Effect of Climate Change on global food production

[Extended Abstract]

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ABSTRACT

In the coming years, climate change is going to affect various aspects of human life drastically. One of the most important effects that climate change is going to have is on the agricultural sector. Due to the growing population, land degradation, emissions of greenhouse gases, the yields in the staple food crops are predicted to go down. Based on the different socioeconomic scenarios, NASA's SEDAC assessed the implications of temperature and precipitation changes for world crop yields and predicted the change in crop yield for future years for different countries. In this project, we clustered these countries based on the yield changes and was able to observe some pattern in the clusters across the scenarios and years.

1. INTRODUCTION

The greenhouse gas emissions in the future is determined by a complex convolution of factors such as demographic and socio-economic development, and technological change [2]. Potential impacts of climate change are estimated for climate change scenarios developed from the Hadley Centre Coupled Model version 3 (HadCM3) global climate model under the Intergovernmental Panel on Climate Change Special Report on Emissions Scenarios (SRES) A1FI, A2, B1, and B2.The scenarios considered in this modeling are shown in Figure 1. The A1FI scenario assumes a large increase in the global temperatures [3]. The data set that we are analyzing predicts the effects of climate change on global food production based on different climate scenarios. This provides a quantitative estimate on the change in yield in these crops for the future years. For simulating the yield change, a baseline was selected for years 1970-2000.

2. MOTIVATION

The main motivation of this project was to study the effect of climate change on global crop production using clustering techniques. One way of doing was to take projected crop yield data for future years and identify clusters of countries based on the change in crop production yield. We wanted to see whether there is a pattern in how the yields change over the years across different scenarios. If we can cluster the countries, we can see what countries moved from one cluster to another or whether new clusters are formed.

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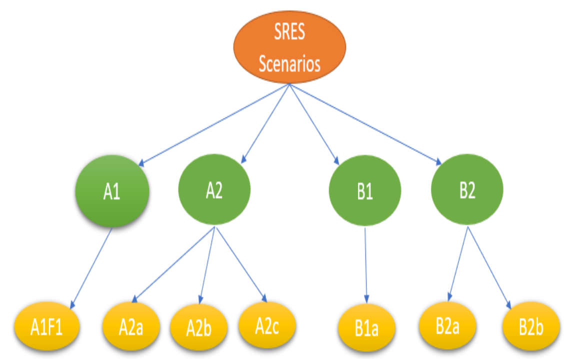

Figure 1: SRES scenarios considered to modeled the effect of climate change in the global food production.

3. METHODOLOGY

The data set was collected from NASA Socioeconomic Data and Applications Center (SEDAC) [1] and it provided us with crop yield information of 165 countries. It had 156 features, out of which we selected only 63 features. They were the projected change in yield for three different crops, rice, wheat, and maize, for years 2020, 2050, and 2080, across the seven different scenarios that we saw in the previous section. Hence, for each scenario and year, we had a three dimensional dataset which was easier to visualize. The data were pre-processed using pandas. Missing values were replaced with zeros so as to give a null change in the yield for that particular entry. We then created a triplet dataset containing the information about the three crops, which was then mapped to RDDs using pySpark.

3.1 Clustering Methods

We utilized two different types of clustering methods to see the some patterns in the data, which are as described below.

3.1.1 k-Means

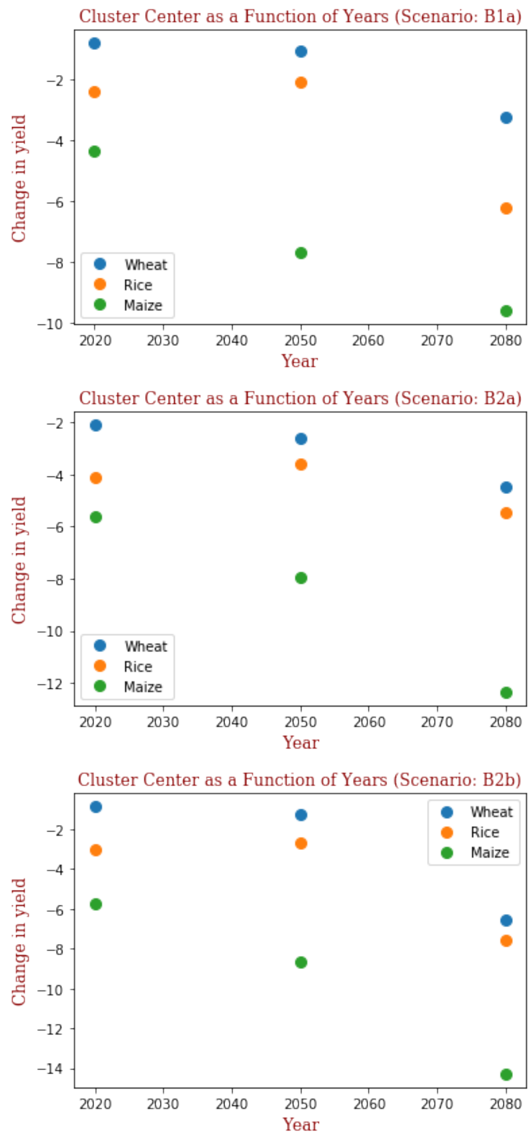

Figure 2: Change in the cluster centers of the crops for three typical scenarios using k-Means

k-Means is a general clustering method which tries to identify spherical cluster in any dimension. We used the elbow method to identify the optimal number of clusters and clustered the countries for each year and scenario and then plotted the cluster centers of the clusters against the years for each scenario.

3.1.2 DBSCAN

We varied the the parameters of the DBSCAN method, *min_pts* and *epsilon* and plotted the heatmaps of number of cluster and percentage of countries clusters to identify the optimal number of clusters. Then we clustered the countries similar to what we did using k-Means and observed how the cluster numbers change over the years.

4. RESULTS

After clustering using the two methods, we looked at the countries in the cluster with largest number of countries and compared them across years for each scenario separately. A general trend of decreasing yield change is observed with the years in almost all the scenarios as shown in Figure 2. Even though we looked at only a single cluster, the greatest yield change is seen in the A1FI scenario as is reported in [3]. Using DBSCAN, we observed that the optimal number of clusters increase over the years for most of the scenarios 3 which is a sign of increasing deterioration of cultivable land and countries showing the same kind of yield moving away from each other.

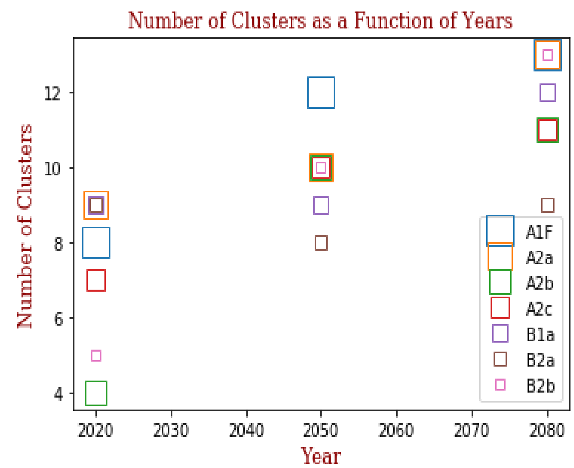

Figure 3: Change in the number of clusters over the years using DBSCAN.

5. REFERENCES

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