Refining Climatic Data in the P3 Switchgrass Co-firing Logistics Decision-making Tool

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UGREAT Research Area

The focus of this study lies in sustainable energy solutions. Particularly, the integration of biomass supply chains into existing infrastructure.

Motivation

Recently, the EPA raised standards for Greenhouse gas emission for pre-existing power plants. As a result, coal-firing power plants in Texas must reduce their emissions[1]. One potential solution is biomass co-firing. To determine the practicality of co-firing for a particular plant, an optimization model was developed. The model accounts for soil composition of nearby land, local climate, investment costs, and transportation costs. Climate data were sourced from ALMANAC, which uses predictive algorithms to assess weather conditions. To ensure that these data points were not skewing run outcomes, historical data was gathered and integrated into the optimization model.

Objectives

The goal of this study is to insure that accuracy of weather data utilized by the optimization model.

Methodology

Historical weather data was taken from NOAA databases, which was in turn sourced from local weather stations. Two stations provided data for Atascosa county, while one was used for Wilson County. This information was linked to the ALMANAC runs and assessed.

The model is optimized in a hub and spoke set up. In this format, the power plant acts as the immovable hub, and the paths between farms and intermediate storage locations, termed depots, act as the spokes. The farms and depots themselves act as the rim of the hypothetical wheel, and are evaluated at all possible locations in the counties surrounding the power plant.

A hub and spoke model is used for the placement of parcels. There are 3 nodes: parcels, depots (intermediate storage and processing stations), and power plants.

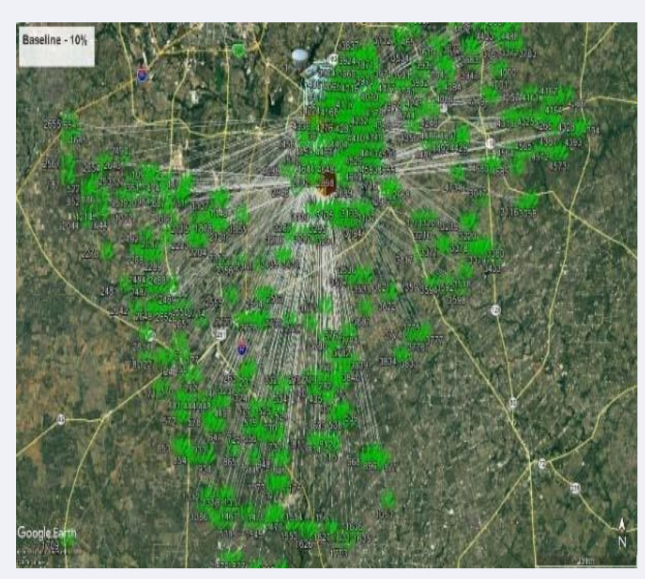

Figure 1: Output from a previous iteration of arable parcel assessment

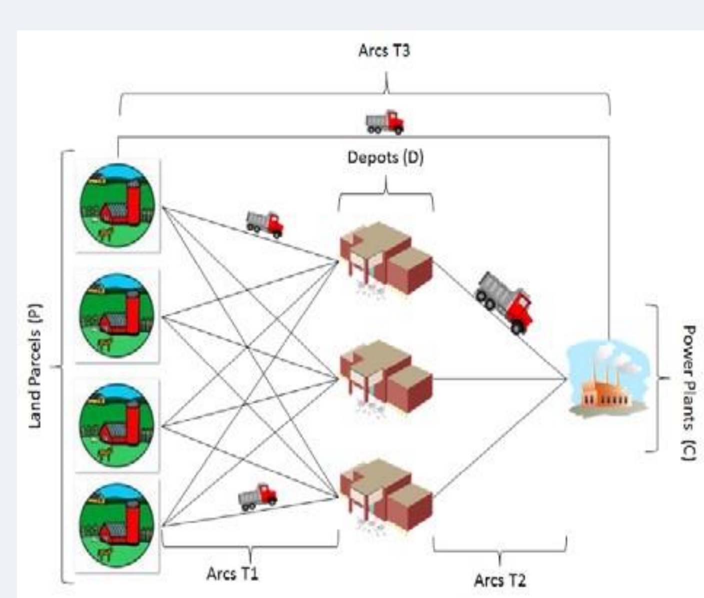

Figure 2: A visualization of the hub and spoke model

There were three essential Components to the optimization model:

1. *ALMANAC:* An agricultural analysis program used to estimate crop yield at each parcel.

2. *ArcGIS:* A python-based geoprocessing application used to geographically map the parcel crop yields.

3. *Optimization Model:* Utilizes Mixed Integer Linear programming to find the most cost effective solution.

Skills and Experience

- Use of ALMANAC in generating weather, soil type, and spatially sensitive crop yields
- Use of Mixed Integer Linear Programming Language like AMPL to utilize pivoting in reaching optimal solutions
- Use of geoprocessing software ARCMap to spatially map and relate datasets

Results

Runs using the historical weather data and ALAMANAC generated weather data were conducted. The predicted average yearly crop yields were compared to each other via a t-test with a 95% confidence interval. It was determined that the two populations were not statistically significant. This suggests that the ALAMANAC generated weather data is robust and reliable.

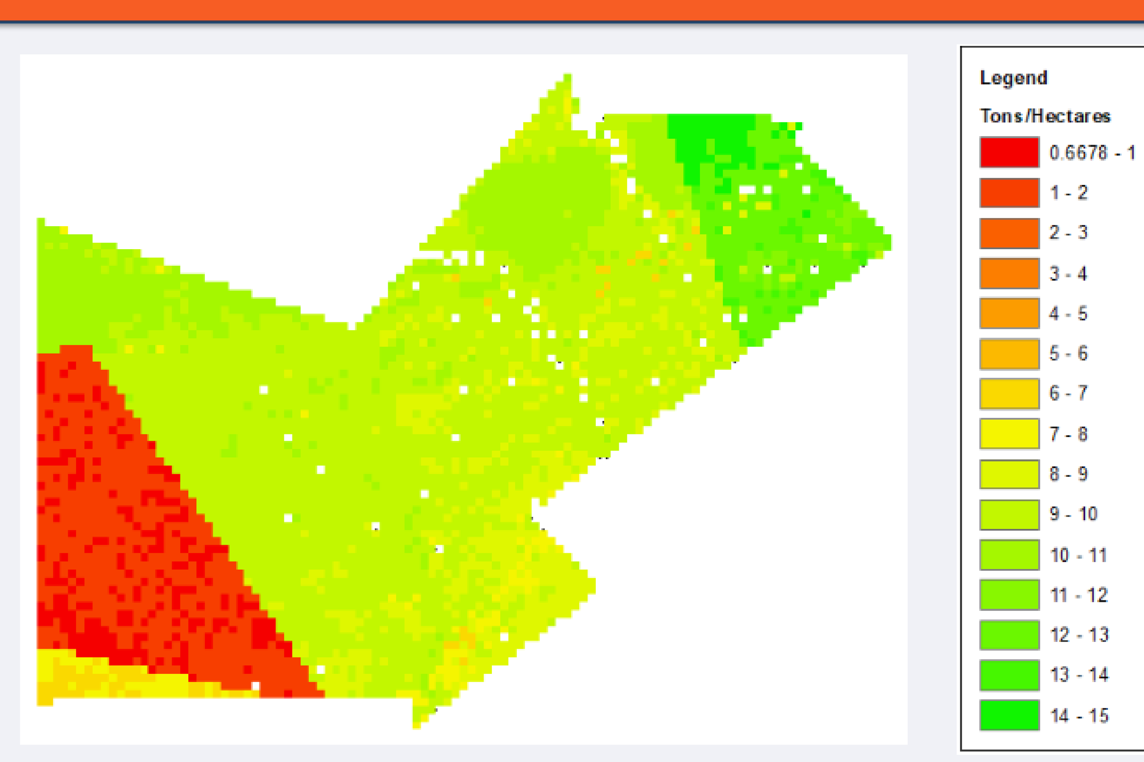

Figure 3: Average Yearly Crop Yield - Historical Data Run

Future Plans

To shed further light on the practicality of co-firing biomass to reduce carbon emission of power plants, more types biomass will be considered depending on location.

Acknowledgments

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References

[1] E. P. Agency, “Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units,” vol. 80, no. 205, 2015