Carbon Sequestration Feasibility Utilizing C4 Plants on Abandoned Mine Lands in West Virginia

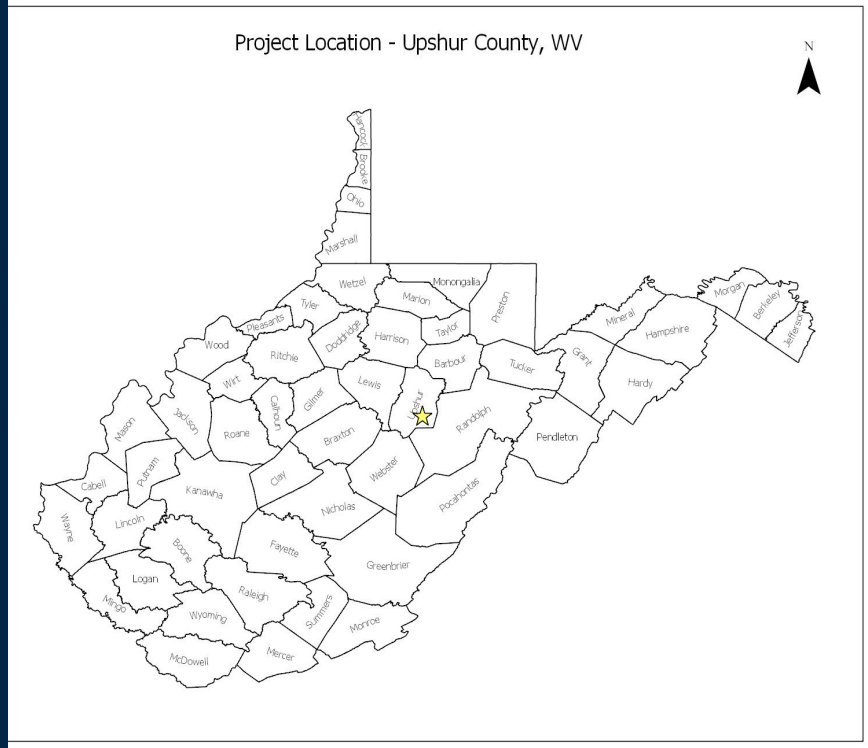
Jacob Morris

Geog - 654 Environmental GIS Modeling

WestVirginiaUniversity.

Study Objectives

- Examine carbon sequestration levels resulting from 10 years of C4 plant growth
- Determine the feasibility of utilizing reclaimed mine lands as an opportunity for greenhouse gas mitigation with a Landscape Suitability Analysis
- Determine Spatial Variability of SOC between Switchgrass and Miscanthus Pre- and Post Growing Season.



West Virginia Coal Mining

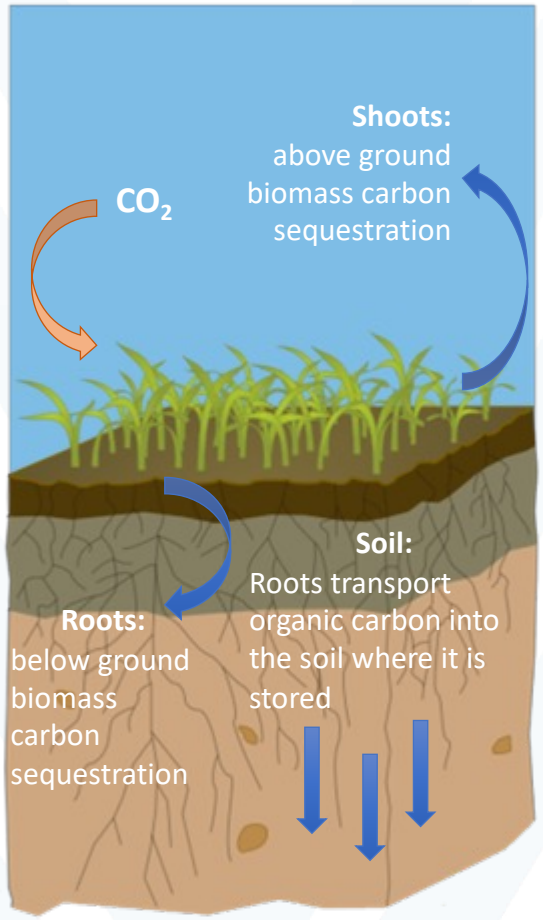
In West Virginia, the reclamation of Abandoned Mine Lands (AML) is an environmental and social Issue

Coal Mining has created over 200,000 acres of underutilized land

These mines can serve as large carbon sinks, absorbing atmospheric carbon

C4 Plants

- Unique carbon fixation pathway to ensure optimal carbon fixation
- Higher rates of photosynthesis and productivity
- Can grow and reproduce even on nitrogen-poor soils, and are particularly able to allocate biomass to roots



Switchgrass and Miscanthus

GROW WELL ON MARGINAL AND RECLAIMED SOILS WITH LITTLE FERTILIZER

TALL-GROWING PERENNIAL GRASSES WITH EXTENSIVE ROOTING SYSTEM

REDUCES THE AMOUNT OF TILLAGE AND FERTILIZING NEEDED AND HAS HIGH TOLERANCE TO ACIDITY.

Study Site

- Located in Alton West Virginia
- Former mine and bond forfeiture site called DLM
- Property consists of hundreds of acres of reclaimed mine lands
- In 2010, 20 plots were planted, this study focuses on 6 Switchgrass and 6 Miscanthus plots

Sampling Methods

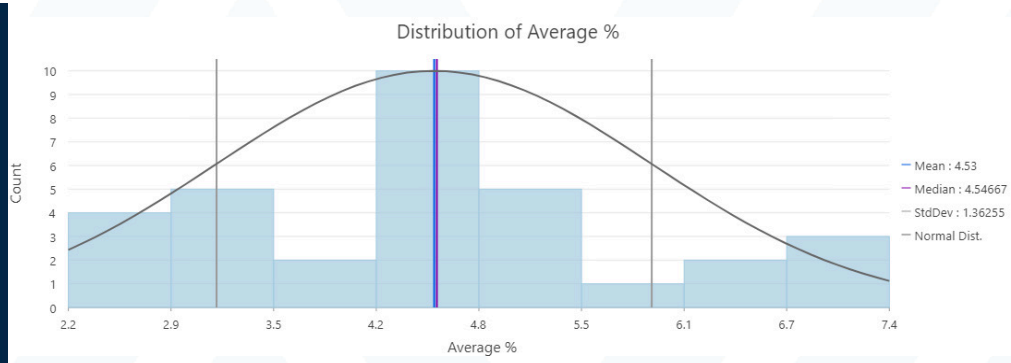
- Four soil Samples of 144 in^2 as well as two root samples were taken from each plot
- Samples analyzed using the Walkley Black, Loss on Ignition, and Combustion methods
- Analyze Total Organic Carbon and soil nutrient levels
- Samples taken at beginning and end of 2023 growing season

Data Preparation Methods

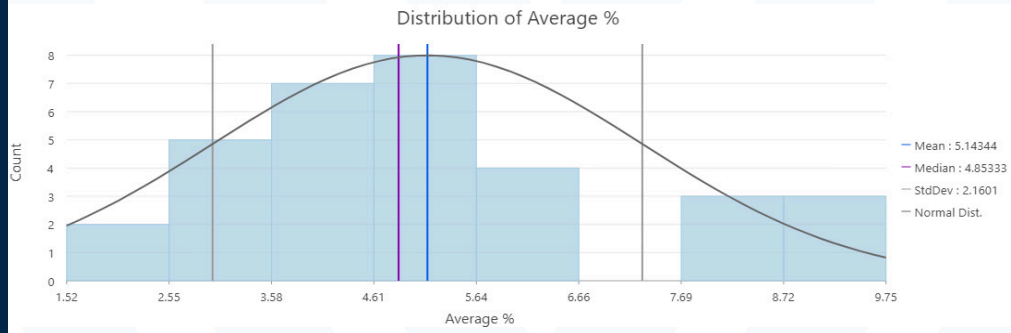
- Dataset was categorized into pre-and post-growing season data
- Biomass sampling was segregated from soil carbon sampling data
- Data was organized and uploaded to visualize x and y location features.
- Data was differentiated between Miscanthus and Switchgrass

Kriging Spatial Correlation Analysis

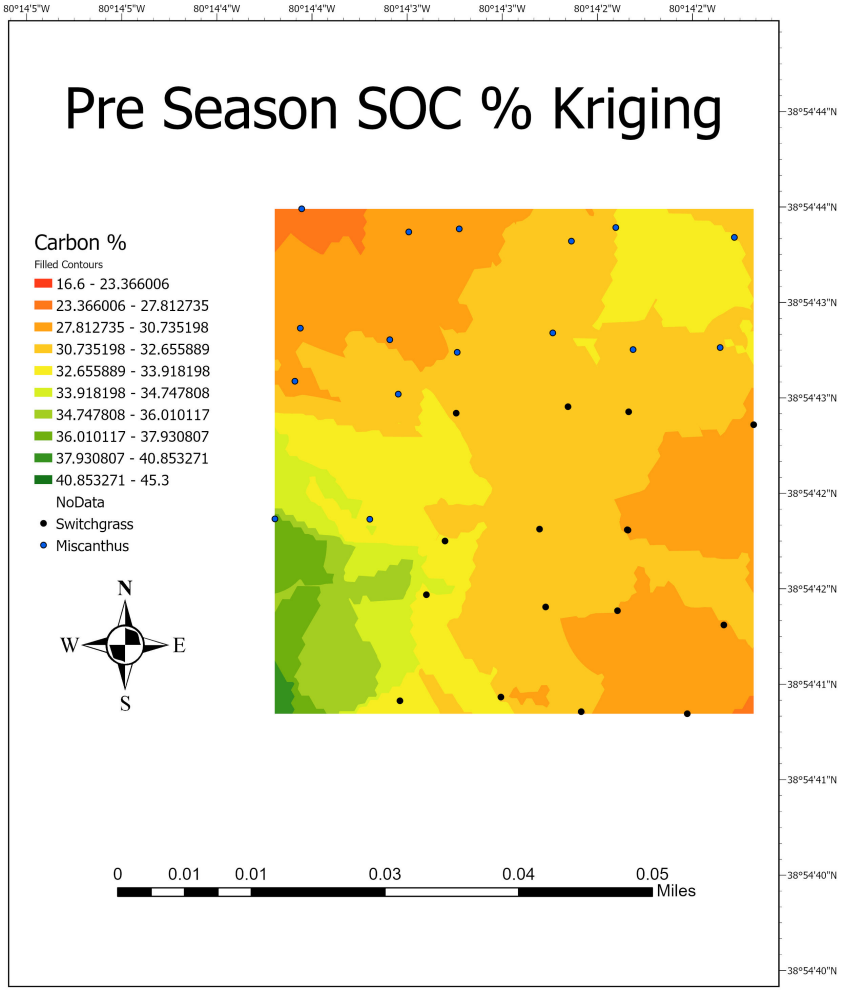
- Histograms were generated to illustrate the data's adherence to the bell curve
- Kriging analyses were performed on both pre-and post-growing season biomass data and soil carbon data. Outliers within the dataset were identified.
- outcomes were integrated into a SOC surface, illustrating the spatial distribution of SOC

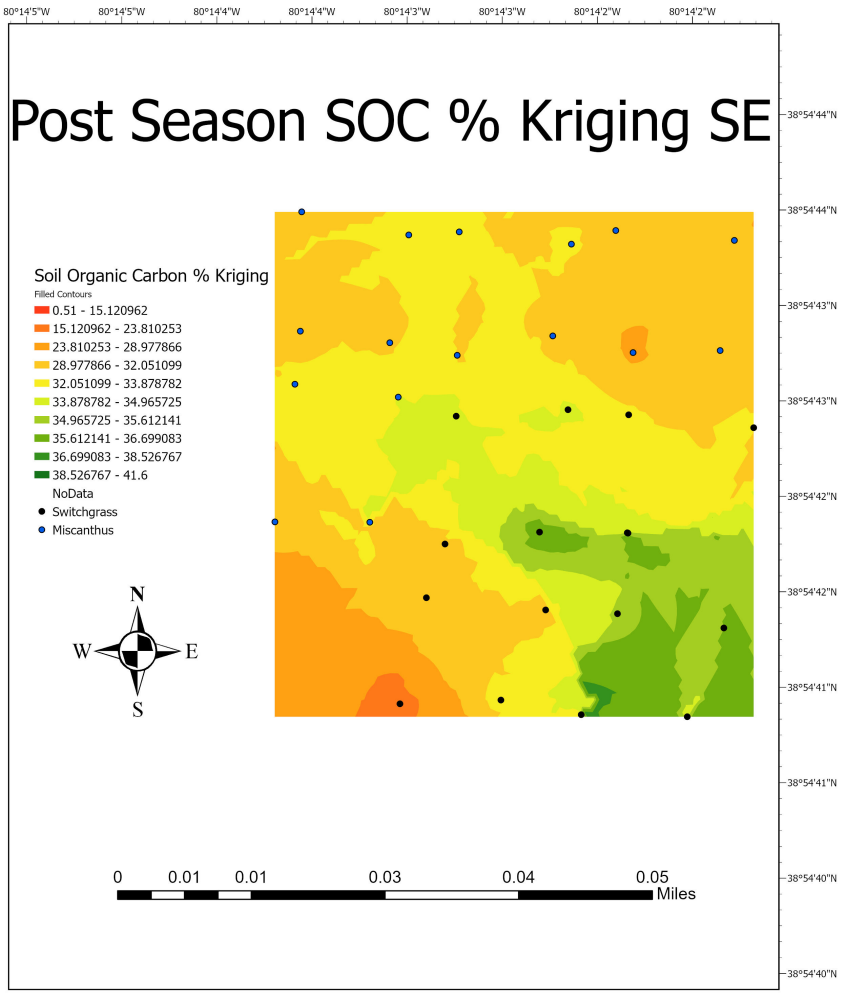


Pre – Season

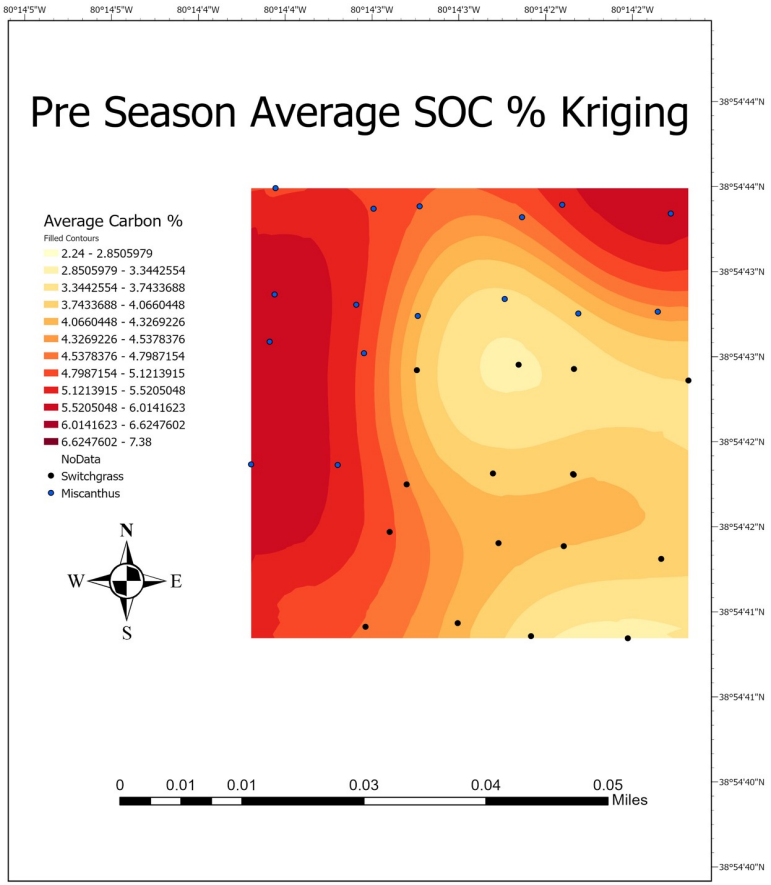


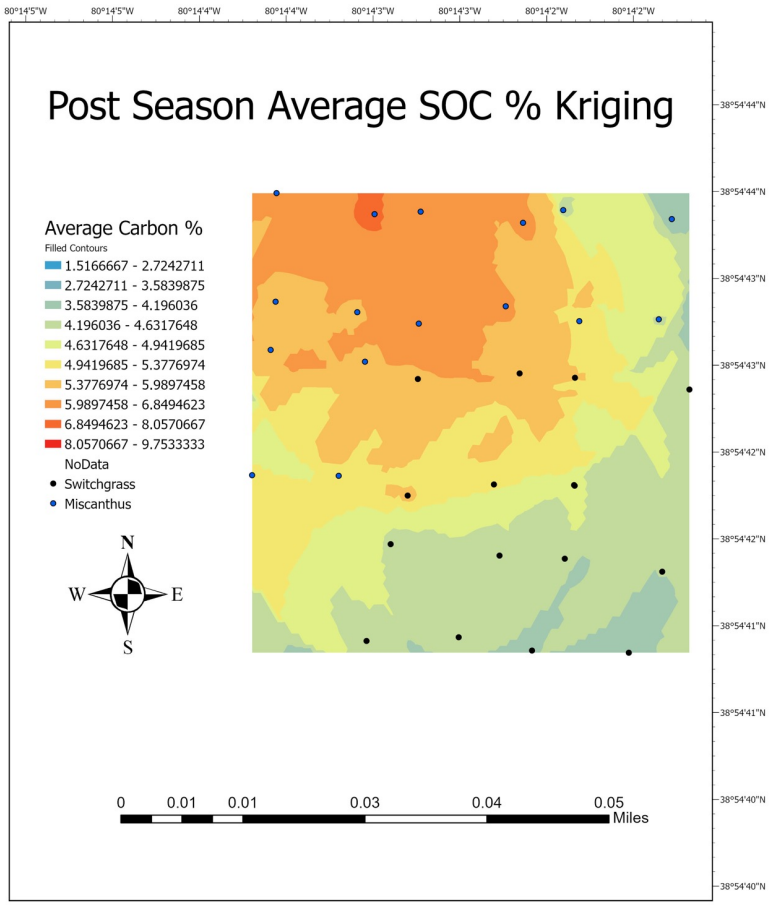
Post - Season



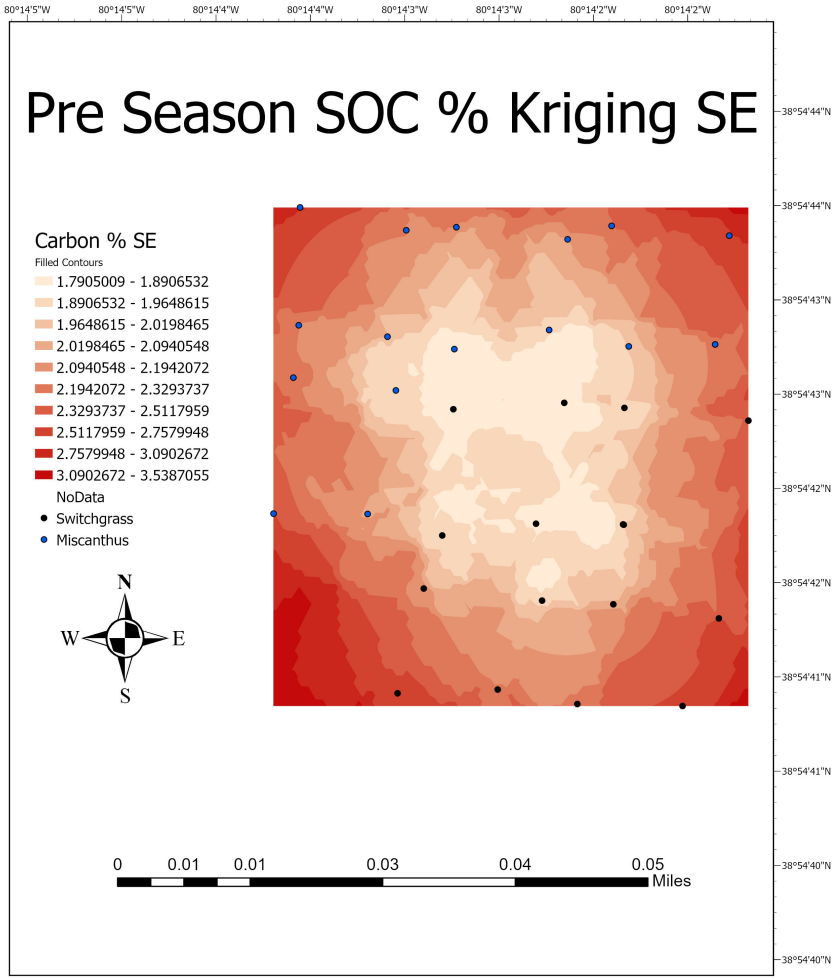


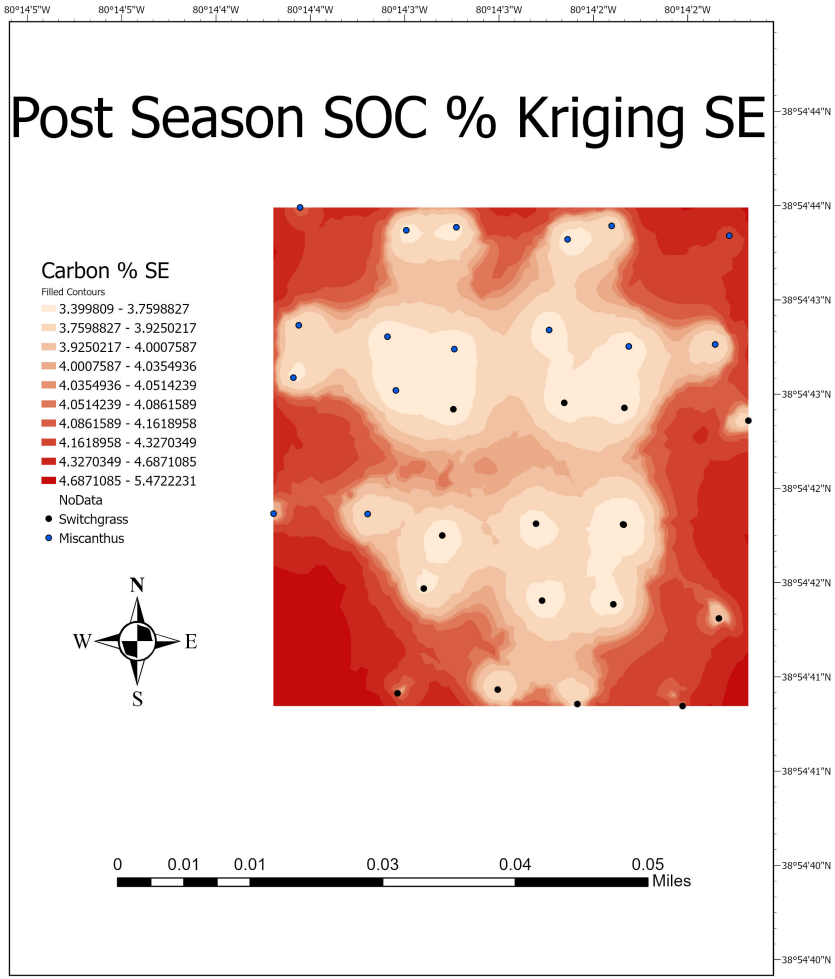
Kriging Spatial Correlation Analysis Biomass Data





Kriging Spatial Correlation Analysis Soil Carbon Data



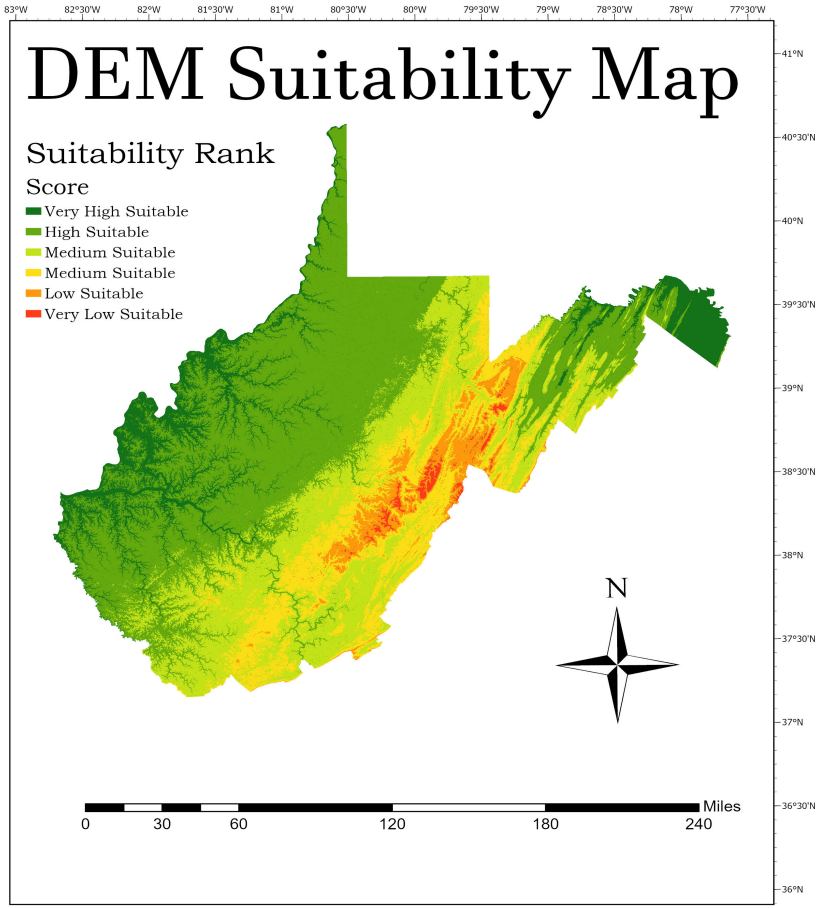


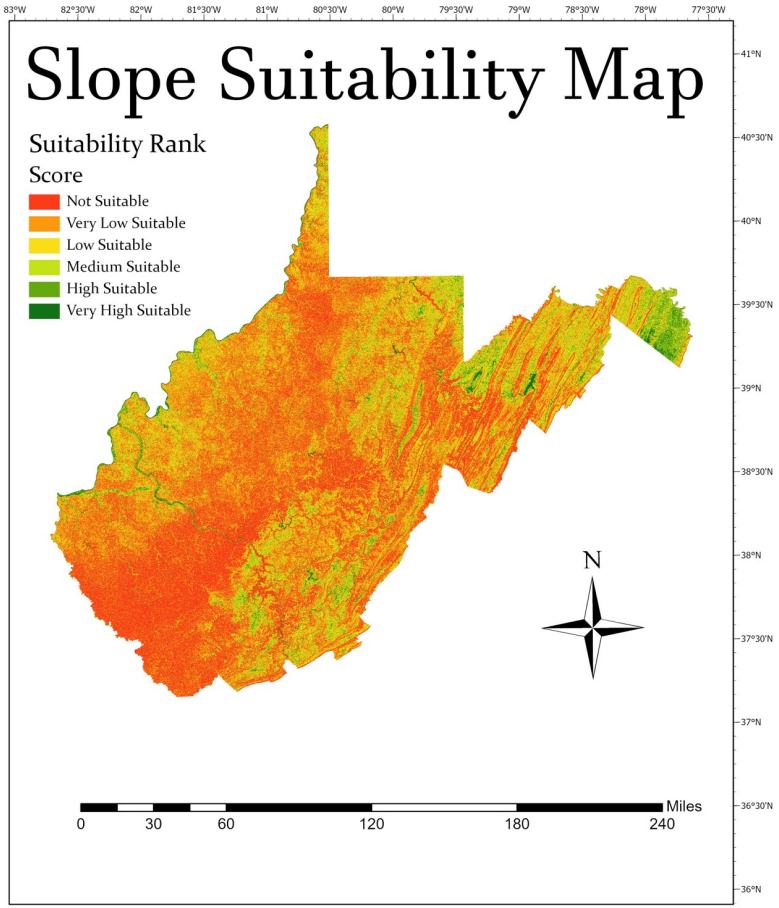
Kriging Standardized Error Analysis

Landscape Suitability Analysis

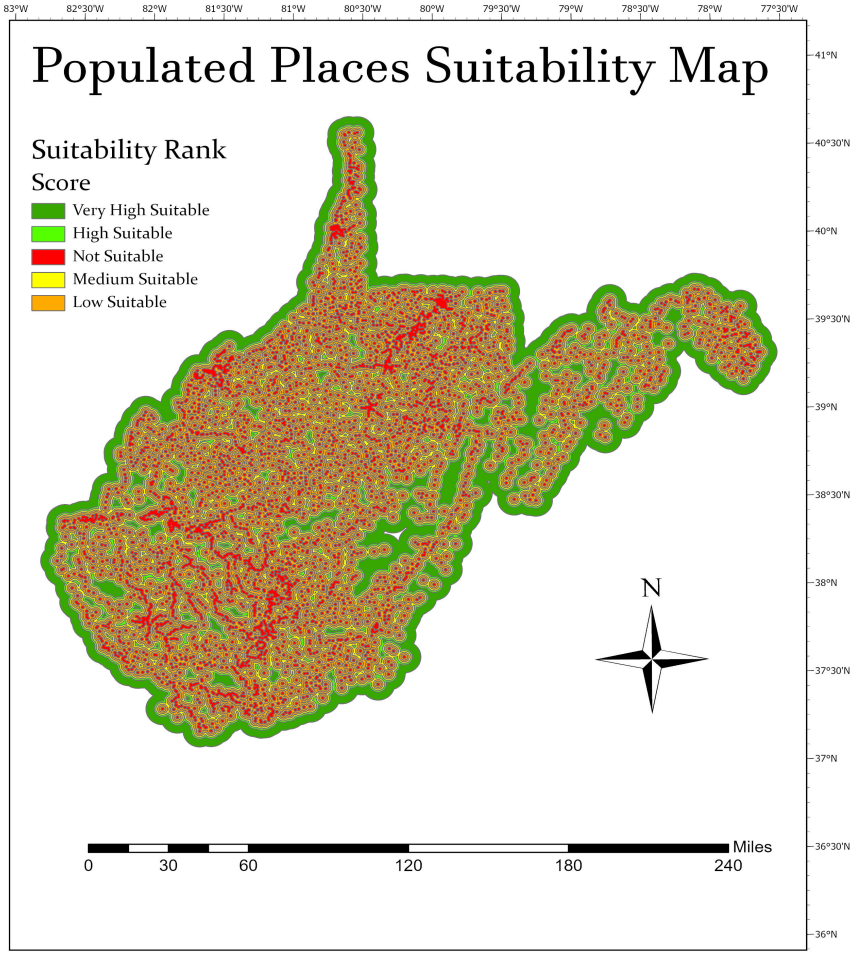
- 3 categories were included in the LSA, climate criteria, Geography Criteria, and other criteria
- Climate Criteria: Minimum temperature, measured from -5° to -10°, received scores from 5 to 3. Precipitation, ranging from 300mm to 900mm, had scores of 1 to 5
- Geography Criteria: Slope scored 5 for a 3-degree flat slope to 0 for extremely steep, Elevation scores ranged from 5 at 200m to 1 at 1400-1600m.
- Other Criteria: Distance to roads and populated places, with a 50m and 100m restricted zone respectively, increased in weight closer to roads and decreased with distance

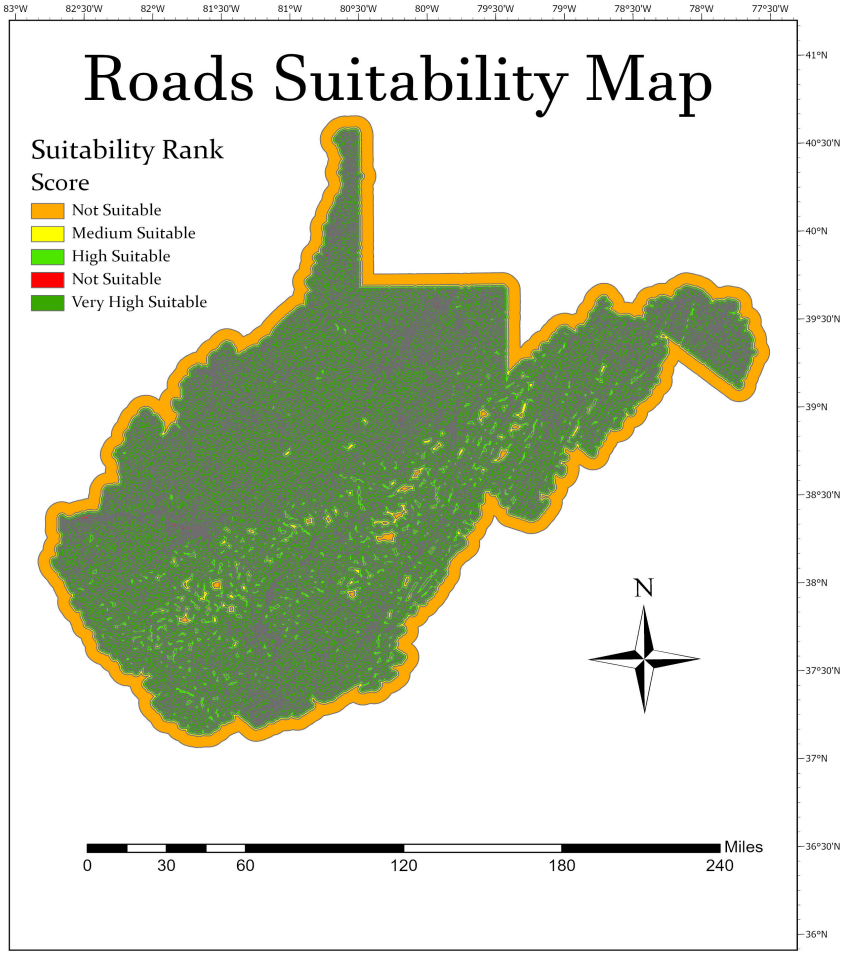
Geography Criteria



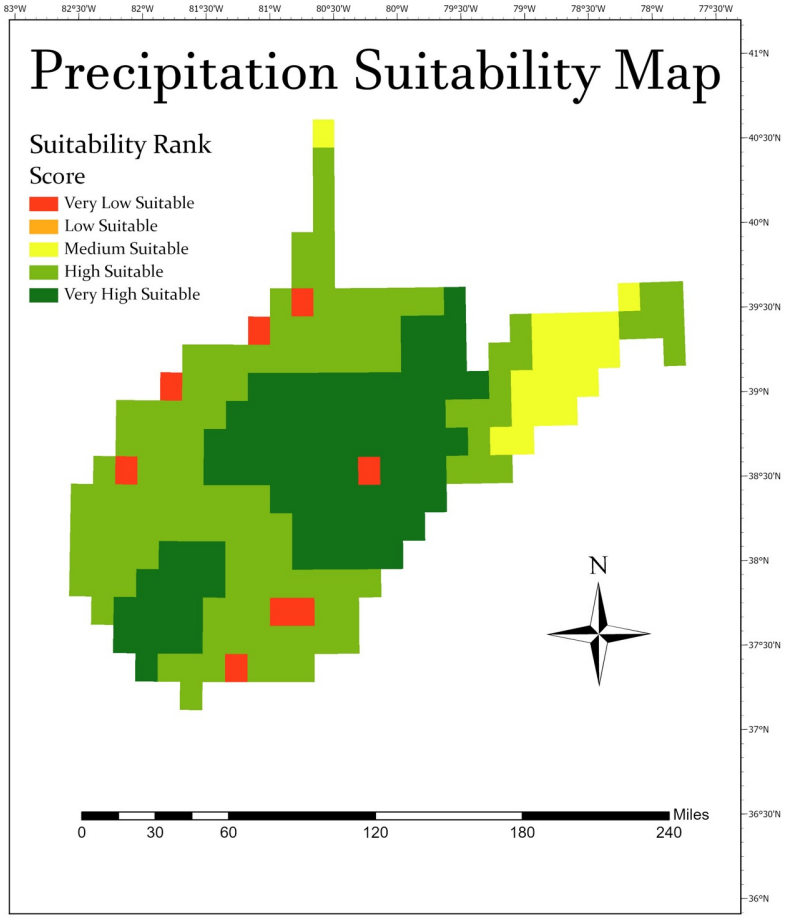


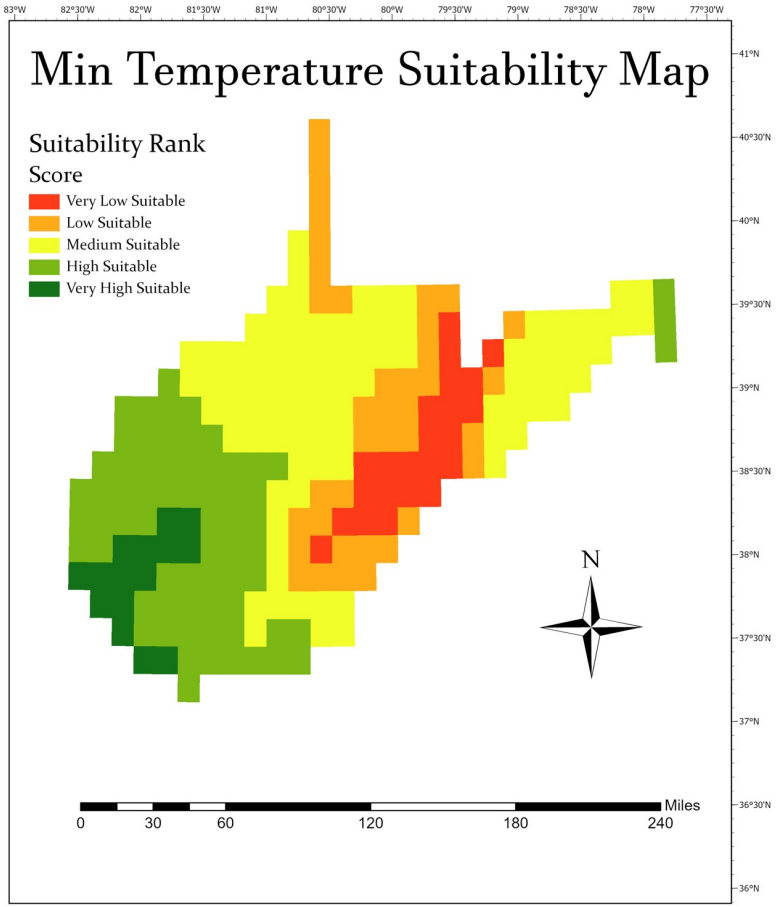
Distance Criteria





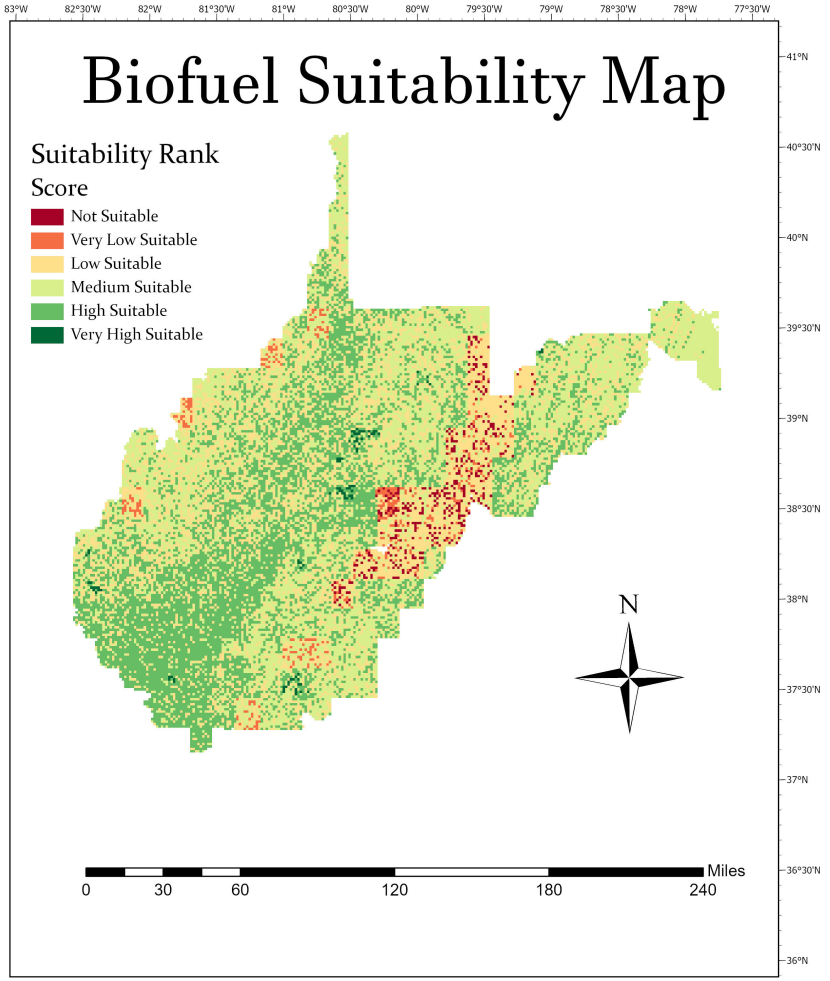
Climate Criteria





Weighted Overlay Analysis

- Assigned weights to each variable based on its importance
- Overlays individual layers, multiplying suitability rankings by assigned weights.
- Utilize the results to guide the transformation of mine lands into sustainable areas for carbon sequestration



Conclusion

- In conclusion, the results of the exploratory spatial analysis shed light on the spatial autocorrelation of Soil Organic Carbon (SOC), revealing distinct patterns in pre- and post-season carbon distribution. The observed adherence of post-season carbon percentages to a bell curve suggests potential changes in SOC distribution during the growing season, likely influenced by the dynamic processes associated with plant growth and microbial activity, particularly in C4 plants like switchgrass and miscanthus. The observed spatial autocorrelation aligns with Tobler's First Law of Geography, emphasizing the proximity of related features. The Landscape Suitability Analysis (LSA) further complements these findings, emphasizing the influence of minimum temperature and elevation on biomass suitability in West Virginia. The study highlights the potential of mine land reclamation for bioenergy crop cultivation, providing insights for sustainable energy production, reduced environmental impact, and informed land management decisions. The integration of spatial analysis techniques contributes to an understanding of carbon dynamics, crucial for the state's long-term energy viability and environmental stewardship.

Impacts

- Provides post mining opportunities for West Virginia
- Transforms a former mine into a mitigation site.
- Creates innovative carbon-reduction solutions, including the offset and sequestration of carbon , as well as crediting and Biomass production

Future Objectives

- Identify Mine lands including abandoned and reclaimed lands to potentially scale up the study
- Determine the acreage of all the mine lands and their suitability rankings
- Extrapolate results from study to all mine lands In West Virginia to determine different carbon sequestration potentials with different suitability rankings