

Water Use in Southern Illinois

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This report presents an analysis of water use for 1990, 1995, and 2000 in 20 Southern Illinois counties: Alexander, Edwards, Franklin, Gallatin, Hamilton, Hardin, Jackson, Jefferson, Johnson, Massac, Perry, Pope, Pulaski, Randolph, Saline, Union, Wabash, Wayne, White, and Williamson. An analysis of water withdrawals of the agricultural, commercial, domestic, industrial, and other¹ sectors is presented to reveal changes in water consumption patterns over time. The water use data was obtained from the United States Geologic Survey (USGS) water use website.² The USGS assesses water use within five year intervals and then publishes the data every five years.

Key Findings

- Between 1995 and 2000 the average total water withdrawal decrease in Southern Illinois was 53%. This is more than double the average percent reduction of water consumption in the State of Illinois (23.7%).
- The largest water consumer in Southern Illinois was thermoelectric power. The average water consumption (1990, 1995, and 2000) was equivalent to 92.8% of the total water withdrawals in the region. This was followed by the domestic sector (1.0%), agricultural (1.4%), commercial (1.4%), industrial (0.4%), and other sectors (0.6%).
- Generally, Southern Illinois was more dependent on groundwater sources (64.8% in 2000) than surface water sources (35.3% in 2000), as compared to the state which primarily depended on surface water sources (94.01% in 2000).
- The domestic sector
 - Domestic water withdrawals increased by 13.1% between 1990 and 1995.
 - The domestic sector was more dependent on public water supply (71.8% in 1990 and 62.4% in 1995). It is interesting that the domestic sector increased its dependence on self water supply (in 1995, 37.6% of the total water withdrawal came from self supplies, as compared to 28.2% in 1990).
- The commercial sector
 - The total water withdrawals for the commercial sector decreased by 66.1% between 1990 and 1995.
 - The commercial sector mainly relied on self water supplies (70.4% in the year 1995), which were mainly supported by groundwater sources. The

¹ Other sectors involve wastewater treatment and reservoir evaporation

² <http://water.usgs.gov/watuse/>

commercial sector at the state level depended more on public water supplies (80.9% in the year 1995).

- The industrial sector
 - Water withdrawals declined by 45.8% for the industrial sector between 1990 and 1995, which was much higher compared to the average state decline (21.1%).
 - The industrial sector depended both on self water and public water supplies, with more emphasis on self water supplies, primarily groundwater sources.
- The mining sector
 - The water withdrawals for the mining sector increased between 1990 and 1995 by 11.9%.
 - Groundwater resources were predominantly used for the mining sector (62.3% in 1995), in contrast to the state that mainly depends on surface water resources for mining (58.1% in the year 1995).
- The thermoelectric power sector
 - Total withdrawal decreased by 58.6% for the thermoelectric power sector between 1995 and 2000. This decrease in total withdrawals was more than the decrease in the state (34.1%).
 - The thermoelectric power sector depended on surface water resources
- The agricultural sector
 - Between 1990 and 2000, water was increasingly used to support irrigation (83.3% of the water was used for irrigation in 2000 as compared to 63.7% in 1990).
 - For irrigation, groundwater was the most common source. The use of groundwater increased by 34.7% between 1995 and 2000, as compared to the state that increased its withdrawals for irrigation by 16.5%.

The decline in total water withdrawals in Southern Illinois is a positive sign. Decreasing water withdrawals protect the area from suffering from water scarcity issues for all sectors. However, the area faces potential threats in terms of its increasing reliance on self water supplies, particularly in the domestic and industrial sector. Self water supplies typically depend heavily on groundwater sources, and less on surface water sources. As these self water sources are privately owned, water withdrawals from these sources are not monitored. Excessive self water withdrawals from groundwater resources may lead to the overexploitation of these resources and water quality risks, especially if water withdrawals exceed the recharge of groundwater resources.

Introduction

Upon examining the water use data for 1990, 1995, and 2000, it was obvious that there were no consistent patterns of increase or decrease in water withdrawals. To overcome this issue and avoid the loss of any significant information, analysis of water withdrawals was conducted for the first and second five year intervals. Analysis involved calculating the percentage change in water withdrawals for the 1990-1995 and the 1995-2000

intervals. A comparison was conducted to interpret water consumption in the two intervals. Average percentage change in water withdrawal in Southern Illinois for each interval was also calculated and compared to that of the State of Illinois. It is important to note that in some cases, the water use data was not available for the year 2000. Hence, comparative analysis was only conducted for 1990 and 1995. This was a limitation for this assessment. Possible discrepancies in USGS data pose a second limitation.

Regional Water Use Profile

Total Water Use in Southern Illinois

The thermoelectric power sector was the largest consumer of water in Southern Illinois as of 2000. On average, the water use by this sector constituted 92.8% of the total water use of the 20 Southern Illinois counties. The second largest consumer of water was the domestic sector, which withdrew an average of 1.8% of the total water withdrawn. This was followed by the mining (1.5%), agricultural (1.4%) and commercial sectors (1.4%). The industrial water consumption was the lowest water consumer (0.4%). In the State of Illinois the largest consumer of water was also the thermoelectric power sector (84.0%), followed by the domestic (5.5%), commercial (3.2%), industrial (2.7%), and agricultural sectors (1.5%) sectors. Agricultural water withdrawal in Southern Illinois (1.4%) was very close to that of the state (1.5%) (Figure 1).

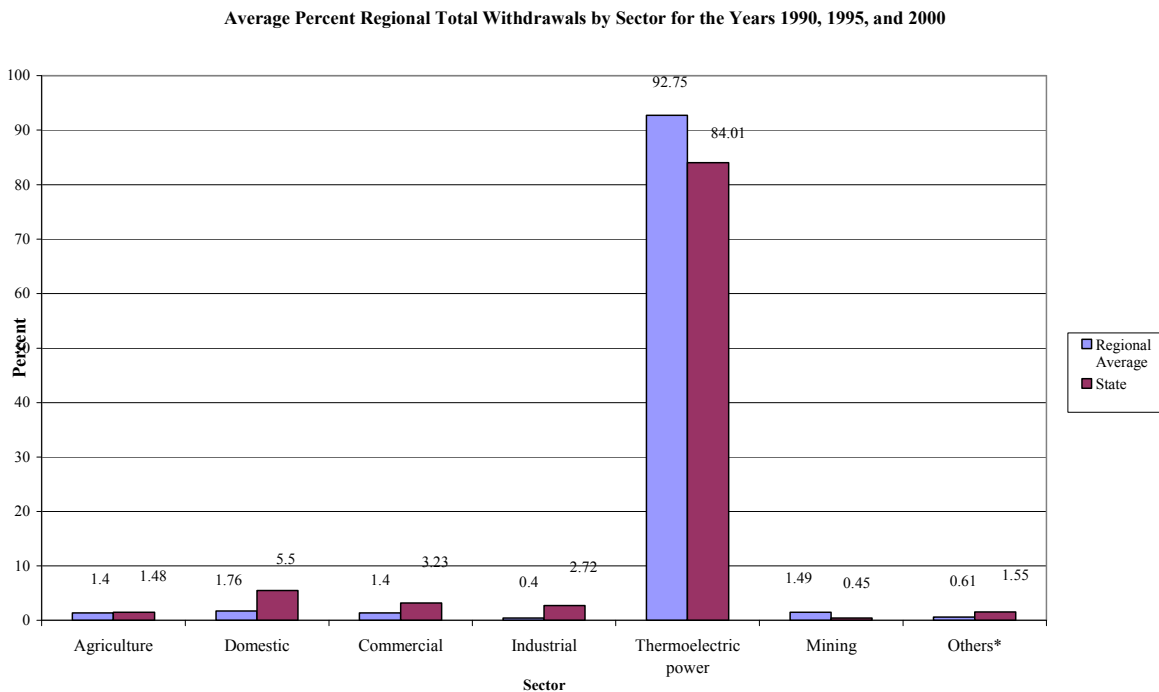


Figure 1. Agricultural, Domestic, Commercial, Industrial, Thermoelectric power, Mining, and Other Sectors Water Use in Southern Illinois Counties for 1990, 1995, and 2000.

On average, the 20 Southern Illinois counties included in this assessment decreased their water withdrawals between 1995 and 2000 by 57.2%, after an increase of 9.9% between 1990 and 1995. The average decrease in Southern Illinois is higher than the average decrease in the state. The largest decrease in water withdrawals between 1995 and 2000 occurred in Randolph County (-96.8%), where water withdrawals decreased from 1,179.4 Mgal/d to 37.37 Mgal/d. This was followed by Perry (-86.7%), Hardin (-85.6%), Wabash (-72.4%), Edwards (-70.1%), Pope (-67.9%), and White (-54.7%) counties. Despite this average decrease in total water withdrawals between 1995 and 2000 in Southern Illinois, Williamson County tremendously increased its water withdrawals by 690.3% and also exceeded withdrawals from 1990 (Table 1).

Table 1. Total Water Withdrawals, 1990, 1995, and 2000

<i>County</i>	<i>Total Water Withdrawals (Mgal/d)</i>			<i>Percent Change (1990-1995)</i>	<i>Percent Change (1995-2000)</i>
	<i>1990</i>	<i>1995</i>	<i>2000</i>		
Alexander	2.33	2.45	3.06	5.15	24.90
Edwards	1.39	1.67	0.50	20.14	-70.06
Franklin	16.36	15.72	14.71	-3.91	-6.42
Gallatin	9.20	10.22	12.76	11.09	24.85
Hamilton	1.54	0.99	0.63	-35.71	-36.36
Hardin	1.62	2.77	0.40	70.99	-85.56
Jackson	177.97	190.91	116.89	7.27	-38.77
Jefferson	5.84	3.53	1.56	-39.55	-55.81
Johnson	1.44	1.96	2.10	36.11	7.14
Massac	476.81	592.23	564.93	24.21	-4.61
Perry	10.83	11.34	1.51	4.71	-86.68
Pope	0.26	0.53	0.17	103.85	-67.92
Pulaski	1.06	1.31	0.97	23.58	-25.95
Randolph	1053.25	1179.41	37.37	11.98	-96.83
Saline	4.88	0.86	0.47	-82.38	-45.35
Union	3.13	3.84	2.17	22.68	-43.49
Wabash	3.82	7.83	2.16	104.97	-72.41
Wayne	4.59	5.37	2.98	16.99	-44.51
White	9.34	6.44	4.23	-31.05	-34.32
Williamson	82.91	13.76	108.75	-83.40	690.33
Southern Illinois Average	93.43	102.66	43.92	9.88	-57.22
State Average	176.63	195.32	134.75	10.58	-31.01

Water Supply in Southern Illinois

The mining, thermoelectric, and agricultural sectors depend only on self water supplies to support their activities. Between 1990 and 1995, the use of self water supplies increased for both the domestic and industrial sectors, but decreased for the commercial sector. In the domestic sector, the self water supply use was at 28.2% in the year 1990 and

increased to 37.6% in the year 1995. Regarding the industrial sector, self water supply use was at 60.4% in the year 1990 and increased to 71.4% in the year 1995. As for the commercial sector, self water supply use was at 97.3% in the year 1990 and decreased to 79.9% in the year 1995 (Figure 2).

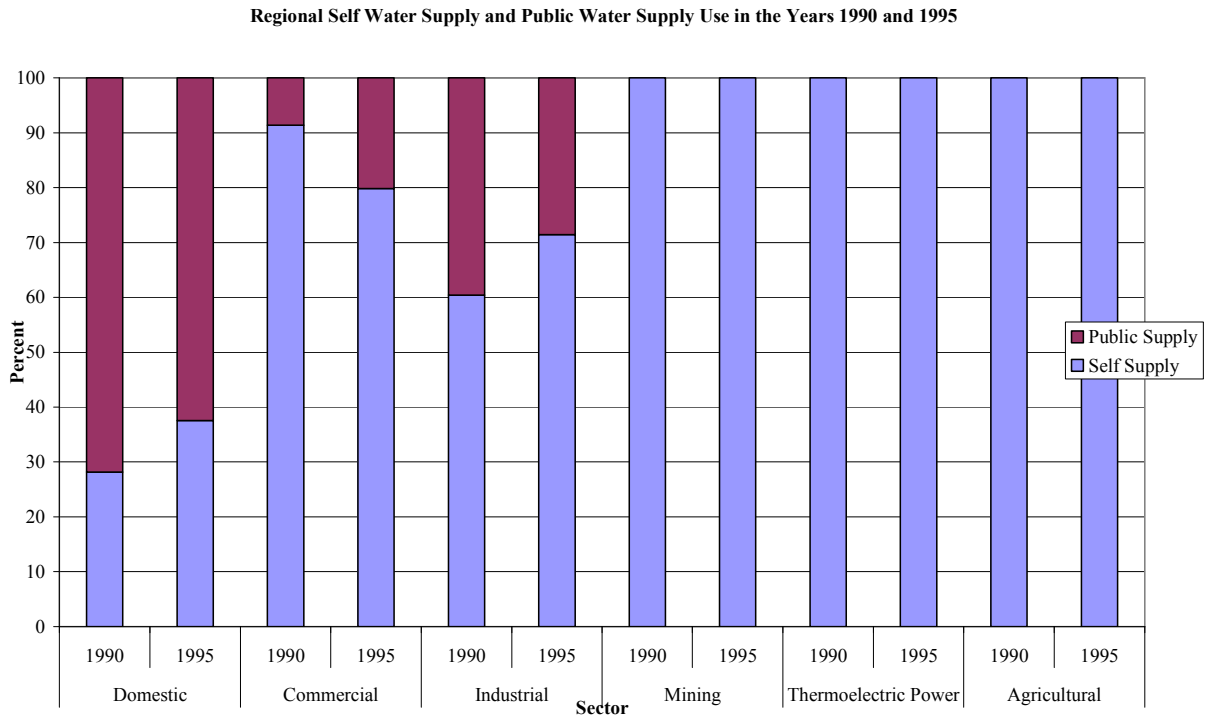


Figure 2. Percent Self Water Supply and Public Water Supply Use in the Southern Illinois Region in 1990 and 1995

Groundwater and Surface Water Use in Southern Illinois

All of the Southern Illinois counties depended on both groundwater and surface water sources. Generally, groundwater use in the designated counties exceeded surface water use. The use of groundwater increased between 1990 and 2000. The situation generally differs at the state level, where the state depends heavily on surface water, rather than ground water (Figure 3).

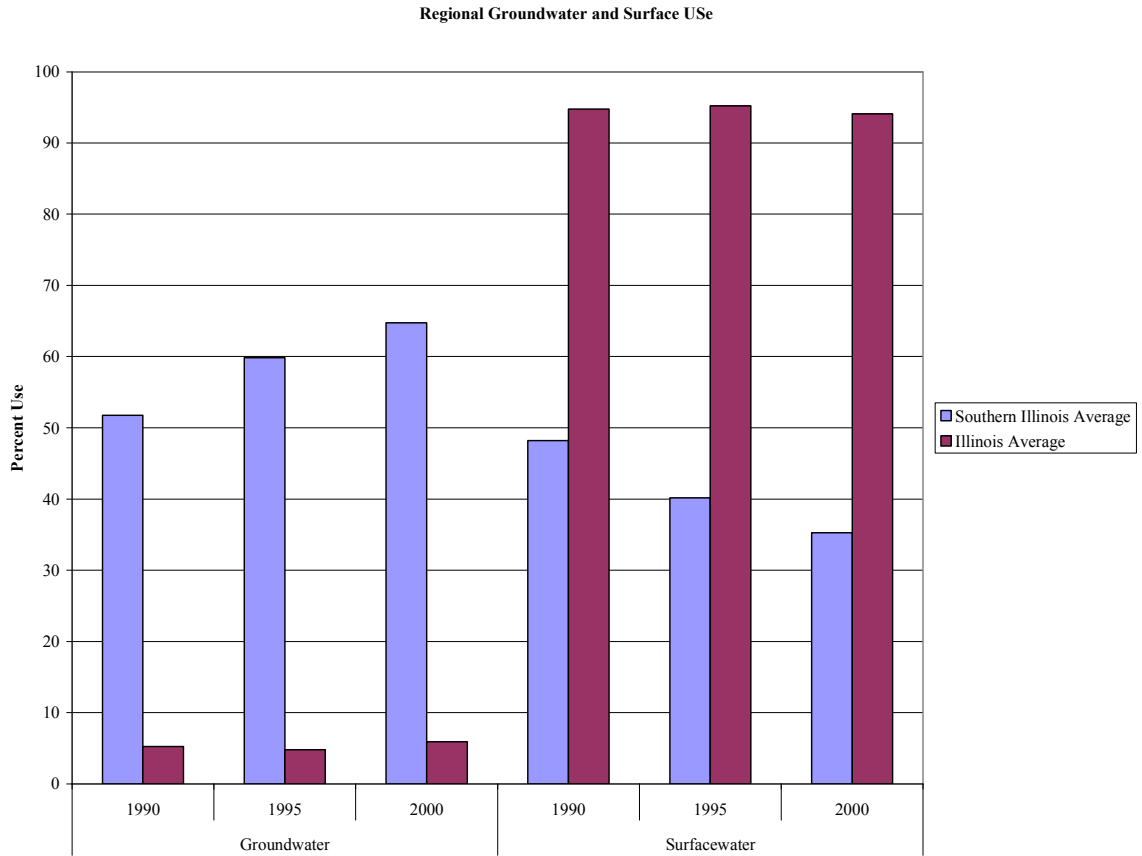


Figure 3. Percent Regional Groundwater and Surface Water Use in 1990, 1995, and 2000

Domestic Water Use

Total Domestic Water Withdrawal

While the average state domestic water withdrawals decreased by 87.3% between 1990 and 1995, the average domestic water withdrawals in Southern Illinois increased by 13.1%. The highest increase in domestic water withdrawals occurred in Johnson County (42.3%), followed by Jackson County (20.2%), Union County (17.3), and Williamson County (16.7%) (Table 2).

Table 2. Total Domestic Water Withdrawals (Mgal/day), 1990 and 1995

	<i>1990</i>	<i>1995</i>	<i>Percent Change</i>
Alexander	0.88	0.91	3.41
Edwards	0.65	0.65	0.00
Franklin	3.38	3.67	8.58
Gallatin	0.57	0.61	7.02
Hamilton	0.72	0.76	5.56
Hardin	0.44	0.46	4.55
Jackson	4.60	5.53	20.22
Jefferson	2.98	3.51	17.79
Johnson	0.78	1.11	42.31
Massac	1.21	1.39	14.88
Perry	1.70	1.92	12.94
Pope	0.38	0.43	13.16
Pulaski	0.66	0.68	3.03
Randolph	2.76	3.09	11.96
Saline	2.23	2.39	7.17
Union	1.39	1.63	17.27
Wabash	1.11	1.16	4.50
Wayne	1.41	1.55	9.93
White	1.37	1.43	4.38
Williamson	4.61	5.38	16.70
Southern Illinois Average	1.69	1.91	13.09
State Average	9.99	1.27	-87.29

The domestic sector in all 20 counties of Southern Illinois was primarily dependent on public water supply. However, the counties were not as dependent on public water supply as the state (Table 8). On average, as the reliance on public water supply in Southern Illinois counties decreased between 1990 and 1995, the reliance on self water supply³ increased. In the year 1990, 28.2% of the total domestic water withdrawals were from self water supplies, which increased to 37.6% in the year 1995. The displayed domestic self water withdrawals were higher than the state average (11.3% in 1990 and 12.2% in 1995) (Table 3).

Four counties (Massac, Pope, Union, Wayne, and Williamson) dramatically reduced their reliance on public water supplies by the year 1995. Saline County depended completely on public water supply (100%) in the year 1995 (Table 3).

³ Self water supply use is the “water withdrawn from a ground-water or surface-water source by a user rather than being obtained from a public supply” (USGS, no date, p.13, <http://pubs.usgs.gov/chapter11/chapter11M.html>).

Self Water Supply

Groundwater sources were used for domestic self water withdrawals. Since no surface water withdrawals are reported, that category is not shown in Table 4. Between 1990 and 1995, domestic water withdrawals from self water supplies significantly increased in Southern Illinois counties by an average of 56.4%, compared to 12.4% in the state. The highest increase occurred in Williamson County (1,085.7%), followed by Pope County (700%), Massac County (370.37%), Wabash County (206.3%), and Hardin County (133.3%) (Table 4).

Between 1995 and 2000, domestic self water supply in the counties of Southern Illinois further increased by an average of 5.3%, compared to 4.7% in the state. The highest increase was in Hamilton County (+100%), followed by Randolph County (56.3%), White County (55%), and Gallatin County (+53%) (Table 4).

Table 3. Proportion of Self and Public Water Domestic Sources Use, 1990 and 1995

<i>County</i>	<i>1990</i>			<i>1995</i>		
	<i>Percent Self Supplied Sources</i>	<i>Percent Public Water Sources</i>	<i>Total</i>	<i>Percent Self Supplied Sources</i>	<i>Percent Public Water Sources</i>	<i>Total</i>
Alexander	8.65	91.35	100	5.89	94.11	100
Edwards	56.45	43.55	100	38.15	61.85	100
Franklin	18.48	81.52	100	3.95	96.05	100
Gallatin	19.39	80.61	100	25.07	74.93	100
Hamilton	55.53	44.47	100	30.28	69.72	100
Hardin	15.61	84.39	100	30.50	69.50	100
Jackson	7.27	92.73	100	7.66	92.34	100
Jefferson	23.93	76.07	100	23.23	76.77	100
Johnson	53.74	46.26	100	68.3	31.70	100
Massac	23.46	76.54	100	91.61	8.39	100
Perry	48.81	51.19	100	15.92	84.08	100
Pope	10.76	89.24	100	74.63	25.37	100
Pulaski	39.36	60.64	100	48.53	51.47	100
Randolph	23.8	76.20	100	25.92	74.08	100
Saline	12.77	87.23	100	0.00	100.00	100
Union	35.58	64.42	100	90.45	9.55	100
Wabash	27.23	72.77	100	26.06	73.94	100
Wayne	49.48	50.52	100	86.00	14.00	100
White	29.78	70.22	100	28.24	71.76	100
Williamson	3.22	96.78	100	30.86	69.14	100
Southern			100			100
Illinois Average	28.17	71.84		37.56	62.44	
State Average	11.31	88.69	100	12.17	87.83	100

Table 4. Groundwater and Surface Water Withdrawals for Domestic Self Supplies, 1990, 1995, 2000

<i>County</i>	<i>Self Supplied Groundwater Withdrawals</i>				
	<i>1990</i>	<i>1995</i>	<i>2000</i>	<i>Percent Change (1990-1995)</i>	<i>Percent Change (1995-2000)</i>
Alexander	0.07	0.05	0.09	-28.57	80.00
Edwards	0.33	0.25	0.23	-24.24	-8.00
Franklin	0.59	0.14	0.13	-76.27	-7.14
Gallatin	0.11	0.15	0.23	36.36	53.33
Hamilton	0.37	0.23	0.46	-37.84	100.00
Hardin	0.06	0.14	0.14	133.33	0.00
Jackson	0.26	0.42	0.17	61.54	-59.52
Jefferson	0.70	0.82	1.19	17.14	45.12
Johnson	0.46	0.76	0.83	65.22	9.21
Massac	0.27	1.27	1.17	370.37	-7.87
Perry	0.79	0.31	0.36	-60.76	16.13
Pope	0.04	0.32	0.05	700.00	-84.38
Pulaski	0.22	0.33	0.36	50.00	9.09
Randolph	0.62	0.80	1.25	29.03	56.25
Saline	0.27	0.00	0.22	-100.00	NA
Union	0.48	1.47	1.40	206.25	-4.76
Wabash	0.28	0.30	0.33	7.14	10.00
Wayne	0.68	1.33	0.71	95.59	-46.62
White	0.39	0.40	0.62	2.56	55.00
Williamson	0.14	1.66	1.80	1085.71	8.43
Southern Illinois Average	0.36	0.56	0.59	56.38	5.29
State Average	1.13	1.27	1.33	12.39	4.72

Commercial Water Supply

Total Self Water Withdrawals and Public Water Supply Deliveries

The average decrease in commercial⁴ water withdrawal in Southern Illinois was more than the water withdrawal decrease for the state of Illinois. The 20 Southern Illinois counties decreased their commercial water withdrawals by an average of 66.1%, compared to the state withdrawal for commercial supply (19%) (Table 5).

According to the data, all counties withdrew water to supply the commercial sector except Hamilton and Perry Counties. This seems unrealistic for these two counties; this may be a discrepancy in the data.

⁴ “Commercial water use includes water used by commercial facilities such as hotels, motels, restaurants, office buildings, government and military facilities, hospitals, educational institutions, and retail sales stores.” (USGS, no date, p. 1, <http://pubs.usgs.gov/chapter11/chapter11E.html>)

Between 1990 and 1995, Alexander, Edwards, Franklin, Jackson, Jefferson, Massac, Pulaski, Saline, Union, Wabash, and Williamson counties decreased their total withdrawals. The largest drop in water withdrawal was in Franklin County (100%), followed by Saline County (96.4%) and Jackson County (89.4%). On the other hand, White County increased its total water withdrawal by 400%. Also, Johnson County, Pope County, and White County, while not withdrawing water for commercial purposes in 1990, did so in 1995. The 2000 data is not available to indicate whether there has been a change in commercial water withdrawal between 1995 and 2000 in these three counties (Table 5).

Table 5. Total Commercial Water Withdrawals (Mgal/d) from Self Supplied Sources and Delivery from Public Water Supply, 1990 and 1995

<i>County</i>	<i>Total Withdrawals and Deliveries (Mgal/d)</i>		
	<i>1990</i>	<i>1995</i>	<i>Percent Change</i>
Alexander	0.21	0.14	-33.33
Edwards	0.11	0.10	-9.09
Franklin	0.13	0.00	-100.00
Gallatin	0.04	0.04	0.00
Hamilton	0.00	0.00	-
Hardin	0.01	0.02	100.00
Jackson	24.82	2.63	-89.40
Jefferson	1.97	0.38	-80.71
Johnson	0.00	0.74	NA
Massac	1.40	0.41	-70.71
Perry	0.00	0.00	-
Pope	0.00	0.58	NA
Pulaski	0.27	0.08	-70.37
Randolph	0.21	0.21	0.00
Saline	1.37	0.05	-96.35
Union	0.92	0.76	-17.39
Wabash	0.17	0.15	-11.76
Wayne	0.04	0.05	25.00
White	0.02	0.10	400.00
Williamson	8.42	7.16	-14.96
Southern Illinois			
Average	2.01	0.68	-66.09
State Average	6.58	5.33	-19.00

Water Supply

Water supply for the commercial sector in the Southern Illinois counties was mainly self supply (91.37% in 1990 and 79.85% in 1995). The situation is different at the state level, where the commercial sector relies more on public water supply, rather than self water supply (Table 6).

Table 6. Proportions of Commercial Self Supplied Water Withdrawals and Public Water Supply Deliveries (%), 1990 and 1995

<i>County</i>	<i>1990</i>		<i>1995</i>	
	<i>Self Supply</i>	<i>Public Supply</i>	<i>Self Supply</i>	<i>Public Supply</i>
Alexander	33.33	66.67	0.00	100.00
Edwards	0.00	100.00	0.00	100.00
Franklin	0.00	100.00	0.00	0.00
Gallatin	0.00	100.00	0.00	100.00
Hamilton	*	*	0.00	0.00
Hardin	0.00	100.00	0.00	100.00
Jackson	98.83	1.17	90.87	9.13
Jefferson	95.94	4.06	5.26	94.74
Johnson	*	*	14.86	85.14
Massac	99.29	0.71	100.00	0.00
Perry	*	*	*	*
Pope	*	*	0.00	100.00
Pulaski	59.26	40.74	50.00	50.00
Randolph	0.00	100.00	0.00	100.00
Saline	0.00	100.00	0.00	100.00
Union	92.39	7.61	98.68	1.32
Wabash	11.76	88.24	13.33	86.67
Wayne	0.00	100.00	0.00	100.00
White	0.00	100.00	0.00	100.00
Williamson	91.92	8.08	99.44	0.56
Southern Illinois Counties' Average	36.4	63.6	26.2	68.2
State	25.81	74.19	19.13	80.87

* indicates that data was not reported

Self Water Supply Withdrawals

Between 1990 and 1995, self water supply at the regional and state level declined. On average, self water supply withdrawals declined in the Southern Illinois counties and the state by 70.4% and 40%, respectively. Self water supply withdrawals dramatically declined in Alexander County (100%), Jefferson County (99%), Jackson County (90.3%), Pulaski (75%), and Massac County (70.5%). Almost half of the counties do not rely on self water supply to support the commercial sector (Table 7).

Public Water Supply Deliveries⁵

Between 1990 and 1995, Public Water Supply (PWS) deliveries decreased in the Southern Illinois counties and the state by 20.8% and 11.7%, respectively. While PWS delivery increased in Jefferson County (350%), Hardin County (100%), Wayne County (25%) and White County (400%), it decreased in Saline County (96.4%), Williamson County (94.1%), Union County (85.7%), Pulaski County (63.6%), Wabash County (13.3%), and Edwards County (9.1%). PWS deliveries in Franklin and Massac counties, which were very small in 1990, disappeared by 1995. (Table 7).

Table 7. Commercial Water Withdrawals from Self Water Supply and Public Water Supply, 1990 and 1995

<i>County</i>	<i>Self Supplied (Mgal/d)</i>			<i>Deliveries from Water Supply (Mgal/d)</i>		
	<i>1990</i>	<i>1995</i>	<i>Percent Change</i>	<i>1990</i>	<i>1995</i>	<i>Percent Change</i>
Alexander	0.07	0.00	-100.00	0.14	0.14	-
Edwards	0.00	0.00	-	0.11	0.10	-9.09
Franklin	0.00	0.00	-	0.13	0.00	-100.00
Gallatin	0.00	0.00	-	0.04	0.04	0.00
Hamilton	0.00	0.00	-	0.00	0.00	-
Hardin	0.00	0.00	-	0.01	0.02	100.00
Jackson	24.53	2.39	-90.26	0.29	0.24	-17.24
Jefferson	1.89	0.02	-98.94	0.08	0.36	350.00
Johnson	0.00	0.11	NA	0.00	0.63	NA
Massac	1.39	0.41	-70.50	0.01	0.00	-100.00
Perry	0.00	0.00	-	0.00	0.00	-
Pope	0.00	0.00	-	0.00	0.58	NA
Pulaski	0.16	0.04	-75.00	0.11	0.04	-63.64
Randolph	0.00	0.00	-	0.21	0.21	0.00
Saline	0.00	0.00	-	1.37	0.05	-96.35
Union	0.85	0.75	-11.76	0.07	0.01	-85.71
Wabash	0.02	0.02	0.00	0.15	0.13	-13.33
Wayne	0.00	0.00	-	0.04	0.05	25.00
White	0.00	0.00	-	0.02	0.10	400.00
Williamson	7.74	7.12	-8.01	0.68	0.04	-94.12
Southern Illinois						
Average	1.83	0.54	-70.37	0.17	0.14	-20.81
State Average	1.70	1.02	-40.00	4.88	4.31	-11.68

⁵ “Public-supply delivery: Water delivered to a user or group of users through a public-supply distribution system.” (USGS, no date, p.11., <http://pubs.usgs.gov/chapter11/chapter11M.html>)

Sources of Self Water Supply

Both groundwater and surface water were used to support self water supplies. As is the case in the state of Illinois as a whole, the Southern Illinois counties' average reflect that in 1990 groundwater sources were used more than surface water sources. The situation changed in 1995, where the opposite became true (Table 8).

Groundwater Withdrawal

Between 1990 and 1995, groundwater sources were used in Jackson, Johnson, Massac, Pulaski, and Union counties. With time, groundwater use dramatically decreased by 85.9%. The average decrease in groundwater withdrawals was more than the state average (69.8%). The highest decrease in groundwater withdrawals for self water supply was in Alexander County (-100%), followed by Jackson County (-90.3%), Pulaski County (-75%), and Massac County (-70.5%) (Table 8).

Surface Water Withdrawal

Surface water resources were used only in Jefferson and Williamson counties for self water supply. In 1995, surface water withdrawals decreased dramatically in Jefferson counties (98.9%). Also, in Williamson, the use of surface water decreased by 8.0% (Table 8).

Table 8. Groundwater and Surface Water Withdrawals (Mgal/d) for Commercial Water Supply, 1990 and 1995

<i>County</i>	<i>Water Withdrawals for Self Water Supply</i>					
	<i>Groundwater</i>			<i>Surface Water</i>		
	<i>1990</i>	<i>1995</i>	<i>Percent Change (1990-1995)</i>	<i>1990</i>	<i>1995</i>	<i>Percent Change (1990-1995)</i>
Alexander	0.07	0.00	-100.00	0.00	0.00	-
Edwards	0.00	0.00	-	0.00	0.00	-
Franklin	0.00	0.00	-	0.00	0.00	-
Gallatin	0.00	0.00	-	0.00	0.00	-
Hamilton	0.00	0.00	-	0.00	0.00	-
Hardin	0.00	0.00	-	0.00	0.00	-
Jackson	24.53	2.39	-90.26	0.00	0.00	-
Jefferson	0.00	0.00	-	1.89	0.02	-98.94
Johnson	0.00	0.11	-	0.00	0.00	-
Massac	1.39	0.41	-70.50	0.00	0.00	-
Perry	0.00	0.00	-	0.00	0.00	-
Pope	0.00	0.00	-	0.00	0.00	-
Pulaski	0.16	0.04	-75.00	0.00	0.00	-
Randolph	0.00	0.00	-	0.00	0.00	-
Saline	0.00	0.00	-	0.00	0.00	-
Union	0.85	0.75	-11.76	0.00	0.00	-
Wabash	0.02	0.02	0.00	0.00	0.00	-
Wayne	0.00	0.00	-	0.00	0.00	-
White	0.00	0.00	-	0.00	0.00	-
Williamson	0.00	0.00	-	7.74	7.12	-8.01
Southern Illinois			-86.2			-25.0
Average	1.35	0.19		0.48	0.36	
State Average	0.53	0.16	-69.8	0.17	0.86	405.9

Industrial Water Use

Total Self Water Withdrawals and Public Water Supply Deliveries

The total industrial⁶ water withdrawals and deliveries in the 20 Southern Illinois counties and the state decreased by an average of 45.8% and 21.6%, respectively. Almost all counties withdrew water to supply the industrial sector. However, industrial water withdrawals varied across counties. Between 1990 and 1995, there was a decrease in water withdrawals and deliveries in almost half of the counties such as, Alexander

⁶ “Industrial water use: Water used for industrial purposes, such as fabrication, processing, washing, in-plant conveyance, and cooling, and includes such industries as steel, chemicals, paper, and petroleum refining. The water may be obtained from a public water supply or may be self supplied.” (USGS, no date, p. 5, <http://pubs.usgs.gov/chapter11/chapter11M.html>)

County (10.0%), Franklin County (100%), Hardin County (100.0%), Jackson County (95.8%), Jefferson County (100%), Massac County (21.7%), Perry County (96.7%), Randolph County (81.3%), Saline County (100.0%), Union County (100.0%), and Wabash County (60.0%). Franklin, Hardin, Saline, and Union countries stopped their water withdrawals for industrial purposes in 1995 (which may also be attributed to discrepancy in the data) (Table 9).

Table 9. Total Industrial Self Water Withdrawals and Public Water Supply Deliveries (Mgal/d), 1990 and 1995

<i>County</i>	<i>1990</i>	<i>1995</i>	<i>Percent Change</i>
Alexander	0.40	0.36	-10.00
Edwards	0.03	0.04	33.33
Franklin	0.19	0.00	-100.00
Gallatin	0.00	0.00	-
Hamilton	0.00	0.00	-
Hardin	0.11	0.00	-100.00
Jackson	2.41	0.10	-95.85
Jefferson	0.02	0.00	-100.00
Johnson	0.00	0.00	-
Massac	4.87	3.81	-21.77
Perry	0.61	0.02	-96.72
Pope	0.00	0.00	-
Pulaski	0.02	0.04	100.00
Randolph	0.16	0.03	-81.25
Saline	0.39	0.00	-100.00
Union	0.06	0.00	-100.00
Wabash	0.15	0.06	-60.00
Wayne	0.00	0.00	-
White	0.00	0.08	increased
Williamson	0.47	0.82	74.47
Southern Illinois Average	0.49	0.27	-45.80
State Average	7.13	5.59	-21.60

Water Sources

Self water supplies and public water supplies were used to supply the industrial sector in the Southern Illinois counties. The use of these supplies varied across Southern Illinois. Most of the counties use a single source to supply the industrial sector, mainly public water supply. Exceptions are Alexander County and Williamson County, which used both supplies. On the other hand, Massac County and Perry County relied completely on self water supply in 1990 and 1995 (Table 10).

Table 10. Proportion of Industrial Self Water Supply and Public Water Supply Use (percent), 1990 and 1995

<i>County</i>	<i>1990</i>		<i>1995</i>	
	<i>Self Supply</i>	<i>Public Supply</i>	<i>Self Supply</i>	<i>Public Supply</i>
Alexander	2.50	97.50	2.78	97.22
Edwards	0.00	100.00	0.00	100.00
Franklin	0.00	100.00	0.00	0.00
Gallatin	0.00	0.00	0.00	0.00
Hamilton	0.00	0.00	0.00	0.00
Hardin	0.00	100.00	0.00	0.00
Jackson	0.00	100.00	0.00	100.00
Jefferson	0.00	100.00	0.00	0.00
Johnson	0.00	0.00	0.00	0.00
Massac	100.00	0.00	100.00	0.00
Perry	100.00	0.00	100.00	0.00
Pope	0.00	0.00	0.00	0.00
Pulaski	0.00	100.00	0.00	100.00
Randolph	0.00	100.00	0.00	100.00
Saline	0.00	100.00	0.00	0.00
Union	0.00	100.00	0.00	0.00
Wabash	0.00	100.00	0.00	100.00
Wayne	0.00	0.00	0.00	0.00
White	0.00	0.00	0.00	100.00
Williamson	85.11	14.89	0.00	100.00

Self Water Supply Withdrawals

Between 1990 and 1995, there have been declines in water withdrawals from self water supplies in the Southern Illinois counties and the state by 34.5% and 2.6%, respectively. Industrial self water supply withdrawals in the counties were only found for Alexander, Massac, and Perry counties. Between 1990 and 1995, industrial self water supply withdrawals in Massac County and Pope County declined by 21.8% and 96.7%, respectively. As for Alexander County, water withdrawals from self water supplies did not change. According to the data, Williamson County ceased withdrawing water from self water supplies (Table 11).

Only fresh water sources were used for self water supply. Fresh groundwater sources were used in Massac and Perry counties. Fresh surface water sources were no longer used in Perry and Williamson counties by the year 1995 (Table 12). This finding may be due to data discrepancies.

Public Water Supply Deliveries

Despite that most of Southern Illinois depended on PWS supplies, the quantity of water delivered from PWS was less than the water quantity withdrawn from self water supplies.

PWS deliveries decreased between 1990 and 1995 in the counties and the state by 62.0% and 55.4%, respectively. The highest decrease occurred in Jackson County (95.9%), Randolph County (81.3%), and Wabash County (60.0%). In 1995, counties such as Franklin, Hardin, Jefferson, Saline, and Union no longer used PWS to support the industrial sector (Table 11).

Despite the decrease in PWS deliveries in most of the counties, PWS deliveries increased tremendously in Williamson County (1,071.4%). Increases also occurred in Pulaski County (100%) and Edwards County (33.3%) (Table 11).

Table 11. Industrial Water Withdrawals and Deliveries (Mgal/d) from Self Supplied and Public Supply Water Sources, 1990, 1995, and 2000.

<i>County</i>	<i>Self Supplied Water Withdrawals</i>			<i>Public Supply Water Deliveries</i>		
	<i>1990</i>	<i>1995</i>	<i>Percent Change</i>	<i>1990</i>	<i>1995</i>	<i>Percent Change</i>
Alexander	0.01	0.01	0.00	0.39	0.35	-10.26
Edwards	0.00	0.00	-	0.03	0.04	33.33
Franklin	0.00	0.00	-	0.19	0.00	-100.00
Gallatin	0.00	0.00	-	0.00	0.00	-
Hamilton	0.00	0.00	-	0.00	0.00	-
Hardin	0.00	0.00	-	0.11	0.00	-100.00
Jackson	0.00	0.00	-	2.41	0.10	-95.85
Jefferson	0.00	0.00	-	0.02	0.00	-100.00
Johnson	0.00	0.00	-	0.00	0.00	-
Massac	4.87	3.81	-21.77	0.00	0.00	-
Perry	0.61	0.02	-96.72	0.00	0.00	-
Pope	0.00	0.00	-	0.00	0.00	-
Pulaski	0.00	0.00	-	0.02	0.04	100.00
Randolph	0.00	0.00	-	0.16	0.03	-81.25
Saline	0.00	0.00	-	0.39	0.00	-100.00
Union	0.00	0.00	-	0.06	0.00	-100.00
Wabash	0.00	0.00	-	0.15	0.06	-60.00
Wayne	0.00	0.00	-	0.00	0.00	-
White	0.00	0.00	-	0.00	0.08	NA
Williamson	0.40	0.00	-100.00	0.07	0.82	1,071.43
Southern Illinois Average	0.29	0.19	-34.5	0.20	0.08	-62.0
State Average	4.55	4.43	-2.6	2.58	1.15	-55.4

Table 12. Sources of Industrial Self Water Supplies, 1990, 1995, and 2000

<i>County</i>	<i>Total Groundwater Withdrawal (Mgal/d)</i>			<i>Total Surface Water Withdrawal (Mgal/d)</i>		
	<i>1990</i>	<i>1995</i>	<i>2000</i>	<i>1990</i>	<i>1995</i>	<i>2000</i>
Alexander	0.01	0.01	0.00	0.00	0.00	0.00
Edwards	0.00	0.00	0.00	0.00	0.00	0.00
Franklin	0.00	0.00	0.00	0.00	0.00	0.00
Gallatin	0.00	0.00	0.00	0.00	0.00	0.00
Hamilton	0.00	0.00	0.00	0.00	0.00	0.00
Hardin	0.00	0.00	0.00	0.00	0.00	0.00
Jackson	0.00	0.00	0.00	0.00	0.00	0.00
Jefferson	0.00	0.00	0.00	0.00	0.00	0.00
Johnson	0.00	0.00	0.00	0.00	0.00	0.00
Massac	4.87	3.81	3.74	0.00	0.00	0.00
Perry	0.00	0.02	0.00	0.61	0.00	0.00
Pope	0.00	0.00	0.00	0.00	0.00	0.00
Pulaski	0.00	0.00	0.00	0.00	0.00	0.00
Randolph	0.00	0.00	0.00	0.00	0.00	0.00
Saline	0.00	0.00	0.00	0.00	0.00	0.00
Union	0.00	0.00	0.00	0.00	0.00	0.00
Wabash	0.00	0.00	0.00	0.00	0.00	0.00
Wayne	0.00	0.00	0.00	0.00	0.00	0.00
White	0.00	0.00	0.00	0.00	0.00	0.00
Williamson	0.00	0.00	0.00	0.40	0.00	0.00

Mining Water Use

Total Water Withdrawals

On average, water withdrawals to support mining activities in Southern Illinois counties were more than those of the state for 1990 and 1995. Water withdrawals for mining decreased in Southern Illinois and the state by 11.8% and 19.6%, respectively (Table 13). Findings related to mining water use should be consulted in conjunction with data from the Income and Employment Report section on mining.

Water withdrawals and deliveries to support mining activities were identified in all counties except Alexander, Johnson, Massac, Pope, Pulaski, and Union counties. In 1995, Perry County had the highest water withdrawals and deliveries, followed by White County, Franklin County, and Hardin County (Table 13).

Between 1990 and 1995, water withdrawals and deliveries related to mining increased in Perry County by 24.7%. The highest increase in water withdrawals and deliveries for mining occurred in Hardin County (95.7%), followed by Wabash County (25.4%) and Perry County (24.7%) (Table 13).

On the other hand, between 1990 and 1995, decreases in water withdrawal for mining occurred in Franklin County (11.0%), Gallatin County (57.2%), Hamilton County (38.6%), Jackson County (100%), Randolph County (59.7%), Saline County (84.0%), and Williamson County (12.6%). Mining related water withdrawal did not change in Edwards, Wayne, and White counties (Table 13).

Table 13. Total Mining Water Withdrawals (Mgal/d), 1990 and 1995

<i>County</i>	<i>1990</i>	<i>1995</i>	<i>Percent Change</i>
Alexander	0.00	0.00	-
Edwards	0.49	0.49	0.00
Franklin	2.72	2.42	-11.03
Gallatin	2.97	1.27	-57.24
Hamilton	0.83	0.51	-38.55
Hardin	1.16	2.27	95.69
Jackson	0.72	0.00	-100.00
Jefferson	1.60	1.72	7.50
Johnson	0.00	0.00	-
Massac	0.00	0.00	-
Perry	7.86	9.80	24.68
Pope	0.00	0.00	0.00
Pulaski	0.00	0.00	0.00
Randolph	0.67	0.27	-59.70
Saline	4.13	0.66	-84.02
Union	0.00	0.00	-
Wabash	1.34	1.68	25.37
Wayne	1.71	1.71	0.00
White	2.58	2.58	0.00
Williamson	2.13	1.86	-12.68
Southern Illinois Average	1.55	1.36	-11.87
State Average	0.92	0.74	-19.57

Sources of Water Supplies

Both surface and groundwater sources were used for mining activities. The Southern Illinois counties depended on groundwater sources more than surface water sources to supply mining activities. This is in contrast to the state which depended more on surface water sources to support such activities (Table 14).

Water withdrawals from groundwater and surface water sources varied across the counties. Some counties depended completely on ground water sources while others, such as Randolph County, totally depended on surface water sources. Other counties reduced their reliance on groundwater sources and increased their dependency on surface waters by 1995 such as Jefferson and Perry counties. The opposite is true for Gallatin,

Hamilton, and Saline counties where dependence on ground water sources to supply the mining activities increased (Table 14).

Table 14. Proportions of Groundwater and Surface Water Use to Support Mining Activities, 1990 and 1995

<i>County</i>	<i>Percent Groundwater Use</i>		<i>Percent Surface Water Use</i>	
	<i>1990</i>	<i>1995</i>	<i>1990</i>	<i>1995</i>
Alexander	-	-	-	-
Edwards	100.00	100.00	0.00	0.00
Franklin	9.19	9.50	90.81	90.50
Gallatin	60.94	100.00	39.06	0.00
Hamilton	61.45	100.00	38.55	0.00
Hardin	100.00	100.00	0.00	0.00
Jackson	-	-	100.00	0.00
Jefferson	48.13	44.77	51.88	55.23
Johnson	-	-	-	-
Massac	-	-	-	-
Perry	16.41	0.51	83.59	99.49
Pope	-	-	-	-
Pulaski	-	-	-	-
Randolph	0.00	0.00	100.00	100.00
Saline	8.47	53.03	91.53	46.97
Union	-	-	-	-
Wabash	100.00	100.00	0.00	0.00
Wayne	100.00	100.00	0.00	0.00
White	100.00	100.00	0.00	0.00
Williamson	1.41	1.61	98.59	98.39
Southern Illinois				
Average	54.31	62.26	49.57	35.04
State Average	35.03	40.54	64.97	58.11

(-) indicates that there are no water withdrawals in the corresponding counties to support mining activities

Thermoelectric and Hydroelectric Power Water Use

Total Water Withdrawals and Deliveries

While water withdrawals and deliveries for thermoelectric and hydroelectric power increased between 1990 and 1995 by 12.1% and 12.5%, they decreased between 1995 and 2000 by 58.6% and 34.1% in the region and the state, respectively (Table 15).

Water for thermoelectric power generation was withdrawn from water resources in Jackson, Massac, Randolph, and Williamson counties. The highest water withdrawals and deliveries occurred in Massac County, followed by Jackson County (Table 15).

Between 1990 and 1995, water withdrawals in Massac County increased by 24.8%. This increase also occurred in Jackson County (26.0%) and Randolph County (12.1%). However, between 1995 and 2000, decreases in water withdrawals occurred in these three counties. The highest decline was in Randolph County (97.3%), where water withdrawals and deliveries decreased from 1,173.98 Mgal/d in 1995 to 32.30 Mgal/d in 2000. This was followed by Jackson County (38.8%). Water withdrawals slightly decreased in Massac County (4.7%).

Table 15. Total Water Withdrawals (Mgal/d) for Thermoelectric Power Generation 1990, 1995, and 2000

<i>County</i>	<i>1990</i>	<i>1995</i>	<i>2000</i>	<i>Percent Change (1990-1995)</i>	<i>Percent Change (1995-2000)</i>
Alexander	0.00	0.00	0.00	-	-
Edwards	0.00	0.00	0.00	-	-
Franklin	0.00	0.00	0.00	-	-
Gallatin	0.00	0.00	0.00	-	-
Hamilton	0.00	0.00	0.00	-	-
Hardin	0.00	0.00	0.00	-	-
Jackson	142.85	180.01	110.10	26.01	-38.84
Jefferson	0.00	0.00	0.00	-	-
Johnson	0.00	0.00	0.00	-	-
Massac	467.48	583.54	556.09	24.83	-4.70
Perry	0.00	0.00	0.00	-	-
Pope	0.00	0.00	0.00	-	-
Pulaski	0.00	0.00	0.00	-	-
Randolph	1047.76	1173.98	32.30	12.05	-97.25
Saline	0.00	0.00	0.00	-	-
Union	0.00	0.00	0.00	-	-
Wabash	0.00	0.00	0.00	-	-
Wayne	0.00	0.00	0.00	-	-
White	0.00	0.00	0.00	-	-
Williamson	69.92	0.00	104.20	-100.00	NA
Southern Illinois					
Average	86.40	96.88	40.13	12.12	-58.57
State Average	148.73	167.68	110.44	12.74	-34.14

Sources of Water

Surface water sources were used more than groundwater sources for thermoelectric power generation. Groundwater sources were used for thermoelectric power generation in Jackson and Massac counties. Between 1990 and 1995, water withdrawals from groundwater sources for thermoelectric power generation increased by an average of 37.3%. However, between 1995 and 2000, there were no changes in the average water

withdrawals and deliveries for thermoelectric power generation in Southern Illinois (Table 16).

Groundwater Sources

Between 1990 and 1995, water withdrawals from groundwater sources for thermoelectric power generation in Massac County increased by 43.0%, but decreased in Jackson County by 22.2%. Between 1995 and 2000, a significant increase in groundwater withdrawals for thermoelectric power generation occurred in Jackson County (42.9%). Massac County also increased its groundwater withdrawals for thermoelectric power generation by 4.5% (Table 16).

Surface Water Sources

Surface water was used for thermoelectric power generation in Jackson, Massac, Randolph, and Williamson counties. Between 1990 and 1995, surface water withdrawals for thermoelectric power generation increased in Jackson, Massac, and Randolph Counties by 26.0%, 24.8%, and 12.1%, respectively. Williamson stopped its surface water withdrawals for thermoelectric power generation during this time interval. However, between 1995 and 2000, while surface water withdrawals for thermoelectric power generation decreased in Jackson, Massac, and Randolph counties, they increased in Williamson County. The highest decrease in water withdrawals for thermoelectric power generation was in Randolph County (97.3%) (Table 16).

Table 16. Total Groundwater and Surface Water Withdrawals (Mgal/d) for Thermoelectric Power Generation, 1990, 1995, and 2000.

<i>County</i>	<i>Groundwater Withdrawals (Mgal/d)</i>					<i>Surface Water Withdrawals (Mgal/d)</i>				
	<i>1990</i>	<i>1995</i>	<i>2000</i>	<i>Percent Change (1990-1995)</i>	<i>Percent Change (1995-2000)</i>	<i>1990</i>	<i>1995</i>	<i>2000</i>	<i>Percent Change (1990-1995)</i>	<i>Percent Change (1995-2000)</i>
Alexander	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	-
Edwards	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	-
Franklin	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	-
Gallatin	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	-
Hamilton	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	-
Hardin	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	-
Jackson	0.09	0.07	0.10	-22.22	42.86	142.76	179.94	110.00	26.04	-38.87
Jefferson	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	-
Johnson	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	-
Massac	0.93	1.33	1.39	43.01	4.51	466.55	582.19	554.70	24.79	-4.72
Perry	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	-
Pope	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	-
Pulaski	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	-
Randolph	0.00	0.00	0.00	-	-	1047.75	1173.97	32.30	12.05	-97.25
Saline	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	-
Union	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	-
Wabash	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	-
Wayne	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	-
White	0.00	0.00	0.00	-	-	0.00	0.00	0.00	-	-
Williamson	0.00	0.00	0.00	-	-	69.92	0.00	104.20	-100.00	NA
Southern Illinois Average	0.05	0.07	0.07	37.25	0.00	86.35	96.81	40.06	12.11	-58.62

Public Water Supply

Public water supplies (PWS) were also minimally used in thermoelectric power plants. However, PWS deliveries were restricted to Randolph and Massac counties. Massac counties started relying on public supply for thermoelectric power generation by the year 1995. As for Randolph county, public water delivery for thermoelectric power generation remained constant (Table 17).

Table 17. Total Public Water Supply Deliveries (Mgal/d)
for Thermoelectric Power Generation, 1990 and 1995

<i>County</i>	<i>1990</i>	<i>1995</i>
Alexander	0.00	0.00
Edwards	0.00	0.00
Franklin	0.00	0.00
Gallatin	0.00	0.00
Hamilton	0.00	0.00
Hardin	0.00	0.00
Jackson	0.00	0.00
Jefferson	0.00	0.00
Johnson	0.00	0.00
Massac	0.00	0.02
Perry	0.00	0.00
Pope	0.00	0.00
Pulaski	0.00	0.00
Randolph	0.01	0.01
Saline	0.00	0.00
Union	0.00	0.00
Wabash	0.00	0.00
Wayne	0.00	0.00
White	0.00	0.00
Williamson	0.00	0.00

Agricultural Water Use

In Southern Illinois, water was used both for raising livestock and irrigation, but mostly for irrigation. The amount of water dedicated to irrigation increased over time. In the year 2000, 83.3% of water for agriculture was used for irrigation compared to 63.7% in the year 1990 (Figure 4).

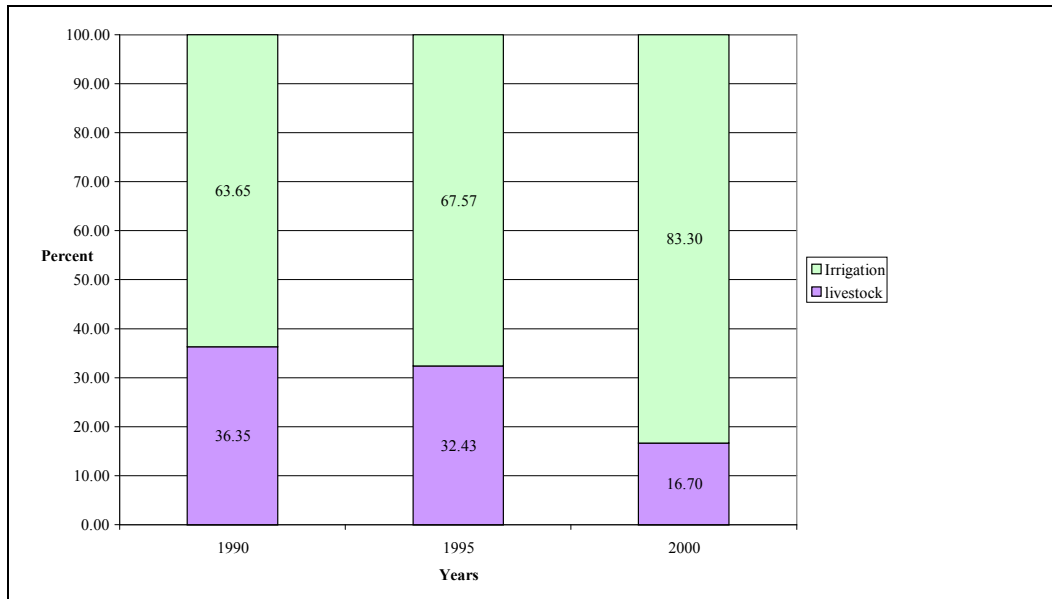


Figure 4. The Proportion of Water used for Livestock and Irrigation in the 20 Southern Illinois Counties for 1990, 1995, 2000

Total Water Withdrawals

The average total water withdrawal to support the agricultural sector in the Southern Illinois counties was consistently lower than the state average for 1990, 1995, and 2000. Between 1990 and 1995, water withdrawals minimally increased in the Southern Illinois counties by 1.23%, as compared to the state that had a huge increase in its water withdrawals (81.9%). However, between 1995 and 2000, water withdrawals in the designated counties of Southern Illinois increased by 15.0%, while there was a general decline in water withdrawals for agriculture at the state level by 18.6%.

Between 1990 and 1995, the highest increase in agricultural water withdrawal occurred in Alexander County (165%), followed by Pulaski County (105.6%), Massac County (71.9%), and Gallatin County (55.6%). Between 1995 and 2000, Alexander County continued to increase its total agricultural water withdrawals. Water withdrawals for agriculture in Alexander County increased by 69.8%. Increases also occurred in Gallatin County (75.4%). Despite the general increase in water withdrawals in the Southern Illinois counties, many counties significantly decreased their water withdrawals, such as Jackson (83.7%) and Edwards (63.9%) Counties (Table 18).

Table 18. Total Agricultural Water Withdrawals (Mgal/d), 1990, 1995, and 2000

<i>County</i>	<i>1990</i>	<i>1995</i>	<i>2000</i>	<i>Percent Change (1990- 1995)</i>	<i>Percent Change (1995- 2000)</i>
Alexander	0.40	1.06	1.80	165.00	69.81
Edwards	0.44	0.36	0.13	-18.18	-63.89
Franklin	0.53	0.29	0.21	-45.28	-27.59
Gallatin	3.40	5.29	9.28	55.59	75.43
Hamilton	0.32	0.25	0.17	-21.88	-32.00
Hardin	0.13	0.15	0.12	15.38	-20.00
Jackson	1.61	1.47	0.24	-8.70	-83.67
Jefferson	0.37	0.47	0.37	27.03	-21.28
Johnson	0.34	0.29	0.23	-14.71	-20.69
Massac	1.14	1.96	2.62	71.93	33.67
Perry	1.02	0.68	0.42	-33.33	-38.24
Pope	0.14	0.14	0.12	0.00	-14.29
Pulaski	0.18	0.37	0.50	105.56	35.14
Randolph	0.84	0.81	0.42	-3.57	-48.15
Saline	0.14	0.20	0.25	42.86	25.00
Union	0.40	0.43	0.56	7.50	30.23
Wabash	0.36	0.17	0.15	-52.78	-11.76
Wayne	0.95	1.08	0.59	13.68	-45.37
White	4.98	2.42	2.37	-51.41	-2.07
Williamson	0.22	0.24	0.29	9.09	20.83
Southern Illinois Average	0.90	0.91	1.04	1.23	14.95
State Average	1.27	2.31	1.88	81.89	-18.61

Livestock

The average water withdrawals to support livestock in Southern Illinois counties were consistently lower than the state averages for 1990, 1995, and 2000. Between 1990 and 1995, the average total water withdrawals to support livestock declined in the designated counties and the state by 9.7% and 32.7%, respectively. Water withdrawals for livestock continued to decrease between 1995 and 2000 in both the 20 counties and the state by 40.8% and 11.3%, respectively (Table 19).

Between 1990 and 1995, the highest decrease in water withdrawals for livestock occurred in Hamilton County (29.2%), followed by Wabash County (28.8%), Edwards County (24.3%), and Johnson County (20.6%). Despite the general decrease in water withdrawals, many counties increased their water withdrawals for livestock, such as Alexander County (40%), Saline County (14.3%), and Union County (11.6%) (Table 19).

Between 1995 and 2000, significant decreases in water withdrawals for livestock occurred in many counties, such as Jackson County (79.4%), Alexander County (57.1%), Edwards County (53.57%), Pulaski County (47.0%), and Randolph County (46.2%). Saline County and Williamson County, on the other hand, increased their withdrawals for livestock by 37.5% and 4.5%, respectively (Table 19).

Table 19. Total Water Withdrawals (Mgal/d) for Livestock, 1990, 1995, and 2000

<i>County</i>	<i>1990</i>	<i>1995</i>	<i>2000</i>	<i>Percent Change (1990- 1995)</i>	<i>Percent Change (1995- 2000)</i>
Alexander	0.05	0.07	0.03	40.00	-57.14
Edwards	0.37	0.28	0.13	-24.32	-53.57
Franklin	0.18	0.2	0.17	11.11	-15.00
Gallatin	0.16	0.13	0.07	-18.75	-46.15
Hamilton	0.24	0.17	0.1	-29.17	-41.18
Hardin	0.13	0.14	0.09	7.69	-35.71
Jackson	1.23	1.17	0.24	-4.88	-79.49
Jefferson	0.37	0.33	0.27	-10.81	-18.18
Johnson	0.34	0.27	0.19	-20.59	-29.63
Massac	0.28	0.23	0.19	-17.86	-17.39
Perry	0.34	0.26	0.19	-23.53	-26.92
Pope	0.14	0.14	0.11	0.00	-21.43
Pulaski	0.18	0.17	0.09	-5.56	-47.06
Randolph	0.77	0.67	0.36	-12.99	-46.27
Saline	0.14	0.16	0.22	14.29	37.50
Union	0.26	0.29	0.19	11.54	-34.48
Wabash	0.14	0.10	0.07	-28.57	-30.00
Wayne	0.73	0.66	0.37	-9.59	-43.94
White	0.24	0.22	0.17	-8.33	-22.73
Williamson	0.22	0.22	0.23	0.00	4.55
Southern Illinois					
Average	0.33	0.29	0.17	-9.68	-40.82
State Average	0.62	0.55	0.37	-32.73	-11.29

Water Sources to Support Livestock

Between 1990 and 1995, the Southern Illinois counties and the state depended on both groundwater and surface water to support livestock. The situation changed between 1995 and 2000, when counties in the Southern Illinois region and the state showed complete dependence of groundwater sources to support livestock (Table 20). As mentioned previously, this finding may be the result of inaccurate data. The percent change from 1990-1995 is not shown for surface water withdrawals, since there was no change.

Between 1990 and 1995, groundwater withdrawals decreased in the counties of Southern Illinois and the state by 0.8% and 3.5%, respectively. The highest decline in groundwater

withdrawals to support livestock occurred in Hamilton County (33.3%), Wabash County (28.5%), Perry County (25.8%), and Edwards County (25.0%). Water withdrawals from surface water resources to support livestock remained the same during this same period in the counties and the state (Table 20). Between 1995 and 2000, groundwater withdrawals to support livestock continued to decrease both in Southern Illinois (21.8%) and the state (30.1%). The highest decline in groundwater withdrawals to support livestock occurred in Alexander County (57.1%), Edwards County (51.8%), and Pulaski County (47.0%). Despite the general decline in groundwater withdrawals, counties such as Saline and Williamson increased withdrawals to support livestock by 37.5% and 21.0%, respectively. Water withdrawals to support livestock from surface water sources ceased in the studied counties and the state (Table 20). This finding is unrealistic and may represent inaccuracies in the datasets.

Table 20. Total Groundwater and Surface Water Withdrawals (Mgal/d) for Livestock, 1990, 1995, and 2000

<i>County</i>	Groundwater Withdrawals (Mgal/d)					Surface Water Withdrawals (Mgal/d)		
	<i>1990</i>	<i>1995</i>	<i>2000</i>	<i>Percent Change (1990-1995)</i>	<i>Percent Change (1995-2000)</i>	<i>1990</i>	<i>1995</i>	<i>2000</i>
Alexander	0.05	0.07	0.03	40.00	-57.14	0.00	0.00	0.00
Edwards	0.36	0.27	0.13	-25.00	-51.85	0.01	0.01	0.00
Franklin	0.18	0.20	0.17	11.11	-15.00	0.00	0.00	0.00
Gallatin	0.13	0.10	0.07	-23.08	-30.00	0.03	0.03	0.00
Hamilton	0.21	0.14	0.10	-33.33	-28.57	0.03	0.03	0.00
Hardin	0.10	0.11	0.09	10.00	-18.18	0.03	0.03	0.00
Jackson	0.38	0.32	0.24	-15.79	-25.00	0.85	0.85	0.00
Jefferson	0.37	0.33	0.27	-10.81	-18.18	0.00	0.00	0.00
Johnson	0.32	0.25	0.19	-21.88	-24.00	0.02	0.02	0.00
Massac	0.26	0.21	0.19	-19.23	-9.52	0.02	0.02	0.00
Perry	0.31	0.23	0.19	-25.81	-17.39	0.03	0.03	0.00
Pope	0.14	0.14	0.11	0.00	-21.43	0.00	0.00	0.00
Pulaski	0.18	0.17	0.09	-5.56	-47.06	0.00	0.00	0.00
Randolph	0.54	0.44	0.36	-18.52	-18.18	0.23	0.23	0.00
Saline	0.14	0.16	0.22	14.29	37.50	0.00	0.00	0.00
Union	0.26	0.29	0.19	11.54	-34.48	0.00	0.00	0.00
Wabash	0.14	0.10	0.07	-28.57	-30.00	0.00	0.00	0.00
Wayne	0.58	0.51	0.37	-12.07	-27.45	0.15	0.15	0.00
White	0.24	0.22	0.17	-8.33	-22.73	0.00	0.00	0.00
Williamson	0.19	0.19	0.23	0.00	21.05	0.03	0.03	0.00
Southern Illinois Average	0.25	0.22	0.17	-0.80	-21.80	0.07	0.07	0.00
State Average	0.59	0.53	0.37	-3.54	-30.19	0.02	0.02	0.00

Irrigation

The average water withdrawals for irrigation in Southern Illinois counties was less than the state average. Between 1990 and 1995, the average water withdrawals in the designated counties and the state increased by 2.4% and 76.2%, respectively. However, between 1995 and 2000, while water withdrawals generally declined in the state by 14.2%, water withdrawals in Southern Illinois counties increased by 41.7% (Table 21).

Between 1990 and 1995, significant increases in water withdrawals for irrigation were apparent in Alexander County (182.8%), Massac County (101.1%), Randolph County (100%), and Wayne County (90.9%), and Gallatin County (59.2%). On the other hand, the highest decrease in water withdrawals for irrigation occurred in Franklin County (74.2%), Wabash County (68.1%), Perry County (63.6%), and White County (53.5%) (Table 21).

Between 1995 and 2000, significant increases in water withdrawals for irrigation occurred in Alexander County (78.7%), Gallatin County (78.4%), Hardin County (200%), Johnson County (100%), Pulaski County (105%), Union County (164.2%), and Williamson County (200%). Despite the huge increase in water withdrawals in the region, many counties decreased or ceased their withdrawals, such as Edwards County (100%), Jackson County (100%), Randolph County (57.1%), Franklin County (55.5%), Wayne County (47.6%), and Perry County (45.2%) (Table 21).

Table 21. Total Water Withdrawals for Irrigation, 1990, 1995, and 2000

<i>County</i>	<i>1990</i>	<i>1995</i>	<i>2000</i>	<i>Percent Change (1990- 1995)</i>	<i>Percent Change (1995- 2000)</i>
Alexander	0.35	0.99	1.77	182.86	78.79
Edwards	0.07	0.08	0.00	14.29	-100.00
Franklin	0.35	0.09	0.04	-74.29	-55.56
Gallatin	3.24	5.16	9.21	59.26	78.49
Hamilton	0.08	0.08	0.07	0.00	-12.50
Hardin	0.00	0.01	0.03	-	200.00
Jackson	0.38	0.30	0.00	-21.05	-100.00
Jefferson	0.00	0.14	0.10	-	-28.57
Johnson	0.00	0.02	0.04	-	100.00
Massac	0.86	1.73	2.43	101.16	40.46
Perry	0.68	0.42	0.23	-38.24	-45.24
Pope	0.00	0.00	0.01	-	-
Pulaski	0.00	0.20	0.41	-	105.00
Randolph	0.07	0.14	0.06	100.00	-57.14
Saline	0.00	0.04	0.03	-	-25.00
Union	0.14	0.14	0.37	0.00	164.29
Wabash	0.22	0.07	0.08	-68.18	14.29
Wayne	0.22	0.42	0.22	90.91	-47.62
White	4.74	2.20	2.20	-53.59	0.00
Williamson	0.00	0.02	0.06	-	200.00
Southern Illinois Average	0.57	0.61	0.87	2.42	41.71
State Average	0.77	1.76	1.51	76.23	-14.20

Water Sources for Irrigation

It is important to note that increases or decreases in freshwater withdrawals are not necessarily related to increases or decreases in surface water withdrawals. For instance, between 1995 and 2000, Gallatin County increased both ground and surface water withdrawals to support irrigation. On the other hand, while freshwater withdrawals decreased in Perry and White counties, surface water withdrawals in these latter counties increased between 1995 and 2000.

Fresh groundwater sources

Fresh groundwater is the main source of irrigation in all the Southern Illinois counties and the state. The amount of fresh groundwater used for irrigation in the state was more than the amount withdrawn in Southern Illinois. Between 1990 and 1995, fresh groundwater withdrawals increased in the Southern Illinois counties and the state by 21.7% and 141.1%, respectively. Between 1995 and 2000, while water withdrawals in the

state decreased by 16.4%, freshwater groundwater withdrawals in the Southern Illinois counties continued to increase (34.6%) (Table 22).

Between 1990 and 1995, the highest increase in freshwater withdrawals occurred in Alexander County (182.8%), Massac County (103.5%), Randolph County (100.0%), Wayne County (90.9%), and Union County (75.0%). Despite the general increase in freshwater withdrawals for irrigation during this time interval, Wabash and White counties decreased their fresh groundwater withdrawals for irrigation by 68.1% and 52.6%, respectively (Table 22).

Between 1995 and 2000, water withdrawals for irrigation increased significantly in Hardin County and Williamson County (200%), Union County (164.2%), Pulaski County (105%), Johnson County (100%), and Alexander County (78.7%). On the other hand, counties that decreased their fresh groundwater withdrawals for irrigation include Edwards County (100%), Jackson County (100%), Franklin County (55.5%), and Randolph County (57.1%) (Table 22). The percent change statistics for 1995-2000 are excluded here since there were no surface water withdrawals recorded in 1995 in Southern Illinois.

Surface Water Sources

Not all of the counties in Southern Illinois depended on surface water sources for irrigation. Surface water sources in the Southern Illinois counties and the state were minimally used. Surface water withdrawals for irrigation in the region and the state dramatically decreased (100%) between 1990 and 1995, but then increased between 1995 and 2000 (Table 26).

Between 1990 and 1995, surface water was not used for irrigation in Franklin County, Jackson County, Perry County, Union County, and White County. However, between 1995 and 2000, surface water was used in Gallatin, Perry, and White Counties.

Table 22. Total Groundwater and Surface Water Withdrawals for Irrigation (Mgal/d), 1990, 1995, and 2000

<i>County</i>	Groundwater Withdrawals (Mgal/d)					Surface Water Withdrawals (Mgal/d)		
	<i>1990</i>	<i>1995</i>	<i>2000</i>	<i>Percent</i>	<i>Percent</i>	<i>1990</i>	<i>1995</i>	<i>2000</i>
				<i>Change</i>	<i>Change</i>			
				<i>(1990-</i>	<i>1995-</i>			
				<i>1995)</i>	<i>2000)</i>			
Alexander	0.35	0.99	1.77	182.86	78.79	0.00	0.00	0.00
Edwards	0.07	0.08	0.00	14.29	-100.00	0.00	0.00	0.00
Franklin	0.00	0.09	0.04	increased	-55.56	0.35	0.00	0.00
Gallatin	3.24	5.16	8.51	59.26	64.92	0.00	0.00	0.70
Hamilton	0.08	0.08	0.07	0.00	-12.50	0.00	0.00	0.00
Hardin	0.00	0.01	0.03	increased	200.00	0.00	0.00	0.00
Jackson	0.23	0.30	0.00	30.43	-100.00	0.15	0.00	0.00
Jefferson	0.00	0.14	0.10	increased	-28.57	0.00	0.00	0.00
Johnson	0.00	0.02	0.04	increased	100.00	0.00	0.00	0.00
Massac	0.85	1.73	2.43	103.53	40.46	0.01	0.00	0.00
Perry	0.00	0.42	0.22	increased	-47.62	0.68	0.00	0.01
Pope	0.00	0.00	0.01	increased		0.00	0.00	0.00
Pulaski	0.00	0.20	0.41	increased	105.00	0.00	0.00	0.00
Randolph	0.07	0.14	0.06	100.00	-57.14	0.00	0.00	0.00
Saline	0.00	0.04	0.03	increased	-25.00	0.00	0.00	0.00
Union	0.08	0.14	0.37	75.00	164.29	0.06	0.00	0.00
Wabash	0.22	0.07	0.08	-68.18	14.29	0.00	0.00	0.00
Wayne	0.22	0.42	0.22	90.91	-47.62	0.00	0.00	0.00
White	4.65	2.20	2.05	-52.69	-6.82	0.09	0.00	0.15
Williamson	0.00	0.02	0.06	increased	200.00	0.00	0.00	0.00
Southern								
Illinois	0.50	0.61	0.83	21.77	34.69	0.067	0.00	0.043
Average								
State Average	0.73	1.76	1.47	141.10	-16.48	0.04	0.00	0.04