the city with high intensity in the number of cases.
The cities with intermediate intensity in the number of deaths are also spread near the states capitals, which also happens for cities with intermediate intensity in the number of cases.
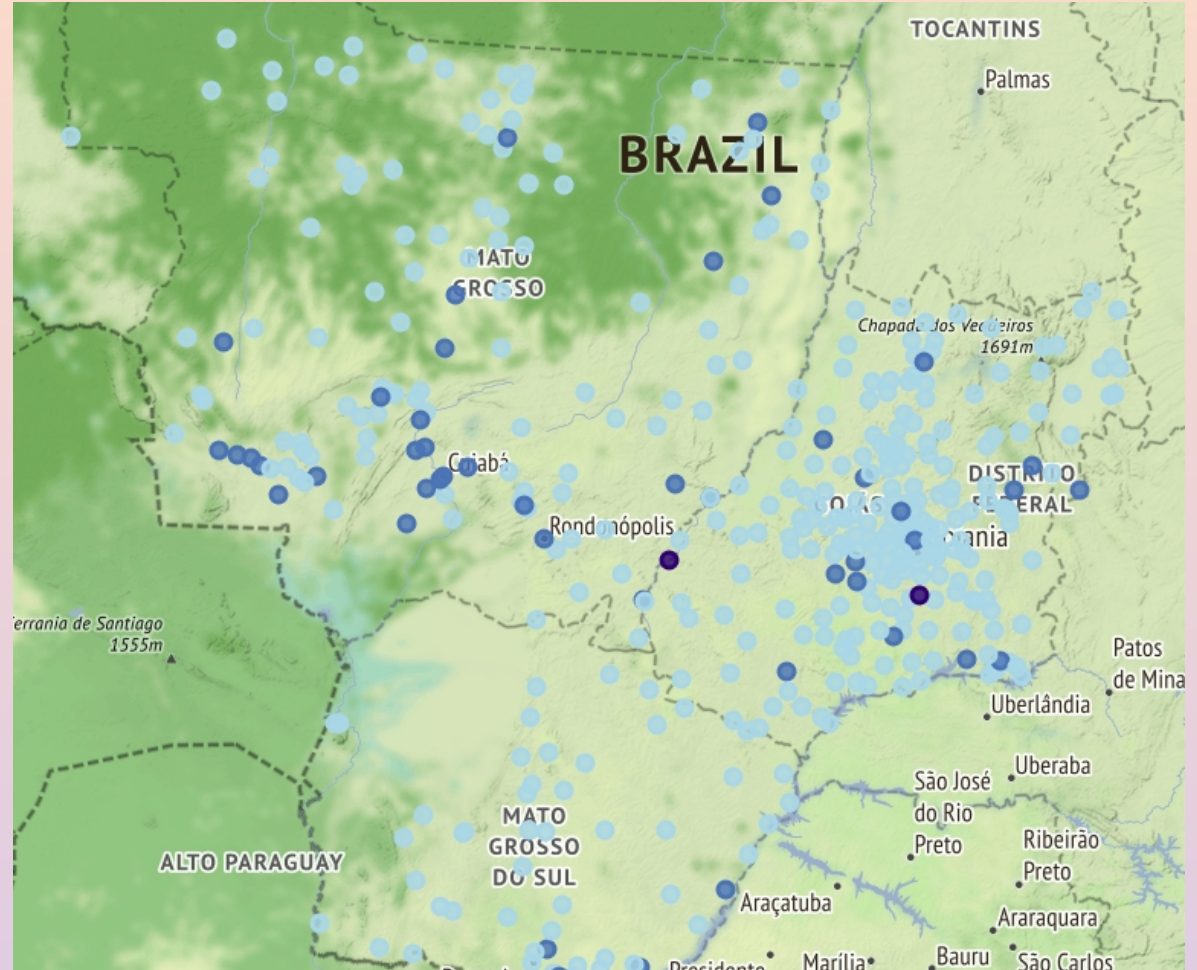
Southeast

The distribution pattern for the intensity in the number of deaths is less strong than the distribution in the number of cases. The north of the region has few cities with intermediate number of deaths and even fewer with high number, in opposition to what is seen in the map for the accumulated number of cases.

Also, the regions with intermediate and high intensity are more concentrated in the state of Espírito Santo, littoral of Rio de Janeiro, but more evenly distributed through the state of São Paulo.
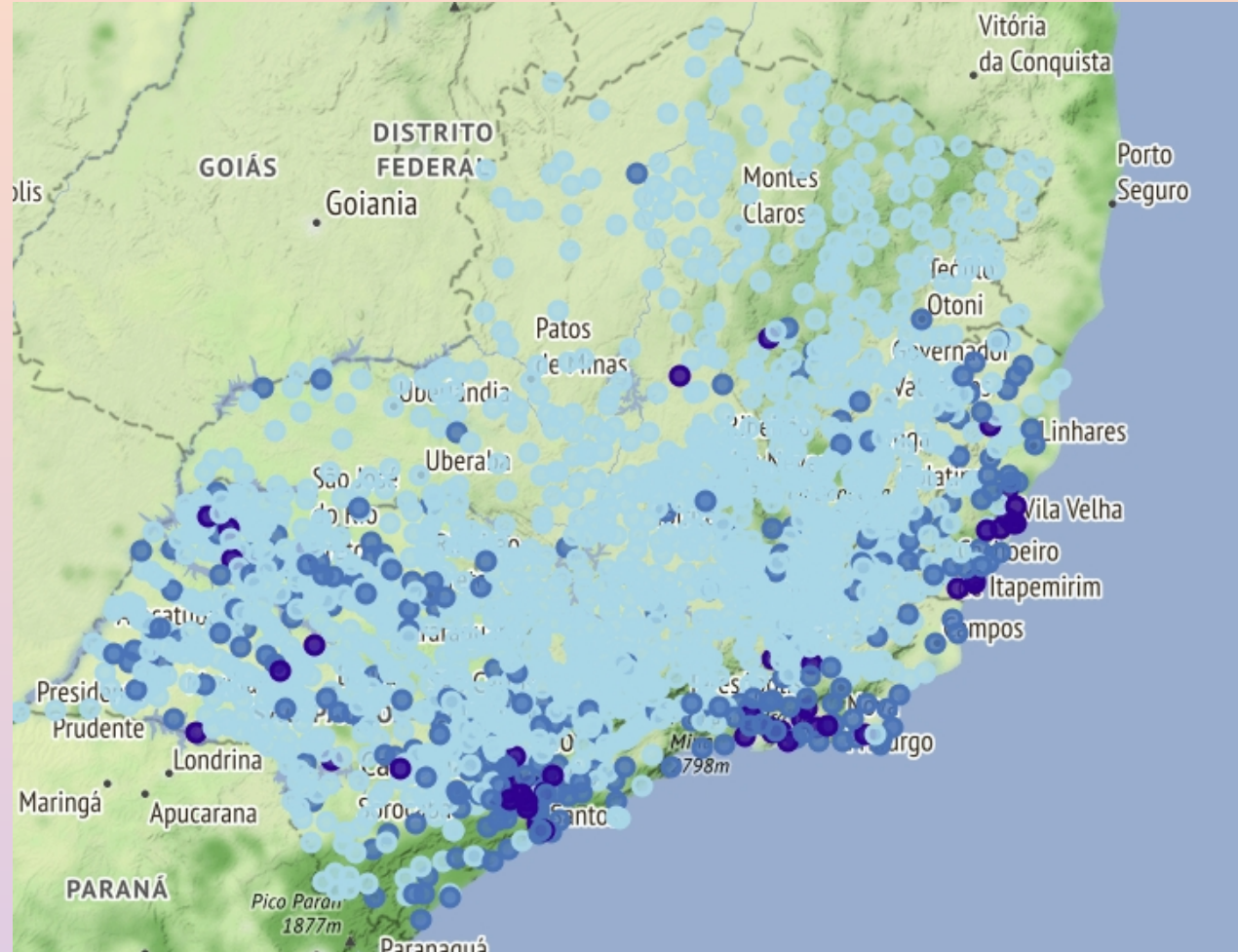
South

Only few cities in the south region have intermediate number of deaths, and only one has high number of deaths, which is Saldanha Marinho, RS. We can do the same as we did for the north region and consider that there are only two clusters in this case, one with low intensity of deaths and one with intermediate intensity of deaths.
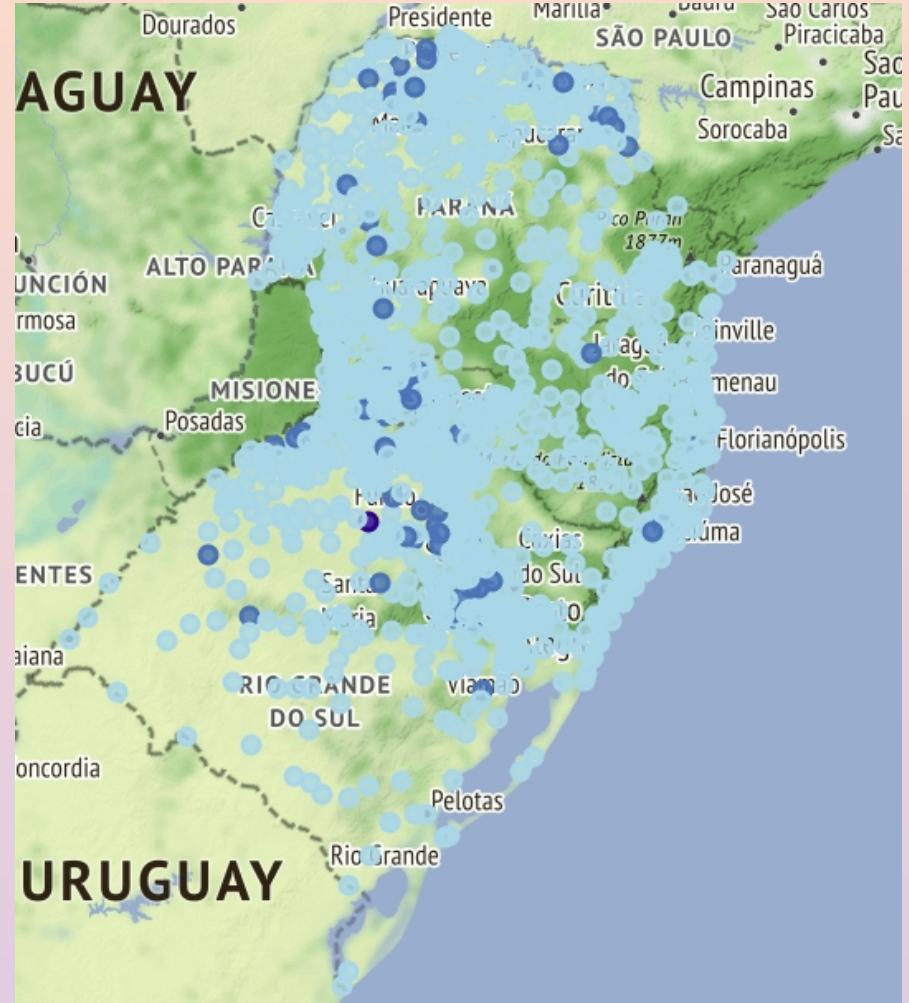
Conclusion

- The spread of coronavirus in Brazil was very fast and intense. In less than 4 months, most of the metropolitan cities in the country has already a great number of cases and deaths. However, there are many cities that still did not register big number of cases or deaths;

- Political measures in a national level could have slown down the spread of the disease in the country, and could also make the pattern of the spread more homogeneous and smooth throughout the country. The maps show some level of regularity in the distribution of cities with high intensity of cases and deaths, but there are many cities that do not follow this pattern throughout the country;

- The notion of where the disease is more concentrated makes possible the adoption of measures to block the spread from some regions with more intense numbers to the others less intense numbers.