The Correlation Between Annual Precipitation and West Nile Virus in the United States

Christine Nam, Julianna Pledgie, Grace Toman

Mentors: Rusty Low, Cassie Soeffing, Peder Nelson, Andrew Clarke

Introduction

Mosquitoes are responsible for the majority of vector-borne diseases in the United States (U.S.), one of these diseases being the West Nile virus (WNV). Unfortunately, mosquitoes breed in a variety of wet environments and containers, making them an insect capable of inhabiting many geographic and climatic conditions of the U.S. Additionally, anthropogenic climate change has accelerated the effects of global warming, one effect being an increase in precipitation rates globally. The following research addresses the relationship between West Nile virus and precipitation amounts in the U.S. By understanding how the two variables, precipitation and West Nile virus, correlate with one another, environmental and health organizations may apply such knowledge towards West Nile virus prediction and prevention models.

Research Questions

What is the general correlation/relationship between annual precipitation (in.) and the number of West Nile virus cases recorded in the United States?

Can this defined correlation be used to designate U.S. states as 'most at risk' vs. 'least at risk' for rising West Nile virus cases dependent upon the increasing rates of precipitation nation wide?

Abstract

Two affairs the United States is currently faced with are the spread of West Nile virus, a vector-borne disease contracted when bitten by an infected mosquito, and increasing precipitation rates. A calculated correlation of the two variables, precipitation and West Nile virus, allows for the acknowledgement of their general relationship and potential applications towards educational outreach, funding, and additional resources in regards to public health and West Nile virus prevention. In order to achieve a numerical value to define the proposed relationship, annual precipitation amounts for each U.S. state were recorded from the National Oceanic and Atmospheric Administration's National Center for Environmental Information and annual West Nile virus case amounts for each U.S. state were recorded from the Center for Disease Control. The data was then analyzed with the Pearson Correlation Coefficient to reveal a weak and inverse correlation of -0.233. The correlation outcome indicates that precipitation amount alone has little affect on the spread of West Nile virus, and too many external variables could have affected the results, as each state has a very diverse environment- including temperature, biodiversity, population density, and geographic and climatic characteristics. No definite correlation can be concluded by this research, however, it is recommended that additional research and environmental modeling be completed to understand how precipitation affects the spread of West Nile virus on a smaller scale.

Keywords: West Nile virus, precipitation, correlation, educational outreach, public health

Research Method

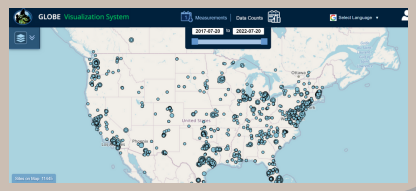
Study Site: United States of America

Data Collection:

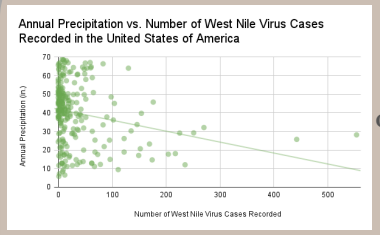
*C*enter for Disease Control's (CDC) West Nile Virus Final Annual Maps and Data for 1999-2020 - *Annual WNV cases*

National Oceanic and Atmospheric Administration's (NOAA) National Center for Environmental Information - Climate at a Glance - T*otal annual precipitation amounts*

National Aeronautics and Space Administration's (NASA) Global Learning and Observations to Benefit the Environment (GLOBE) Visualization System - *current public knowledge of mosquito breeding sites and mitigation*



Results



Line of Best Fit:

y = - 0.0589x + 41.923

Correlation Coefficient:

r = - 0.2333704374

The Pearson Correlation Coefficient was used to analyze the linear relationship between annual precipitation and annual WNV cases in the U.S. Our research resulted in a correlation coefficient of -0.233 between annual precipitation and annual WNV cases in the U.S. This means that the two variables relate to each other with a generally weak and inverse relationship. To enunciate, according to the correlation coefficient defined within this research, as precipitation amount increases, the number of WNV cases decreases.

In observing the GLOBE Visualization System data with regards to analyzing current public knowledge of mosquito breeding habitats and vector-borne disease prevention, we found that highly urbanized cities - such as San Francisco, California and San Antonio, Texas - reported large quantities of mosquito breeding habitats. In contrast, rural locations recorded few to no mosquito habitats. The midwestern states Montana and Nebraska withheld no mosquito breeding habitat reports over the five year time period of 2017 to present day.

Discussion

Interpretation of the correlation between the two variables should be applied sparsely and only once further environmental modeling and research has been completed because this research was introduced to multiple sources of error. Precipitation amounts across the U.S. vary due to a multitude of climatic factors, including air temperature, humidity, precipitation patterns, and altitude. To assume that any one of these climatic factors does not directly affect WNV cases in the U.S. would be incorrect. Additionally, WNV cases may also be affected by other extraneous factors, including atmospheric pollution, population density, geographic and climatic characteristics, and public awareness. Understanding the connections of WNV cases to these factors, as well as the connections of annual precipitation amounts to these factors, would increase this research's outcome both in credibility and potentiality.

Conclusion

After collecting extensive data from the CDC, NOAA, and NASA GLOBE Observer, then analyzing said data with the Pearson correlation coefficient and GLOBE Visualization System, this study concludes that the research does not withhold enough evidence to define a solid relationship between annual precipitation and WNV cases in the U.S. Instead, further research and environmental modeling will be needed to consider the effects of precipitation as a factor of WNV case rates. With such a conclusion, it has been reasoned that public awareness and the education of mosquito breeding and vector-borne disease risks should be encouraged and funded for across the entirety of the U.S. - with a focus on those states and locations whom we observed do not currently practice frequent participation in mosquito prevention and tracking through the GLOBE Observer platform. Research following this study would focus on understanding the other factors of WNV case rates, including surface temperature, atmospheric pollution, population density, and geographic and climate characteristics. Additional GLOBE Observer protocols that may be studied in regards to their relationship to WNV may be the Atmosphere's Aerosols, Surface Ozone, and Surface Temperature protocols, to name a few.

Acknowledgements

This project was successful thanks to the help and guidance of Dr. Rusty Low, Ms. Cassie Soeffing, Mr. Peder Nelson, Ms. Sylvie Wurmser, and the TSGC/SEES team

References