Analyzing the Dispersion of Air Pollutants in Las Vegas

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Introduction

Large sprawling cities such as Las Vegas and Houston are well known for having poor air quality; a problem because poor air quality has been linked to respiratory illness. Las Vegas is one city that has experienced both a rise in population and air pollution over the past three decades. Presently, there lies no simple means for the public to identify where air pollution is higher and lower throughout the region.

The purpose of this study is to create an interpolation map that displays the severity of pollution within any particular area in Clark County for the year 2016. One of the key reasons for choosing this area of study is that the Las Vegas area has experienced urban sprawl as it has grown quickly over time. This study highlights the dispersion and severity of ozone, nitrogen dioxide, and particulate matter.

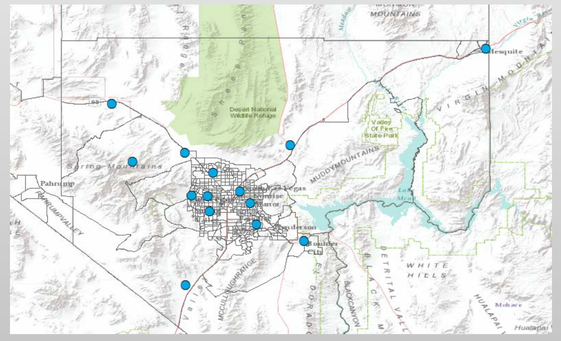


Figure 1. *Map of all monitoring sites that record Ozone levels in Clark County.*

Data and Data Sources

The data that best suited the needs of the study came from the Environmental Protection Agency (EPA). The EPA keeps and records daily maximum values of all major pollutants through various monitoring sites. In addition, it is important to note that not all monitoring sites monitor the same pollutants. For example, nitrogen dioxide was only measured in four monitoring sites, however, ozone was monitored in approximately twenty sites. The EPA was versatile, contained latitude and longitude values of the monitoring sites.

Table 1. List of data and data sources used in the project

Dataset	Source
Daily Air Pollution Max	Environmental Protection Agency (EPA)
Census Tract Data	United States Census Bureau

Methodology

After the data was downloaded from the Environmental Protection Agency's website, the Excel files were georeferenced within an mxd file in ArcMap. The data was then exported as a shapefile. Once this was done, a new shapefile was created from the existing one for the date that had recorded the highest level of its respective pollutant.

Having filtered and extracted the data, the time slider tool was used for the three shapefiles that represented the entire year. The settings were set so that the animation presentation duration was one minute. Also, a green to red color scheme was chosen in order for high levels to be represented as red, and low levels as green.

The next step was to create six interpolation maps, two for each pollutant. One map represented the entire year's pollutant distribution, while the other only showcased the data with the greatest severity. Kriging was chosen because it grouped all the monitoring sites smoothly, and created a more aesthetically pleasing map in comparison to IDW and Nearest Neighbor interpolations, which created a more rigid and distorted look that was difficult to understand. The same interpolation was done for the three other maps, which included the same color ramp based legend in order to highlight the variability of the data.

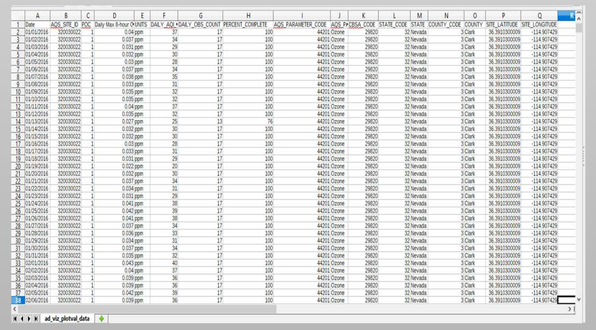


Figure 2. *CSV report of daily Ozone max levels for 2016 in Clark County.*

Timeline

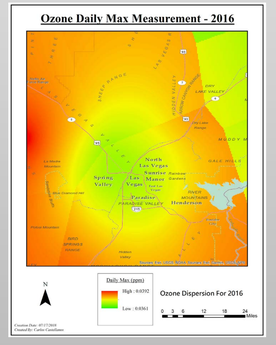
Date	Source
06/01/18	Search for appropriate data files for analysis.
06/20/18	Manual processing of sample air pollutant data - Convert CSV to .Shp
07/05/18	Interpolate values between monitoring stations at yearly and daily level
07/10/18	Utilize time slider feature to create three animation maps for 2016
07/12/18	Perform six interpolations analyses for entire year and highest daily max
07/15/18	Add cartographic features to all maps (i.e. legend, color scheme, scale)
07/18/18	Export final animation map video files

Results

The ozone concentration interpolation map for the entire year of 2016 has a low of .0361 ppm, while the highest is .0392. There was a high concentration originating from the eastern part of Clark County that is progressing towards the downtown area. In contrast, the worst day of the year for ozone had a maximum value .0832, while the lowest value on this day was .0683 ppm, a 42% increase. Also, the concentration of the ozone on this day drifts towards Northern Las Vegas. This is due to 12 mile per hour winds blowing northward on this day. In a similar day, yearly dispersion of particulate matter also originates on "The Strip", which is attributed to this area being at the bottom of the Las Vegas valley and having the a strong population density.

Nitrogen dioxide presents an interesting scenario, since the yearly dispersion had a high average concentration downtown at 43.47 ppb with a low of 25.10 ppb. The high on December 30, 2016 was 65.49 ppb, while the low was 45.42, an increase of 33% from the yearly distribution.

A



B

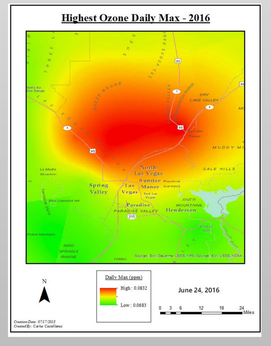


Figure 5A and B. *Ozone yearly distribution compared to highest recorded daily level.*

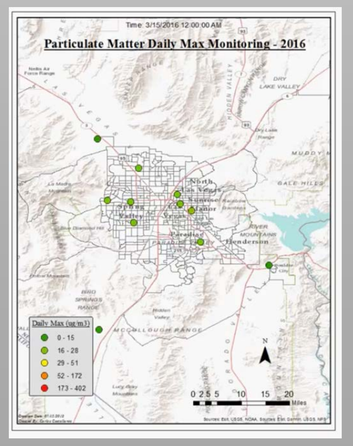


Figure 6. *Screenshot of one of three animation maps.*

Discussion

The first map is an animation map that highlights how pollution has changed throughout 2016. The animation map shows that ozone increases during the summer months. This raises speculation that an increase in tourism and temperature might be major contributing factors. The months that see the least amount of ozone are during the winter months. Las Vegas Boulevard experiences the highest amount of ozone in comparison to the outer monitoring sites. One assumption that can be made is that tall infrastructure in the area traps chemicals and prevents them from dissipating over time.

The highest daily max for ozone was recorded in summer, and lowest (.002 ppb) during the month of December. At the same time, ozone levels shifted and increased to the northern part of the county during its highest recorded level on June 24th, a day in which there was northerly winds at 12 miles per hour. Also, nitrogen dioxide was recorded the highest on December 30th. A day in which fireworks, which have been linked to elevate nitrogen dioxide levels, are commonly set off due to the New Year's Day holiday. Although one would assume that December 31st would have a higher recorded value of nitrogen dioxide, this is not the case as most fireworks are set off at midnight on January 1st.

Conclusion

The major takeaway from the analysis is how air pollution is concentrated around the "The Strip", and then migrates to the northern part of Clark County due to topography and wind patterns. One suggestion for future studies would be to obtain more complex data. Although the data that was acquired from the Environmental Protection Agency was well organized, it only had one attribute suitable for spatial analyses, which was the daily max exposure recorded for any particular pollutant.

In conclusion, analyses will go a long way in formulating active conversation both in communities and local governments, including Las Las Vegas, about limiting their air pollution. For cities still in their infant stages of development, the conversation of prevention will be more impactful as the opportunity to eliminate a majority of air pollution will still be worth pursuing.

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https://youtu.be/ -xjxTwAJ304 https://youtu.be/D6OF -h7ACwc

https://youtu.be/upL5jw8kUxs