Emission Reduction Using Switchgrass for Co-Firing in Atascosa and Wilson Counties Case Study

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BE AWARE Research Area

Due to recent EPA regulations, emissions must be reduced by 2030, therefore this research primarily focuses on the use of biomass used in power plants in order to reduce CO2 emissions by co-firing. Co-firing is the process of combusting coal with biomass simultaneously to produce the same amount of energy and reduce emissions. In this case, switchgrass was the primary biomass observed for Atascosa and Wilson counties. Optimization of the supply chain was assessed for providing practical logistics for co-firing.

Motivation or Background

Yearly CO_2 emissions can be reduced by 3 million tons by substituting 20% coal used by power plants with a biomass [1]. The Environmental Protection Agency has also defined "building block" regulations for power plants relating to pollution prevention [3]. Small percentages (<20%) of switchgrass can be co-fired with coal in existing power plants; this is why co-firing is a practical solution for power plants since it can provide an alternative without changing its current infrastructure. Switchgrass was selected as the observed biomass for its environmental benefits. When switchgrass grows, it absorbs the same amount of CO2 it released when combusted and unlike coal, it does not produce COX and CO when burned [3].

Objectives

The model aims to optimize the supply chain for co-firing coal power plants by selecting specific planting and depot locations.

1. Calculate the capability of the area to meet the demand of the power plant

2. Reduce the emissions of the power plant by co-firing with switchgrass

3. Maximize profit and minimize cost.

Methodology

USDA's Alternative Land Management Alternatives with Numerical Assessment Criteria modelling software (ALMANAC) was used for locating biomass supply for co-firing coal power plants and modeling supply chain networks by creating multiple scenario outputs using Batch Runs [2].

A Hub and spoke model (figure 2) consisting of parcels and its corresponding depot was used for optimizing the supply while minimizing the cost to create a competitive market. The model created uses 50 years (1950-2000) of weather data obtained from NCDC's NOAA and soil data obtained from SSURGO. 4,810 land parcels (possible planting locations) and 20 possible depots are considered to optimize shipping cost, investment, shortest possible shipping distance, biomass production cost, biomass yield, harvesting cost and transportation cost.

Fig. 1
Switchgrass

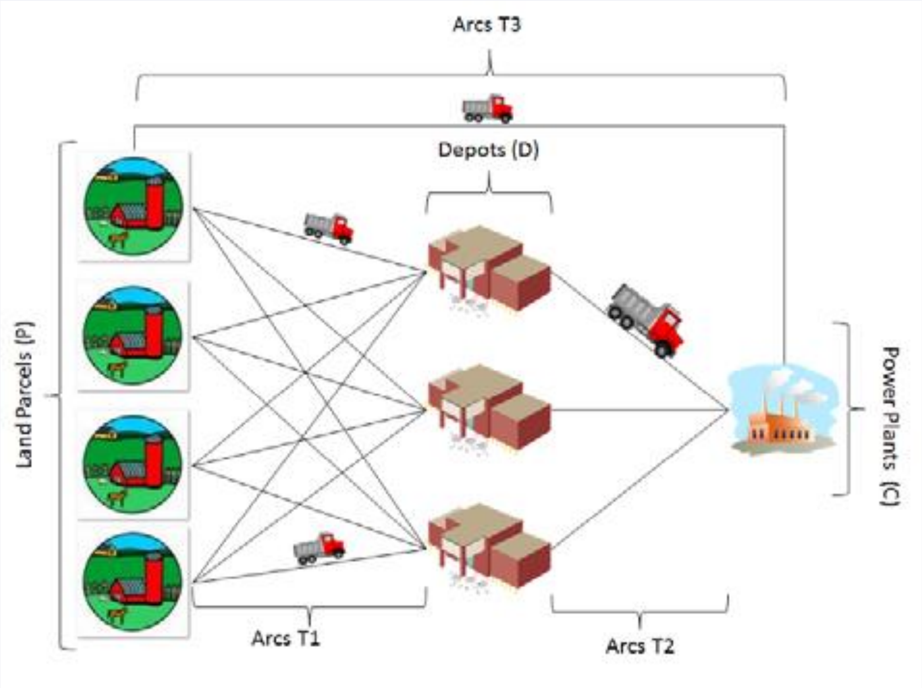

Fig. 2
Hub and Spoke model

Results

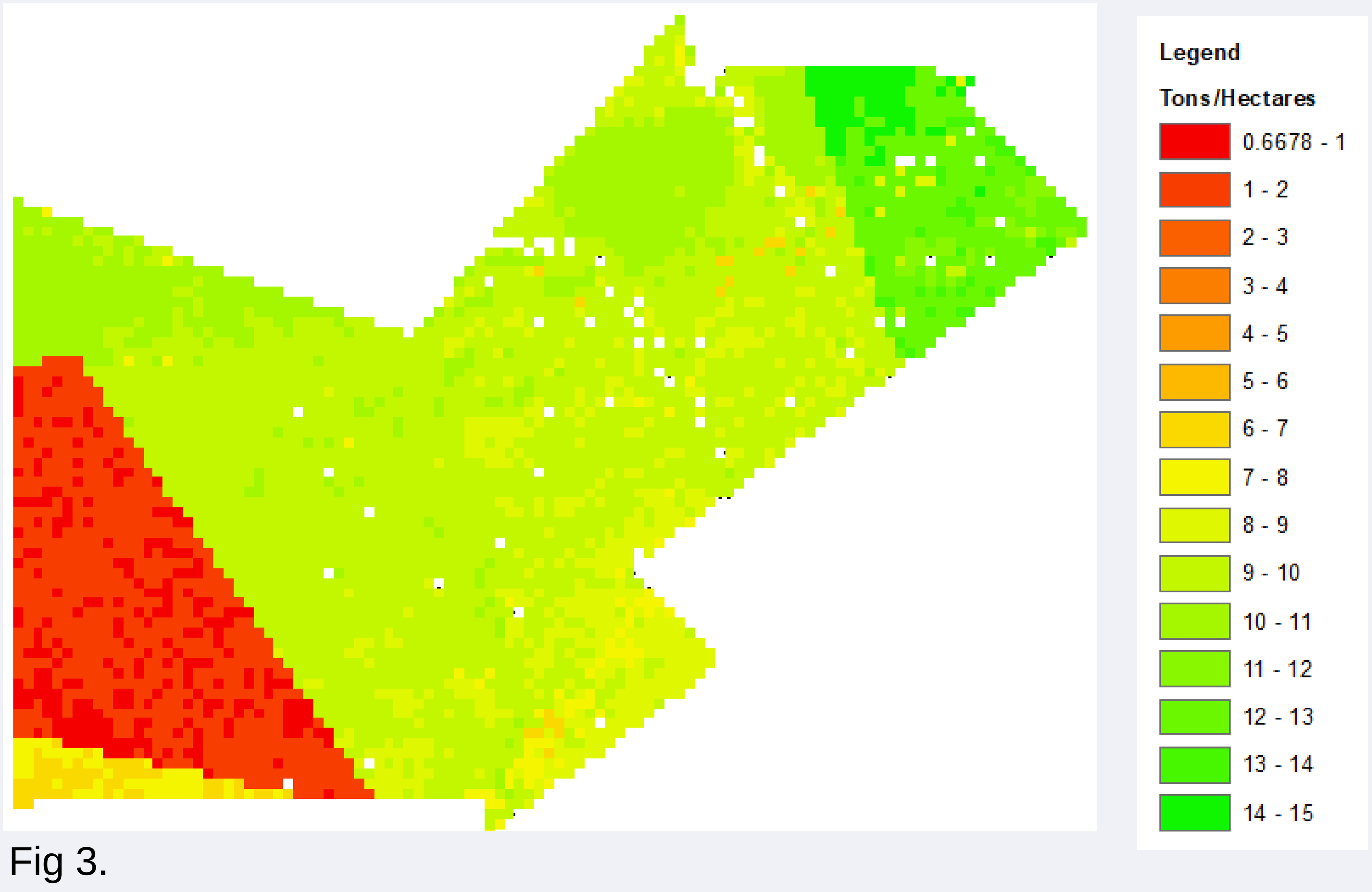

Fig 3.
ARCMAP result

ALMANAC was ran to produce the crop yield which was then converted for ARCMAP use. ARCMAP then generated the result shown in figure 3. This result represents the yield of switchgrass in both Atascosa and Wilson counties by tons per hectare. Compared to the P3 report [1], there seemed to be little difference in crop yield when using historical weather data.

Skills and Experience

- Conversion and use of Comma Separated Value files (wth, csv, txt, prn)
- Application of ALMANAC software
  - Obtaining data from databases
  - Running simulations for yearly crop yield
- Application of ArcMap
  - Converting data files
  - Mapping for spatial analysis

What I Learned

- Assessment of multiple objective optimization
  - Hub-and-spoke model
  - Mixed-integer linear programming
- Sufficiency of co-firing as an alternative process for CO2 reduction
- ALMANAC software and its possible applications specifically for crop yield
- ArcMap capabilities
- Manipulation of large data files and databases in Excel
- Use of SSURGO datasets in shapefile format for ArcMap

Future Plans

By providing sufficient data, including historical weather, this research will expand and have the capability run more accurate scenarios. The goal is to improve models to help decision makers with optimal minimization of cost in order to reduce greenhouse gases, which would expand to other areas. A web based tool that models the optimization is under development. The goal for this tool is to make it available for public use.

Acknowledgments

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References

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