Food security assessment in U.S. using climate indicators and remote sensing from 1961 to 2011

Author: Lubna Begum
Co Authors: Dr. Tarendra Lakhankar and Ehsan Najafi
lubnak422@gmail.com

Abstract

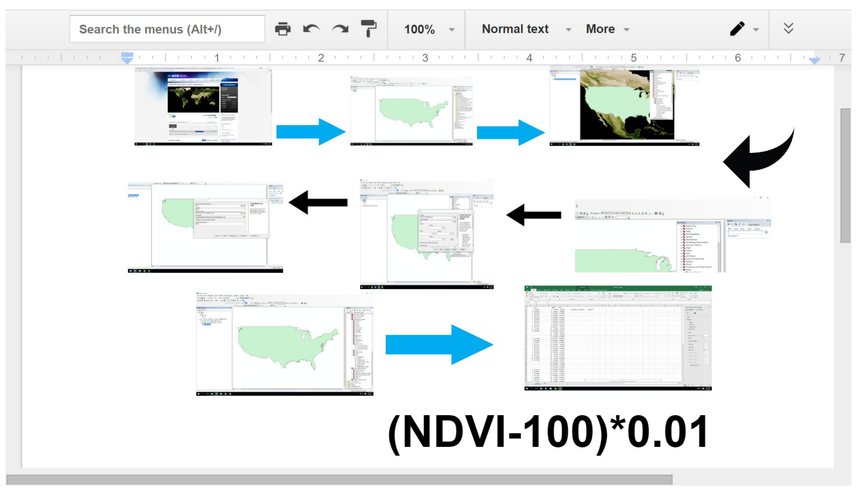
Our world continues to progress, as does our population. And so today, we face the problem of sufficiently providing food to our growing global population. And so we have to develop a way to stop the risk of drought and crop failure. Thus, we have created a system to stop world hunger by food security, which is having a consistent access to an abundant supply of affordable and nutritious food in order to properly nourish. Nevertheless, the focus of this project is finding the relationship between food security and the climate change, to evaluate how it can have an impact on agriculture, which our source of food is dependent upon and this study focuses on the United States.

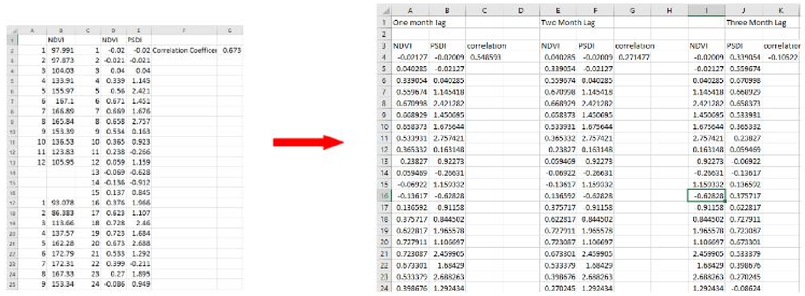
Introduction

Food security is very important when it comes to making sure we don't face famine, food shortage, or a stock market crash. As our population grows, our food production is not increasing along with it in whole region. And so, food security helps to access sufficient food to feed them. Nevertheless, food production is mostly affected by climate change.This study is focused on the United States using yields of six major crops (barley, maize, rice, sorghum, soybeans, and wheat) and how they're related to precipitation, CO2, temperature, and technology from 1961 to 2011. In addition, this study investigates Palmer Drought Severity Index (PDSI) which directly contains temperature and precipitation data to estimate relative dryness and the Normalized Difference Vegetation Index(NDVI) of the United States which assess whether or not the target being observed contains live green vegetation from 2006 to 2010. This investigation examines how each of these factors have impacted food production. Currently, the Food and Agriculture Organization (FAO) plays a significant role by displaying data that consist of yields of major crops from every country in the world on their website. In addition, World Bank also on their website played important rules by displaying many kinds of data including temperature and precipitation.

Methodology

In this project, yield of six major crops, CO2, temperature, and precipitation data (ranging from 1961 to 2011) were chosen for this study, using Excel software to graph. Also this data used MatLab software to find the coefficient using a equation which is
Log(yield)=a+b1*precipitation+b2*temperature+b3*CO2+b4*technology
and then another equation used for calculating the coefficient in Matlab which is (coefficient = X/ Yields.
Also, ArcMap software was used to get the NDVI data of the United States.
The first step to get this NDVI data was to download the boundary of the United States in ArcGis software. This system predates all the months between the years 2006 and 2010 and especially clip and zonal statistic as a table from this procedure used to get the monthly average of the United States NDVI data. Later on, Excel software was used for converting the monthly average of NDVI data to the number between -1 and 1, which is correlation coefficient by a equation and this correlated with PCDI data of the U.S by graph. Furthermore, this study used 'correl function' in Excel to see the correlation between NDVI and PCDI from 2006 to 2010. In addition, this study used NDVI correlation coefficient of each months and PCDI data to no month lag, one month lag, two month lag and three month lag and obtained the correlation coefficient of those month lag by using correl function.





Processing correl function

Data

The yield of six major crops collected from FAO website.
In addition, the precipitation, temperature and CO2 data obtained from World Bank website and NDVI data contained from Nasa Earth Observation (NEO) website.

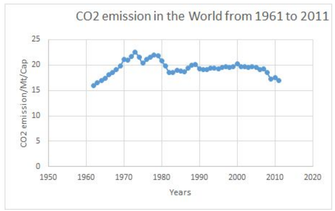


Figure #1
CO2 was increasing but is now stable

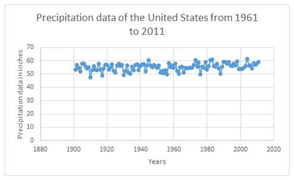


Figure #2
Precipitation remains in a constant range between 1880 to 2020.

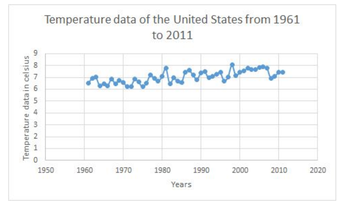


Figure #3
Temperature is gradually increasing

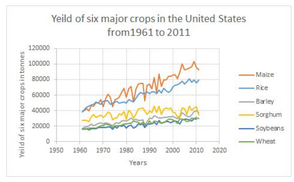
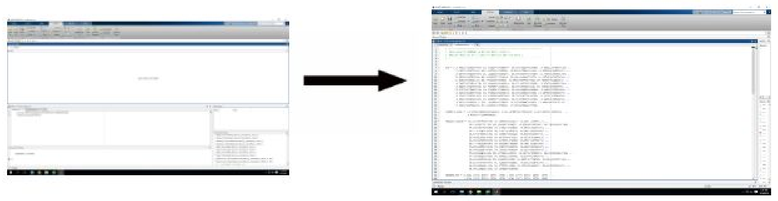


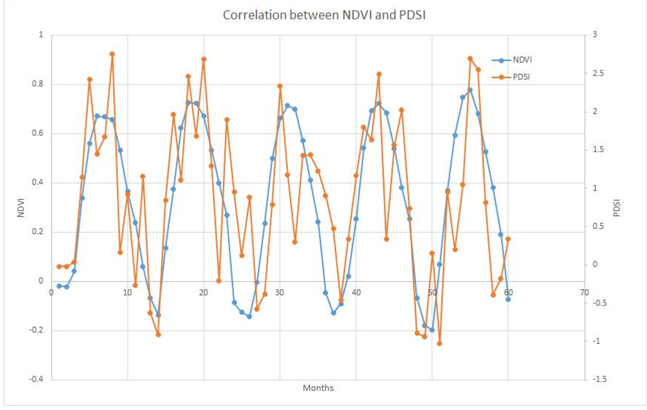
Figure #4
Crop yield increase per year, because technology is improving.



Processing the equation in MatLab

Results

Figure 1, 2 and 3 illustrate the data of CO2, precipitation and temperature from 1961 to 2011 to examine how they increase or decrease year by year.Furthermore, Matlab investigated that if we have precipitation, temperature, co2 and technology data, we can predict yield of food. Figure 4 illustrates the correlation of yield of six major crops of the U.S and it increases day by day because technology is improving. Figure # R shows most strong relationship between NDVI and PCDI which means when PSDI low, the NDVI increase and when PSDI high, NDVI decrease.In adddition the correlation between NDVI and PSDI is (0.67) in no month lag, in which vegetion is mostly healthy.



Conclusion

Excel and ArcGIS are most conducive softwares for data analyzing over time and helpful to obtain data. Excel especially was used for finding correlation coefficient to compare relation between NDVI and PCDI. In addition, it especially used to graph precipitation, temperature and CO2 to see how it increases or decreases. ArcGIS software helps get the monthly average of NDVI data. Overall, with the correlation data of NDVI and PCDI people can understand when the food production good.

References

1 http://faostat3.fao.org/browse/Q/*/E
2http://climatedataapi.worldbank.org/climateweb/rest/v1/country/cru/pr/year/COUNTRYCODE.CSV
3http://climatedataapi.worldbank.org/climateweb/rest/v1/country/cru/tas/year/COUNTRYCODE.CSV.
4 http://neo.sci.gsfc.nasa.gov/view.php?datasetId=MOD13A2_M_NDVI

Acknowledgement

"NOAA CREST program is funded by NOAA/EPP Grant # NA11SEC4810004" and *"NOAA CREST HIRES program is a part of the Science Research Mentoring Program and funded by Pinkerton Foundation"*.

I express my deepest gratitude to my mentor Ehsan Najafi for helping me in this project and explaining difficult concepts. Also, I am thankful to my faculty advisor Tarendra Lakhankar for teaching me about ArcMap. I would like to thank Shakila Merchant, Professor Reza Khanbilvardi and Neelambari Save for constant support and guidance. I am thankful to my High School science teacher Ms.Zaman; without her guidance, it would not be possible to bring me into this topic. I would like to give special thanks to faculty members without whom this project would have been a distant reality.