Analyzing the West Nile Virus 2014 outbreak in Orange County

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Research Questions

- Does waste management control have an effect on the spread of mosquito borne disease?
- Is there a link between the spread of mosquito borne disease and environmental factors?
- Is there a link between mosquito borne disease and climate factors?

Abstract

Mosquito-borne diseases are major threats to public health across the world. Therefore, it is crucial to analyze mosquito-borne disease outbreaks to determine which factors increase mosquito breedings and diseases. We investigated the correlation between droughts and waste management with the 2014 West Nile Virus outbreak in Orange County. We hypothesized that waste management contributed to the 2014 Orange County West Nile Virus outbreak. We gathered precipitation, land cover, and waste management data from the time frame 2011-2018. We collected data from GLOBE Observer, Giovanni NASA earth science data, NOAA National Centers for Environmental Information, Collect Earth Online, and Orange County Mosquito and vector control district. We found that 2014 showed an increase in Orange County's waste production as well as statistical significance between the average perception of 2013 compared to 2011. We concluded that though the drought was the major cause of the 2014 WNV in Orange County as proven by experts, the increase in waste production may have also contributed to the rise of WNV human cases. This stresses the importance of the need for an increase in waste management in Orange County as it provides a sanitized environment, decreases WNV human cases, and improves the economy through methods such as recycling.

Introduction

- It is essential to analyze the causes for mosquito-borne diseases outbreaks to prevent future epidemics.
- The objective of this project is to analyze the 2014 WNV outbreak in Orange County.
- Experts in the field believe that the drought of 2014 played a major role in the spread of mosquito disease at that time.
- Orange County was chosen as the Area of interest to study the region on a granular level.
- We found a correlation between relatively low average precipitation and an increase in waste production with the 2014 WNV outbreak in Orange County.

IVSS Badges

I am a Collaborator: We formed a collaborative team with differing skills. We worked together with different background and schools to improve our research. Each member efficiently utilized their skills in order to produce the research. As we worked together, we overcame challenges and effectively studied Orange County to analyze its 2014 WNV outbreak.

I make an impact- Our research studies Orange County's WNV outbreak on a granular level. Such analysis may prevent future outbreaks and epidemics. Additionally, the stress for waste management benefits the environment as well as the economy to decrease poverty levels as well as contribute to the fight against climate change.

I am a STEM Professional- We worked with STEM professionals such as Dr. Rusty Low, Ms. Cassie Soeffing, and Andrew Clark for inquiries and support in methods and data collections.

I am a data scientist- We utilized student and professional data in order to find trends that can prevent future mosquito outbreaks. We collected environmental data from GLOBE Observer, Giovanni NASA earth science data, NOAA National Centers for Environmental information, and Orange county Mosquito and vector control district as well as analyzing our AIO.

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Results

- The mean of the WNV Cases data is 4.225 because of the outbreak in 2014 that swayed the data that ranged from 2011 to 2018.
- The WNV cases, the precipitation, and the waste management graphs comparing the state of California to Orange County were consistent during the year of 2014.
- For 2014 and 2011 the p-value resulted in .34704 ($p > .05$). For 2014 and 2012 the p-value resulted in .413179 (p > .05). For 2014 and 2013 the p-value resulted in .186444 ($p > .05$). For 2014 and 2015 the p-value resulted in .287539 ($p > .05$). For 2014 and 2016 the p-value resulted in .287539 ($p > .05$). For 2014 and 2017 the p-value resulted in .280631 (p > .05). For 2014 and 2018 the p-value resulted in 0.24438 (p > .05). However, the p-value for 2011 compared to 2013 resulted in .034028 (p < .05).
- In 2014 there was a drought and an increase in WNV cases.
- This indicates that while WNV cases increased, precipitation levels decreased. As for waste management, the data demonstrates an overall increase of waste in California from 2011-2018 going from 29 to 39 million tons that can contribute to the attraction mosquitoes carrying WNV has towards Orange County.
- . In addition to the other environmental factors, by using the Land Cover data we were able to uncover that about 23.3% of the Land Cover data in Orange County has standing water

WNV Rates per 100,000 people

Waste in lbs per person per day
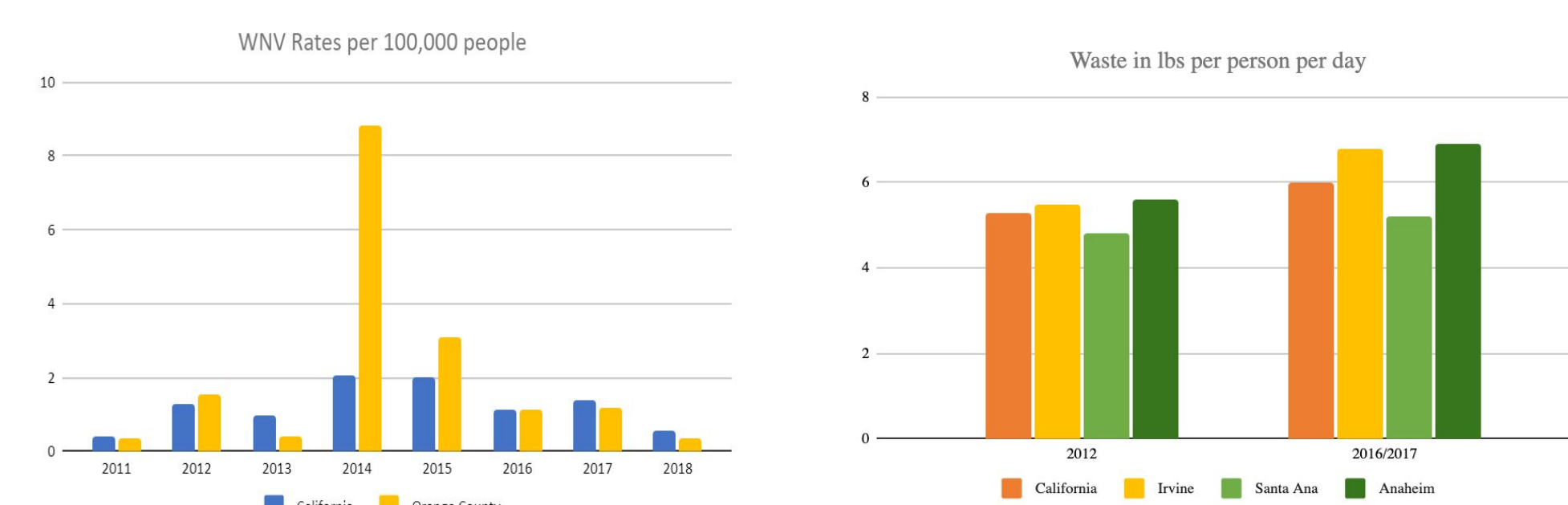
Methods

- We analyzed the historical data of precipitation, waste management, WNV cases as well as GLOBE land cover data
- We utilized the websites Globe Observer, The national Weather service, Nasa's Giovanni data software, and Orange county Mosquito and vector control district to look for data collection sites from the area and dissected the data to add to our background for the area
- Once we had the mosquito data, we used the National weather service and NASA's Giovanni software in order to get precipitation data for orange county during the years 2011-2018
- we used Giovanni's graphing program to graph our data in correspondence throughout the year so we could overlay the graphs to see sudden decreases or rises.
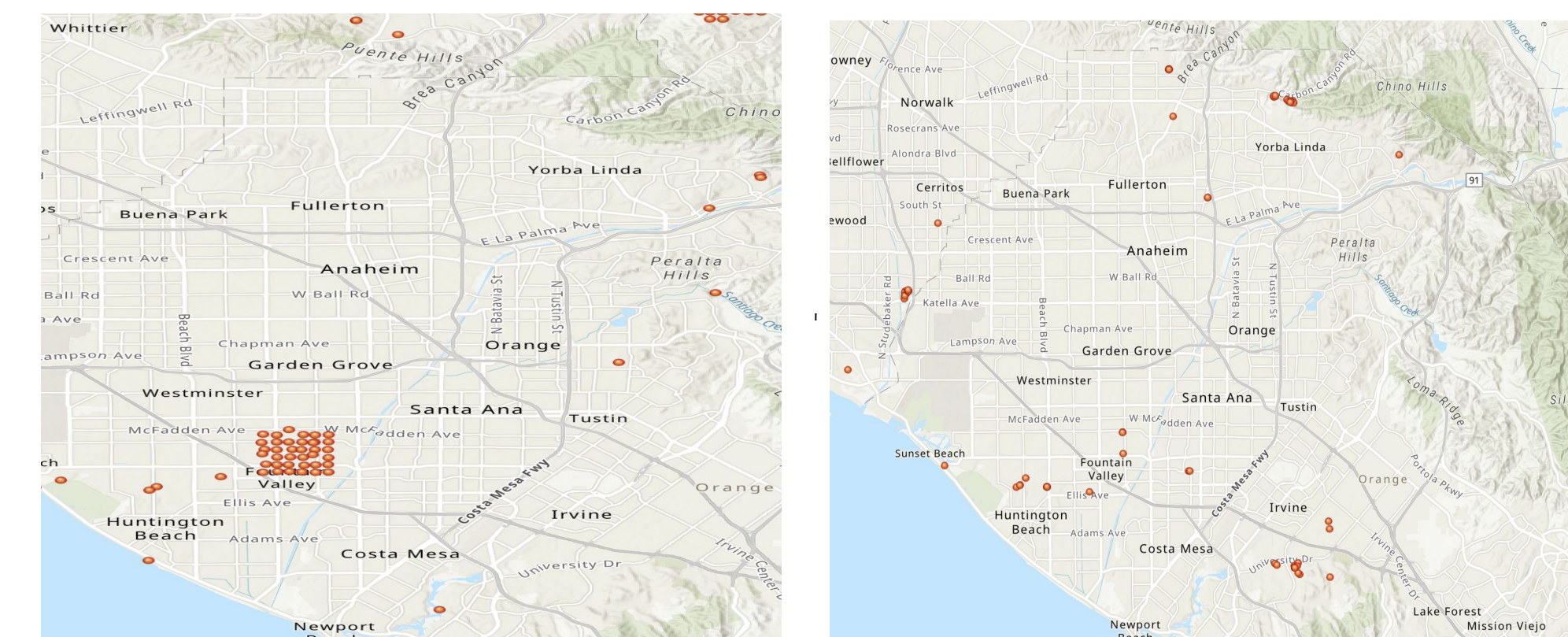
Statistical Analysis-

- The significant threshold used was $p < 0.05$. The equation used for the t-test is given below:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\dfrac{s_1^2}{N_1} + \dfrac{s_2^2}{N_2}}}$$

Where n is the sample size, X is the sample mean, s2 is the variance, Subscript 1 is sample 1, and Subscript 2 is sample 2.

Discussion

We calculated the statistical difference between the average precipitation of 2014 compared to 2011-2013 and 2015-2018. The p-values for each of the years resulted in a $p > .05$, which indicates there was no statistical significance between these years in average precipitation compared to that of 2014. However, there was statistical significance ($p < .05$) in the average precipitation between 2011 and 2013. Dendroecological studies indicate that there may be a lag in terms of weather conditions and disease outbreaks resulting from it (12). Future studies should collect data through longer time points. A similar study done by Kelly Helm Smith et al. looked at predicting mosquito outbreaks in Nebraska, using temperature and precipitation data (13). The difference between these studies is the length of time, location, and variables. The study utilized Nebraska as their select location, used temperature instead of waste management, and used data from 2002-2017. We found that waste management had a relative effect on the spread of mosquito disease, as more trash can cause more mosquito habitats, which in turn has more mosquitoes that can spread the disease. From the drought data compared to the data with mosquitoes at that time, it was predicted that precipitation and waste affected the spread of mosquito-borne disease.

Conclusion

- Using a t-test, we found that the average precipitation in 2014 was relatively low, it was not statistically significant from 2011-2013 and 2015-218.
- We concluded that though the drought was the major cause of the 2014 WNV in Orange County as proven by experts, the increase in waste production also contributed to the rise of WNV human cases.
- Using Orange County waste management data, the drought was the major cause of the 2014 WNV in Orange County as proven by experts, the increase in waste production also contributed to the rise of WNV human cases.
- Future studies should investigate the correlation between WNV human cases with distinct environmental and social factors.

References

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