Investigating the Relationship Between Mosquito Hotspots and Urbanization

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Abstract

In order to further understand the way mosquitoes affect human-daily activity, the paper attempts to understand how urban development in metropolitan areas affects both mosquito hotspots and awareness of citizen science. Previously, the correlation between mosquitoes and factors such as their breeding grounds have been the basis for studies. Instead, by using three different cities (Los Angeles, Charlotte, Atlanta), specific variables such as population and rainfall data, and available local larvae data. Using regression graphs, a python and pandas program, and survey data results depicting whether or not there was a correlation between urbanization and mosquitos were drawn. The results represent that more mosquito hotspots occur in locations with high precipitation, yet more awareness of citizen science exists in places with a higher population. With these results, the conclusion of an existing relationship between urbanization along with mosquito hotspots and citizen science has been drawn. However, to improve the validity of these findings, future endeavors include using more cities, using different variables such as building density, and branching out to foreign nations.

Introduction

Urbanization, which we are defining as population growth in urban areas, is rapidly occurring throughout the continental United States. This can have serious effects on mosquito habitats and the humans impacted by the mosquitoes. For example, in Florida, urbanization and mosquito control efforts are more likely to be the dominant drivers of mosquito populations. This is due to the fact that urbanization changes the species composition in an area, favoring the types of mosquitoes that live near and feed on people, such as Aedes aegypti, and causing other species to decline, such as those adapted to wetlands and other natural habitats. We aim to look further

into this relationship using three urban cities and observing various patterns related to their urbanization rates and environmental factors of these areas (climate, precipitation, etc.). To track these findings, citizen science, defined as the collective strength of communities and the public to understand and solve environmental problems, has proved to be an effective method of collecting data globally. Citizen science helps fill data gaps by gathering crowdsourced data that would be hard to obtain due to time, geographic, or resource constraints, helps leverage resources by using the efforts of a large group of people to research environmental problems that EPA may not have the resources to pursue, and helps build meaningful relationships with communities which increase environmental engagement and problem-solving — and with states and tribes to promote open government.

However, only one-in-ten U.S. adults say they have taken part in an activity classified as citizen science in the past year, and 26% say they have ever done so, according to Pew Research Center. Therefore, more research needs to be done on this as well to determine areas of low/high citizen science engagement to be targeted for increased outreach. This prompted the creation of our question, to what extent is urbanization affecting mosquitoes and their habitats. We hypothesized that due to urbanization's increase in empty lots and stored rainwater, urbanization increases the rate at which mosquitos are creating hotspots.

Methods

After developing our question, we chose three areas of interest to study. Qualifications for these locations included, personal proximity to location, various levels of urbanization, a visible increase in urbanization, and the data to show that the city has become more urbanized. With these constraints, we chose Los Angeles, California, Atlanta, Georgia, and Charlotte, North

Carolina. Los Angeles, California acted as our most urbanized location, as Los Angeles has been a major metropolitan city for almost a hundred years. Atlanta, Georgia was the middle ground for both urbanized but still fairly suburban dominated. Charlotte, North Carolina was the least urbanized but the one that is currently booming in population.

We used US Census data to calculate the increase in population of these locations to confirm their urbanization levels, we also used US Weather data to determine if the weather of these urbanized locations would increase the number of mosquitos. With these cities, we had a good range of how to tell if urbanization has affected the number of reported mosquito hotspots. After we found the difference in population and the weather data, we conducted a regression data analysis, depicting the correlation between precipitation levels, population, and our local data sourced from the Mosquito Mappers cohort. This allowed us to tie data to whether or not it was related to precipitation or population growth.

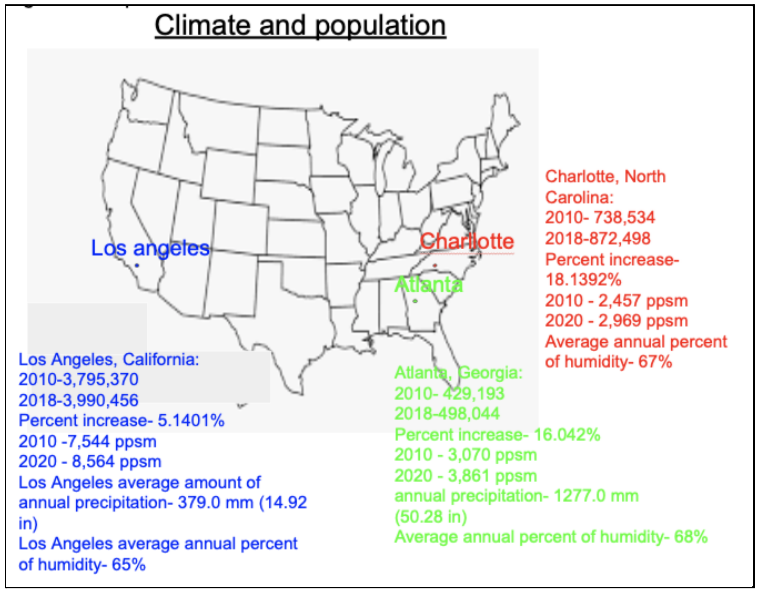

Figure 1: Specific climate statistics for each city.

To sort the mosquito mappers cohort data, we used a pandas geohash code that counted the amount of time the zip code for one of the three locations showed up in the data. Finally, in

order to find out about awareness of citizen science, we conducted a survey among our peers, family, and neighbors which asked them about urbanization, mosquitos, and their awareness of citizen science.

Results

In the results of our regression analysis comparing the numbers of mosquito larvae collected from the 2021 Mosquito Mapper's cohort of mosquito trap data and precipitation levels, we found a significant relationship for Los Angeles ($p < 0.05$, $p = 4.6\ e^{-5}$) between precipitation and mosquito larvae count (Figure 2). The r^2 comes out to be approximately 0.706 which shows that the model describes the data with moderately high accuracy. (~ 70%)

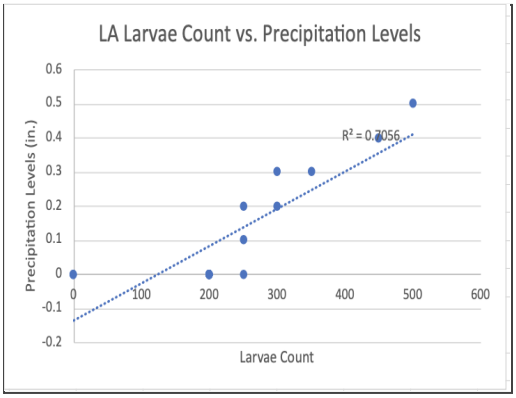

Figure 2

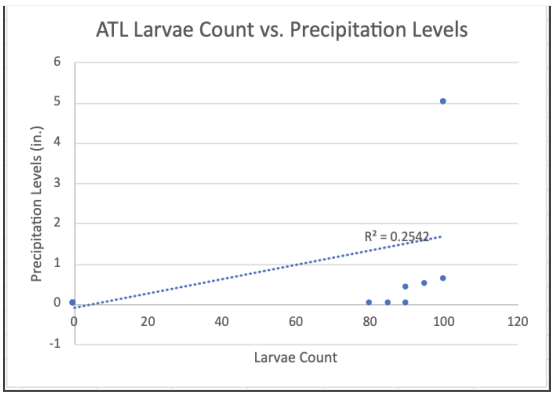

Figure 3

For Atlanta (Figure 3) & Charlotte (Figure 4), we found a significant relationship ($p = 0.046$) & ($p = 0.009$) between precipitation and mosquito larvae count. However, we also found the r^2 value to be about 0.254 for Atlanta & 0.395 for Charlotte which shows that the model describes the data with moderately low accuracy (~25%) & (~40%). The reason for this could be consistency issues with Atlanta's & Charlotte's precipitation data as they could have had inconsistent climate patterns during the time period of data collection.

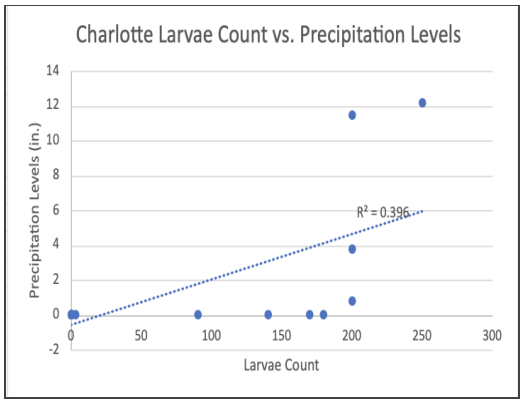

Figure 4

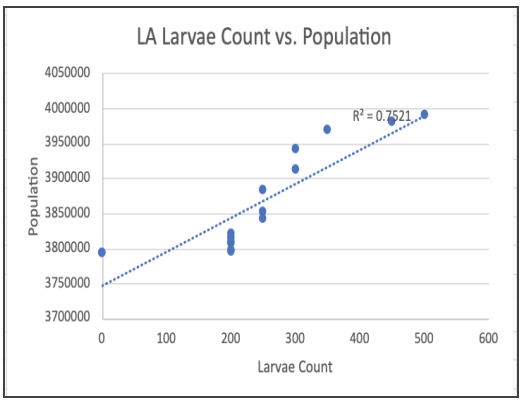

Figure 5

Next, for the regression analysis comparing the numbers of mosquito larvae collected and population changes, we found an insignificant relationship for Los Angeles ($p = 0.733$) between population and mosquito larvae count (Figure 5). However, we also found a low r^2 value of 0.008 for Los Angeles. Such results may be due to the scale of population observation that we used and the fact that both cities have very dense populations with greater room for errors and various factors affecting the relationship.

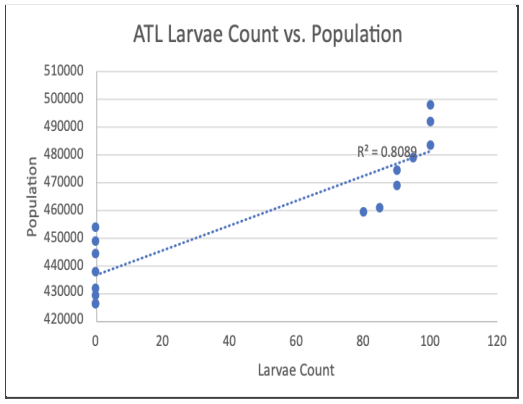

Figure 6

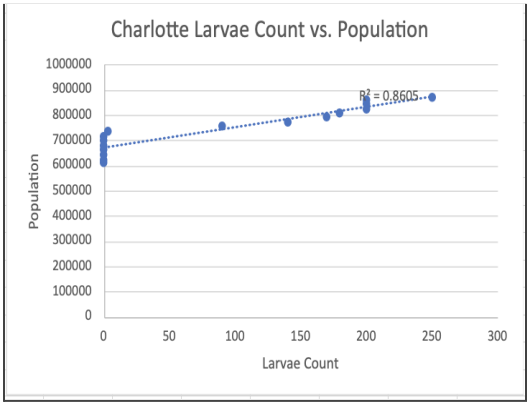

Figure 7

For Atlanta (Figure 6) & Charlotte (Figure 7), however, we found significant relationships ($p = 2.1\ e^{-6}$, $p = 2.2\ e^{-7}$) between population and mosquito larvae count with high model accuracy. The r^2 comes out to be approximately 0.861 which shows that the model

describes the data with moderately high accuracy. (~ 86%). This may be due to Charlotte's relatively suburban landscape in comparison to Atlanta & Los Angeles which allows for slightly improved data collecting conditions and minimal external factors.

When conducting our survey asking participants about urbanization, mosquitos, and their awareness of citizen science, we sent a sharable link to our social media, friends, and neighbors who also were encouraged to share the survey with people they know. We received a total of 47 responses, but the amount of responses varied from question to question since not all questions were answered by each participant. 95.6% of the total participants said they saw more urban development now compared to previous years. 70.2% said they saw more mosquito activity than previous years.

Using our simple python program using pandas and geohash, we found that Los Angeles had the most reported mosquito habitats with 37, Atlanta was second with around 7, and Charlotte was the least with 2.

Discussion/Conclusion

Using our data collection, we found that urbanization does indeed have an effect on mosquito hotspots, according to variables such as population density that affect the ability for mosquitos to create proper habitats, the survey data's positive correlation, the different significances of the regressions, and the positive correlation between the use of the GLOBE app and population. Overall, there is a correlation between urbanization and mosquito hotspots, particularly one that favors cities with high precipitation and fairly low people per square mile density. High precipitation leads to increased still water, which is perfect for mosquitoes to lay their larvae, whereas low people per square mile density allows the mosquito hotspots to not be

disrupted by human activity. However, in order to improve these results for future research, rather than focusing data collection on three cities, the focus would be on multiple in different regions of the United States, also potentially moving our focus out of the United States and collecting in different parts of the world, especially in places that are prone to mosquito diseases like Zika and dengue. Moreover, using different variables such as rate of poverty and building density to discuss the correlation between urbanization and mosquito hotspots. Overall, while our data collection got results, there are many ways to improve the project that can allow for new results and potentially new conclusions.

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