The Economic Benefits to Agricultural Producers of Water Right Retirement in Kansas

Linking Stated Preference Valuation Functions to Physical Models

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Colorado State Univ Agricultural and Resource Economics

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Ogallala Water Coordinated Agricultural Project

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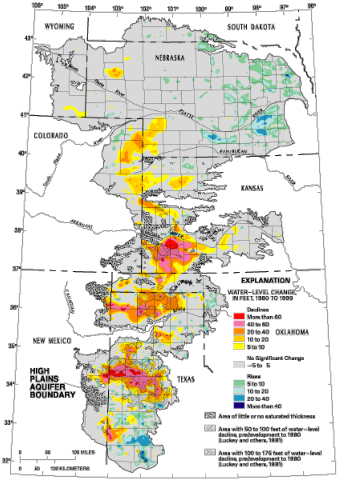
- Policy options: pumping restrictions, water prices, payments for conservation, etc.

Groundwater Depletion in the Ogallala Region



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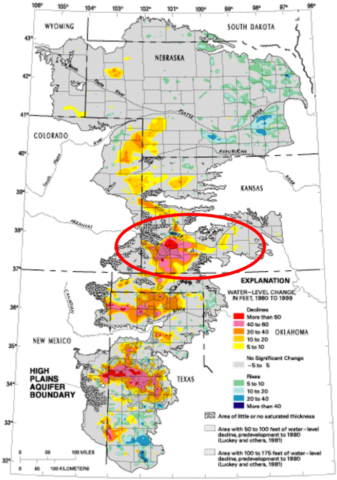

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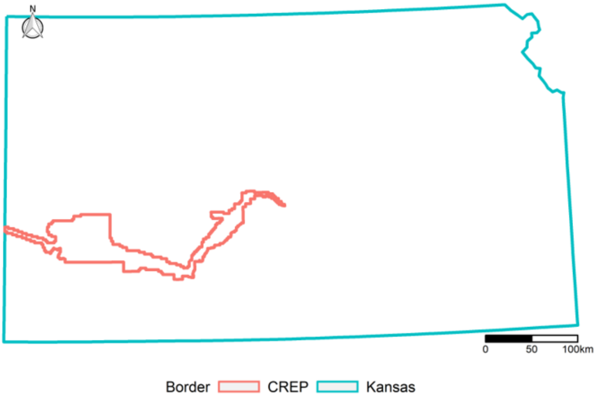
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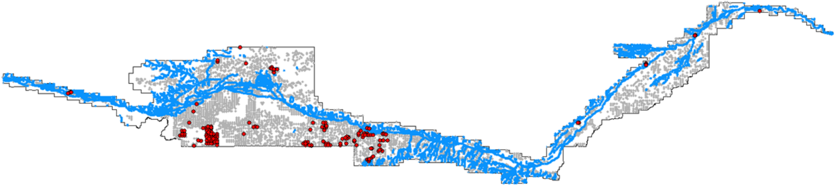
Well Retirement in the Arkansas River Basin in Kansas



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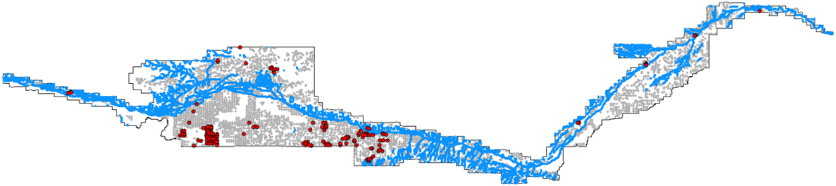

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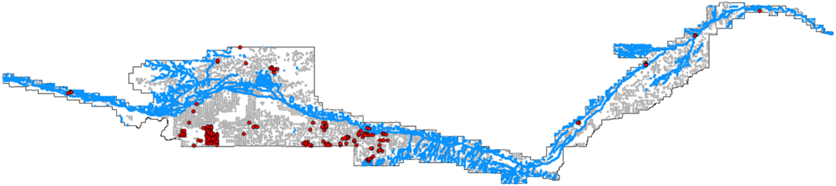

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- Surprisingly little information on the value of program benefits

Research Questions

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  - What is the value of the conserved water, considering both use (profit, community) and non-use (bequest) values of GW?
- Consider program benefits from 15, 30, and 50 years of retirement

Relevant Literature

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- We use a stated preference valuation function linked to the output of a physical model to estimate the use and non-use benefits to agricultural producers of a USDA program that conserves GW stocks

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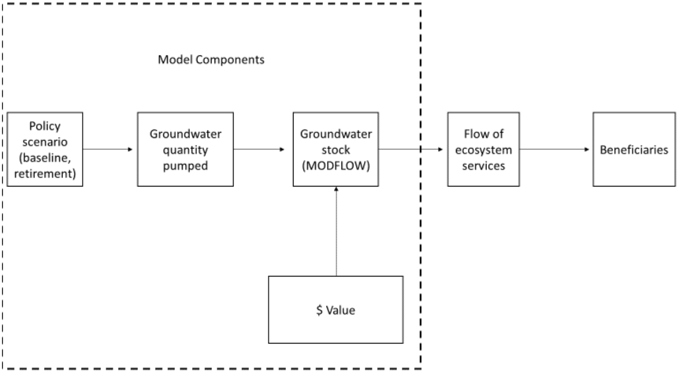


Groundwater Terminology

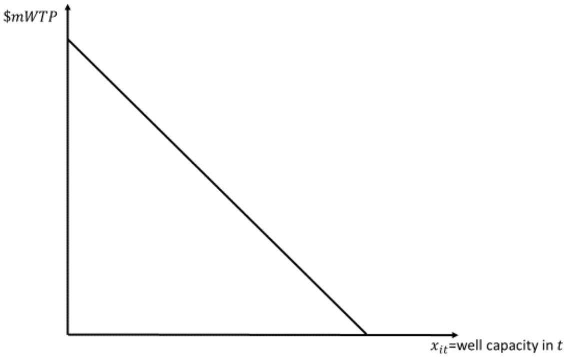
Saturated thickness - vertical distance permeated by water, measures resource stock in a location

Well capacity (yield)- max flow rate (gallons per minute) a well can sustain over a period of time

Well capacity is an increasing function of saturated thickness at the well, and is known by producers

1. Value of Groundwater

- We model a producer's marginal WTP (mWTP) for GW, conditional on the current stock, measured by **well capacity**, x_{it}, in the area of a well



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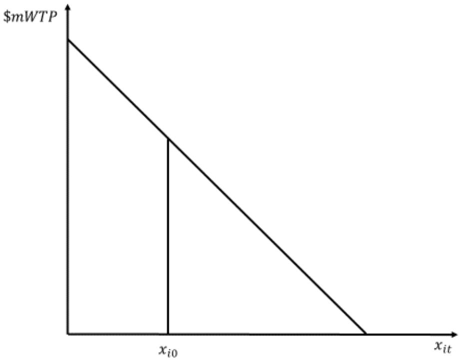

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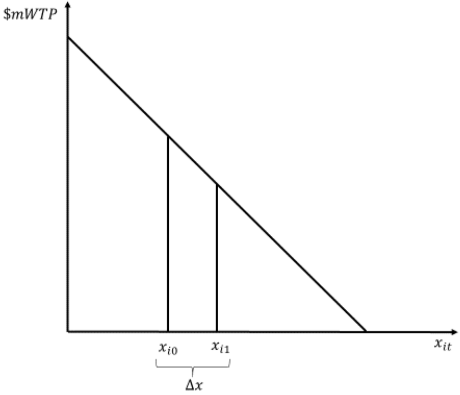

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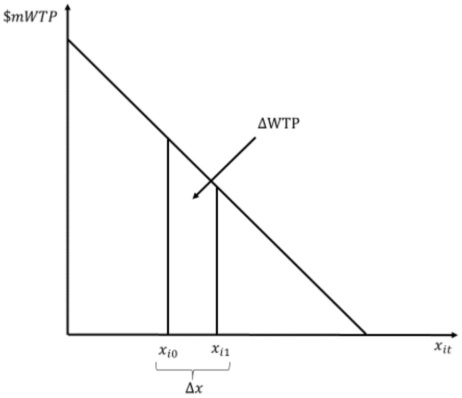

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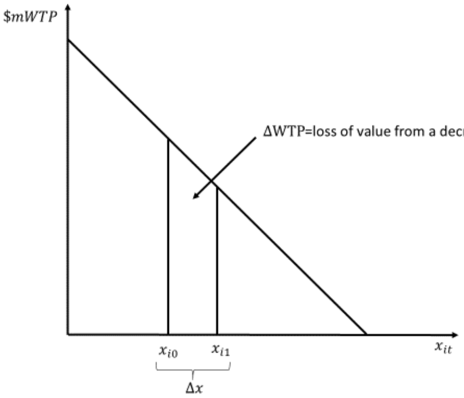

Approximating mWTP

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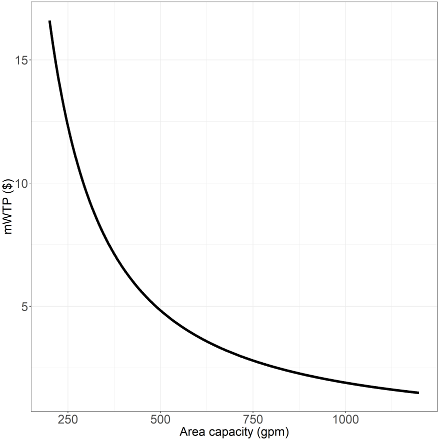
- x_i is well capacity averaged across producer i's wells
- z_i is climate in the county (30-year average temperature and precipitation during the growing season (PRISM))

Approximating mWTP in the Study Area

- We predict $\frac{\Delta WTP_i}{\Delta x_i} \approx mWTP_i$ for each well in the Arkansas River Basin of Kansas as a function of average well capacity (GPM) within 1 mile and climate at that well



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  - Integrate from current to future well capacities at all wells, sum across wells and compare change in values

Results: Policy Impacts

Impacts of CREP			
	15 years	30 years	50 years
Additional Saturated Thickness (ft)	3.9	7.5	12.7
Additional Well Capacity (GPM)	10.8	19.5	27.6
Current Value of Additional GPM ($)	1.2 million	3.7 million	13.5 million
Present Value ($) (5% discount rate)	0.58 million	0.9 million	1.2 million
		% of Baseline	
Additional Saturated Thickness	13.49	12.58	12.89
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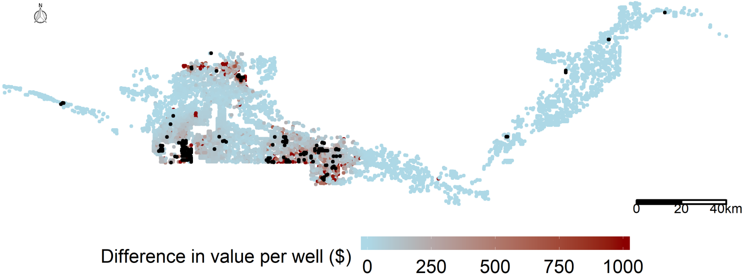

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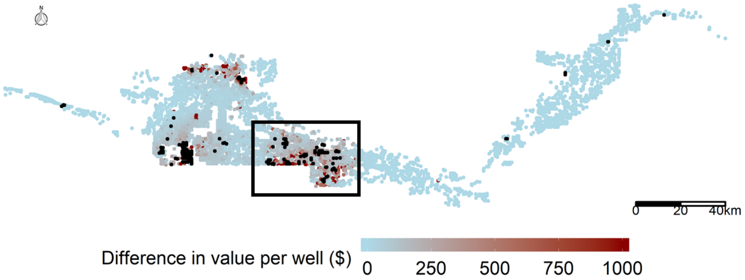

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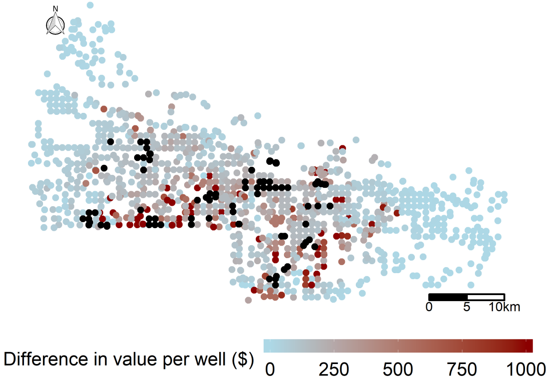

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- Local nature of impacts suggests the importance of spatial targeting

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- Using valuation methods to value natural capital has unique challenges
  - How does policy change (beliefs about) resource dynamics and competition, and become capitalized in resource values (Edwards 2016)?
  - Better to directly value a stock or value the flows over time?

Thanks!

Results: Baseline

Table 5: Baseline Change in Groundwater and Value

	Variable	15 years	30 years	50 years
1	Saturated thickness (ft)	-28.933	-59.611	-98.543
2	Well capacity (GPM)	-81.323	-164.564	-258.277
3	Value ($)	-5,482,229	-17,447,124	-48,207,468
4	Present value ($)	-2,637,046	-4,036,871	-4,203,871
5	Value per well ($)	-1,080.455	-3,438.534	-9,500.881
6	Present value per well ($)	-519.717	-795.599	-828.512

Results: Baseline

Table 4: Impact of Saturated Thickness on Well Capacity

	Dependent variable:
	Well capacity
Saturated thickness	3.584**
	(1.593)
Observations	76,266
R^2	0.006
Adjusted R^2	−0.118
F Statistic	0.818 (df = 464; 67815)

Note: Model includes controls for well and county-year fixed effects
*p<0.1; **p<0.05; ***p<0.01

Results: Baseline

Table 3: Coefficient Estimates from Logit Model

	Dependent variable:
	Support
Log well capacity	−0.591**
	(0.283)
Log mean temperature	4.747***
	(1.618)
Log mean precipitation	−2.130***
	(0.613)
Log project cost	−0.439***
	(0.134)
Constant	0.608
	(5.902)
Observations	532
Log Likelihood	−267.616
Akaike Inf. Crit.	545.232
Note:	*p<0.1; **p<0.05; ***p<0.01

Results: Baseline

Table 6: Well Retirement Policy Benefits

	Wells	Variable	15 years	30 years	50 years
1	All wells	Saturated thickness (ft)	3.862	7.470	12.679
2	All wells	Well capacity (GPM)	10.778	19.548	27.617
3	All wells	Value ($)	1,215,256	3,708,376	13,535,172
4	All wells	Present value ($)	584,559	858,034	1,180,317
5	All wells	Value per well ($)	239.507	730.858	2,667.555
6	All wells	Present value per well ($)	115.207	169.104	232.621
7	Within 1 mile	Saturated thickness (ft)	9.335	18.455	32.726
8	Within 1 mile	Well capacity (GPM)	31.916	57.017	80.239
9	Within 1 mile	Value ($)	479,589	1,843,511	5,279,023
10	Within 1 mile	Present value ($)	230,690.9	426,546.8	460,350.5
11	Within 1 mile	Value per well ($)	769.807	2,959.086	8,473.552
12	Within 1 mile	Present value per well ($)	370.290	684.666	738.925

Note: All wells represents the aggregation across the entire study area. Within 1 mile represents the impacts only on wells that are within 1 mile of a well participating in CREP.

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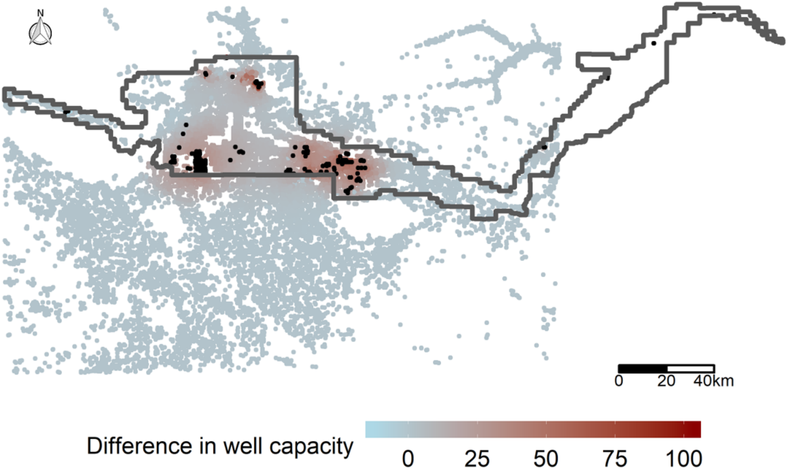
- $V(x_{it}, m_i)$ is the discounted flow of utility from time t to the end of a planning horizon, T
  - Depends on beliefs about the change in x_{it} moving forward as producers in an area make optimal pumping decisions
- With constant marginal utility of non-farm income, δ, the mWTP for GW is $\frac{1}{\delta}\frac{\partial V}{\partial x_{it}}$

1. Value of Groundwater

- We model a producer's marginal WTP (mWTP) for GW, conditional on the current stock, measured by **well capacity**, x_{it}, in the area of a well
- Indirect utility depends well capacity around producer i's well at time t and on exogenous non-farm income, m_i
- $V(x_{it}, m_i)$ is the discounted flow of utility from time t to the end of a planning horizon, T
  - Depends on beliefs about the change in x_{it} moving forward as producers in an area make optimal pumping decisions
- With constant marginal utility of non-farm income, δ, the mWTP for GW is $\frac{1}{\delta}\frac{\partial V}{\partial x_{it}}$
- We examine the value to producer i of changes in well capacity between two levels, x_{it}^0 and x_{it}^1 (Fenichel and Hashida 2019)

Results: Policy Impacts



Results: Policy Impacts

Table A2: Well Retirement Policy Benefits, including Wells Outside The Arkansas River Basin

		Variable	15 years	30 years	50 years
1	All wells	Saturated thickness	1.703	3.326	5.686
2	All wells	Well capacity	5.748	10.496	14.651
3	All wells	Value	1,530,901	4,729,176	18,358,190
4	All wells	PV Value	736,389	1,094,225	1,600,903
5	All wells	Value per well	132.660	409.807	1,590.831
6	All wells	PV Value per well	63.812	94.820	138.726
7	Within 1 mile	Saturated thickness	9.210	18.186	32.342
8	Within 1 mile	Well capacity	32.332	57.484	80.663
9	Within 1 mile	Value	542,969	1,962,197	5,658,792
10	Within 1 mile	PV Value	261,177	454,008	493,467
11	Within 1 mile	Value per well	847	3,061	8,828
12	Within 1 mile	PV Value per well	407	708	769