Land Value Impact of Woody Encroachment in Kansas

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Background

- Over the past century, there has been a consistent, directional shift towards greater woody plant cover
- Woody encroachment is not limited to non-native species, but also native species that have expanded due to environmental changes
- The Central Great Plains exhibit woody encroachment at rates that are 5 to 7 times higher than ecoregions outside this area
- In United States' grasslands, the humid region provides great climate for trees to proliferate.

(Archer et al., 2017) & (Barger et al., 2011)

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Great Plains Grassland Initiative

- Launched by NRCS in 2021
- Goal of reducing woody encroachment in select grassland regions of the state.
- Landowners within these core regions are eligible for financial incentives and technical support to monitor and mitigate woody encroachment

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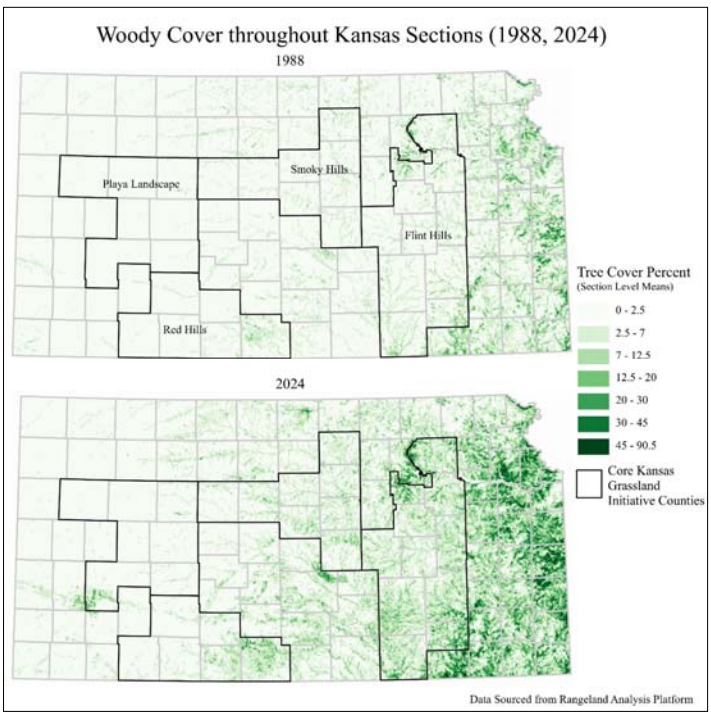

- Data is obtained from USDA's Rangeland Analysis Platform.
- Gives yearly tree cover at a 30-meter x 30-meter grid at a value of 0-100.
- Averaged those grids across each Kansas sections.
- Outlined counties are within the core KGPGI funding areas.

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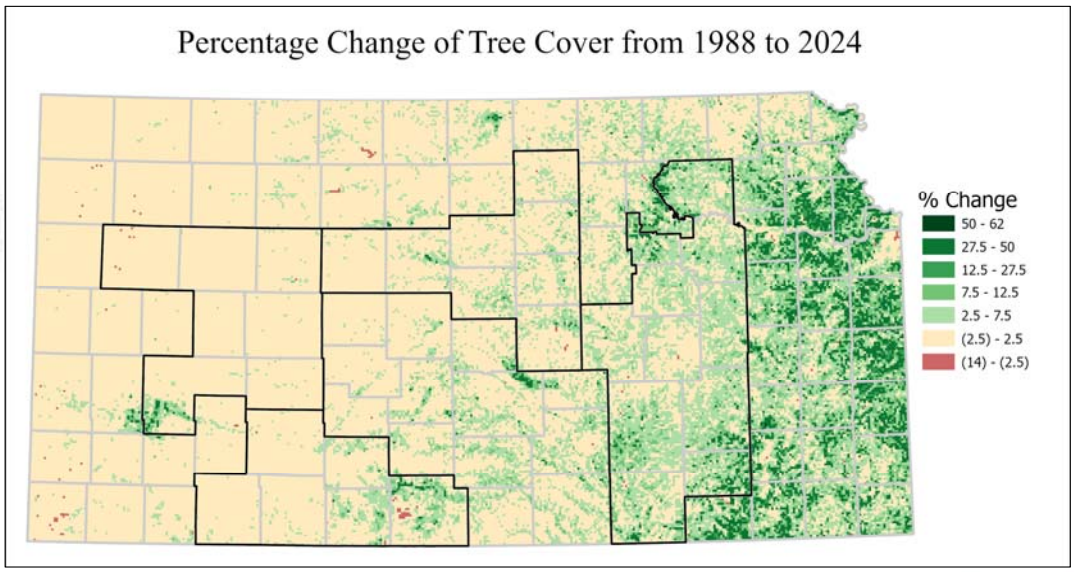

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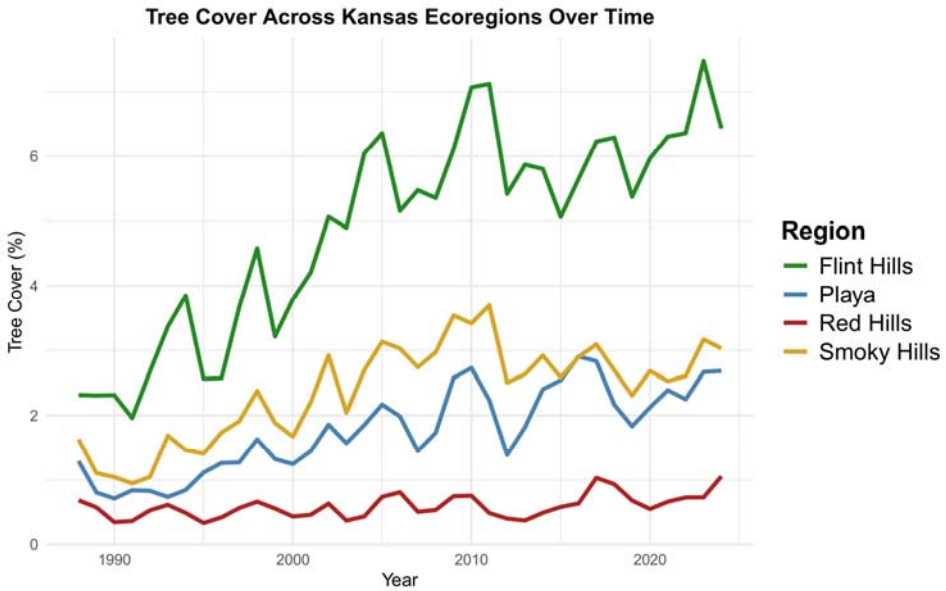

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Two Sides of Woody Cover

Positives

- Aesthetic improvements
  - Increasing shade, more appealing visually, leading to "better" areas to live.
- Shelter belts
  - Reduces wind erosion, noise reduction, etc.
- Hunting
  - Tree cover provides better habitats for big game animal such as whitetail deer
  - Hunting leases from individuals and outfitters

Negatives

- Impacts ecology
  - Reduces plant life diversity
- Decreases forage productivity
- Changes pre-existing wildlife habitats
  - With a changing ecosystems, wildlife habitats can be destroyed or hindered.
- Water consumption
- Larger wildfire risks

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Research Question

- What is producer's perception on woody encroachment and its impact on farmland values?
- How does woody encroachment, particularly tree cover, impact Kansas farmland values?
- How does the impact of tree cover vary across the study area?

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Survey

- Survey sent out to Kansas landowners in the core Kansas Grassland Initiative counties.
- Survey provides landowner level thoughts on woody encroachment and the impact it has in their area.
- While transaction-level data tells us what is happening, survey data reveals landowner perceptions of why it's happening.

Funded by NRCS project titled "Using vulnerability analysis to guide woody plant control outreach efforts in support of maintaining and improving NRCS's Kansas Great Plains Grassland Initiative-identified core grasslands in Kansas"

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

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Sample

- Kansas landowners
  - Operating within the KGPGI Core Area counties
  - Around 650 respondents
  - Across over 65 Kansas counties
  - Representation of the four different ecoregions that exist within the core area

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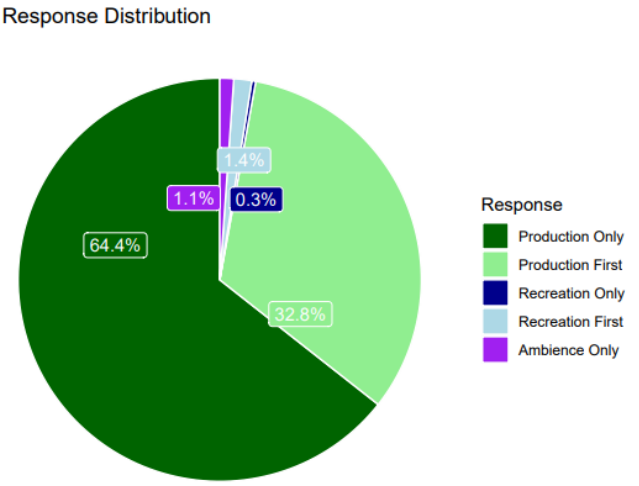
3. Which of the following most closely aligns with your purpose for owning land in Kansas? [select 1]
   - ☐ Agricultural production is my only purpose.
   - ☐ Agricultural production is the primary purpose, with recreational (e.g., hunting) access a secondary benefit.
   - ☐ Recreation (e.g., hunting) is my only purpose.
   - ☐ Recreation (e.g., hunting) is the primary purpose, with agricultural income as a secondary benefit.
   - ☐ Ambience/beauty of living in the country is my only purpose.



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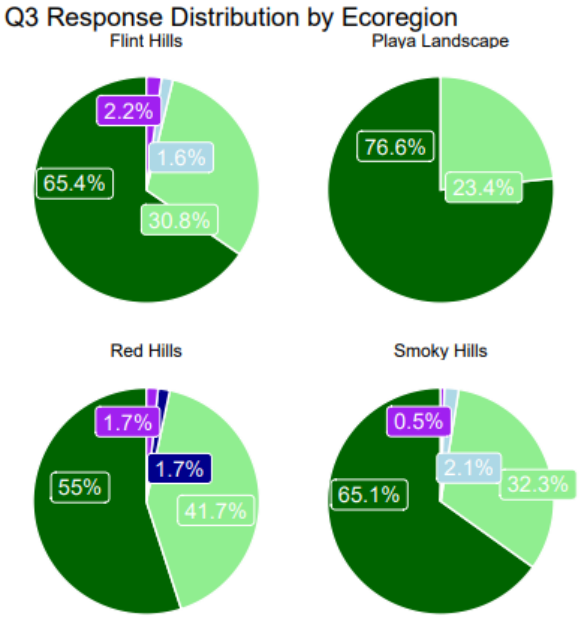

Ecoregion	# of Responses
Flint Hills	185
Playa Landscape	77
Red Hills	60
Smoky Hills	195

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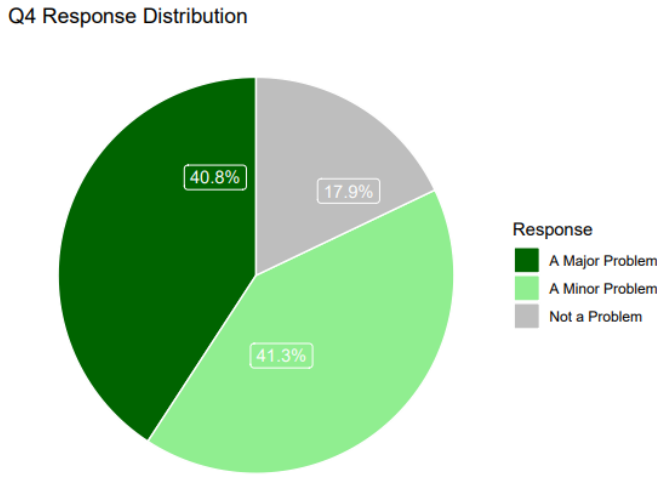
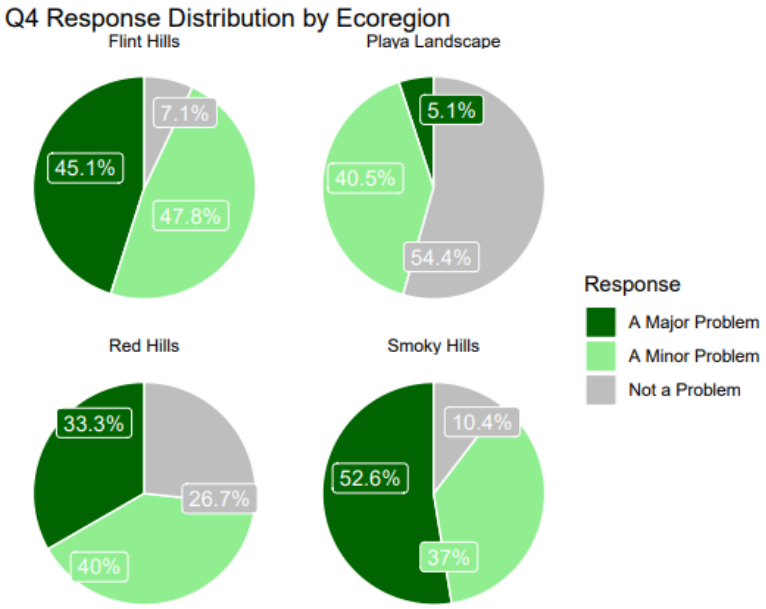
4. How would you rate the severity of tree/brush encroachment in pastures around your operation? [select 1]

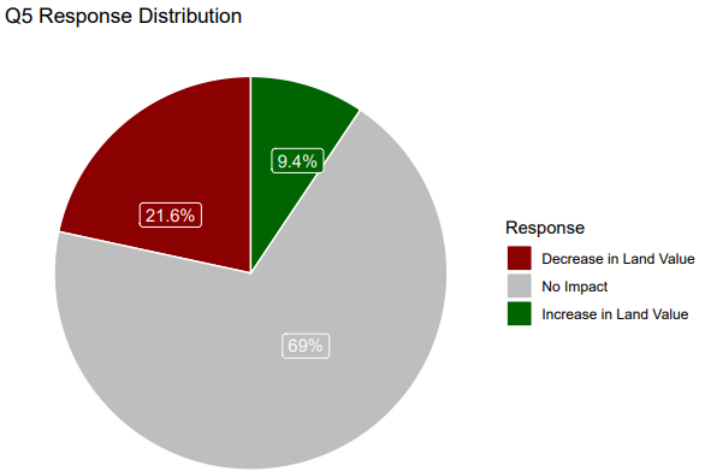
- ☐ A major problem
- ☐ A minor problem
- ☐ Not a problem





Ecoregion	# of Responses
Flint Hills	184
Playa Landscape	79
Red Hills	60
Smoky Hills	192

5. Have you experienced/observed any impacts to land values or rental rates for pasture due to tree/brush encroachment? [select 1]
   - ☐ Yes. Decreases in land values or rental rates due to tree/brush encroachment.
   - ☐ I have not experienced/observed any impacts.
   - ☐ Yes. Increases in land values or rental rates due to tree/brush encroachment.



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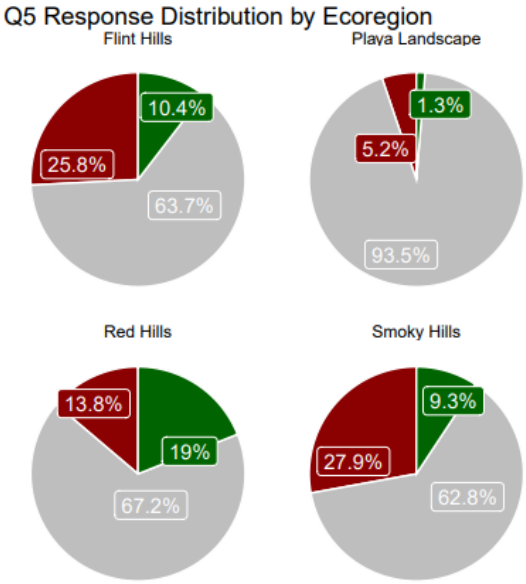

Ecoregion	# of Responses
Flint Hills	182
Playa Landscape	77
Red Hills	58
Smoky Hills	183

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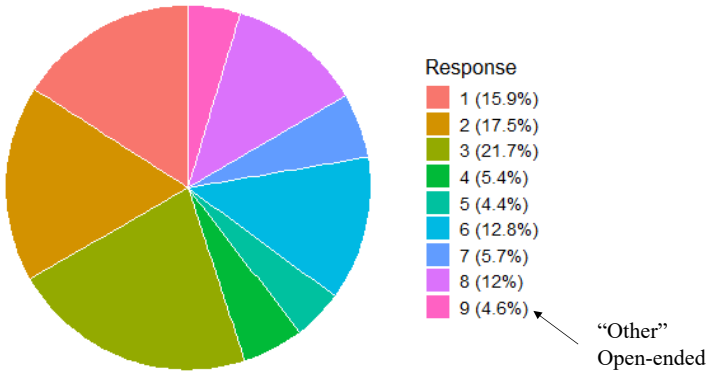
6. In your experience, what are the top three factors contributing most to the difficulty of controlling tree/brush encroachment? [Select up to 3]

1 ☐ Deciding where to prioritize control treatments for greatest benefit given resource limitations (e.g., labor/equipment/time/money etc.)
2 ☐ Cost of control, including lack of or difficulty applying for cost-share programs
3 ☐ Labor limitations to get started, including limited time and equipment/crew availability
4 ☐ Lack of information regarding which control techniques are the most effective/appropriate
5 ☐ Past control efforts have been ineffective or had short duration benefit (rapid re-encroachment)
6 ☐ Liability/risk/fear associated with prescribed burning and/or lack of training and experience with prescribed burning
7 ☐ Perceptions by neighboring landowners that tree and brush cover benefit wildlife/ecosystem or are "natural" for this ecosystem, leading to reluctance to control woody species.
8 ☐ Absent/unengaged landowners with minimal interest/investment in land management improvement activities



"Other" Open-ended

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Data

- Transaction-level Data
  - From 1988 to 2024
  - Obtained from Property Valuation Division
  - Dropped transactions that were less than 40 acres in size, greater than 5000 acres, or total appraised values of improvements greater than $100,000.
  - Dropped transactions with irrigated acres.
  - Restricted to arms-length transactions.
  - Transactions limited to that of the counties in the Core Kansas Grassland Initiative
  - These restrictions leave around 20,000 observable transactions.

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Summary Statistics					
Variable (unit)	Mean	Median	St. Dev.	Min	Max
Real Price per Acre (dollar/acre)	1,560.90	1,227.57	1,148.88	82.65	14,225.60
Tree Cover (%)	2.93	1.11	4.87	0.00	67.47
Total Parcel Acreage	248.56	157.50	313.82	40.00	4,953.60
Dryland (% of Land)	0.51	0.55	0.40	0.00	1.00
Grassland (% of Land)	0.46	0.41	0.40	0.00	1.00
Clay Soil (% of Land)	31.75	29.66	8.56	3.15	58.67
Sand (% of Land)	16.39	10.74	15.13	2.93	94.59
Silt (% of Land)	51.86	52.58	10.24	2.26	67.81
Slope (%)	3.95	3.34	2.64	0.00	26.99
Organic Matter (% of Soil Weight)	1.18	1.14	0.40	0.06	3.77

Modeling

- A hedonic approach is used.
- This allows an understanding of how different characteristics contribute to its market value.
  - Services like Zillow use these models to give estimates of house values using square footage, number of bedrooms and bathrooms, etc..
  - In our case, land estimates can be made using different land characteristics such as soil type, weather conditions, and location.

Regression Results

- The model coefficients of tree cover (positive) and tree cover squared (negative) indicate that there are diminishing returns and eventually higher levels of tree cover result in little to no effect on land value.
- The coefficients for each year not shown in output for readability, show that there is a strong trend in rising land prices throughout the time of our study.

Impact of Land Characteristics on Log Land Price

Fixed Effects by Township; Clustered SE by Year

Variable (unit)	Coefficient Estimate	Statistically Significant
Tree Cover (%)	0.0121	Yes
Tree Cover Squared	-0.0002	Yes
Native Grassland (%)	-0.0768	Yes
Tame Grassland (%)	0.1014	Yes
Water Deficit	-0.0079	Yes
Hot Days > 34C	-0.0059	No
Moderate Heat Days (10–34C)	0.0011	Yes
Slope (%)	-0.0087	Yes
Sand (%)	0.0062	Yes
Silt (%)	0.0069	Yes
Soil Organic Carbon (0–100cm)	0.0149	Yes
# Parcels in Transaction	-0.0215	Yes

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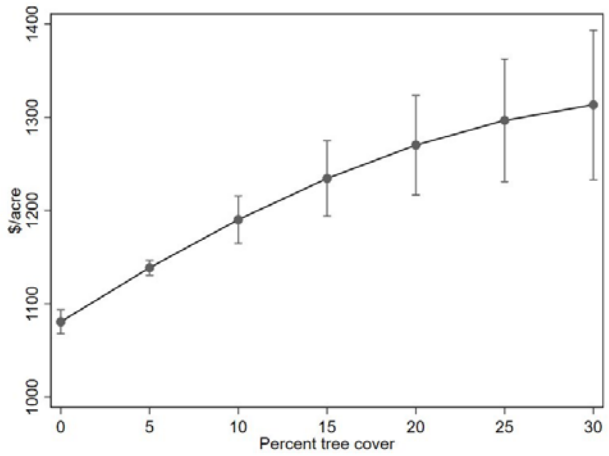
Effect of Tree Cover



- The turning point for decreasing return on percent tree cover is 34.55%, and the point where tree cover results in lesser land value than that of zero percent is 69.11%
  - However, there are not many parcels being sold with greater than 30% tree cover and the highest in our observed transactions being 64%
- With an average of 3% tree cover across the observations, there is an associated 3.53% increase in land value per acre compared to the land without tree cover.

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Measuring the Effect of Tree Cover

- To answer the question of how the effect of tree cover varies among each transaction, the regression model can be used.
- Two predictions are found, one is using all the observed values, and the other is setting the tree cover to zero.
  - The difference of this shows the "value" of tree cover on each transaction

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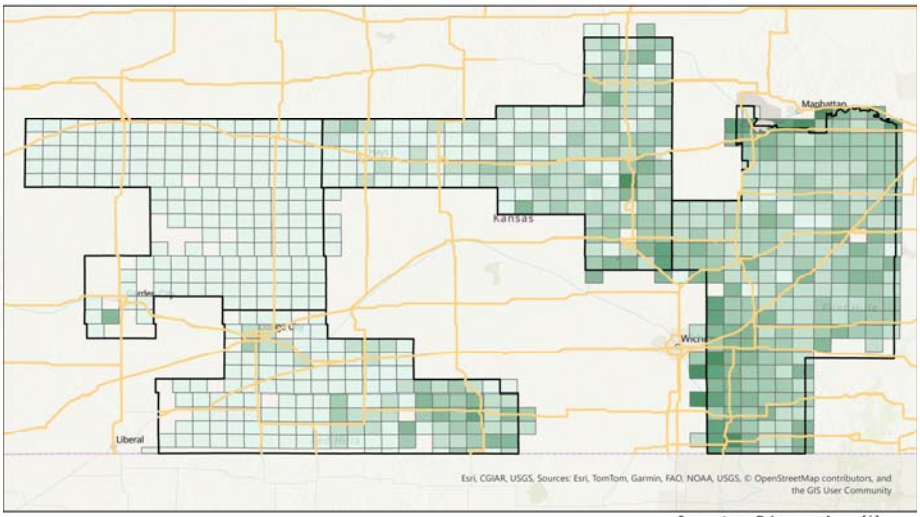
Effect of Tree Cover on Predicted Price per Acre (by Township)



Note: Total dollar impact per acre is estimated using a nonlinear hedonic pricing model. For each transaction, price per acre is predicted twice: once using the observed tree cover at the time of sale, and once with tree cover set to zero. The difference represents the total effect of tree cover on price per acre. These differences are averaged across all transactions within each township. Township-level aggregation is used because it is the finest spatial resolution available given data limitations and confidentiality concerns.

Impact on Price per Acre ($)

- 0.21 - 28.54
- 28.54 - 68.30
- 68.30 - 122.21
- 122.21 - 206.56
- 206.56 - 346.16
- 346.16 - 625.86

0 12.5 25 50 Miles

US Highways & Interstates

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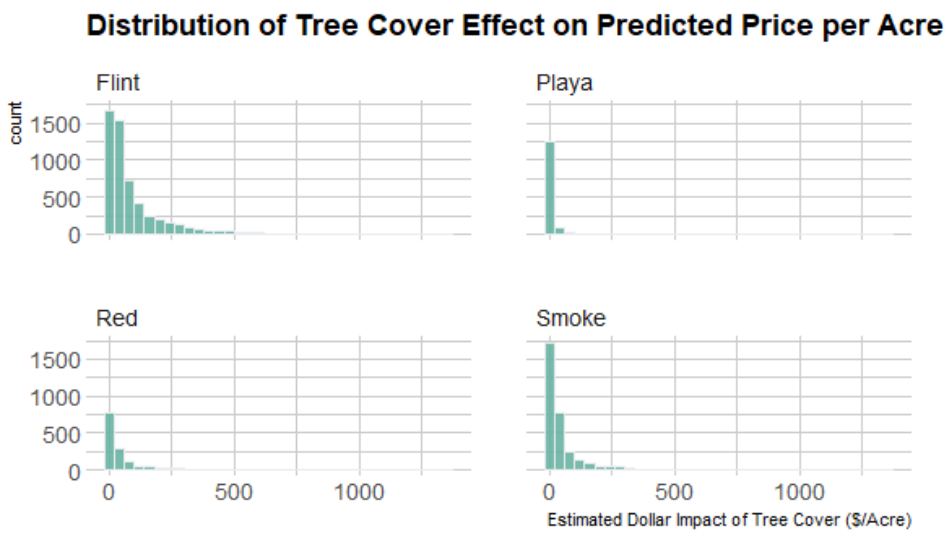

- The large distribution of transactions in our sample having effects of tree cover near zero show that in the typical parcel tree cover has little to no effect.

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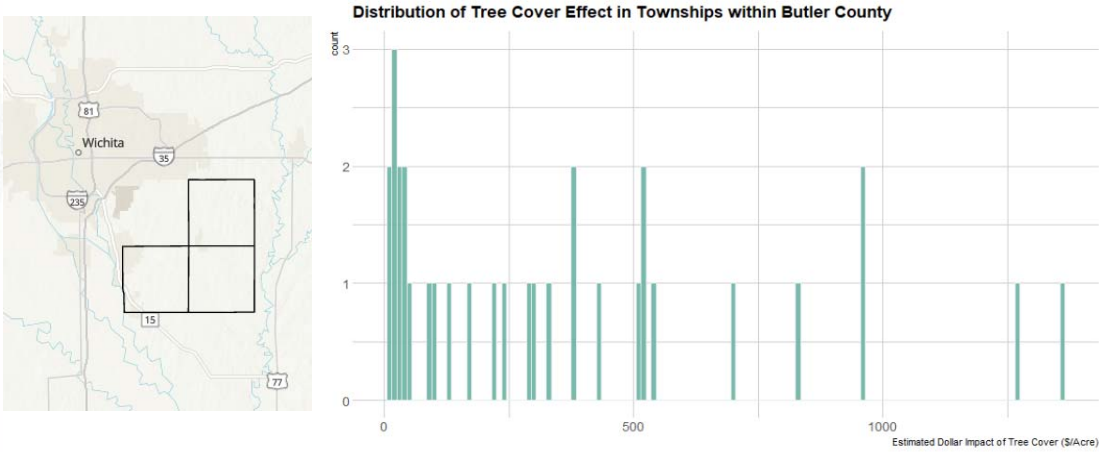
Example of Outliers



- These transactions are examples of parcels that are more recreationally-focused, where tree cover fetches a larger premium over that of agricultural land.

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Conclusions

- A majority of the land transactions observed show that tree cover had little to no effect on land values, however in some areas tree cover provides a large increase in land value.
- With woody encroachment requiring lots of labor and high costs to control and with the land market not penalizing higher woody covers, the issue of woody encroachment becomes more complicated.

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Acknowledgements

- The joint support of the Kansas Department of Agriculture and the Kansas Water Institute for providing financial support for my graduate research position and education at Kansas State University.
- The NRCS project titled “Using vulnerability analysis to guide woody plant control outreach efforts in support of maintaining and improving NRCS’s Kansas Great Plains Grassland Initiative-identified core grasslands in Kansas” which funded the surveying.

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