The Impact of Water Availability on Land Values in Kansas

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Introduction & Previous Literature

The Ogallala Aquifer stretches across eight states from South Dakota to Texas. It is one of the world's largest aquifers and is the primary source of agricultural irrigation within the study region. Three million acres within the state of Kansas are dedicated to irrigated agriculture producing a variety of crops including corn, alfalfa, sorghum, soybeans, and wheat. With the increase in groundwater pumping, the aquifer has seen steady declines since the 1940s (Whittemore et al., 2018). To date, the depletion of the Ogallala has increasingly exceeded the rate of recharge, and the exhaustion of the aquifer is of heightened concern (Brauer et al., 2017).

Past research regarding land values and groundwater has produced mixed conclusions. Torell and others (1990) illustrated that land sale prices are dependent on water available by 30 to 60 percent, while Sampson et al. (2019) found irrigated land to be more valuable than non-irrigated land, even when restrictions on water use are in place. Conversely, Schlenker et al. (2007) and Mendelsohn and Dinar (2003) found no statistical significance between groundwater and farmland values.

Region Examined

Groundwater Management District Number 4 (GMD4) is located across 10 counties in Northwestern Kansas (Figure 1). The counties analyzed in this study are Cheyenne, Sheridan, Sherman, and Thomas County.

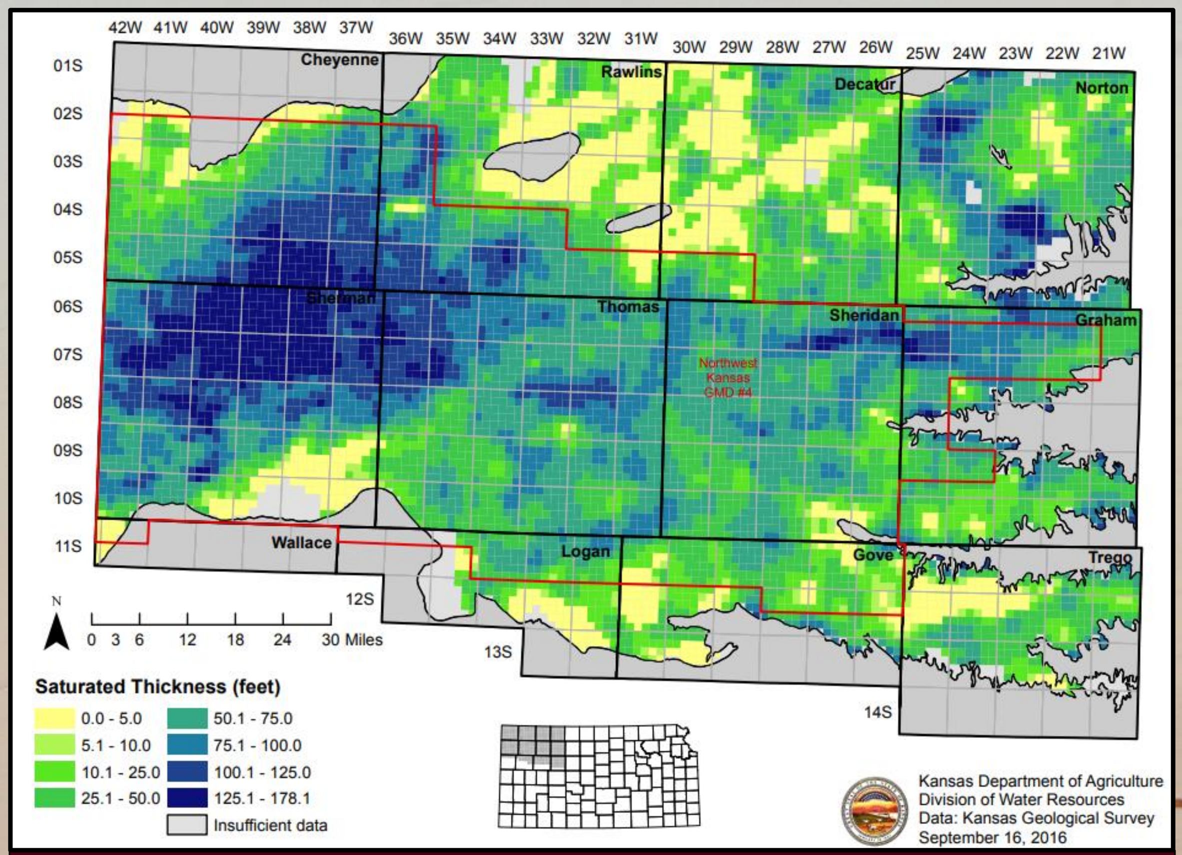

Figure 1. Map of Groundwater Management District No. 4

Objectives

The primary objective is to determine the relationship and impact of water availability on land prices in Northwest Kansas from 2012 to 2021. The hedonic price model approach is employed to determine the impact of water availability on average price per acre. A solid understanding of the relationship between water resources and land prices will be critical for estimation of future land values and for creating economic policies.

Data

Data was sourced from the Water Information Management and Analysis System (WIMAS, 2015), the Kansas Department of Revenue (KDR, 2021), and Geographic Information System (GIS, 2021). For model functionality, only observations coded as auction market, valid sale, or financing were examined (Figure 2), resulting in 526 useable observations within GMD4. Land sale prices were adjusted for inflation and presented in 2020 dollars. Information on over 2,000 dryland and irrigated land sale transactions were collected from 2012 to 2021. Water data consisted of 2,497 individual wells in GMD4 from 2005 to 2015 (Figure 3). The water information also provides the primary crops that are grown with the water used (Figure 4). To best analyze the data, the water data and the sale information were merged by a distance analysis using the spatial features (SF) package in R. The distance analysis uses the geographical coordinates from the sale information to find the nearest well coordinates. Once the nearest well was found, the water information from that well was merged to the sale observation. Summary statistics for this data set can be found in Table 1. However, special attention should be noted to adjusted price per acre's significant variation, which will be discussed.

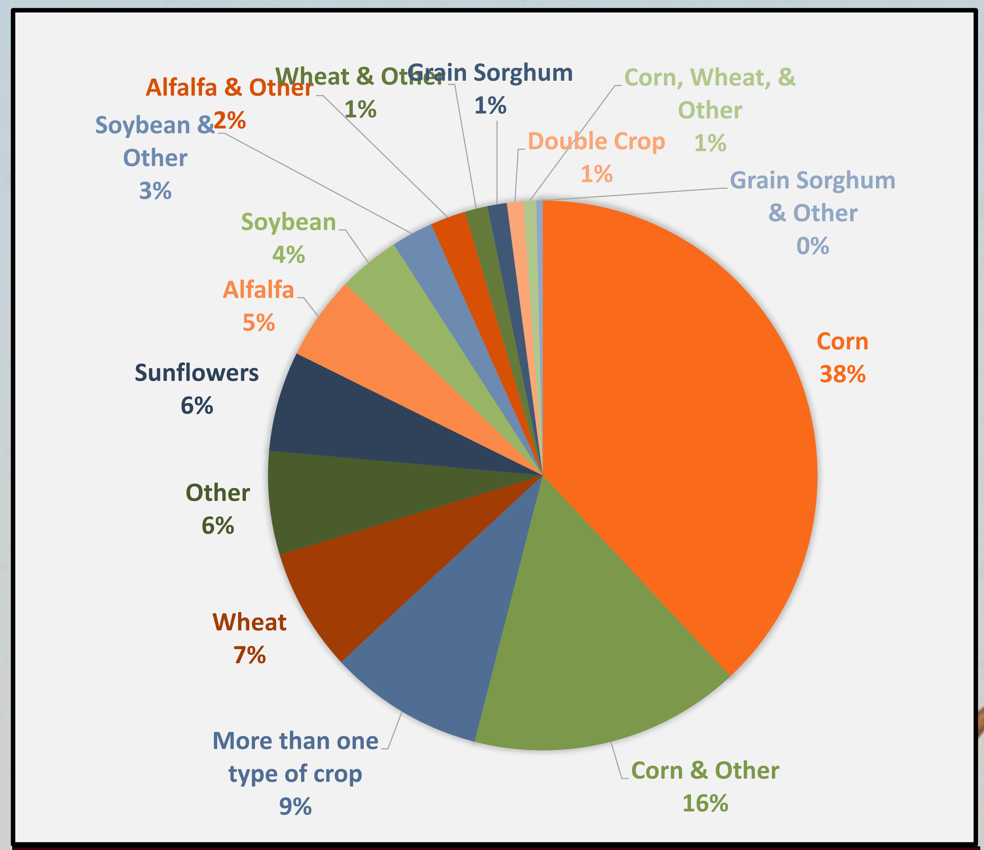

Figure 2. Primary Crop of Parcel Sold

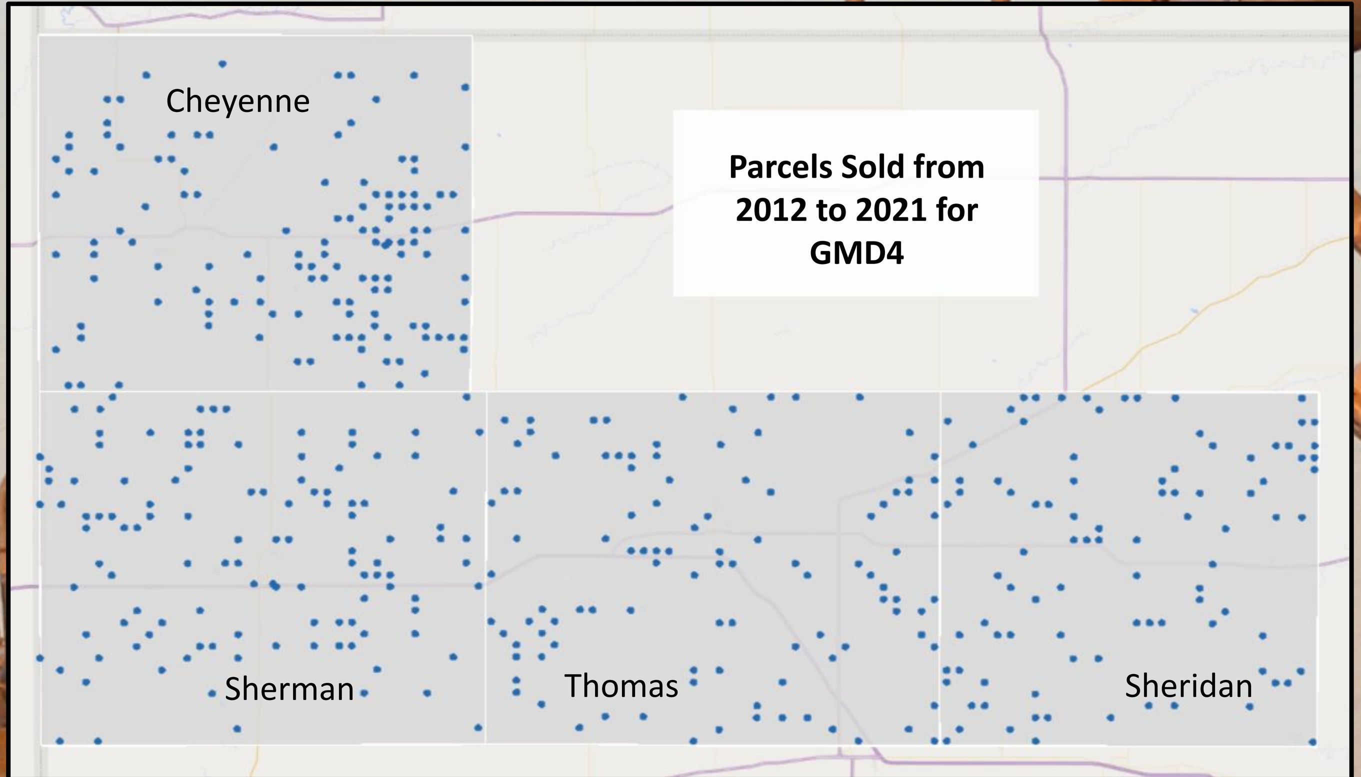

Figure 3. Sale Observations by Longitude and Latitude

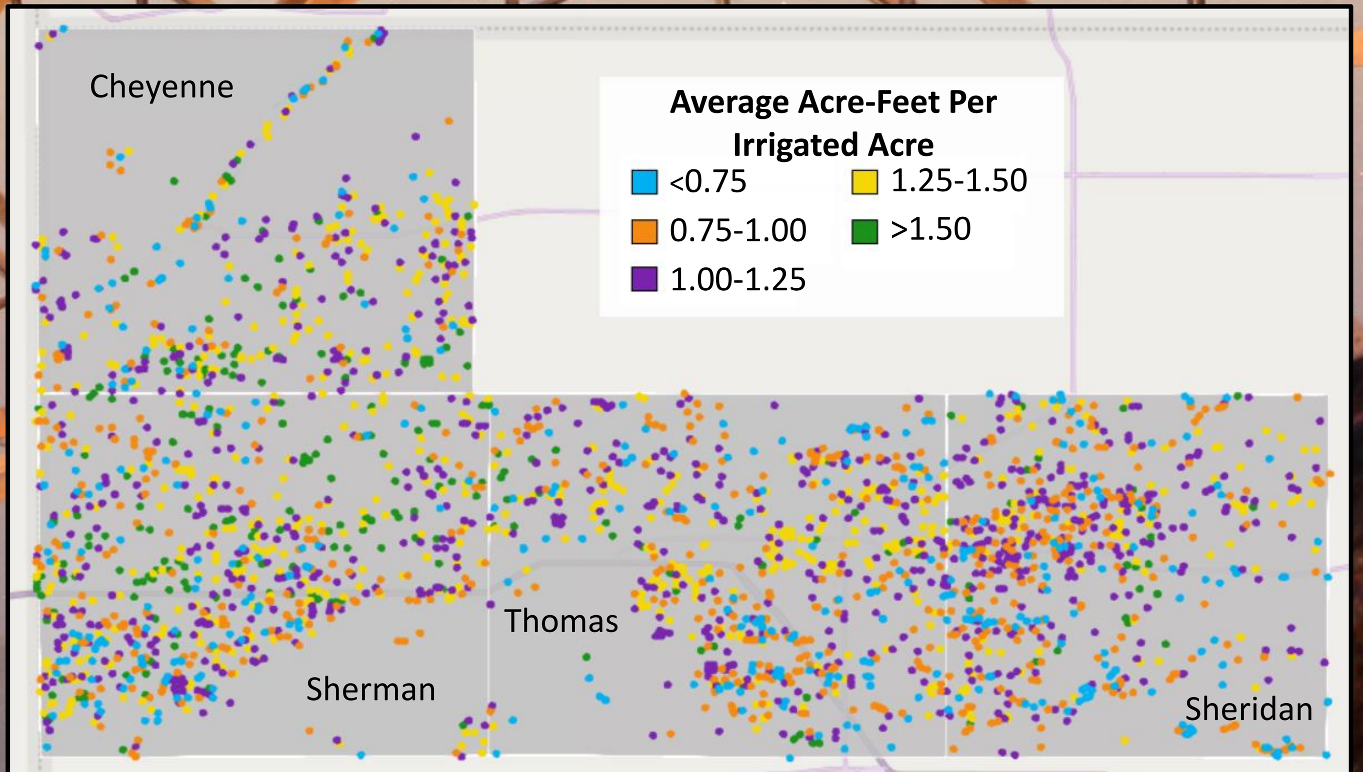

Figure 4. Water Data by Longitude and Latitude

Table 1. Summary Statistics

Variable	Mean	Std. D	Min	Max
Adjusted Price Per Acre	3,276.36	6,918.55	225.74	110,657.13
Acre-Feet Per Irrigated Acre	1.14	0.35	0.07	2.95
Building	0.68	0.47	0	1
Time Trend	5.44	2.90	1	10
Access Code	2.50	0.60	1	4
Irrigated Acres	0.28	0.45	0	1

Methods

To determine the impact of water availability on land prices, this study used the hedonic price method. Hedonic analysis illustrates how the characteristics of the land determines the inherent value. The data was analyzed using a log-linear regression analysis. The log-linear regression model accounts for the possible exponential growth relationship between the variables.

Log Linear Hedonic Regression Model Estimated

The equation for the adjusted price per acre for parcel *i* in year *t* estimate is:

$$ln\frac{Price}{Acre_{i,t}} = \beta_0 + \beta_1 AF_{it} + \beta_2 Bldg_{it} + \beta_3 TT_{it} + \beta_4 AC_{it} + \beta_5 IR_{it} + \varepsilon_{it}$$

where *AF* is defined as the acre-foot of water per irrigated acre for each parcel, *Bldg* indicates the presence of a building on parcel *i*, *TT* specifies the year parcel *i* was sold during time period *t*, *AC* describes the type of road to access parcel *i*, and *IR* indicates whether parcel *i* is irrigated or dryland.

Table 2. Estimates of the Hedonic Model

Variable	Parameter Estimate	Standard Error
Intercept	8.02	0.16
Acre-Feet Per Irrigated Acre	-0.09	0.08
Building	-0.50*	0.06
Time Trend	-0.04*	0.01
Access Code	0.11*	0.05
Irrigated Acres	0.24*	0.07
* means a p- value <0.01		

Results

In the hedonic model, the positive parameter estimates were as expected, Table 2. The negative signage were unexpected given related literature. The independent variables, excluding acre-feet per irrigated acre, are significant to the land value. After further examination, acre-feet per irrigated acre remained consistent across the ten year period.

Discussion

- ◊ The distance between the geographical coordinates from the sale and water data have not been expressed in this study. In the future, the distance could be used to filter the married data for an alternative result.
- ◊ The total acreage used for agriculture varies greatly from less than 1 acre to over 600 acres. Most of the observations consist of acreage that suggest family farming. The smaller parcels propose to be a family residence that could be closer to large cities. A variable to express the distance to larger cities should be included in further research.
- ◊ A possible limitation of the current model is the large variance in the adjusted price per acre. Future models should include a variable to control for this or the filtering of those outliers.
- ◊ The incorporation of saturated thickness can further improve the model estimation, as it has been shown to impact the future productivity and profitability of the land.
- ◊ In future research using percentage of irrigated acres may be a better indicator than the current binary variable.

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