



HONEY! Where's My Citrus Fruit?



Problem Statement

How has the changing climate affected citrus production in the State of Florida?



Alternative Hypothesis

If temperature and precipitation are changing, then citrus production in the State of Florida will decrease.



Null Hypothesis

If temperature and precipitation are changing, then citrus production in the State of Florida will neither increase nor decrease.



Background Information

- ❑ For millions of years, the Earth's climate has been changing naturally. But, for the past few centuries, humans have disrupted the natural climate change in many ways, including the overuse of fossil fuels. When burned, fossil fuels such as coal, natural gas and oil can create energy to power homes, cars, and electronics, but there is a harmful byproduct from fossil fuels. Once burned, fossil fuels release a gas called Carbon Dioxide (CO₂) into the atmosphere.
- ❑ The Earth's atmosphere naturally traps heat from the sun to control temperatures on Earth, and then releases that heat, a process known as the greenhouse effect. Gasses like CO₂ on the other hand, prevent this heat from escaping by absorbing it. Decomposition of waste in landfills, agriculture, and domestic livestock also produce gasses such as methane and nitrous oxide contributing to climate change. These "greenhouse gasses" also prevent heat from escaping the Earth.
- ❑ Climate change can affect agriculture in all parts of the world. The United States is ranked #3 in Citrus producing countries around the world. Florida is one of four citrus producing states in the United States. Ninety percent of Florida's oranges are used to make orange juice, and it is sold all around the United States. Florida is also one of the world's largest producers of grapefruit.
- ❑ Florida's citrus industry is worth \$9 billion and generates \$1 billion in taxes to help improve the State of Florida. It also employs over 76,000 Floridians. The production of citrus also has a great impact on the environment by providing homes to over a hundred of species of native wildlife species, and producing over sixteen tons of oxygen per year.
- ❑ The changes in the climate that we see today include global temperature rise, sea level rise, intense rainfall, warming oceans and more, all of which, can effect citrus production in many ways.



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Abstract

The purpose of this science fair project was to determine how the changing climate affected citrus production in the State of Florida. Citrus production is extremely important to the State of Florida, producing \$1 billion in taxes and employing over 76,000 Floridians. But recent decline in Citrus production may have grave consequences for Florida's Citrus economy.

The problem statement is "How has the changing climate affected citrus production in the State of Florida?" To answer this research question, Citrus Production data from the United States Department of Agriculture (USDA), and temperature and precipitation data from the National Oceanic and Atmospheric Administration (NOAA) extracted and analyzed.

Using this data, I observed that Citrus Production in the State of Florida dropped by 42% from 2004 to 2005. This decreasing trend has continued since 2005, and citrus crop production in the State of Florida has never gone back to levels seen prior to 2004.

After analyzing the recorded weather and citrus crop data from 1916-2016, it was discovered that climate change does not seem to be the direct contributor to the decrease in citrus production, because temperature and precipitation levels remained relatively unchanged from 1916-2016. Further analysis revealed evidence of an underlying cause for this decrease in Citrus Production in the form of a disease known as "Citrus Greening" or Huanglongbing.

The results disapprove my alternative hypothesis, which stated "If temperature and precipitation are changing, then citrus production in the State of Florida will decrease." This project applied data science to the area of Citrus production analysis.



Materials

1. Computer with internet connection
2. Climate Data Online (CDO) for access to National Climate Data Center (NCDC) archive of global historical weather and climate data including quality controlled daily, monthly, seasonal, and yearly measurements of temperature and precipitation for the last 100 years. The archive is part of the National Oceanic & Atmospheric Administration (NOAA).
3. National Agricultural Statistics Service (NASS) of United States Department of Agriculture (USDA) for access to Citrus production by county for the State of Florida.
4. Spreadsheet to document dates, temperature, precipitation, and citrus production.
5. Data Visualization and Predictive Analysis Software – Tableau Software



Procedures

1. Query Climate Data Online (CDO) for recorded temperatures and precipitation in different areas of Florida on specific dates throughout the last 100 years.
 - I. Extract Weather Data (temperature and precipitation) from 2000–2016 for Citrus producing counties in the State of Florida.
 - II. Extract Weather Data (temperature & precipitation) for 1916 -2016 (100 years) for the State of Florida.
 - III. Cleanse and normalize data by Citrus producing counties in the State of Florida.
 - IV. Stage the normalized data for importing into Tableau.

2. Query National Agricultural Statistics Service (NASS) Citrus crop production in the State of Florida on specific dates throughout the last 100 years.
 - I. Extract State level Citrus crop production data for 100 years (State Level).
 - II. Extract Citrus production data by county from 1997 – 2016.
 - III. Extract Citrus production data by major regions for 1997 – 2016.
 - IV. Cleanse and normalize data for importing into Tableau.
 - V. Stage the normalized data for importing into Tableau

3. Data Visualization & Predictive Analysis
 - I. Import normalized Citrus production data and Climate data
 - II. Run data visualizations at both state, county and region level to observe patterns of change in Citrus production with changes in temperature and precipitation.
 - III. Analyze impact of weather change factors including temperate and precipitation to validate or disprove the alternative hypothesis.



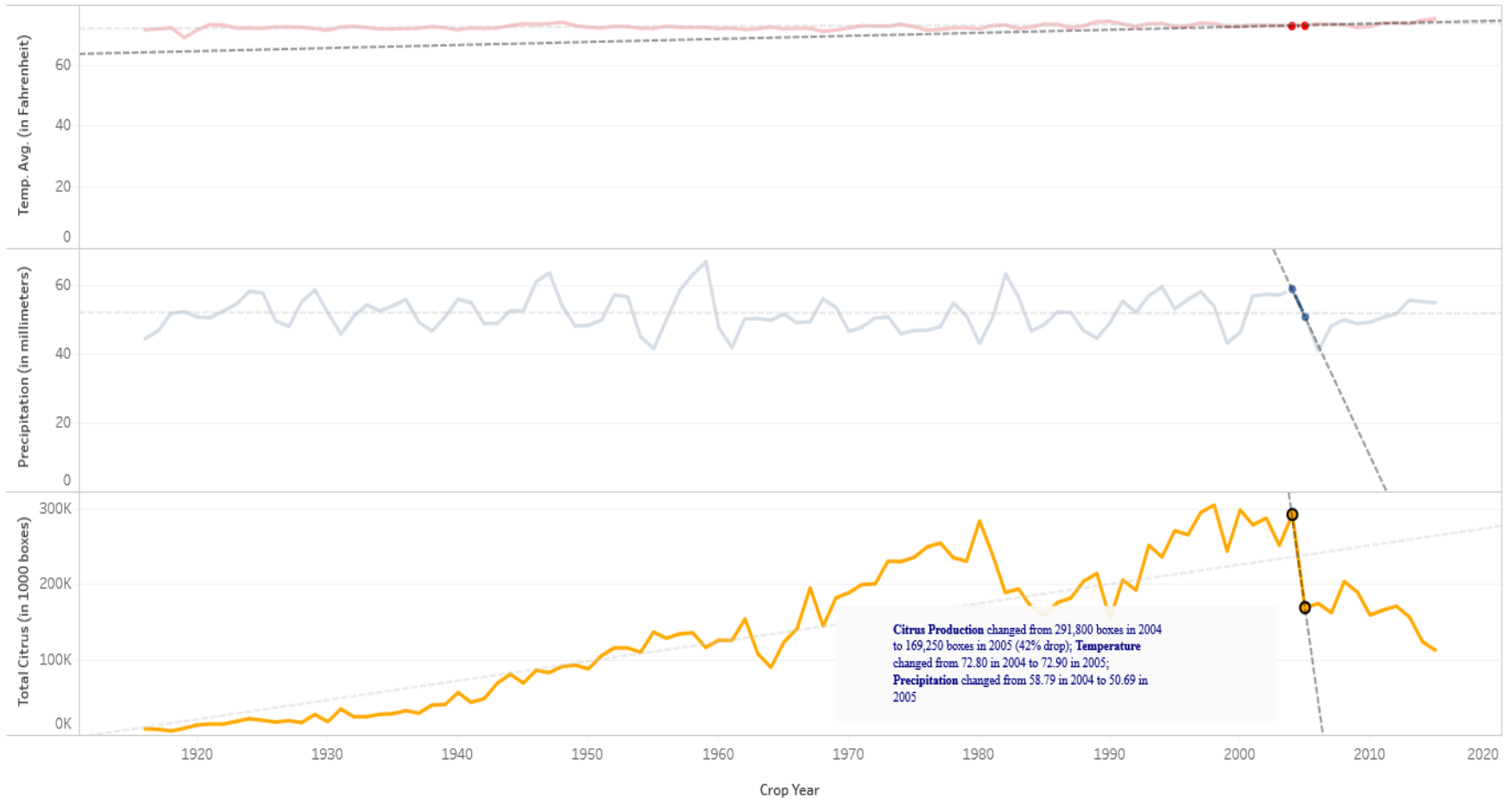
Statistical Data

- Recorded Data (1916-2016) - Florida Weather Data – Temperature & Precipitation – Median
- Recorded Data for Top 10 Counties (2000 - 2016) - Florida Weather Data - Temperature & Precipitation – Median
- Recorded Data (1916-2016) - Florida Citrus Production
- Recorded Data for Top 10 Counties (2000-2016) - Florida Citrus Production



Tables and Graphs

Recorded Data (1916-2015) - Florida Citrus Crop Production, Temperature & Precipitation

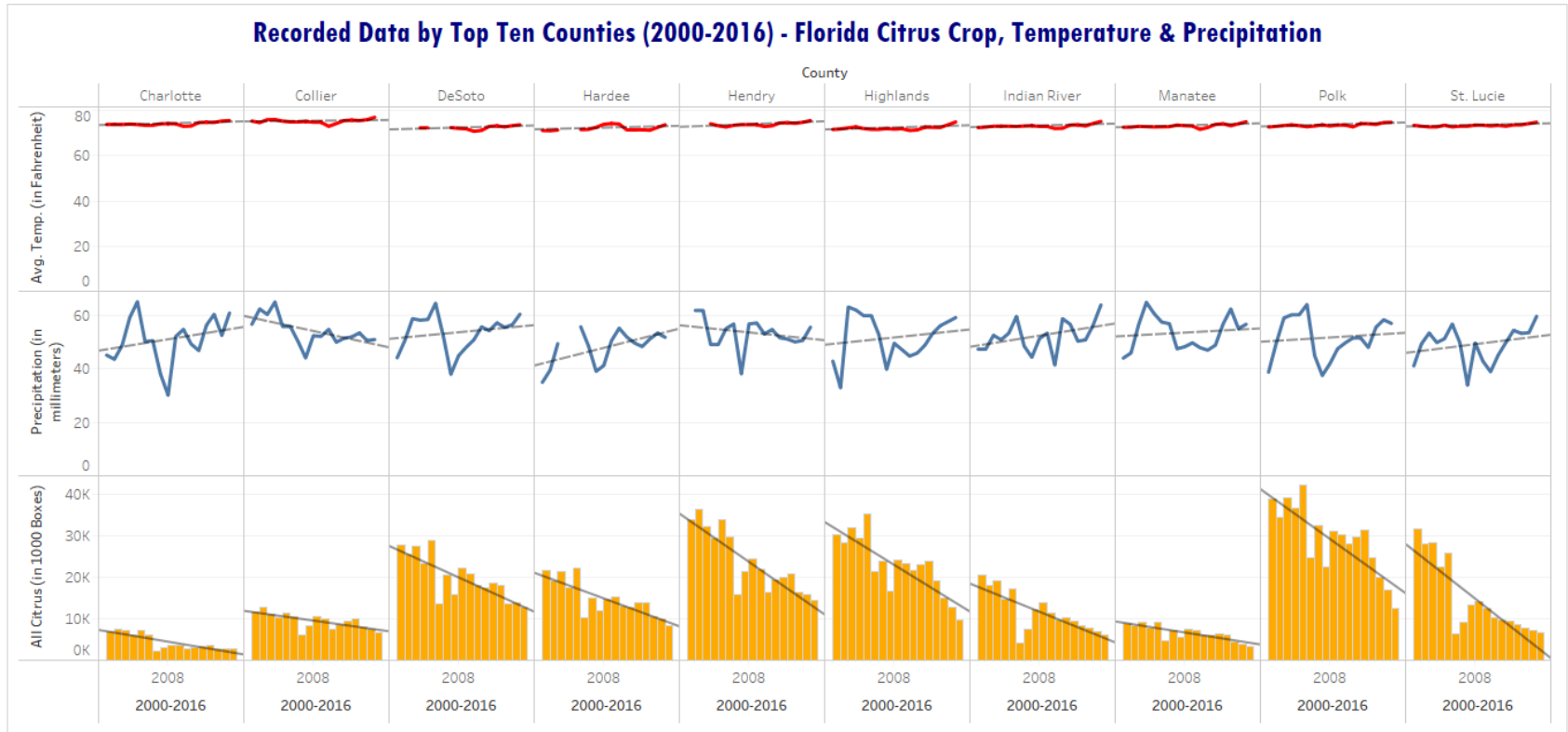


The trends of sum of Tavg, sum of Prcp and sum of Total for Crop Year.

Sources: National Agricultural Statistics Service (NASS) | Climate Data Online (CDO) / National Oceanic and Atmospheric Administration



Tables and Graphs



Caption

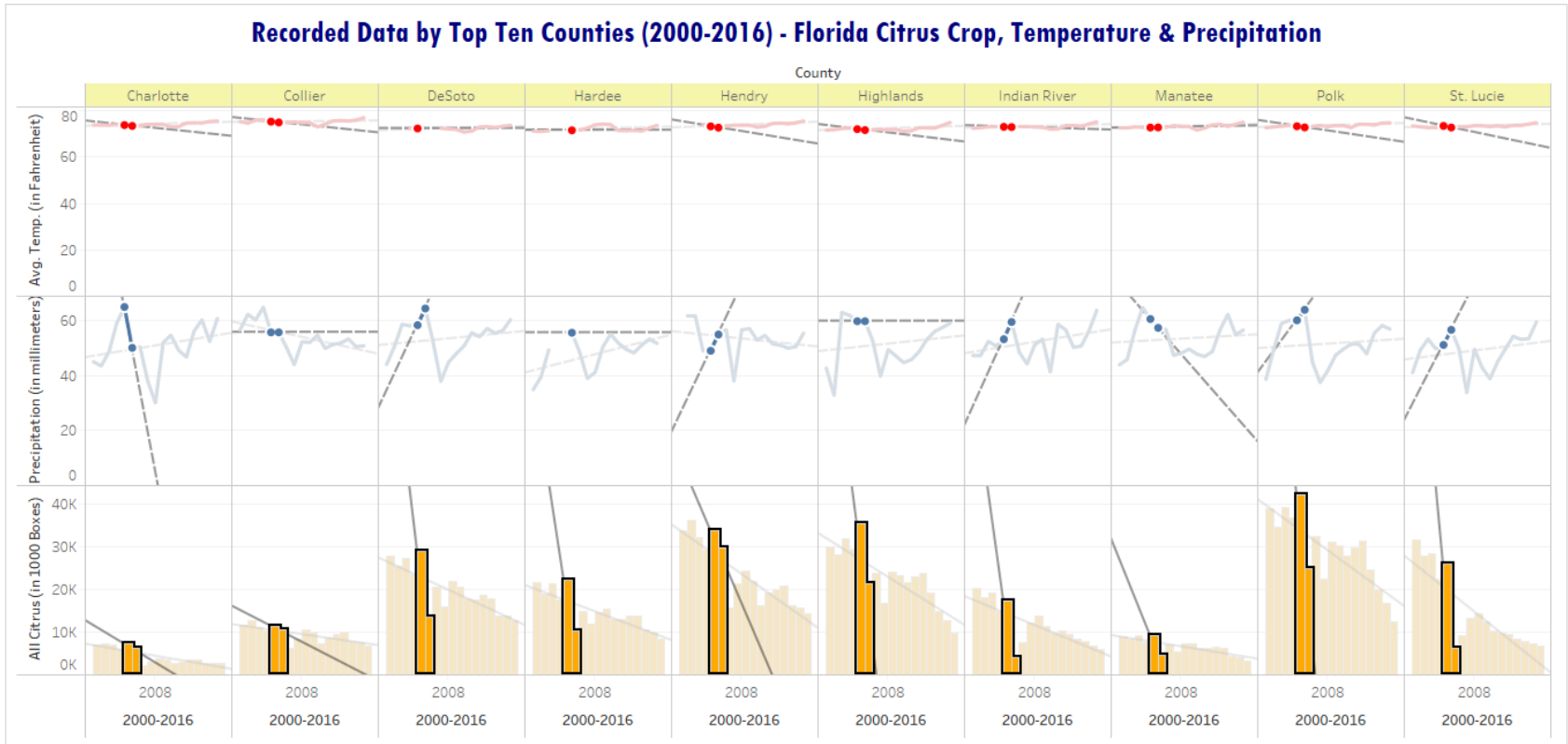
The trends of Median Temperatures, Precipitation and Total Crop Production from the Top 10 Citrus producing counties.
Sources: National Agricultural Statistics Service (NASS) | Climate Data Online (CDO) / National Oceanic and Atmospheric Administration

Recorded Data - Top 10 Counti...





Tables and Graphs



Caption

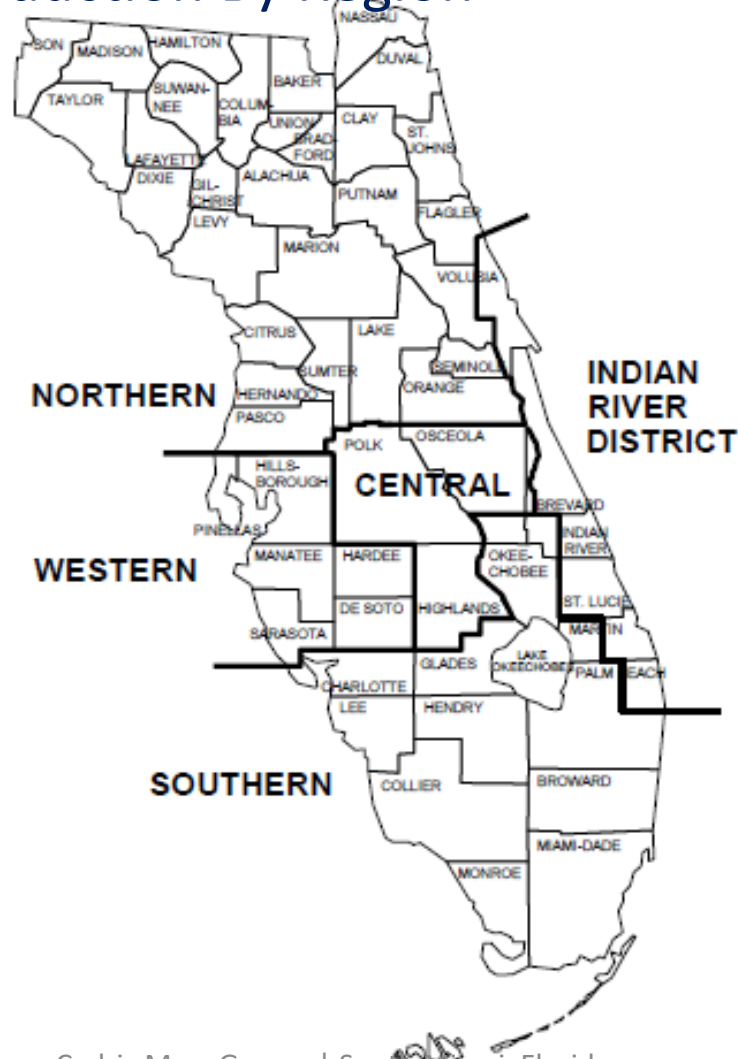
The trends of sum of Avg, sum of Prcp and sum of Total for Crop Year (2000-2016) from Top 10 Citrus producing counties.
 Sources: National Agricultural Statistics Service (NASS) | Climate Data Online (CDO) / National Oceanic and Atmospheric Administration

2004-2005 Crop Decrease ☰ ■ ◀ ▶ ☐ 🗨



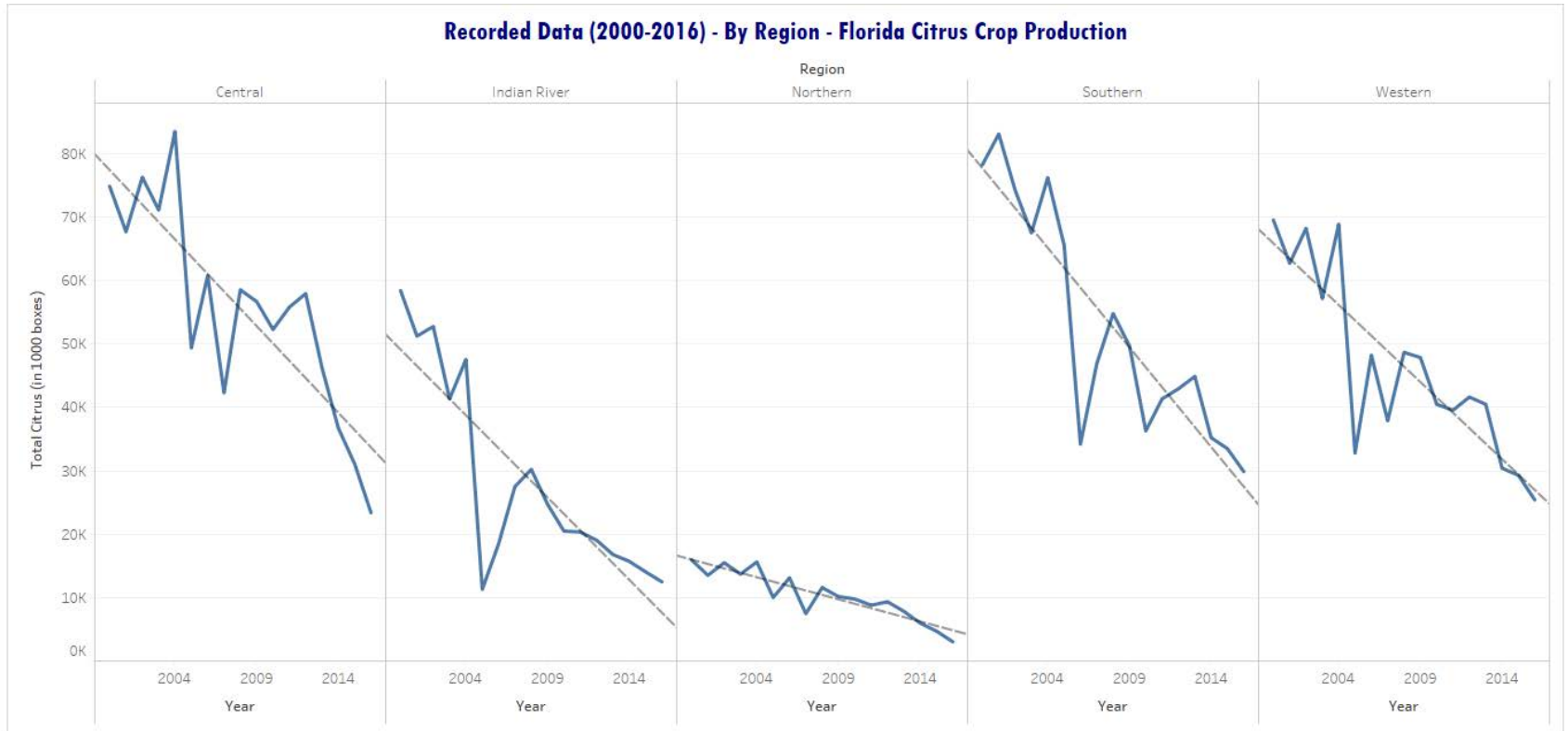
Tables and Graphs

☐ Florida Citrus Production By Region





Tables and Graphs



Caption

The trend of sum of Total Citrus Production (Oranges + Grapefruit) for Crop Year broken down by Region.

Recorded Data by Region





Conclusion

In analyzing the recorded weather and citrus crop data from 1916-2016, climate change does not seem to be the direct contributor to the decrease in citrus production. Temperature and precipitation levels remained relatively unchanged over the 100 year period from 1916-2016. Minor increase and decrease in temperature and precipitation levels over the same period did not directly correlate to citrus crop production in respective years. Citrus crop production increased significantly from 1916-2004, with relatively insignificant changes in temperature and precipitation over the same period.

In 2004, the recorded data shows Citrus Production in the State of Florida was at 291,800 boxes. In 2005, production dropped by 42% to 169,250. Over the same period, the Temperature changed from 72.800 to 72.900 degrees Fahrenheit (relatively insignificant), and Precipitation levels changed from 58.79 to 50.69 milliliters (fluctuating levels similar to historical trends). This decreasing trend has continued since 2005, and citrus crop production in the State of Florida has never gone back to levels seen prior to 2004. It is important to note that in 2004, the State of Florida experienced four category 3 hurricanes impacting most of the citrus producing regions. However, in analyzing the recorded data, Hurricane Andrew which was the most devastating hurricane to ever hit Florida in 1992 did not have the kind of impact on citrus production as compared to 2004. Therefore, further investigation was needed to understand the other potential causes for the significant decrease in citrus production in the State of Florida.

In analyzing citrus crop production in further detail for the period starting crop year 2000 to 2016 (by citrus producing Counties and Regions), the falling crop trends are clearly noticeable beginning in 2005. Upon further investigation, I found recorded data on another potential reason for the decline in citrus production since 2005. This decline in citrus production



can be attributed to a crop disease commonly referred to as “Citrus Greening” (or Huanglongbing). A February 2016 publication by Ariel Singerman and Pilar Useche from the Food and Resource Economics Department in Gainesville, Florida, studied “Citrus Greening” and its effect on the Florida citrus industry. This study noted a 42 percent decrease in production from 2004-2005, an observation similar to one I have compiled in my data analysis. In another study “Economic Impacts of the Florida Citrus Industry in 2012-13, sponsored by Florida Department of Citrus also identified the significant decrease in Citrus production attributed to “Citrus Greening”.

Similar inferences have been made by several other organizations and individuals using survey data collected directly from citrus producers. Several national news organizations have also reported on “Citrus Greening”. However, it is quite troubling that the United States Department of Agriculture (USDA) in published citrus crop reports since 2004, makes no mention whatsoever of “Citrus Greening” as a probable cause for decline of citrus production in the State of Florida. My review of all such reports from the USDA identified a single instance where “Citrus Greening” was mentioned. The USDA does not explicitly identify “Citrus Greening” as the cause for the decline in citrus production, but states that “abandoned groves” may be the cause for the spread of the virus that causes “Citrus Greening”. However, recorded studies show that “Citrus Greening” has caused growers to abandon these groves (and is the opposite of the statement by the USDA).

“Citrus Greening” is beyond the scope of my current study and it will have to be investigated in further detail to validate my own observations about “Citrus Greening” on crop production. However, at this point, the recorded data does not support my alternative hypothesis which states that the changing climate has decreased citrus production in the State of Florida.



Application

- ❑ Data analysis and visualization tools created for this project can be repurposed in several ways by researchers and government agencies interested in detailed recorded data based analysis of the impact of weather changes on agricultural crops in general.
- ❑ The data analysis can also be used by researchers and government agencies as supporting analysis in their study of the impact of “Citrus Greening” on citrus crop production.
- ❑ The data analysis and visualization tools have already been made available in public domain.



Data Log

- USDA Citrus Production Data – Sample Summary
- 100 Year Weather Data – Sample Temperature & Precipitation
- County Weather Data – Sample Temperature & Precipitation
- NOAA Climate Data Online Search