ZONAL STATISTICS OF SERVICE AREAS AND POINT INTERPOLATION OF FORECASTED HOSPITAL CAPACITY

Introduction and Background

As we head into the flu season with COVID-19 cases rising at rates not seen since the height of the pandemic, concern for the capacity of hospitals to handle COVID-19 cases that require hospitalization and intensive care is growing among officials of California and Los Angeles County. The goal of this project was to help visualize the percent capacity of hospital beds and intensive care beds based on the current active cases for Los Angeles County. Two approaches were taken to visualize this data to show both specific hospital service area capacity, and capacity of specific neighborhoods around LA County. Zonal statistics for hospital service areas gives us the capacity for these facilities, while the use of IDW interpolation shows a heatmap of estimated capacity for localized areas of LA.

Data

Four main data sets were utilized in this project. The first data set is a shapefile for the statistical areas used by the LA County Department of Health [1].
The second data set is of daily cumulative COVID-19 cases that correspond to the shapefile from 3/16/20 to present [2].
This data set was used to create 14-Day totals of positive COVID-19 cases for each area from 11/18/20 – 12/01/20. A 14-Day sample period was chosen due to information presented by the CDC, which is a cumulation of previous COVID research. The median time to symptoms (large catalyst for test positive test) was 4-5 days, and the mean median time from symptoms to hospitalizations and ICU admission was 10-11 days [3].
14 days was selected to allow for reporting of cases, while still giving a decent average of active cases. With the 14-day totals of reported cases, estimates were made for the percentages of those cases that will either require hospitalization or intensive care. Of reported positive cases, 14% required some form of hospitalization and 2% required intensive care [3].
The third data set was point data of hospital locations with the capability to handle COVID-19 cases [4].
The fourth data set was of the specific number of hospital beds (total, acute care, intensive care) reported at each facility in the point data set [5].
From these two layers, service areas were generated for each hospital with a count of the total number of beds, acute care beds and intensive care beds.

Methods

Zonal Statistics of Service Areas:

14-Day COVID-19 case totals were joined to the statistical areas used by the LA County Department of health from which a ratio layer was created. The next step was to create the service areas for the hospital point layer. 23 miles was the driving distance towards each facility to make sure that 95% of the statistical area was covered, and a split was used to maintain separate service areas and avoid overlaps, creating a service area that represents each statistical area's closest hospital. Service areas were split by attributes into a folder to be iterated on by a model. This model simply used each hospital service area as a clip feature for the statistical areas, and then summarized and spatial joined the clipped features back into the individual service areas, giving us a proportion of the population, total cases, estimated hospitalizations and intensive care admissions for each service area. These service areas were then merged back into one layer to allow for analysis and visualization.

The next step was to create two attributes that represented the capacity for each hospital to deal with hospitalizations and intensive care admissions that were forecasted to be in their service area. This was done by taking the total number of beds, or of a combination of acute and ICU beds in each facility and subtracting those by the estimated hospitalization or intensive care admissions respectively, giving the available beds left. This divided by the total number or acute and ICU beds gives the percentage of available capacity for hospitalization or intensive care for each hospital service area, represented in Figure 1 (General Hospital Capacity) and Figure 2 (ICU Capacity) classified in quantiles.

IDW Interpolation of Hospital Points and Place Centroids:

Using the 14-day totals joined to the statistical areas used by the LA County Department of health, a layer of centroid points was created and joined with the 14-day case totals, hospitalizations and ICU admission estimates. This was used to create IDW interpolation layers for estimated hospitalizations and ICU admissions. A power of 1 was used for the fall off, and the search radius was 12 points. Two other IDW layers were made from the hospital point layer, with a power of 1 and radios of 5 points. One for general hospital bed totals and another for intensive care and a percentage of acute care beds.

With these IDW layers, as represented in Figures 3 – 6, a raster layer was made with the raster calculator, again representing capacity for general hospital and intensive care admissions as a percentage of the total. This is the same formula as used in the zonal statistics of service areas. This is represented in Figures 7 and 8.

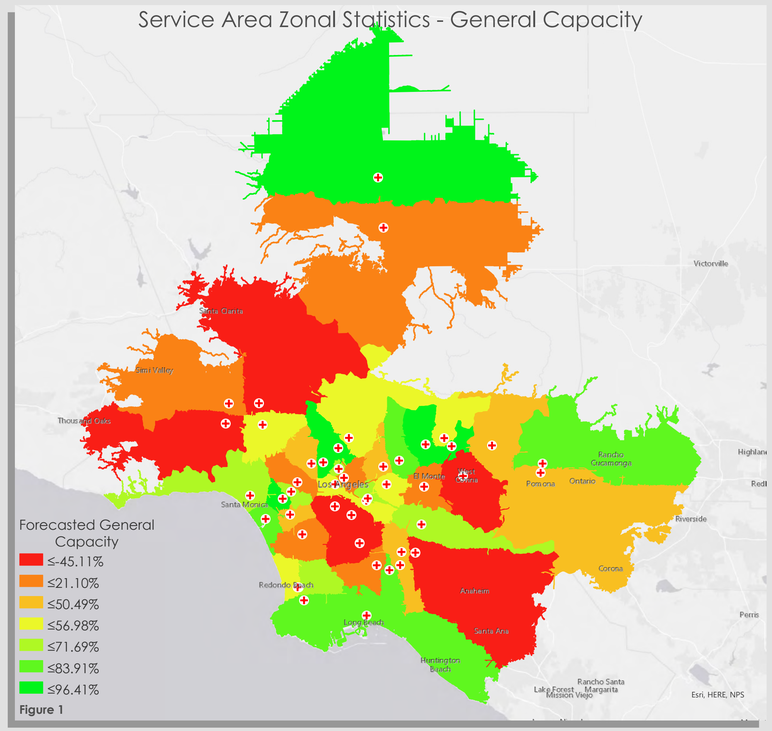


Figure 1

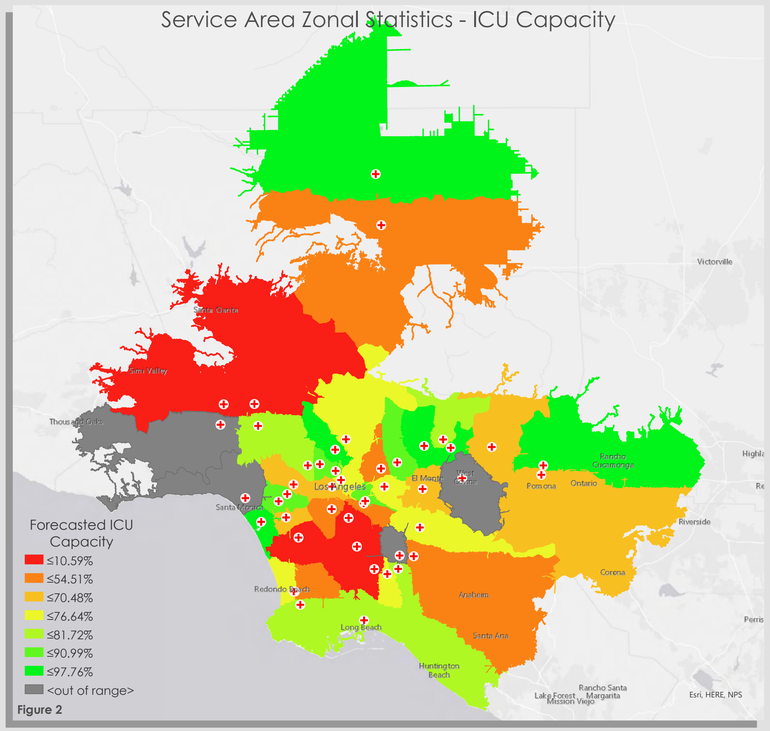


Figure 2

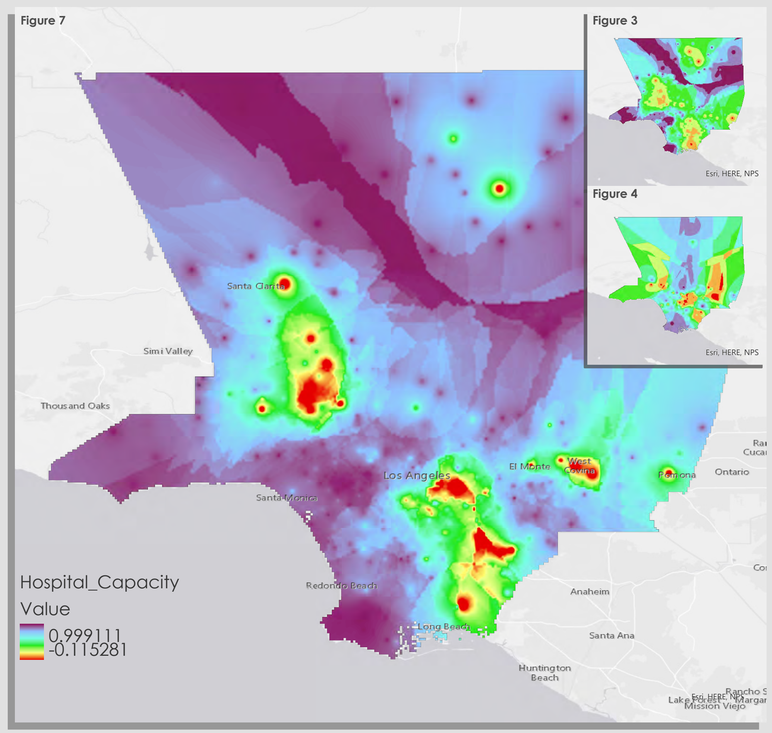


Figure 7

Figure 3

Figure 4

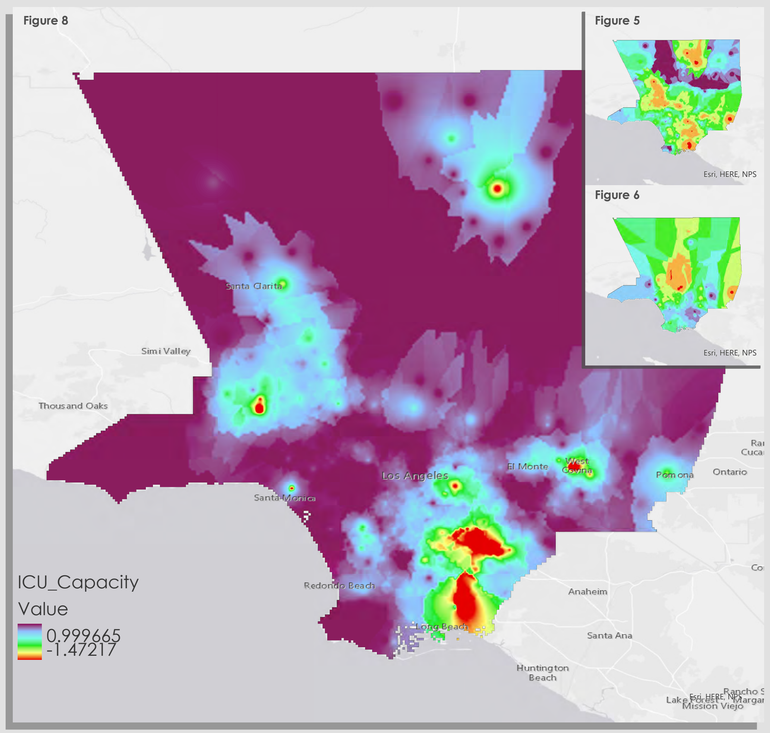


Figure 8

Figure 5

Figure 6

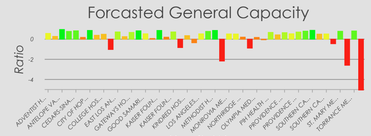
Results

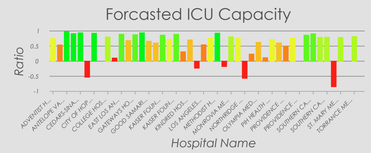
Zonal Statistics of Service Areas:

General Capacity
Min:-545%, Max: 96.4%, Mean: 16.6%, Median: 51.7%

ICU Capacity
Min: -86.3%, Max: 97.6%, Mean: 57.3%, Median: 75.6%

As show in the service area maps and their charts below, most hospital service areas were above their forecasted capacity. The most severe service areas could be due to missing hospital data, creating an outlier in percent due to errors in reporting. However, as represented by the maps, an area in red is at extreme risk for going below capacity, orange is high risk, while yellow is the suggested maximum safe capacity.





IDW Interpolation of Hospital Points and Place Centroids:

Here a very similar estimation of hospital capacity was made but utilizing point data and interpolation. The end results more clearly show the specific neighborhoods' or areas' capacity for COVID hospitalization or intensive care instead of a lack of beds in specific facilities. We end up with heat maps illustrating more localized areas of concern. The redder an area the less capacity they must handle COVID cases. We see a maximum of nearly 100% capacity for some areas, and down to -140% capacity for intensive care, and -11% for general hospitalization.

Conclusion

This analysis of the referenced data shows that there are places in LA County that are approaching capacity. If the current increase in the rate o infections is not reduced, hospitals around LA County could start to be overrun with COVID patients. However, better data is required for a more accurate assessment of forecasted capacity. Specifically, better hospital data including overall bed type and count, as well as current available beds that is updated in regular intervals would greatly improve the accuracy of the forecasts. Better estimations of hospitalization and intensive care needs can be made by considering demographic data of service areas on co-morbidities like age or obesity rates to further increase accuracy of forecasted capacity.

Sources

[1] LA County Health Department Statistical Area Shapefile; https://raw.githubusercontent.com/datadesk/california-coronavirus-data/master/los-angeles-countywide-statistical-areas.json

[2] LA Times' independent tally of coronavirus cases in California; https://raw.githubusercontent.com/datadesk/california-coronavirus-data/master/latimes-place-totals.csv

[3] CDC, Interim Clinical Guidance for Management of Patients with Confirmed Coronavirus Disease (COVID-19); https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinical-guidance-management-patients.html

[4] California Health and Human Service Open Data Portal, Current California Healthcare Facility Listing; https://data.chhs.ca.gov/dataset/licensed-healthcare-facility-listing/resource/641c5557-7d65-4379-8fea-6b7dedbda40b

[5] California Health and Human Service Open Data Portal, Licensed and Certified Healthcare Facility Bed Types and Counts; https://data.chhs.ca.gov/dataset/healthcare-facility-bed-types-and-

by Aaron Gaines
California State University Northridge
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