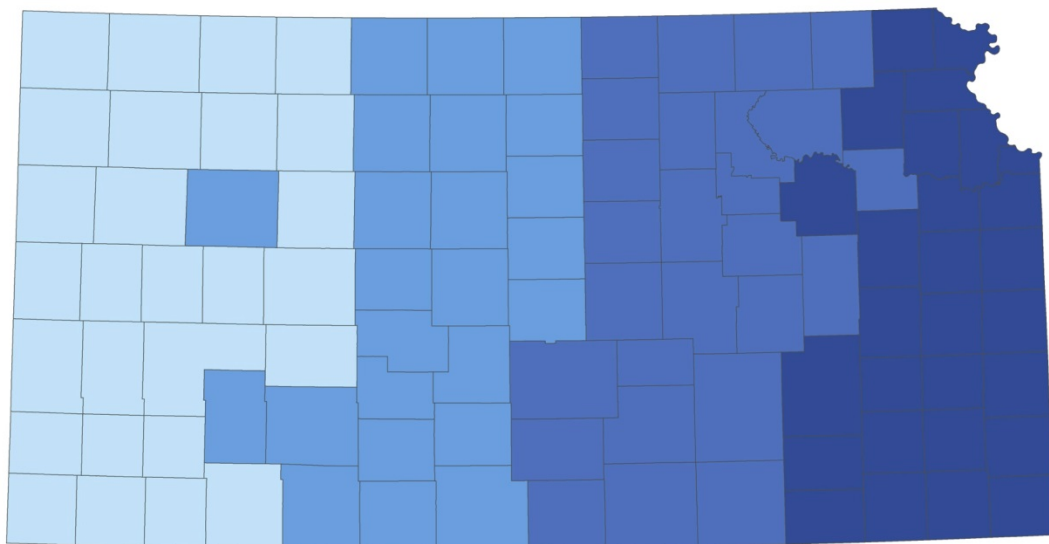


APPENDIX: FIGURES AND TABLES

Figure A1

Precipitation Gradients across Kansas



Source: Institute for Policy & Social Research, The University of Kansas;
data U.S. Department of Agriculture, National Agricultural Statistics Service, Kansas Field Office.

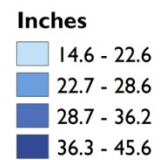


Figure A2
Placebo Treatment Years (Total Water Use):
Coefficient Estimates and 95 % Confidence Intervals

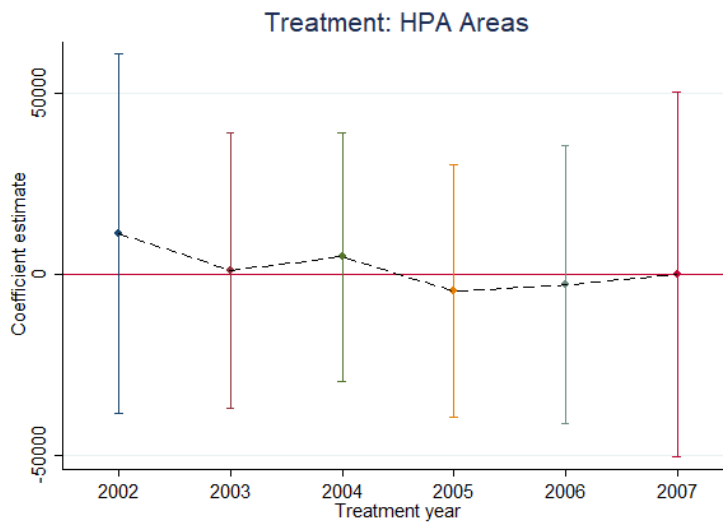
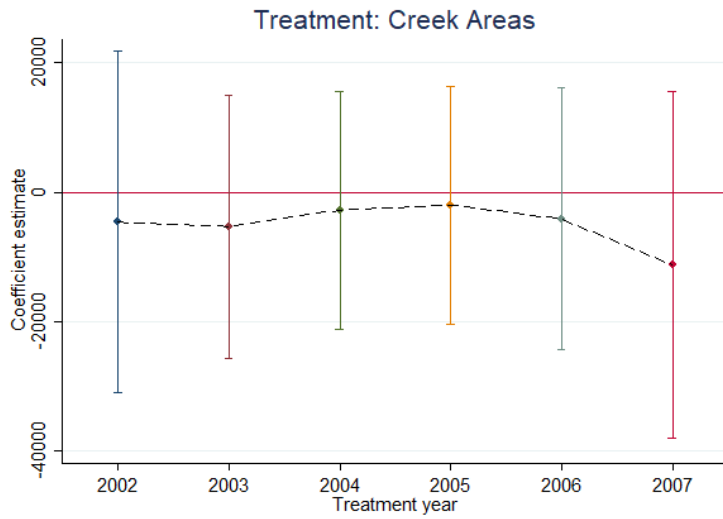
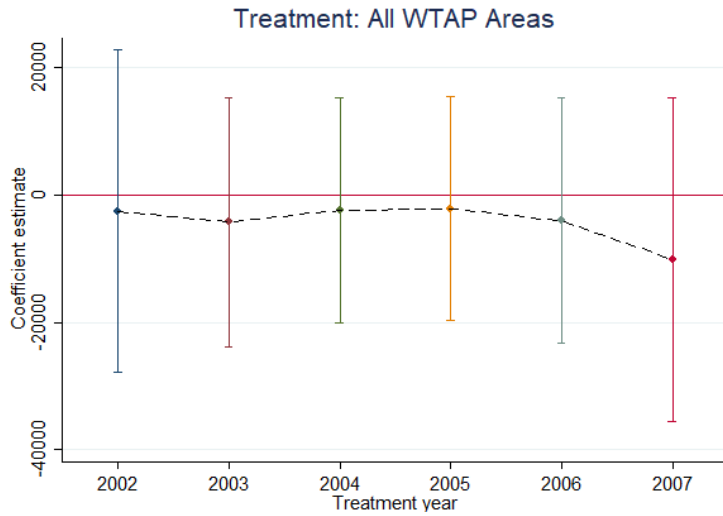


Figure A3

Pre-Treatment Trends in Groundwater and Surface Water Use: Primary Control Group

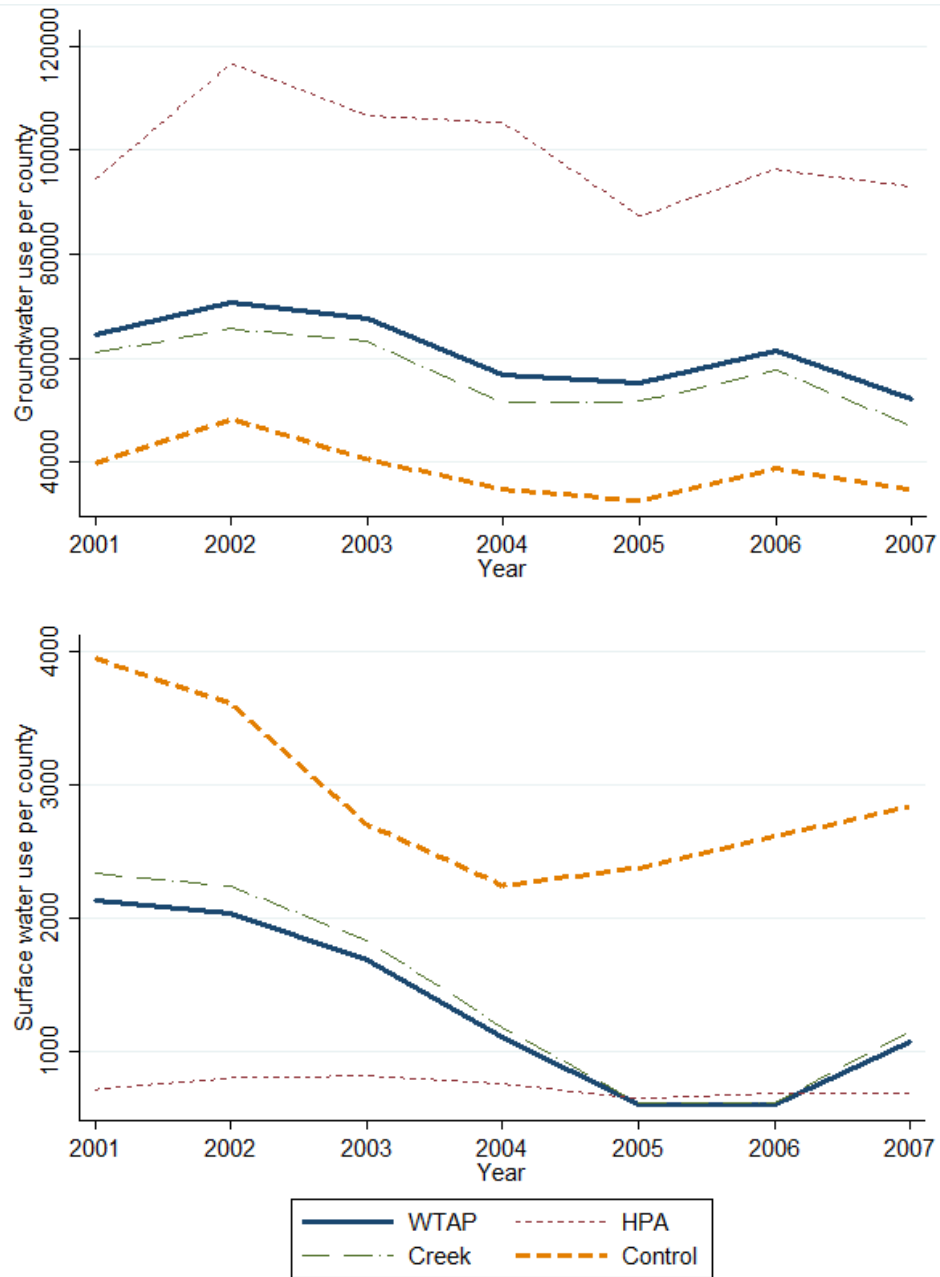
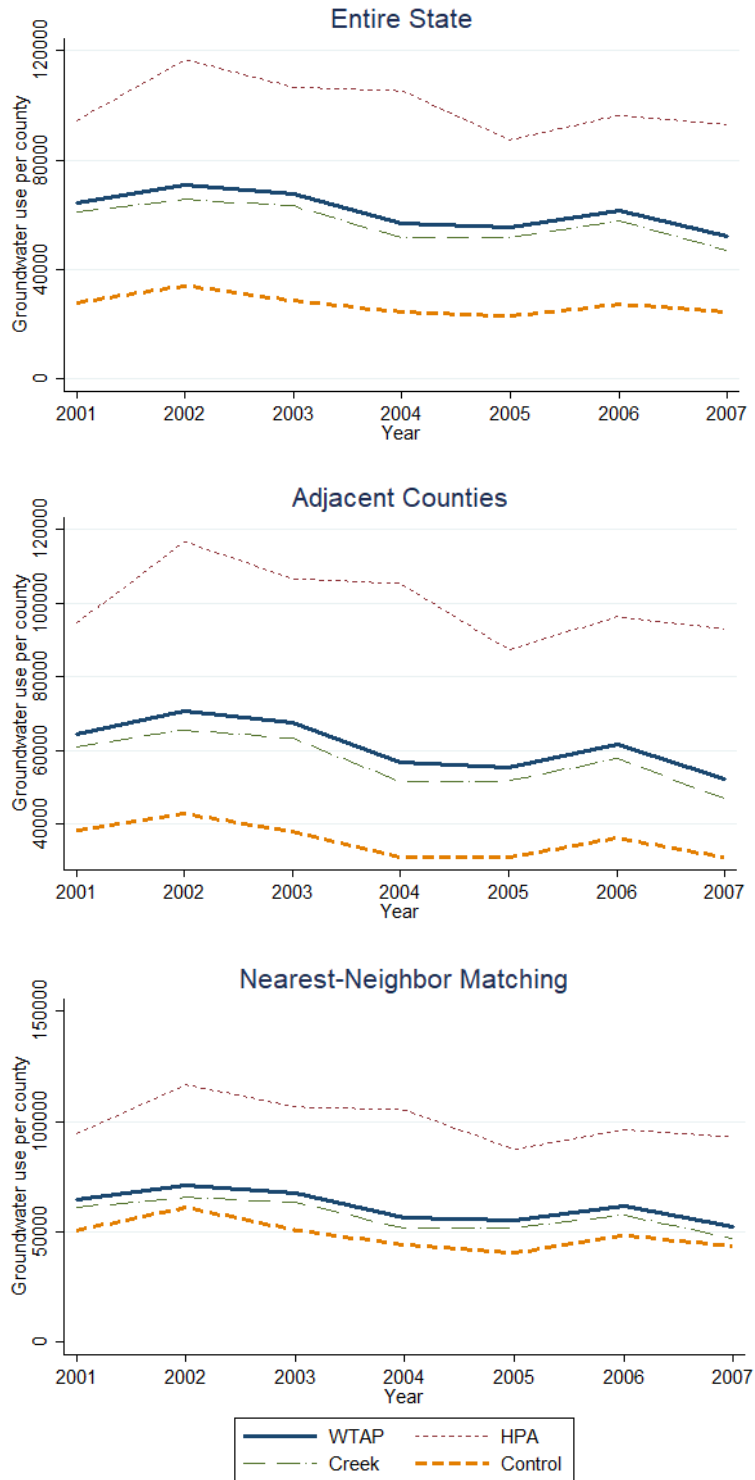


Figure A4

Pre-Treatment Trends in Groundwater Use: Alternative Control Groups



Matching weights are used to calculate average groundwater use in the control group under nearest-neighbor matching.

Table A1
Summary Statistics for All Counties in Kansas (N=1,260)

Variable	Mean	Std. Dev.	Min	Max
DEPENDENT VARIABLES				
Total Water Use (acre-feet)	35,288.47	62,112.71	0	409,136.60
Groundwater Use (acre-feet)	33,258.42	61,313.37	0	409,136.60
Surface Water Use (acre-feet)	2,030.05	7,773.10	0	85,439.13
PRIMARY REGRESSORS				
WTAP Indicator	0.06	0.23	0	1
HPA Indicator	0.01	0.10	0	1
Creek Sub-basin Indicator	0.05	0.22	0	1
WTAP Territory (%)	0.98	6.07	0	54.50
HPA Territory (%)	0.10	1.47	0	24.29
Creek Sub-basin Territory (%)	0.89	5.76	0	54.50
CONTROL FACTORS				
January Temperature (°C)	-0.67	2.61	-7.81	7.02
February Temperature (°C)	0.43	2.35	-4.88	6.30
March Temperature (°C)	7.12	2.70	0.52	14.81
April Temperature (°C)	12.81	2.04	7.82	17.56
May Temperature (°C)	17.93	1.55	13.12	22.31
June Temperature (°C)	23.53	1.53	19.52	28.05
July Temperature (°C)	26.70	1.83	22.08	31.79
August Temperature (°C)	25.47	1.74	20.97	29.77
September Temperature (°C)	20.11	1.69	14.95	23.99
October Temperature (°C)	13.13	1.97	6.18	16.69
November Temperature (°C)	7.11	1.66	2.97	11.61
December Temperature (°C)	0.36	2.18	-6.56	5.32
January Precipitation (mm)	17.93	19.15	0	124.39
February Precipitation (mm)	29.24	25.47	0	127.60
March Precipitation (mm)	51.61	35.06	0	173.26
April Precipitation (mm)	71.13	36.88	8.24	232.70
May Precipitation (mm)	95.72	55.85	5.27	297.28
June Precipitation (mm)	108.89	64.18	14.69	502.57
July Precipitation (mm)	78.59	46.29	7.68	226.38
August Precipitation (mm)	88.79	42.57	12.24	280.55
September Precipitation (mm)	63.76	44.83	6.93	275.70
October Precipitation (mm)	62.39	45.18	0	220.32
November Precipitation (mm)	26.68	28.90	0	167.12
December Precipitation (mm)	29.07	30.78	0	147.02
Depth-to-Water (feet)	77.61	71.78	12.86	316.88
Per Capita Income (2012\$)	36,657.44	6,959.64	22,725.42	73,328.00
Unemployment Rate (%)	4.64	1.61	2.40	12.00
White Population (%)	92.44	7.02	58.39	100.14
Bachelor’s Degree or Higher (%)	19.72	5.93	11.03	52.33
Male (%)	49.31	1.60	46.23	57.50
Median Age (years)	40.55	5.43	23.94	52.82
Population Density (per sq. km)	18.57	59.56	0.60	456.69

Unit of observation is county-year.

Table A2

Estimation of Groundwater and Surface Water Use in Pre-Treatment Period

Dependent Variable	Explanatory Variable	WTAP	HPA	Creek
Groundwater	Time Trend × Treatment Group Indicator	-949.19 (1,108.81)	-1,719.15 (2,312.14)	-1,106.95 (1,048.85)
	Surface Water	Time Trend × Treatment Group Indicator	205.50 (422.81)	264.68 (528.83)
Inclusion of Control Factors				
	Time Trend	yes	yes	yes
	Treatment Group Indicator	yes	yes	yes
	Weather	yes	yes	yes
	Depth-to-Water	yes	yes	yes
	Demographics	yes	yes	yes
Sample Features				
	# of Observations	553	455	539

Unit of observation is county-year.

Estimation uses only years 2001 to 2007.

Sample in each regression contains all non-WTAP counties west of the 96th meridian and counties that belong to the respective treatment group (WTAP, HPA, or creek).

Standard errors clustered by county shown in parentheses.

$p < 0.1$ (*), $p < 0.05$ (**), $p < 0.01$ (***)

Table A3

Regressions with a Single WTAP Treatment Variable (N=948)

Table A3a. Dependent Variable: Total Water Use

Treatment Variable	Model		
	I	II	III
WTAP % of County	-33.64 (62.99)	-4.10 (53.48)	-13.00 (64.48)
Inclusion of Control Factors			
County Indicators	yes	yes	yes
Year Indicators	yes	yes	yes
Intermediate Year	yes	yes	yes
Weather	no	yes	yes
Depth-to-Water	no	no	yes
Demographics	no	no	yes

Unit of observation is county-year.

Standard errors clustered by county shown in parentheses.

$p < 0.1$ (*), $p < 0.05$ (**), $p < 0.01$ (***)

Table A3b. Dependent Variables: Surface Water Use and Groundwater Use

Dependent Variable	Treatment Variable	Model		
		I	II	III
Groundwater	WTAP % of County	-39.32 (63.32)	-5.04 (54.68)	-12.54 (65.47)
Surface Water	WTAP % of County	5.68 (7.81)	0.94 (8.53)	-0.46 (8.04)
Inclusion of Control Factors				
	County Indicators	yes	yes	yes
	Year Indicators	yes	yes	yes
	Intermediate Year	yes	yes	yes
	Weather	no	yes	yes
	Depth-to-Water	no	no	yes
	Demographics	no	no	yes

Unit of observation is county-year.

Standard errors clustered by county shown in parentheses.

$p < 0.1$ (*), $p < 0.05$ (**), $p < 0.01$ (***)

Table A4

Sample Includes All Counties in Kansas (N=1,260)

Dependent Variable	Treatment Variable	Model		
		I	II	III
Groundwater	HPA % of County	-396.53 ** (153.89)	-447.01 *** (165.38)	-499.47 *** (169.55)
	Creek % of County	16.81 (39.57)	28.10 (30.85)	25.02 (40.10)
Surface Water	HPA % of County	-17.33 (12.81)	-29.72 (38.48)	-31.94 (35.39)
	Creek % of County	7.78 (8.80)	2.47 (9.60)	1.74 (9.54)
Inclusion of Control Factors				
	County Indicators	yes	yes	yes
	Year Indicators	yes	yes	yes
	Intermediate Year	yes	yes	yes
	Weather	no	yes	yes
	Depth-to-Water	no	no	yes
	Demographics	no	no	yes

Unit of observation is county-year.

Standard errors clustered by county shown in parentheses.

$p < 0.1$ (*), $p < 0.05$ (**), $p < 0.01$ (***)

Table A5

Sample Includes Adjacent Counties to WTAP Target Areas (N=444)

Dependent Variable	Treatment Variable	Model		
		I	II	III
Groundwater	HPA % of County	-497.64 ** (153.89)	-319.89 * (165.38)	-395.37 ** (173.06)
	Creek % of County	17.87 (46.72)	31.72 (31.65)	55.30 (33.39)
Surface Water	HPA % of County	-27.65 (19.88)	-32.63 (25.92)	-34.65 (29.17)
	Creek % of County	4.57 (7.06)	1.43 (7.88)	1.78 (9.41)
Inclusion of Control Factors				
	County Indicators	yes	yes	yes
	Year Indicators	yes	yes	yes
	Intermediate Year	yes	yes	yes
	Weather	no	yes	yes
	Depth-to-Water	no	no	yes
	Demographics	no	no	yes

Unit of observation is county-year.

Standard errors clustered by county shown in parentheses.

$p < 0.1$ (*), $p < 0.05$ (**), $p < 0.01$ (***)

Table A6

Nearest-Neighbor Matching to Construct Control Group (N=396)

Dependent Variable	Treatment Variable	Model		
		I	II	III
Groundwater	HPA % of County	-478.73 *** (171.88)	-359.67 * (182.92)	-448.63 ** (183.34)
	Creek % of County	18.53 (50.60)	26.70 (37.12)	50.91 (42.51)
Surface water	HPA % of County	-15.68 (15.59)	-30.81 (30.25)	-44.54 (35.98)
	Creek % of County	8.10 (6.70)	4.20 (5.32)	4.46 (6.14)
Inclusion of Control Factors				
	County Indicators	yes	yes	yes
	Year Indicators	yes	yes	yes
	Intermediate Year	yes	yes	yes
	Weather	no	yes	yes
	Depth-to-Water	no	no	yes
	Demographics	no	no	yes

Unit of observation is county-year.

All regressions use matching weights.

Standard errors clustered by county shown in parentheses.

$p < 0.1$ (*), $p < 0.05$ (**), $p < 0.01$ (***)

Table A7

Balance of Covariates with Propensity Score Matching

Table A7a. Pre-Matching

Variable	Mean		Sample Means <i>t</i> -test	
	Treated	Control	<i>t</i> -value	<i>p</i> -value
January Temperature	-0.21	-0.21	-0.02	0.99
February Temperature	0.05	0.25	-0.97	0.33
March Temperature	6.44	6.85	-1.57	0.12
April Temperature	12.26	12.92	-3.59	0.00
May Temperature	17.62	18.05	-3.32	0.00
June Temperature	22.80	23.01	-1.34	0.18
July Temperature	26.49	26.61	-0.79	0.43
August Temperature	25.33	25.69	-2.10	0.04
September Temperature	20.07	20.47	-2.21	0.03
October Temperature	12.96	13.46	-2.75	0.01
November Temperature	6.32	6.85	-3.06	0.00
December Temperature	0.69	0.94	-1.37	0.17
January Precipitation	15.99	20.83	-2.85	0.00
February Precipitation	19.10	25.50	-2.82	0.01
March Precipitation	45.24	50.03	-1.39	0.17
April Precipitation	52.37	58.33	-2.23	0.03
May Precipitation	79.18	92.08	-2.38	0.02
June Precipitation	86.49	106.97	-3.56	0.00
July Precipitation	69.01	71.56	-0.55	0.58
August Precipitation	77.70	89.36	-2.78	0.01
September Precipitation	46.09	53.47	-2.65	0.01
October Precipitation	48.37	56.85	-1.98	0.05
November Precipitation	13.98	16.19	-1.12	0.26
December Precipitation	27.19	28.78	-0.45	0.65
Depth-to-Water	69.19	70.38	-0.18	0.86
Income per capita	33,816	34,476	-1.51	0.13
Unemployment	3.50	3.86	-4.31	0.00
White	94.16	92.47	2.40	0.02
BA or higher	18.95	18.74	0.49	0.62
Male	49.41	49.11	1.90	0.06
Median Age	41.23	40.10	2.09	0.04
Population Density	4.37	8.71	-2.06	0.04
Total Water Use	62,567	41,436	3.15	0.00

Unit of observation is county-year.

Only data from 2001-2007 period used in the means comparison.

The treatment group includes 18 counties, and the control group includes 61 counties.

Table A7b. Post-Matching

Variable	Mean		% Bias	Sample Means <i>t</i> -test	
	Treated	Control		<i>t</i> -value	<i>p</i> -value
January Temperature	-0.21	-0.46	24.6	0.74	0.46
February Temperature	0.05	-0.10	12.9	0.41	0.69
March Temperature	6.44	6.54	-9.4	-0.29	0.77
April Temperature	12.26	12.62	-31.2	-0.99	0.33
May Temperature	17.62	17.84	-22.8	-0.69	0.49
June Temperature	22.80	22.87	-10.7	-0.32	0.75
July Temperature	26.49	26.51	-4.0	-0.12	0.90
August Temperature	25.33	25.42	-10.5	-0.34	0.74
September Temperature	20.07	20.20	-15.1	-0.46	0.65
October Temperature	12.96	13.21	-25.0	-0.78	0.44
November Temperature	6.32	6.48	-14.1	-0.49	0.63
December Temperature	0.69	0.66	2.5	0.08	0.94
January Precipitation	15.99	17.68	-16.1	-0.92	0.36
February Precipitation	19.10	23.88	-50.4	-1.61	0.12
March Precipitation	45.24	44.99	1.5	0.05	0.96
April Precipitation	52.37	54.55	-14.6	-0.55	0.59
May Precipitation	79.18	86.78	-27.2	-0.95	0.35
June Precipitation	86.49	94.24	-27.1	-1.21	0.24
July Precipitation	69.01	71.39	-19.7	-0.71	0.48
August Precipitation	77.70	88.13	-53.7	-1.57	0.13
September Precipitation	46.09	55.81	-92.6	-2.30	0.03
October Precipitation	48.37	52.53	-23.0	-0.80	0.43
November Precipitation	13.98	14.61	-7.9	-0.48	0.63
December Precipitation	27.19	28.39	-16.0	-0.62	0.54
Depth-to-Water	69.19	73.51	-7.7	-0.23	0.82
Income per capita	33,816	32,510	33.1	1.32	0.19
Unemployment	3.50	3.60	-11.8	-0.59	0.56
White	94.16	95.71	-25.1	-1.05	0.30
BA or higher	18.95	18.36	12.4	0.70	0.49
Male	49.41	49.38	1.2	0.03	0.97
Median Age	41.23	42.16	-20.0	-0.67	0.51
Population Density	4.37	2.84	3.4	1.11	0.27
Total Water Use	62,567	43,863	35.1	1.01	0.32

Unit of observation is county-year.

The treatment group includes 18 counties.

The control group includes 15 counties.

The procedure uses matching weights to calculate the mean and variance of the control group.

The “% Bias” column reports the standardized percentage bias as the percentage difference in (weighted) means normalized by the average sample standard deviation.

Table A8

Pre-Treatment Total Water Use Trends Included in Nearest-Neighbor Matching

Table A8a. Balance of Covariates

Variable	Mean		% Bias	Sample Means <i>t</i> -test	
	Treated	Control		<i>t</i> -value	<i>p</i> -value
January Temperature	-0.21	-0.53	32.0	0.96	0.34
February Temperature	0.05	-0.17	19.5	0.60	0.55
March Temperature	6.44	6.46	-2.2	-0.07	0.95
April Temperature	12.26	12.46	-17.2	-0.57	0.58
May Temperature	17.62	17.75	-14.2	-0.45	0.66
June Temperature	22.80	22.84	-6.2	-0.2	0.84
July Temperature	26.49	26.49	0.4	0.01	0.99
August Temperature	25.33	25.32	0.9	0.03	0.98
September Temperature	20.07	20.16	-10.7	-0.34	0.73
October Temperature	12.96	13.10	-13.9	-0.44	0.66
November Temperature	6.32	6.33	-0.5	-0.02	0.99
December Temperature	0.69	0.58	11.4	0.36	0.72
January Precipitation	15.99	16.61	-5.9	-0.28	0.79
February Precipitation	19.10	20.94	-19.4	-0.65	0.52
March Precipitation	45.24	41.38	22.1	0.78	0.44
April Precipitation	52.37	51.21	7.7	0.30	0.77
May Precipitation	79.18	80.31	-4.0	-0.14	0.89
June Precipitation	86.49	90.72	-14.8	-0.56	0.58
July Precipitation	69.01	70.09	-9.0	-0.31	0.76
August Precipitation	77.70	76.65	5.4	0.21	0.84
September Precipitation	46.09	53.36	-69.2	-2.03	0.05
October Precipitation	48.37	45.28	17.1	0.70	0.49
November Precipitation	13.98	14.21	-2.9	-0.14	0.89
December Precipitation	27.19	27.64	-5.9	-0.24	0.81
Depth-to-Water	69.19	81.15	-21.2	-0.63	0.54
Income per capita	33,816	32,811	25.5	0.92	0.36
Unemployment	3.50	3.56	-6.8	-0.29	0.77
White	94.16	92.04	34.1	0.93	0.36
BA or higher	18.95	17.65	27.5	1.17	0.25
Male	49.41	49.07	18.3	0.59	0.56
Median Age	41.23	40.46	16.3	0.39	0.70
Population Density	4.37	4.09	0.6	0.18	0.86
Total Water Use	62,567	92,031	-55.4	-0.92	0.36
Water Use Trend	-2,693	-2,920	10.1	0.23	0.82

Unit of observation is county-year.

The treatment group includes 18 counties; the control group includes 13 counties.

The procedure uses matching weights to calculate the mean and variance of the control group.

Table A8b. Regression Results (N=372)

Dependent Variable	Treatment Variable	Model		
		I	II	III
Groundwater	HPA % of County	-603.01 *** (192.77)	-455.22 ** (183.52)	-461.87 ** (177.48)
	Creek % of County	-52.45 (70.93)	-7.43 (47.89)	25.50 (34.95)
Surface water	HPA % of County	-44.24 (34.03)	-50.95 (39.52)	-52.25 (37.77)
	Creek % of County	-2.06 (11.14)	-7.46 (12.83)	-9.72 (14.85)
Inclusion of Control Factors				
	County Indicators	yes	yes	yes
	Year Indicators	yes	yes	yes
	Intermediate Year	yes	yes	yes
	Weather	no	yes	yes
	Depth-to-Water	no	no	yes
	Demographics	no	no	yes

Unit of observation is county-year.

All regressions use matching weights.

Standard errors clustered by county shown in parentheses.

$p < 0.1$ (*), $p < 0.05$ (**), $p < 0.01$ (***)

Table A9

Placebo Test for Control Counties

Dependent Variable	Explanatory Variable	False “Treatment” Group		
		Western/Central Kansas	Adjacent Counties	Adjacent Counties
Groundwater	Treatment Group Indicator	796.62 (714.77)	-1,248.79 (1,748.29)	-1,087.21 (1,942.87)
Surface water	Treatment Group Indicator	-98.08 (254.98)	-60.51 (510.94)	-78.47 (604.11)
Inclusion of Control Factors				
	County Indicators	yes	yes	yes
	Year Indicators	yes	yes	yes
	Intermediate Year	yes	yes	yes
	Weather	no	yes	yes
	Depth-to-Water	no	no	yes
	Demographics	no	no	yes
Sample Features				
	Eastern Kansas	included	included	excluded
	# of Observations	1,044	1,044	732

The sample excludes the 18 WTAP counties regardless of the false “treatment” group.

Treatment group indicator equals one for the false “treatment” group during the time period 2008-2012 and zero for all other observations in the sample.

“Adjacent Counties” share a border with at least one WTAP county.

“Eastern Kansas” consists of the 26 counties located east of the 96th meridian.

Standard errors clustered by county shown in parentheses.

$p < 0.1$ (*), $p < 0.05$ (**), $p < 0.01$ (***)