Analysis of a Solution to EPA Sanctions Utilizing Historical Climatic Data to Assess Crop Yield Simulations

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Research

Run simulations and become familiarized with the programs **(ALMANAC)** from the US department of Agriculture and ArcGIS. Access and input fifty years of historical climatic data into **ALMANAC** to project the yields of switchgrass for Atascosa and Wilson counties. Determine if the greater San Antonio area is capable of sustaining a biomass co-firing operations at 10%-15%. Gain an understanding of optimization for a scenario where the cost of transporting switchgrass was minimized.

Fig 1 Bale of Switchgrass

Motivation

With **one third** of U.S electricity powered by coal[1], recent sanctions have been set down by the **Environmental Protection Agency** (EPA) in order to **reduce carbon emissions**. These sanctions have required power plants to pursue new methods of producing energy**. Biomass co-firing at 10%-15%** has shown to effectively reduce carbon emissions while maintaining a constant energy output. A San Antonio area case study was developed to determine the possibility of such a proposed plan. If the surrounding areas can support the amount of biomass required for a co-firing approach, then this carbon emission reduction method should be a top consideration for use.

Objectives

Climatic historical data was used to determine the average yearly yield of switch grass. Climatic data came from weather stations and was requested from **the National Climatic Data Center (NCDC).** Using fifty years worth of data from three weather stations**, ALMANAC** ran simulations for the counties of Atascosa and Wilson. Fifty years was needed to account for all natural cooling and warming processes such as La Nina, and El Nino. Furthermore soil types are to be considered. Such information was accessed through the Soil Survey Geographic database **(SSURGO)**

Methodology

Programs to become familiarized with:

Agricultural Land Management Alternative with Numerical Assessment Criteria *(ALMANAC)* – A Department of Agriculture program used to estimate switchgrass yearly yield.

ArcGIS – Graphical tool used for locating parcels crop yields and graphing of results

Understanding the usage of a **Hub-and-Spoke** model which consists of three sets of nodes. The first set represents the parcels, the second set regards the depots (storage), and the third represents the power plant. Fig. 2 is a simplified Hub-and-Spoke model[3]. The optimization model aims to locate harvesting locations and depots at optimal locations in order to minimize the overall supply chain cost.

Historical weather data was requested for the towns of Charlotte, Floresville, and Poteet from the **National Climatic Data Center (NCDC)**. The Data was requested in a .csv format in order to be compatible with the **ALMANAC** program. All Climatic data begins in 1950 and considers Minimum-Maximum temperatures and precipitations. Once entered into **ALMANAC** the simulations are run for all the possible planting locations and an output for yearly yields of switchgrass is obtained. Patches with in the data were covered using projected values using **ALMANAC** software. The effects of soil on switchgrass yield was a component to consider in the simulation. Soil data was accessed through **SSURGO**, where Wilson and Atascosa counties were determined to contain 45 different soil types over various coordinates throughout the counties.

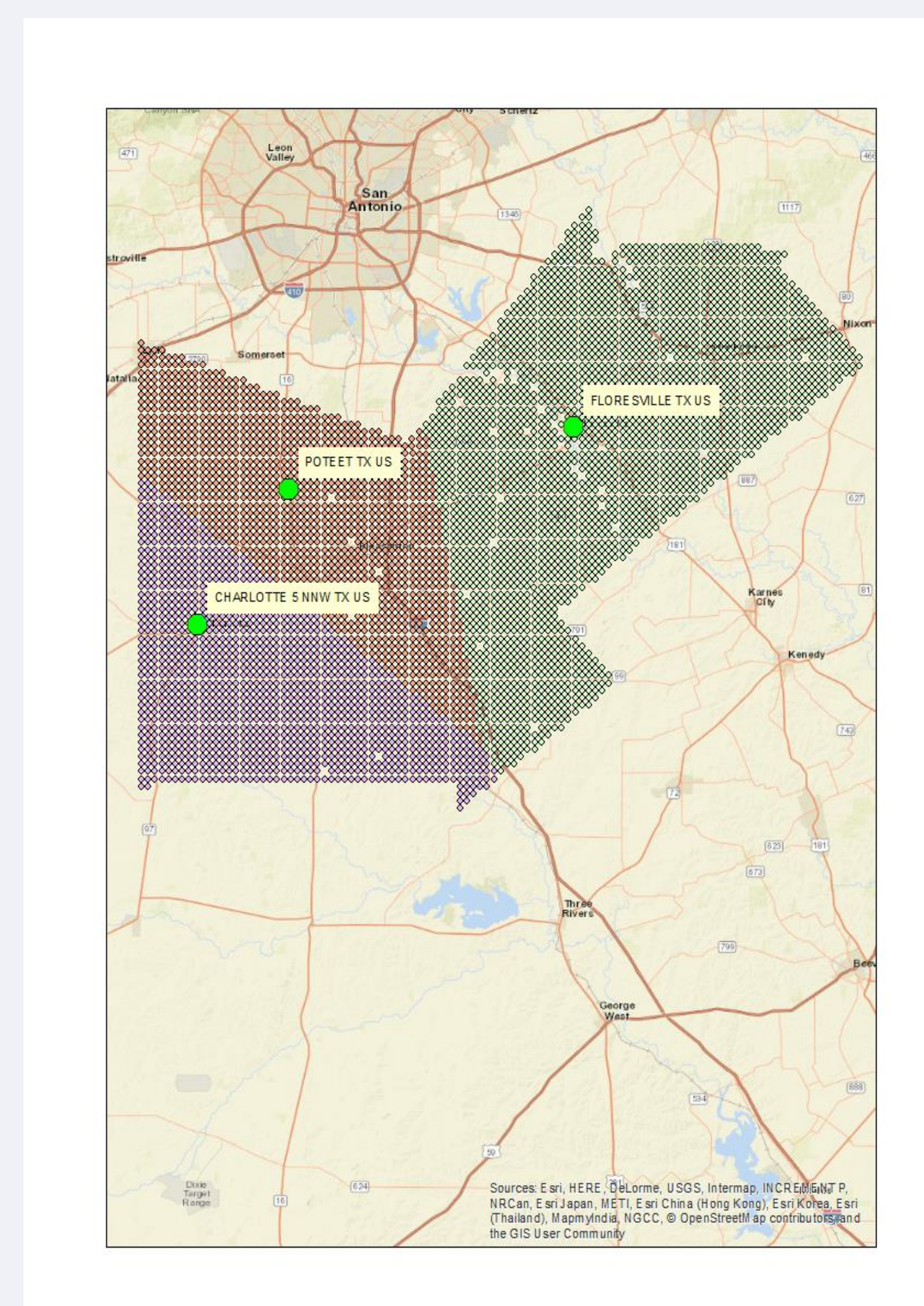

Fig 4 Map of Weather Stations in Atascosa and Wilson counties

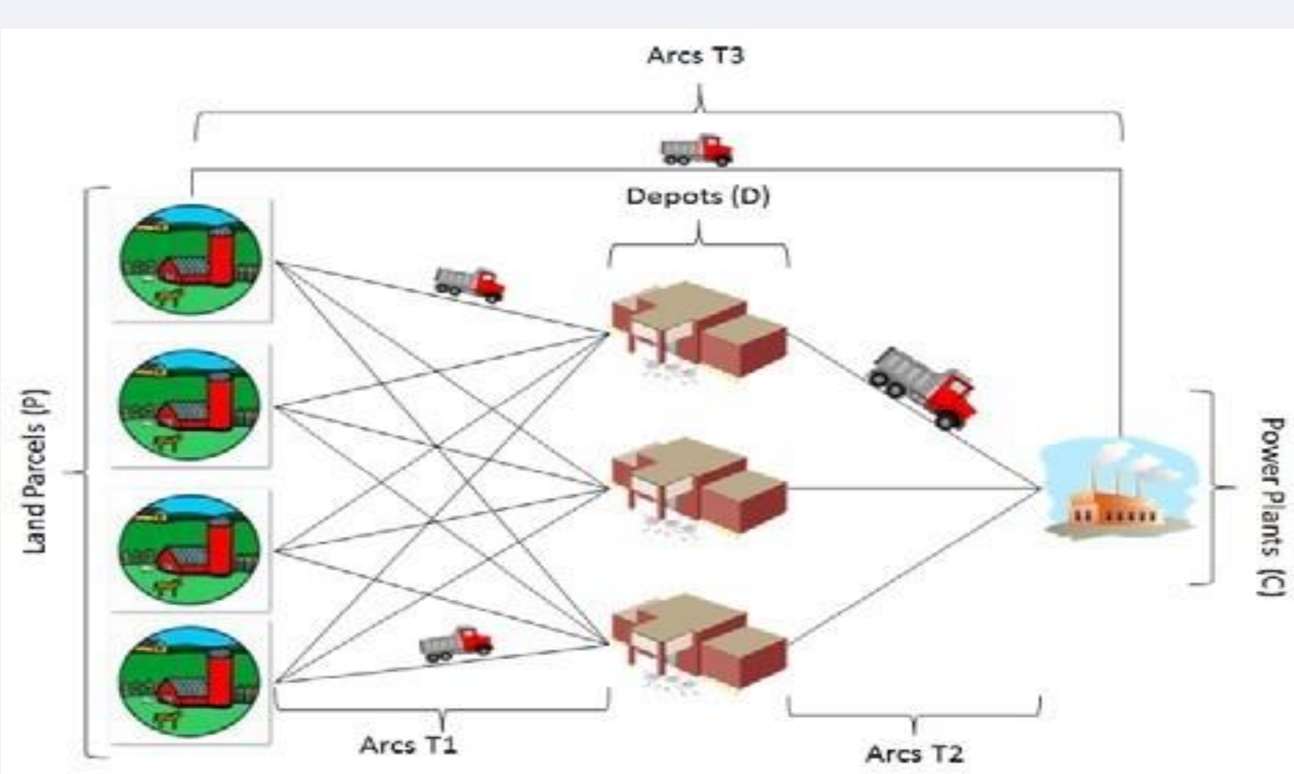

Fig 2 Simplified Hub-and-Spoke Visual Diagram

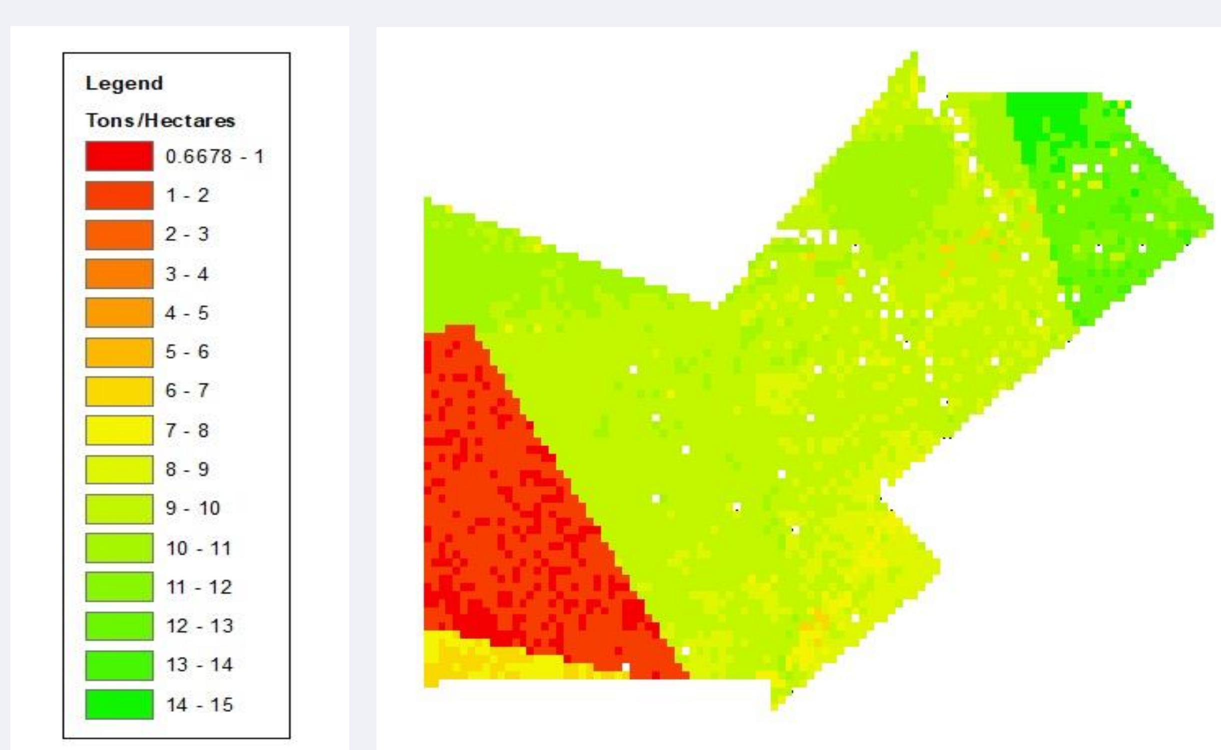

Fig 3 Output yield with Legend for ALMANAC simulation

Results

37 out of 45 soils types found in the region are able to produce **11.49 metric ton** of switchgrass per hectare yearly, the remaining eight soil types can produce **2.5 metric tons**[1]. This gives an average of **9.89 metric tons** per hectare over the forty-five soil types. Each parcel is one hundred hectares. A total of **4,810 parcels** over all coordinates was projected through the ALMANAC simulation.

San Antonio used **6.4 million tons** of coal in 2014 alone[2] and this number can only be expected to rise as the growth of populations continue to rise. A **10%-15%** co-firing rate would require (640,000 -960,000) metric tons of switchgrass to be burned. In Conclusion San Antonio and its surrounding area are adequately able to sustain a **10%-15% co-firing rate** with some switchgrass left over. A surplus of switchgrass can only be beneficial to the proposal where it can account for natural fires, bad crop years, or severe droughts where the availability of switch grass could decline.

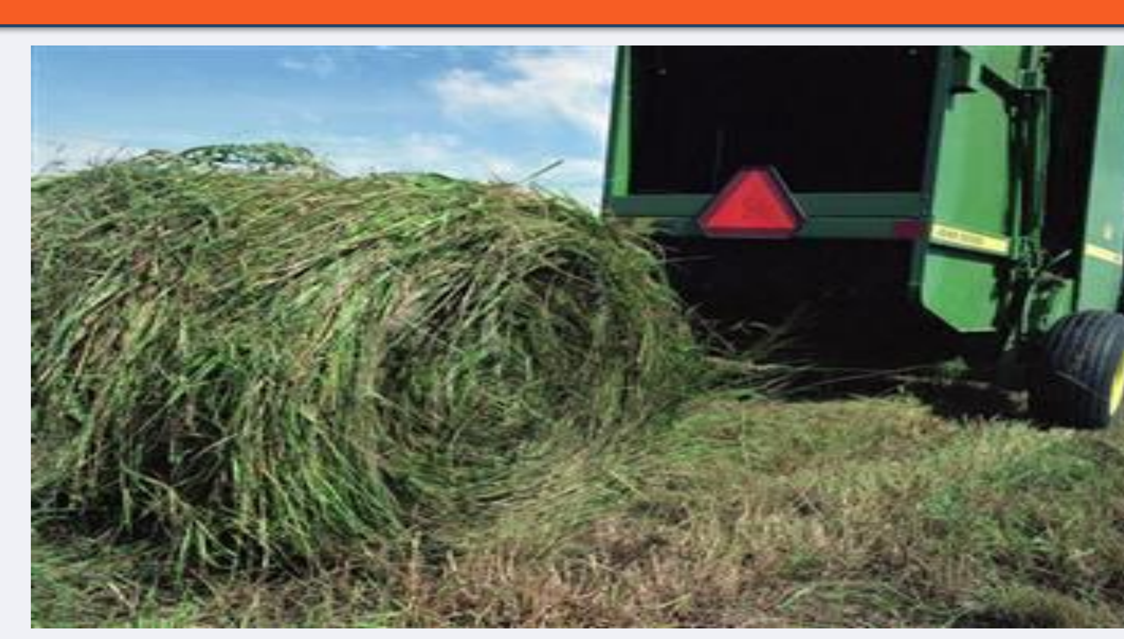

Fig 5 cultivation of switchgrass

Future Plans

Eleven out of the last twelve years ranking among the twelve warmest years since the instrumental recording of global surface temperatures[4]. The observed heating trend along with the population of Texas expected to double by 2060[3], can evidently portray the rising need for energy throughout Texas. EPA sanctions leave the enormous task of reducing carbon emissions from power plants while attempting to keep up with the rising demand for energy. Biomass Co-firing is a zero emitting technology that can be sustained in the San Antonio greater area and should be used immediately and continually be utilized for future generations until a better method is proposed or technological advancements form the practice to become obsolete.

Acknowledgments

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