INTERBASIN TRANSFER

WHY AND HOW TO REGULATE IBTS

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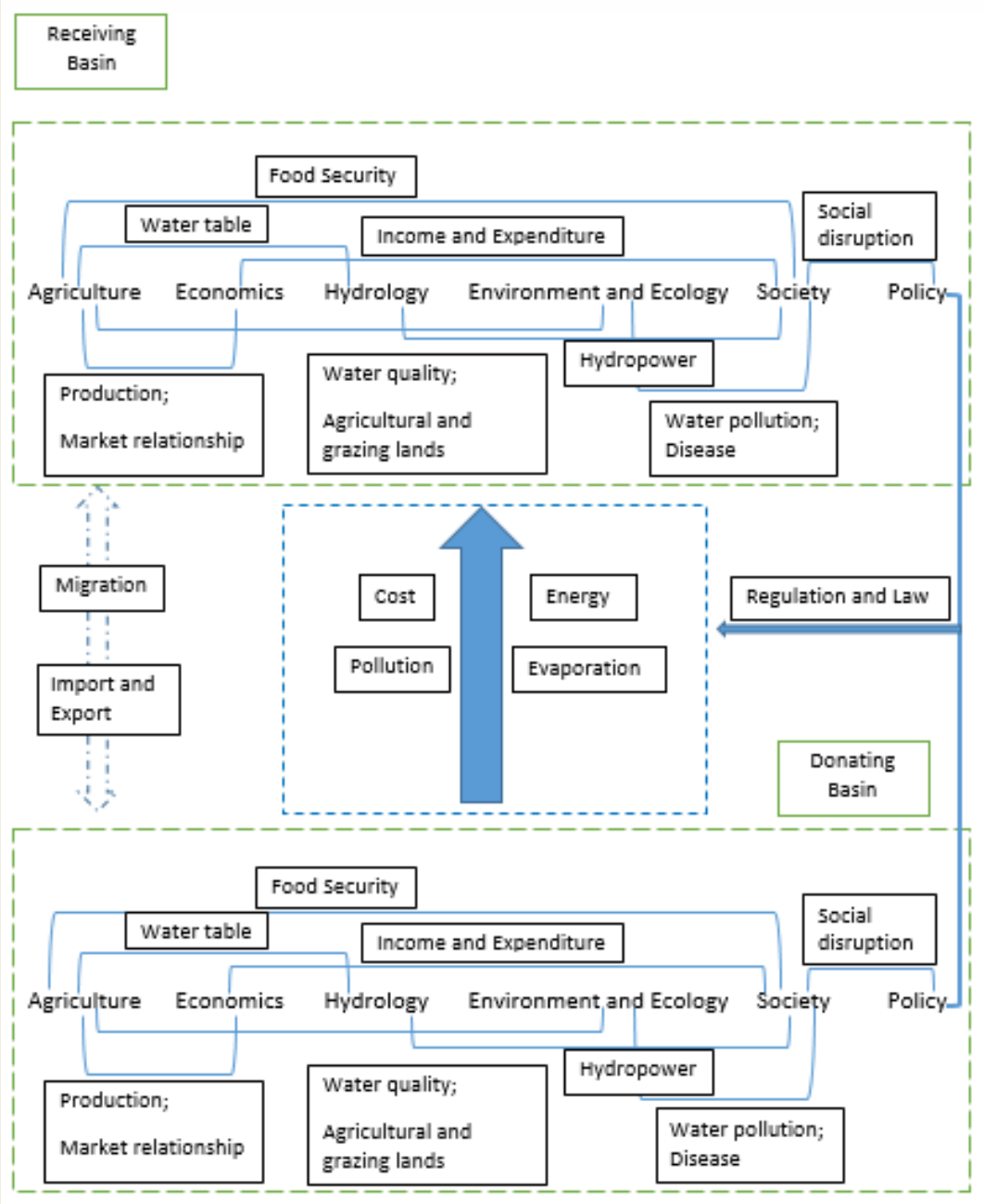
Research Background

- Interbasin transfer: Man-made reallocate water from water available area to water less available area to overcome water deficits.
- Interbasin transfer projects are usually large-scale, costly, and unchangeable in a short time.
- Multi-dimensions impacts.

Why Regulate IBTs



Why Regulate IBTs

- Case from neighbors

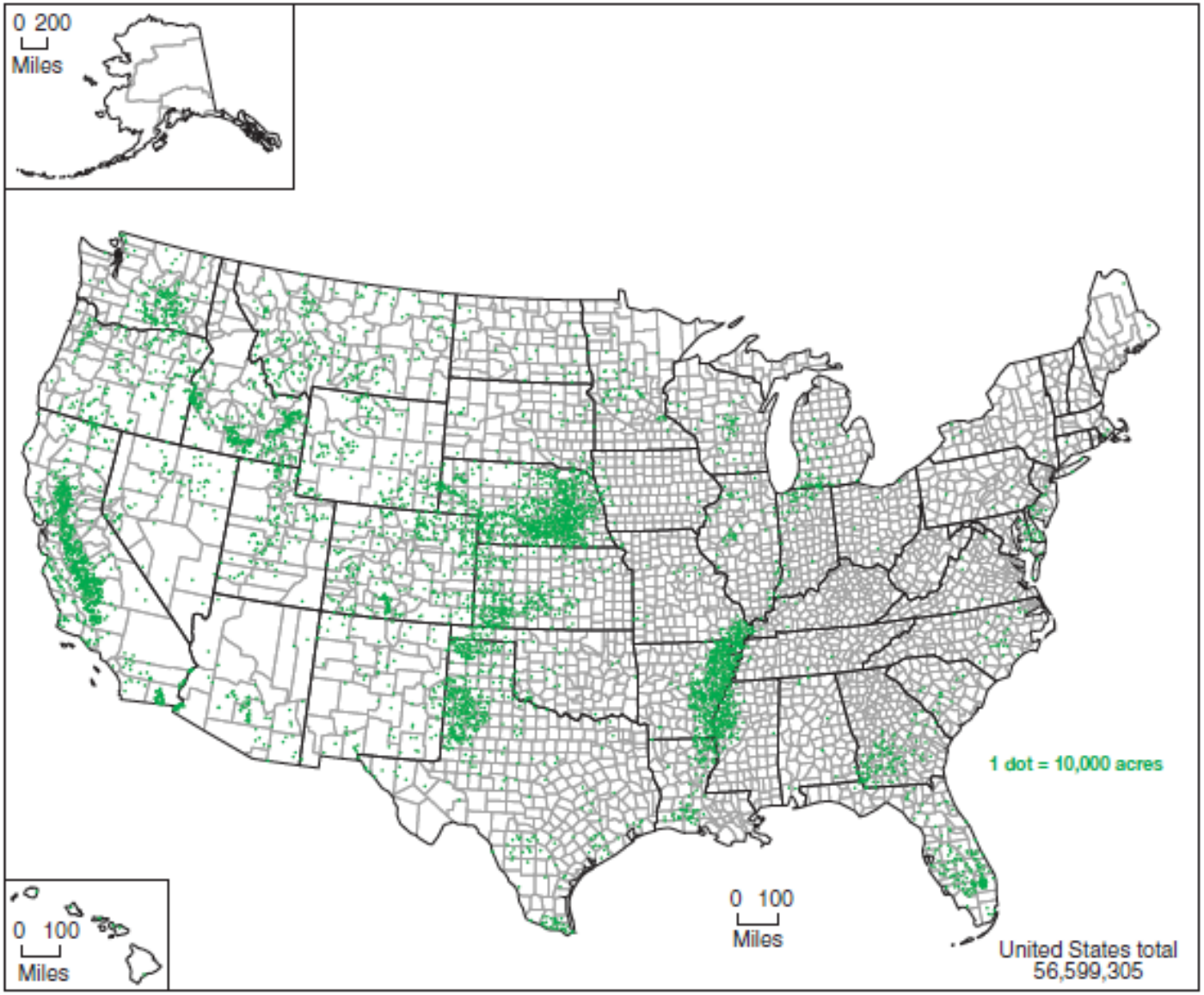
Gwinnett County Case Study:
In 2006, EPD issued a surface water withdrawal permit to Gwinnett County to pump up to 150 MGD from Lake Lanier. This permit involves the transfer of water from the Chattahoochee to the Ocmulgee River basin. EPD's record on the application and permit reveals no discussion or analysis of the impacts of the transfer. EPD personnel have stated that the agency does not consider the IBT criteria in the state water plan, or any other criteria, when evaluating such water withdrawal applications.

The only additional condition EPD placed on the Gwinnett permit was a requirement that the permittee collect and annually report the annual average estimate of all water transferred out of or into the basin of origin. This example shows that, in practice, existing water withdrawal rules and regulations do not address potential impacts associated with interbasin transfers. This withdrawal permit involves a transfer of more than 20 MGD with no evaluation of the transfer's impacts.

Why Regulate IBTs

- Other cases
- California water transfer Project, (USA)
- Central Arizona Project, (USA)
- Lesotho Highlands Water Project, (South Africa)
- South–North Water Transfer Project, (China)

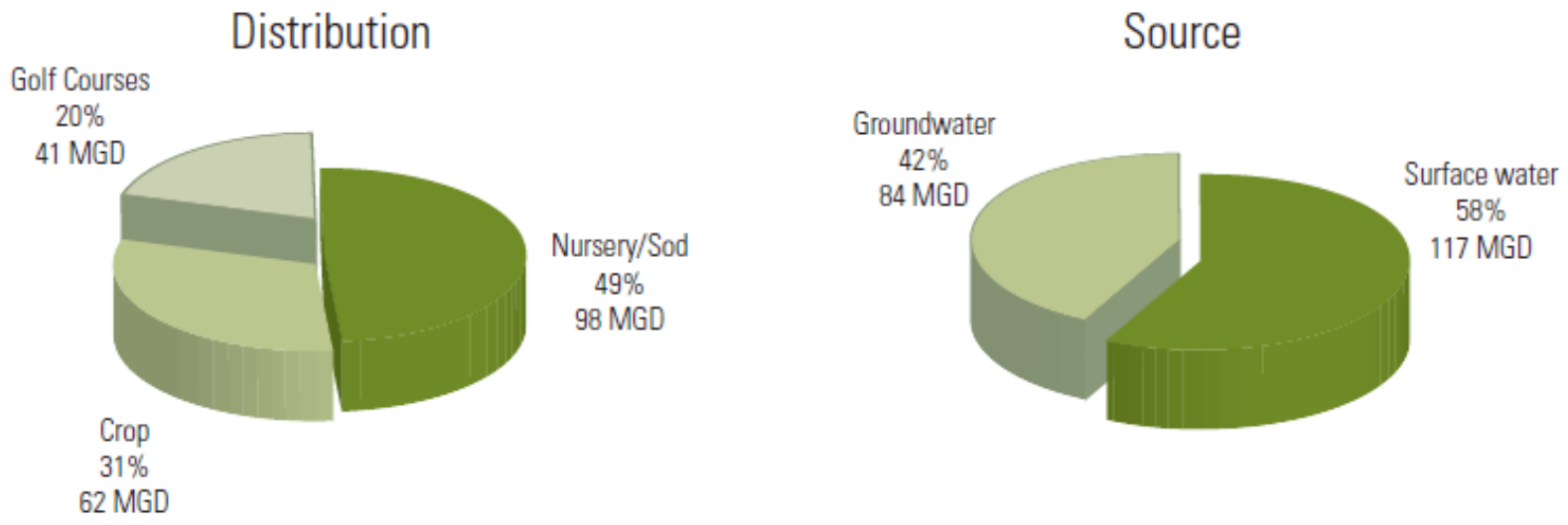
Acres of irrigated land, 2007



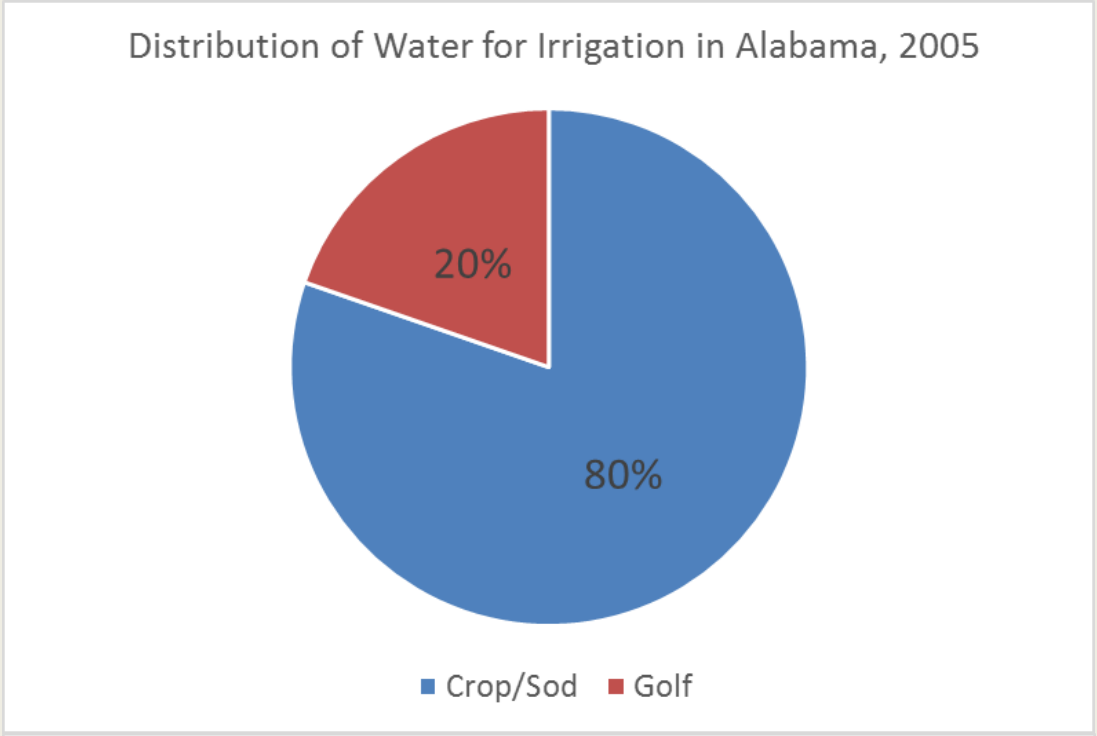
Source: USDA, National Agricultural Statistics Service, map # 07-M080, www.agcensus.usda.gov/Publications/2007/Online_Highlights/Ag_Atlas_Maps/Farms/Land_in_Farms_and_Land_Use/07-M080-RGBDot1-largetext.pdf.

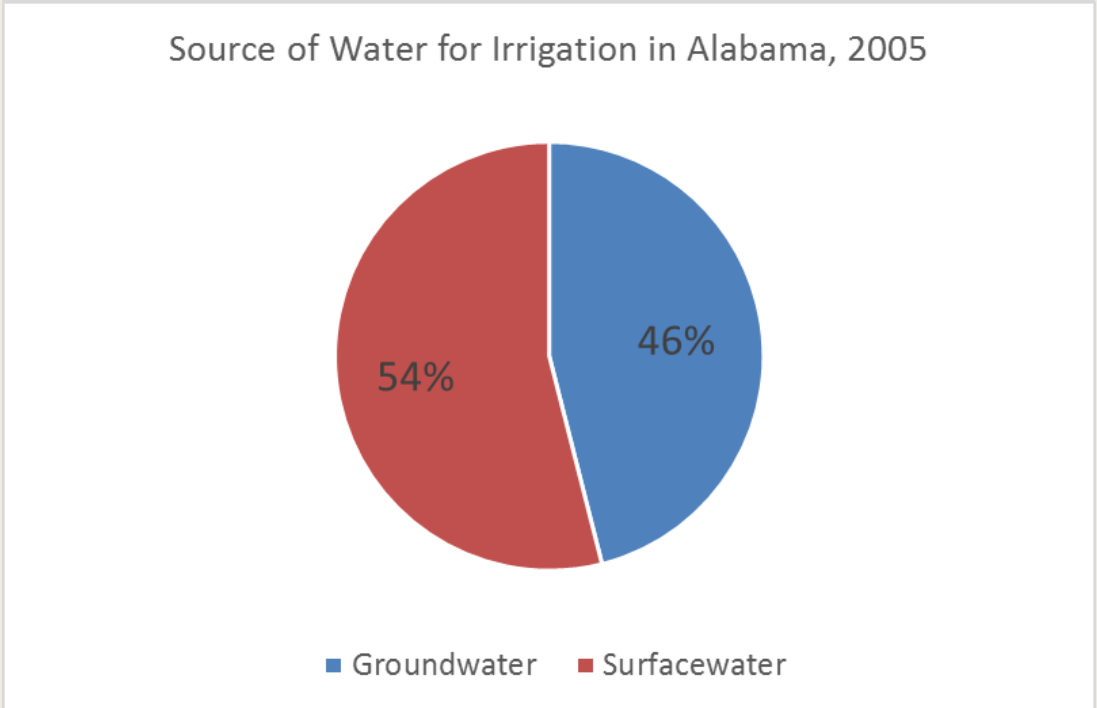
Irrigation Status

Figure 22. Source and distribution of water for irrigation use in Alabama, 2010
[MGD, million gallons per day; values may not sum to total estimated use because of rounding.]



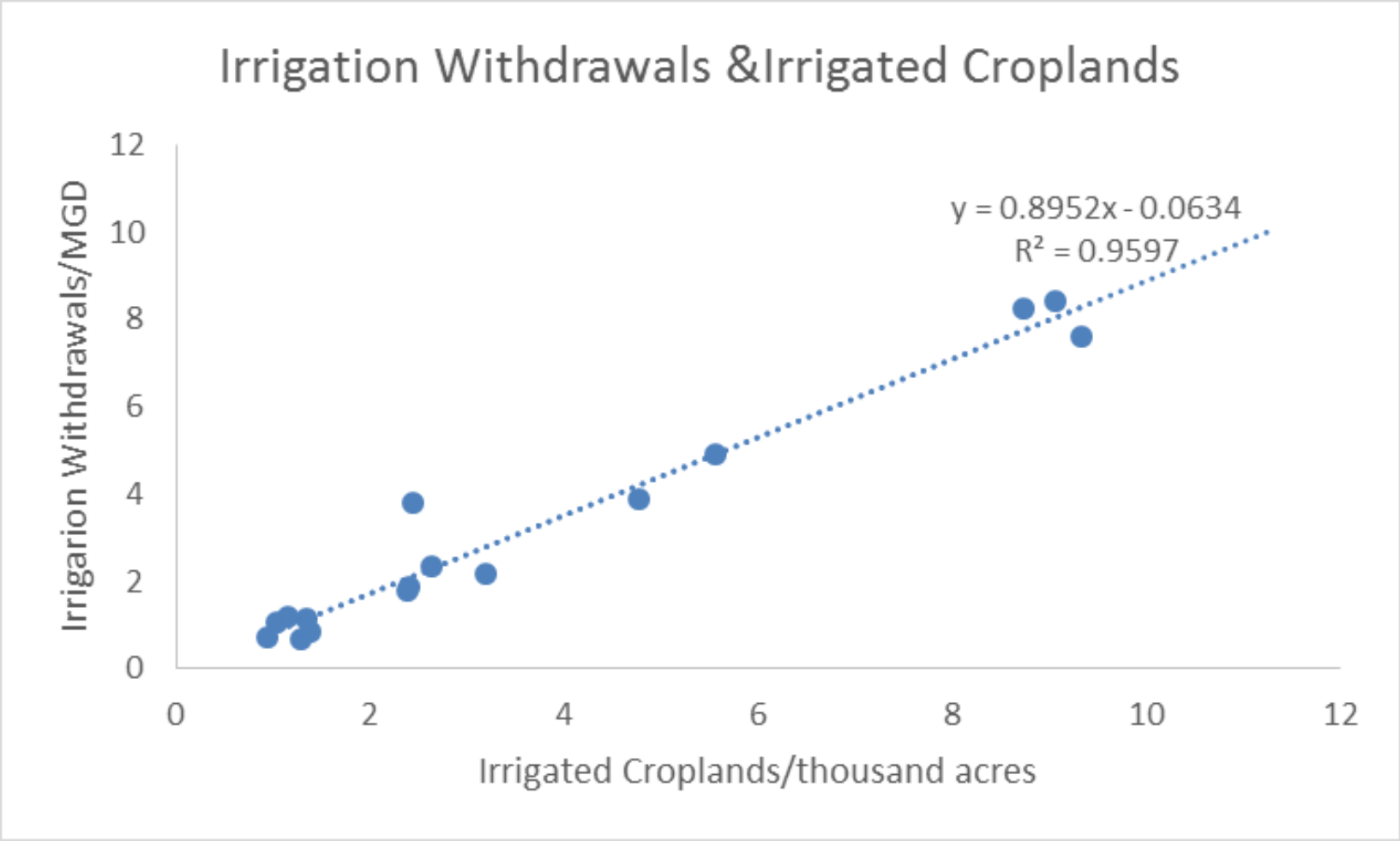
Source: Estimated Use of Water in Alabama in 2010





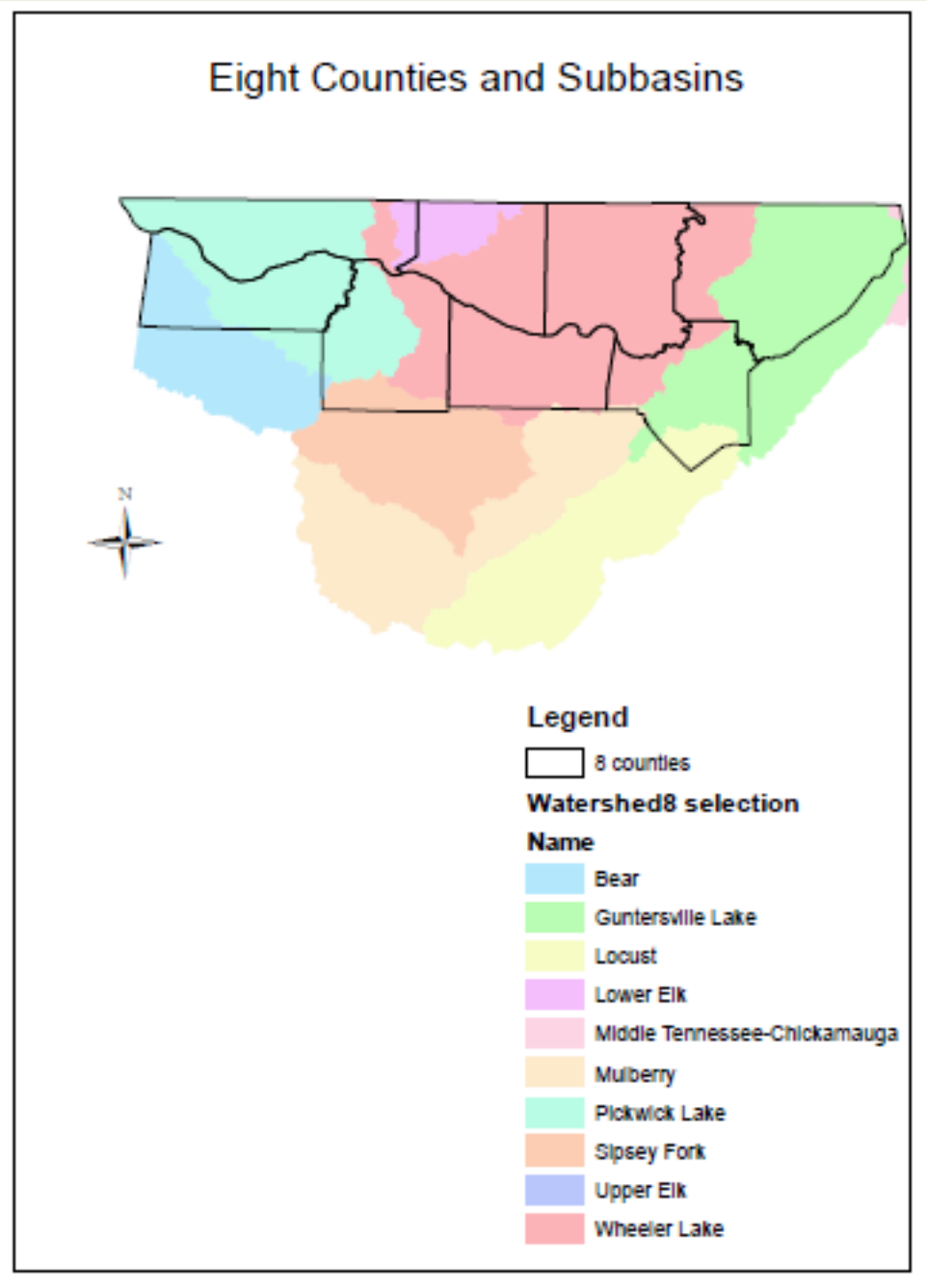
Source: Estimated Use of Water in Alabama in 2005

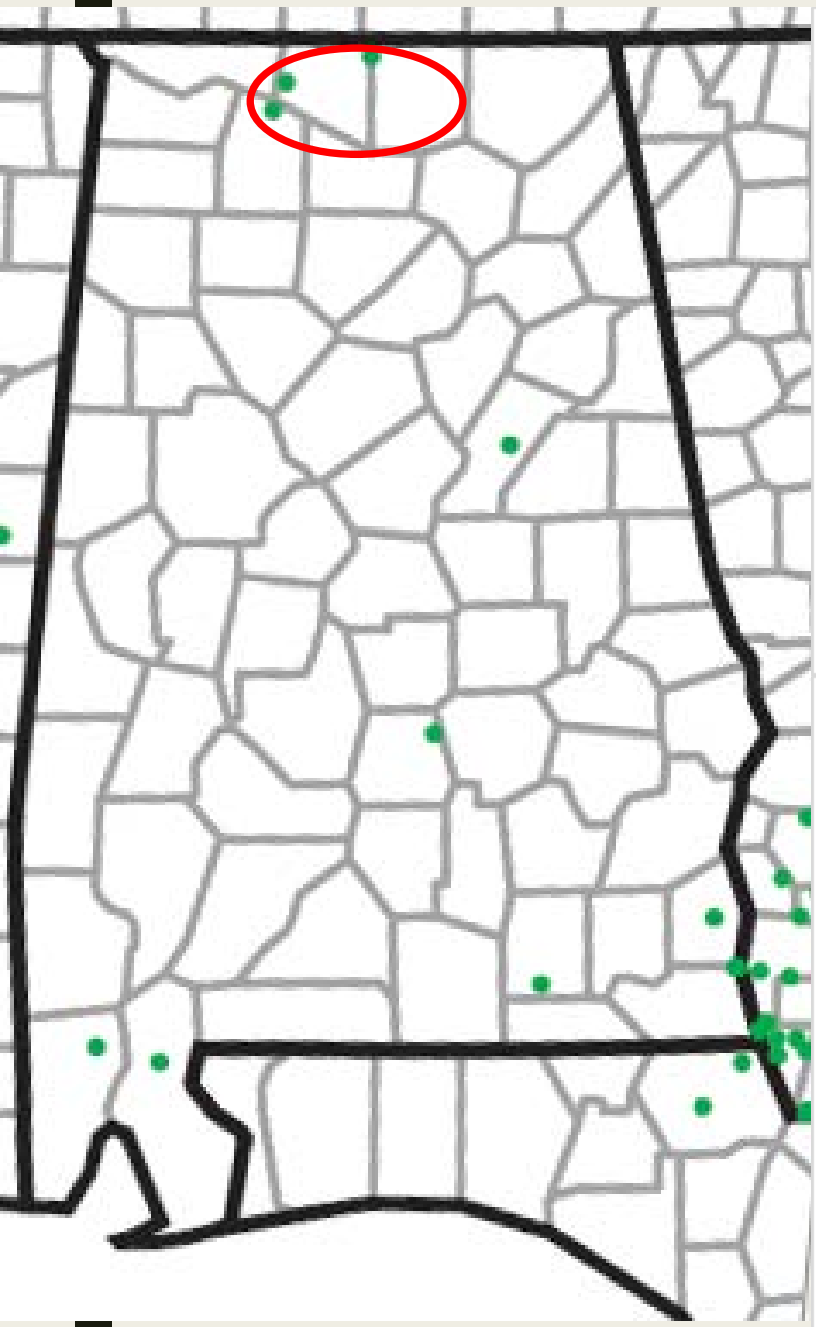
Irrigation Status

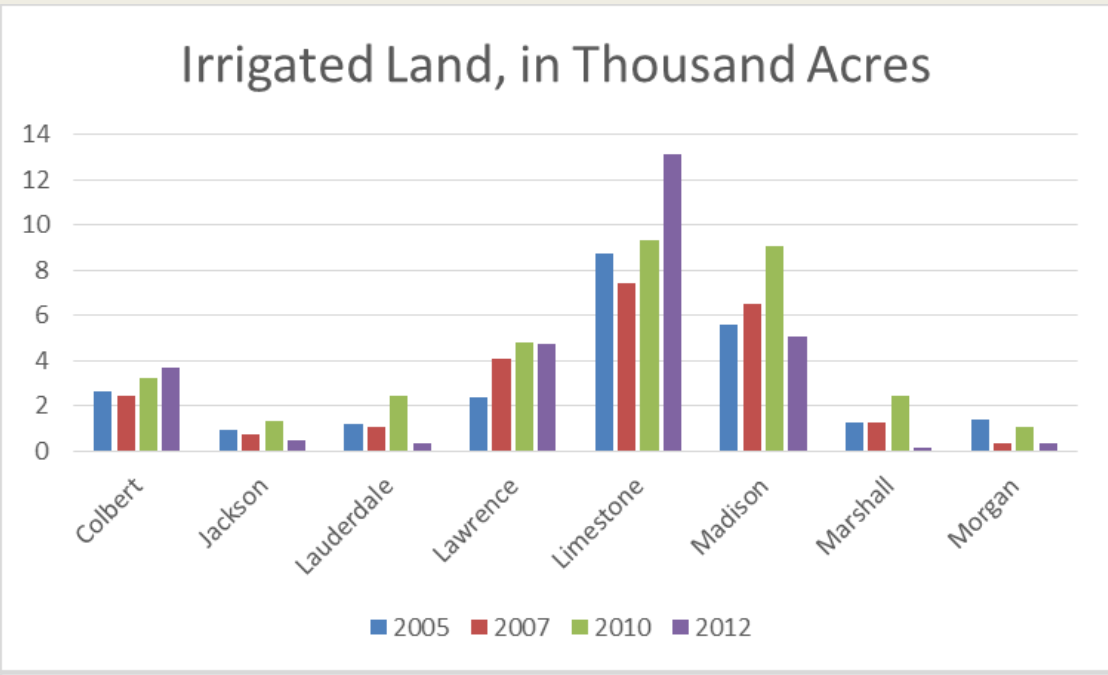


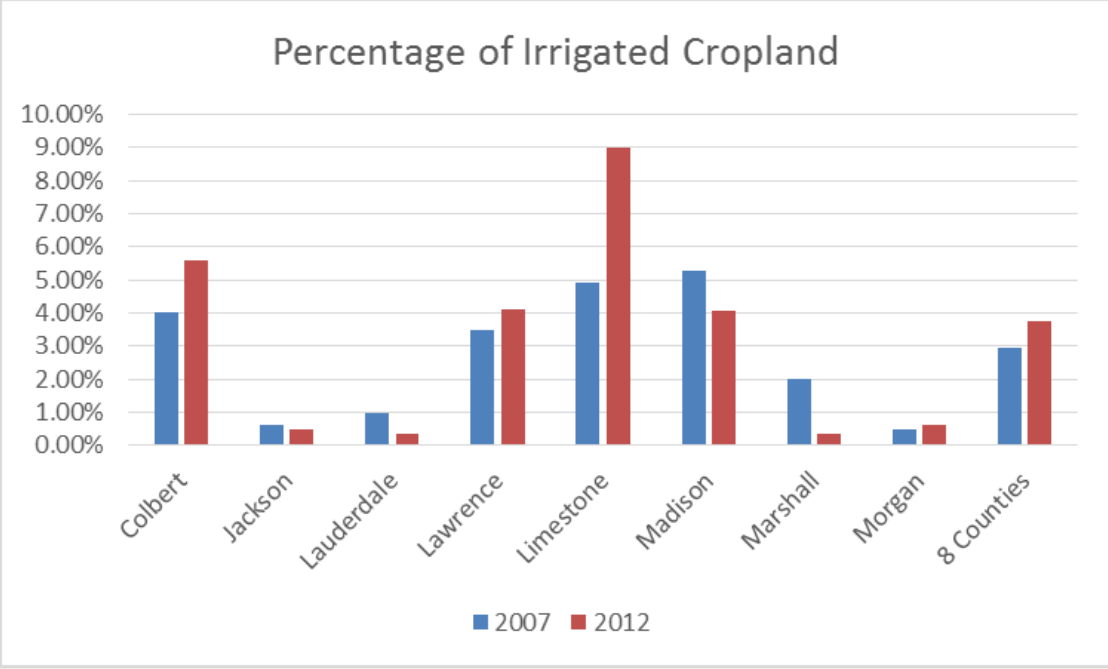
Source: USGS, 2005 and 2010

Study Area

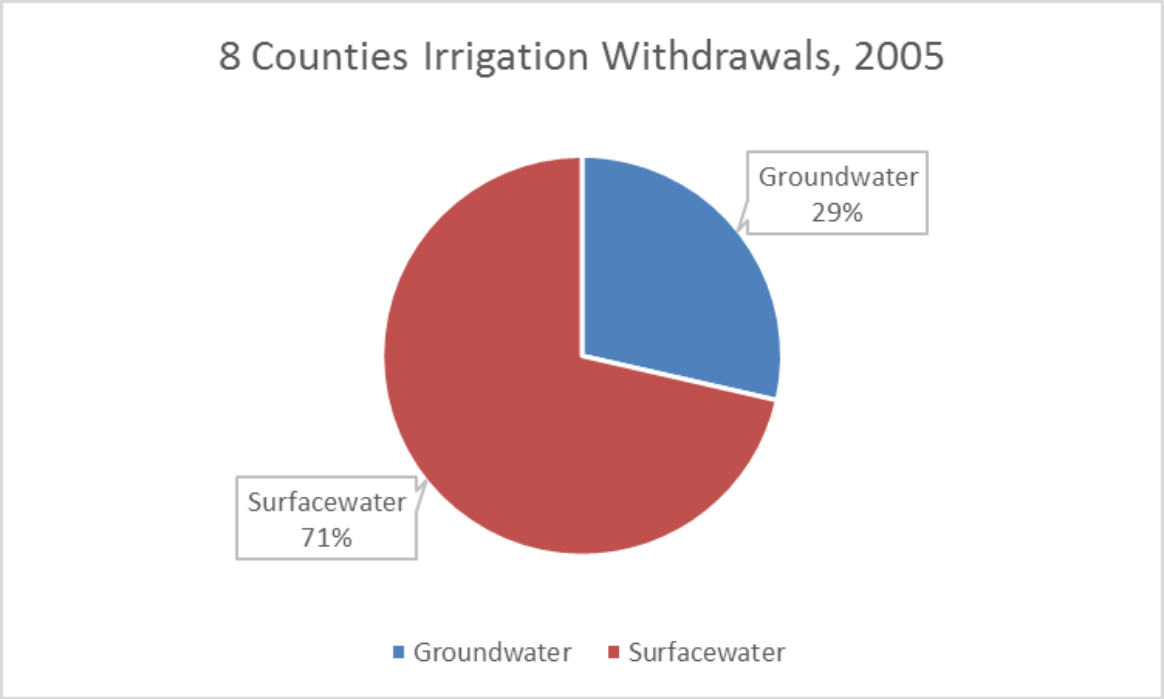

Eight Counties and Subbasins
N
Legend
8 counties
Watershed8 selection
Name
Bear
Guntersville Lake
Locust
Lower Elk
Middle Tennessee-Chickamauga
Mulberry
Pickwick Lake
Sipsey Fork
Upper Elk
Wheeler Lake

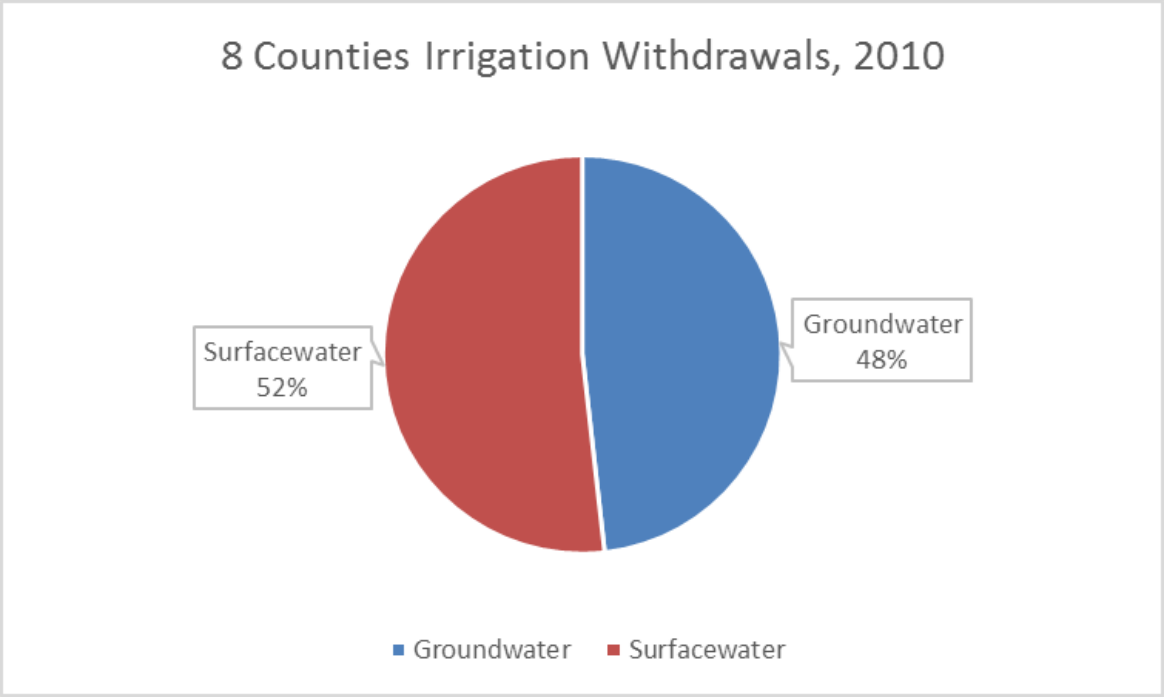


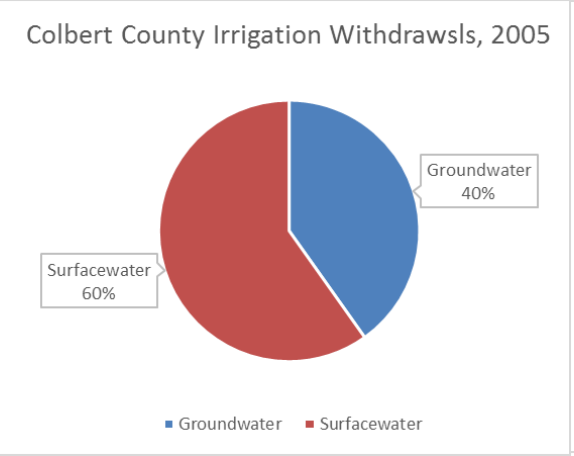

Irrigated Land, in Thousand Acres
14
12
10
8
6
4
2
0
Colbert
Jackson
Lauderdale
Lawrence
Limestone
Madison
Marshall
Morgan
2005
2007
2010
2012

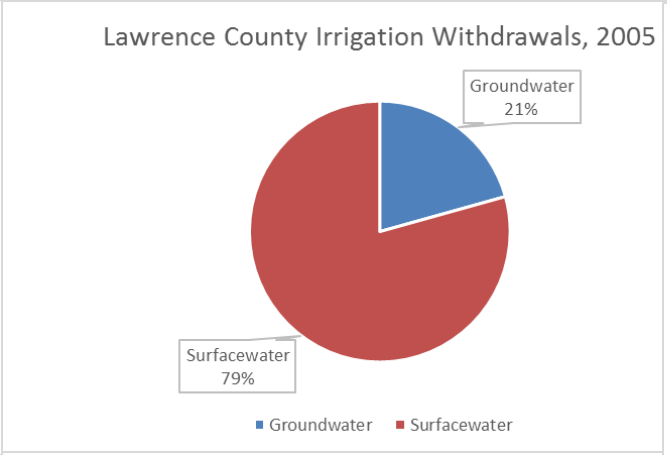

Percentage of Irrigated Cropland
10.00%
9.00%
8.00%
7.00%
6.00%
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
Colbert
Jackson
Lauderdale
Lawrence
Limestone
Madison
Marshall
Morgan
8 Counties
2007
2012

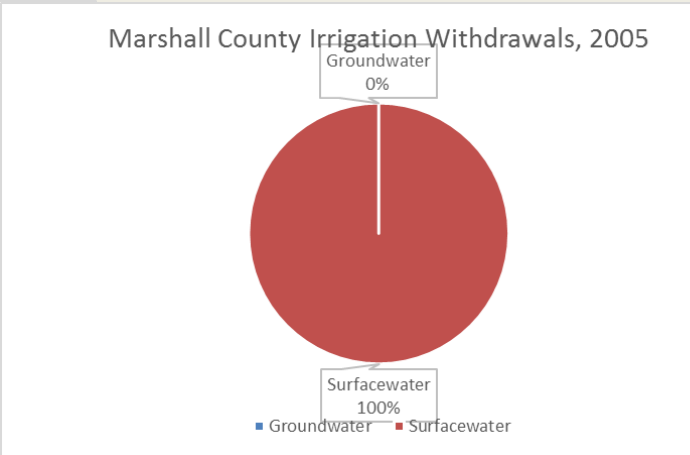
Irrigation Water Resources in the Study Area

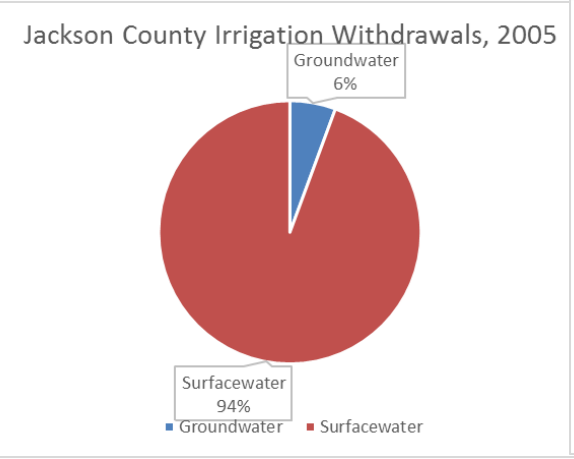


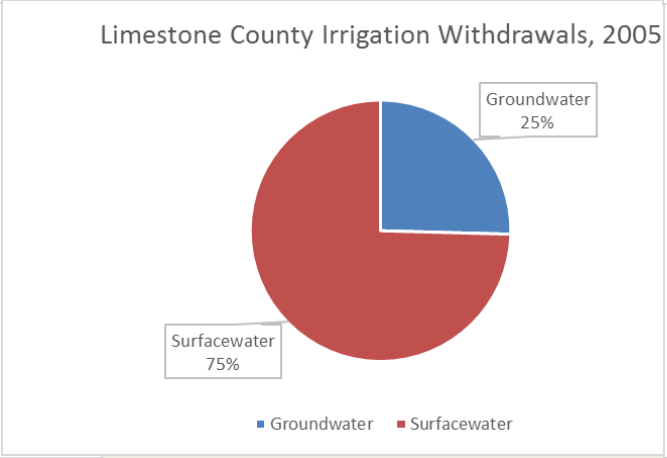


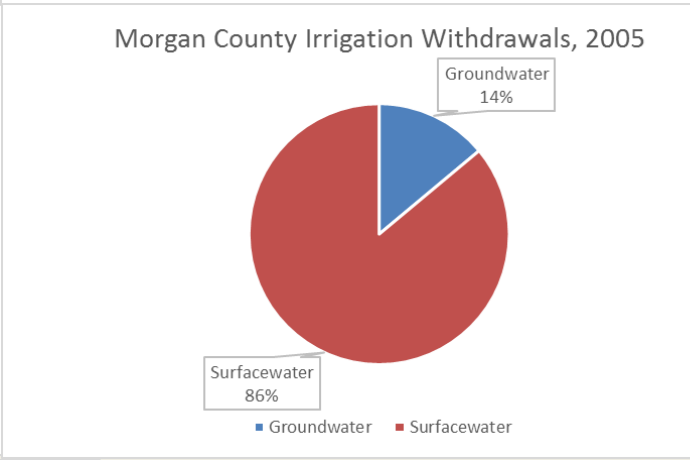

Colbert County Irrigation Withdrawsls, 2005
Groundwater 40%
Surfacewater 60%
Groundwater
Surfacewater

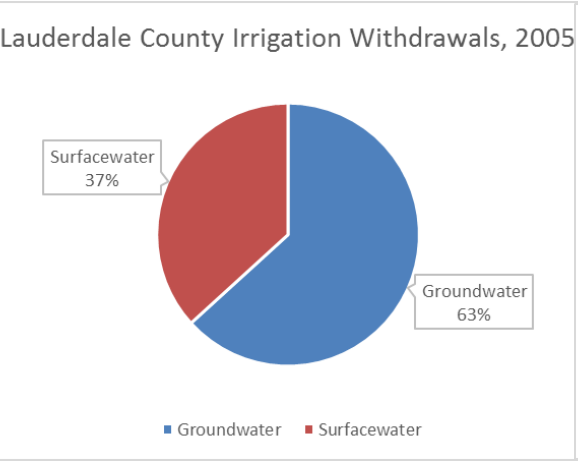

Lawrence County Irrigation Withdrawals, 2005
Groundwater 21%
Surfacewater 79%
Groundwater
Surfacewater

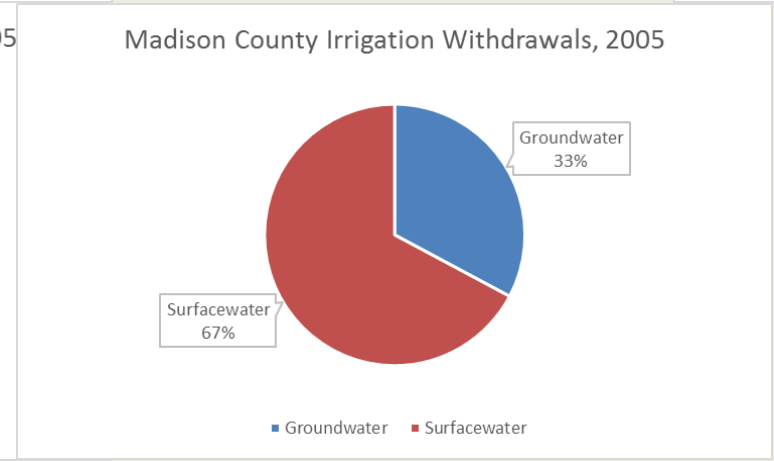

Marshall County Irrigation Withdrawals, 2005
Groundwater 0%
Surfacewater 100%
Groundwater
Surfacewater

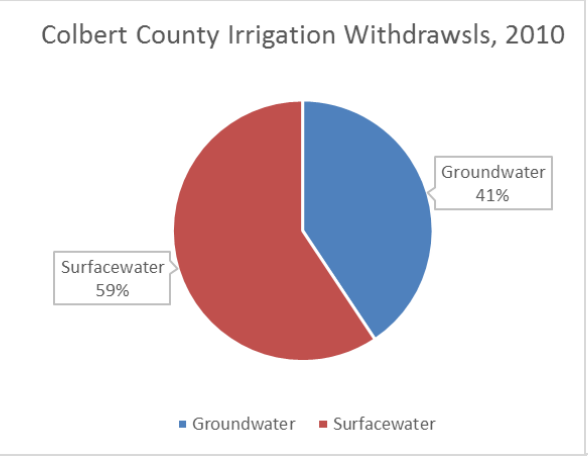

Jackson County Irrigation Withdrawals, 2005
Groundwater 6%
Surfacewater 94%
Groundwater
Surfacewater

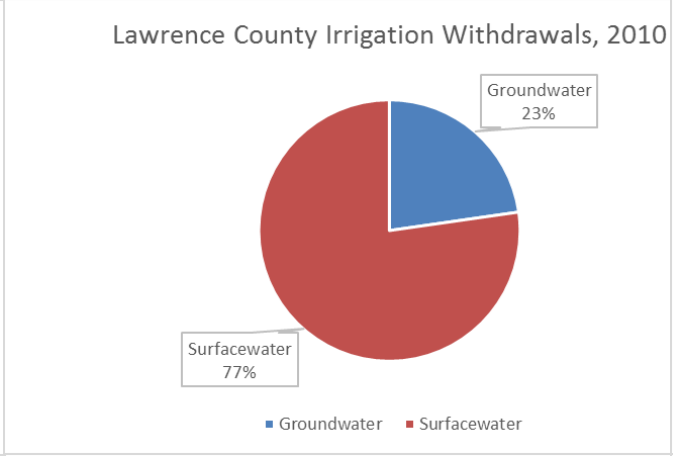

Limestone County Irrigation Withdrawals, 2005
Groundwater 25%
Surfacewater 75%
Groundwater
Surfacewater

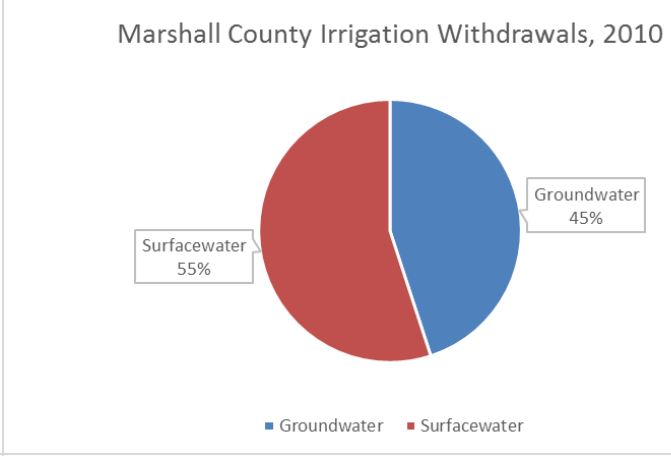

Morgan County Irrigation Withdrawals, 2005
Groundwater 14%
Surfacewater 86%
Groundwater
Surfacewater

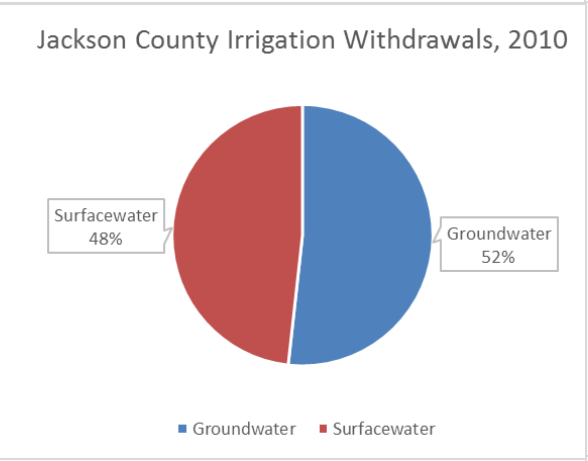

Lauderdale County Irrigation Withdrawals, 2005
Surfacewater 37%
Groundwater 63%
Groundwater
Surfacewater

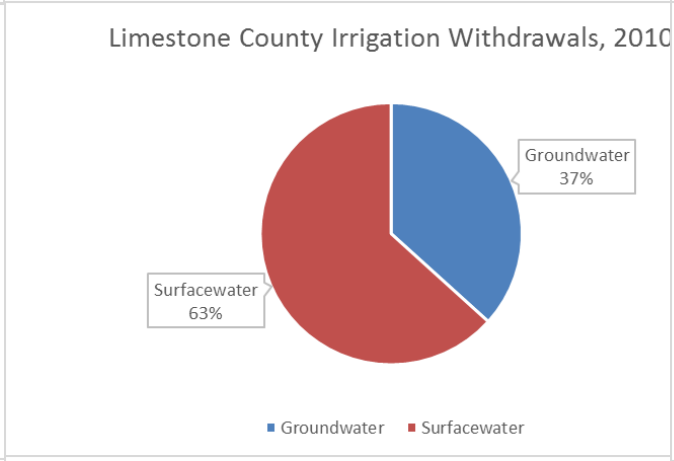

Madison County Irrigation Withdrawals, 2005
Groundwater 33%
Surfacewater 67%
Groundwater
Surfacewater

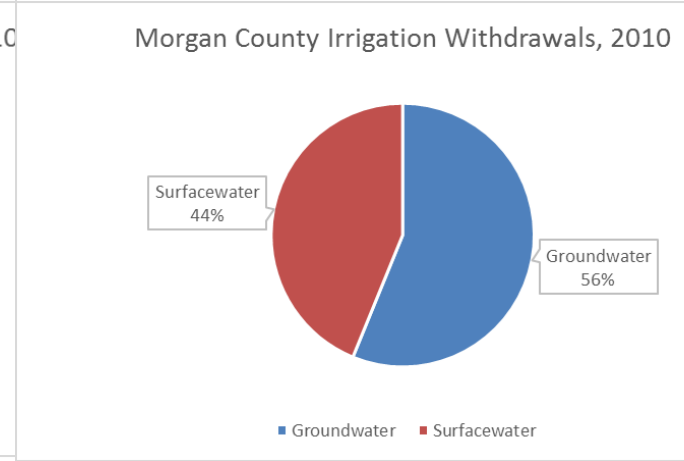

Colbert County Irrigation Withdrawsls, 2010
Groundwater 41%
Surfacewater 59%
Groundwater
Surfacewater

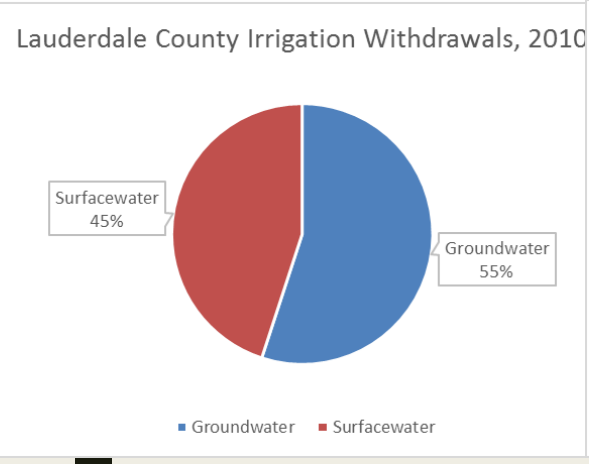

Lawrence County Irrigation Withdrawals, 2010
Groundwater 23%
Surfacewater 77%
Groundwater
Surfacewater

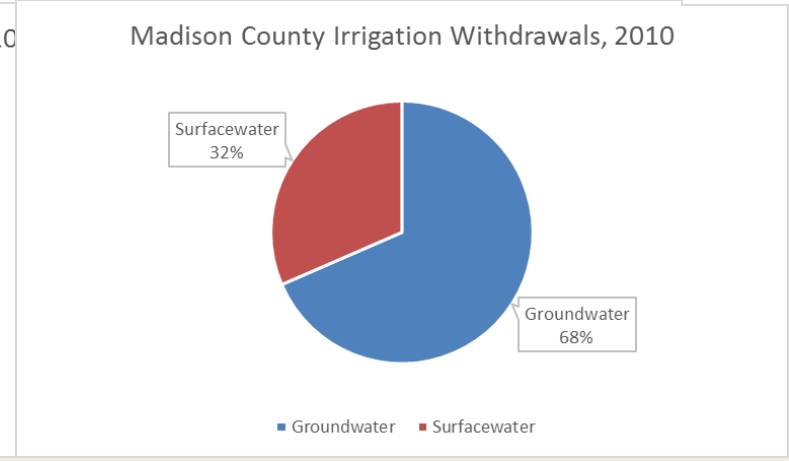

Marshall County Irrigation Withdrawals, 2010
Groundwater 45%
Surfacewater 55%
Groundwater
Surfacewater


Jackson County Irrigation Withdrawals, 2010
Surfacewater 48%
Groundwater 52%
Groundwater
Surfacewater


Limestone County Irrigation Withdrawals, 2010
Groundwater 37%
Surfacewater 63%
Groundwater
Surfacewater

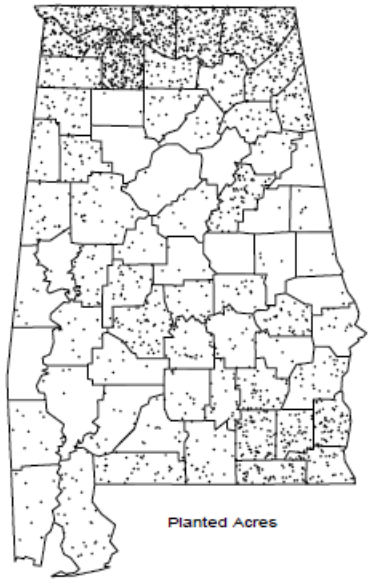

Morgan County Irrigation Withdrawals, 2010
Surfacewater 44%
Groundwater 56%
Groundwater
Surfacewater


Lauderdale County Irrigation Withdrawals, 2010
Surfacewater 45%
Groundwater 55%
Groundwater
Surfacewater


Madison County Irrigation Withdrawals, 2010
Surfacewater 32%
Groundwater 68%
Groundwater
Surfacewater

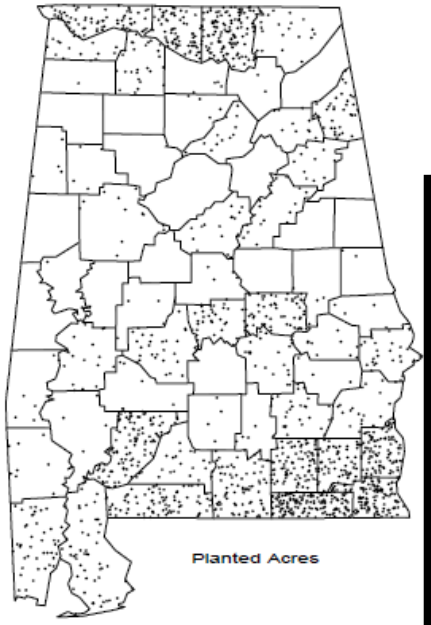
Studied Crops

Corn Acreage And Production, 2010



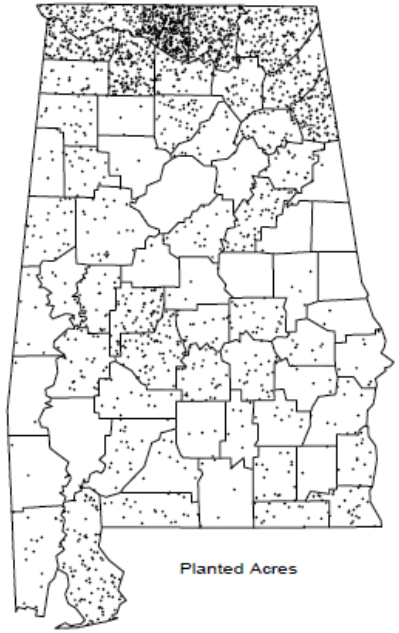
Leading Counties	Bushels
Lawrence	4,198,000
Limestone	3,101,000
Colbert	3,009,000
Lauderdale	2,589,000
Madison	2,429,000

Cotton Acreage And Production, 2010

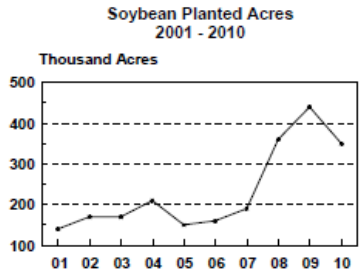


Leading Counties	Bales
Escambia	40,100
Madison	38,300
Lauderdale	31,600
Houston	28,600
Limestone	26,300

Soybeans Acreage And Production, 2010



Leading Counties	Bushels
Limestone	1,456,000
Jackson	841,000
Madison	790,000
Lawrence	636,000
Baldwin	600,000



Data Preparation

Normal Crop Progress

Crop	Planting Begins	Planting Ends	Harvest Begins	Harvest Ends
Corn	Mid-March	Mid-May	Early August	Early October
Cotton	Early April	Mid-June	Early September	Mid-December
Hay, first Cutting	---	---	Early May	Mid-July
Peaches	---	---	Mid-May	Mid-July
Peanuts	Mid-April	Mid-June	Early September	Early November
Pecans	---	---	Early October	Mid-December
Spring Potatoes	Mid-January	Mid-March	Early May	Early July
Summer Potatoes	Early March	Early April	Early July	Late August
Sweet Potatoes (South)	Mid-March	Late June	Mid-July	Early-November
Sweet Potatoes (North)	Mid-May	Early July	Mid-September	Late October
Soybeans	Mid-April	Early July	Early September	Mid-December
Wheat	Early October	Late-November	Mid-May	Mid-July

Data Preparation

- Planting date and harvest date

Crop Type	Planting Date	Harvest date
Corn	April 1st	August 10th
Cotton	April 15th	October 5th
Soybean	July 1st	October 8th

Climate for during the planted season

Date Preparation

- Climate date

Monthly Precipitation Data

month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	142.4308	147.1417	139.1786	60.45385	97.00769	77.33571	158.4429	72.1	64.19392	108.2574	123.6105
2	67.33077	132.5583	60.55385	222.9923	182.2692	129.58	77.75385	59.64375	113.2805	82.26446	80.42185
3	128.5417	160.5417	174.5231	65.29231	128.0917	89.2	62.2	28.43889	117.5273	134.6675	107.8151
4	219.375	91.13333	56.21538	109.7846	75.29231	122.72	121.6	89.07368	100.4291	121.8179	62.81711
5	37.94167	166.0417	173.4	259.4846	89	41.59333	102.9313	35.44	130.0946	230.8633	126.9465
6	119.5083	177.5583	59.51538	122.3385	147.1077	132.7	52.2125	61.37895	62.29048	57.74226	86.55467
7	51.56923	129.7231	121.4077	108.9385	158.2071	139.3533	59.15625	148.1474	80.21879	143.5875	78.61689
8	55.375	132.0167	84.18333	111.6615	99.75714	97.24	63.90588	40.83684	148.2211	75.78929	82.65743
9	73.05	128.5615	173.5769	113	119.44	83.15333	103.3471	66.62632	27.9875	165.9922	39.06294
10	5.381818	85.8	101.6308	29.08462	105.68	2.3625	125.6059	44.81579	77.1432	181.8958	97.22829
11	208.15	91.66923	110.2231	126.4538	196.1267	99.81333	112.2235	79.49137	76.25749	57.3425	130.4228
12	89.78182	148.7333	161.5846	91.36923	199.5133	107.32	84.45882	54.09241	257.0367	174.1273	47.10139
corn	103.1198	140.4143	101.2153	147.1769	116.0445	108.18	82.43122	80.22745	97.48614	133.6786	88.26637
cotton	79.06389	140.0767	115.964	136.7934	118.0185	98.08125	81.75657	71.37099	90.3325	135.0352	81.43264
soybean	69.52996	137.6445	109.0524	107.4538	129.1705	104.5925	73.9593	76.59879	79.48436	116.2484	73.68493

Date Preparation

- Climate date

Monthly Min Temperature

month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	10.1	8.166667	12.75833	7.458333	10.725	13.26923	14.86923	11.22	9.5	9.994444	6.994444
2	16.5	14.51667	12.375	11.05833	10.60833	14.22143	10.64167	10.73333	13.52222	13.84444	7.516667
3	19.94545	14.31667	17.66667	18.09167	19.88182	15.95	18.22308	22.2	17.90556	17.94444	15.01111
4	20.58182	23.46667	23.91667	23.03333	22.475	22.2	25.94615	21.18333	21.85556	21.59444	24.72778
5	28.54545	26.80833	25.425	25.48333	28.01667	25.72857	26.14	28.70556	25.67778	25.07222	27.48333
6	31.06364	29.03333	30.69167	28.44167	28.83333	29.42143	31.28667	32.67222	31.36111	31.77778	32
7	33.18182	31.41538	32.06667	30.19167	30.63846	31.3	33.72	30.48889	32.85	30.01667	33.5
8	33.49091	30.225	32.56364	31.6	29.27692	32.63571	34.09375	36.06111	31.31111	30.44118	34.03889
9	28.72727	26.76154	30.00833	28.45	28.05	30.57857	28.0375	30.45	28.55556	27.21176	31.23333
10	25.65	22.06154	22.45	23.24167	23.97143	23.32143	21.5	24.90588	22.38333	20.44706	25.18333
11	15.83636	21.19231	14.325	19.73333	17.77143	18.30714	16.6875	17.55556	15.18889	17.73529	17.93333
12	6.76	14.075	10.825	11.17273	11.56429	9.778571	13.675	14.76111	12.23333	9.917647	7.633333
corn	28.73916	27.87663	28.37413	27.15769	27.62825	27.58352	29.64402	28.86239	28.19573	27.37112	29.78248
cotton	29.925	28.17421	29.37447	28.15711	28.24379	29.05609	29.97076	30.55066	29.01422	28.01024	30.85
soybean	31.15699	28.79749	30.6493	29.17628	28.79751	30.39451	30.99337	31.8402	30.35513	29.13763	32.11538

Date Preparation

- Climate date

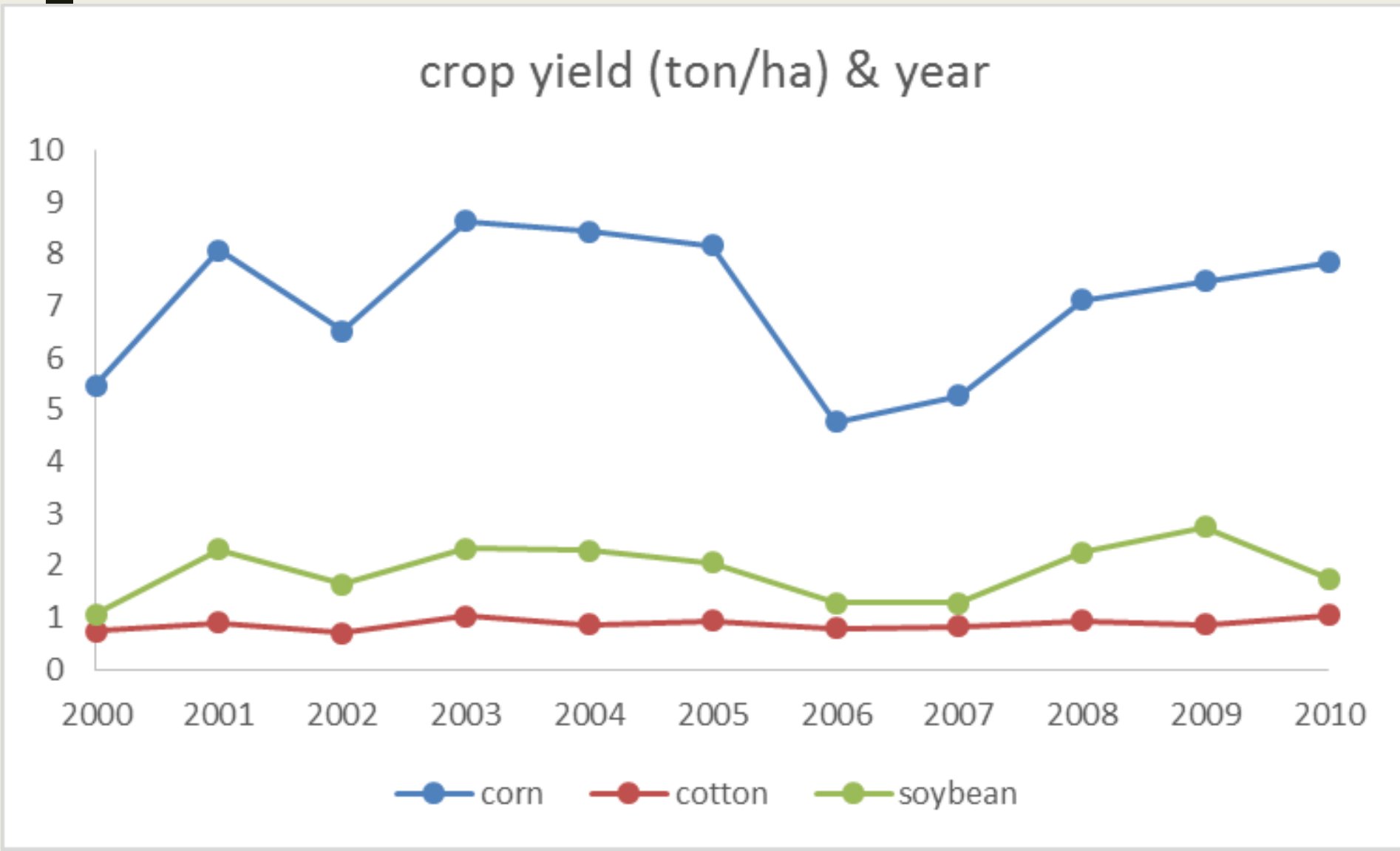
Monthly Max Temperature

month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.284615	-2.58333	0.533333	-3.65833	-1.29167	2.192308	2.123077	0.713333	-1.88889	-1.55556	-3.45
2	2.225	2.433333	-0.425	0.925	0.575	2.828571	-0.65	-1.98	0.677778	0.133333	-2.27778
3	6.390909	3.108333	4	6.341667	6.454545	3.907143	4.246154	6.952941	4.044444	6.022222	3.483333
4	8.163636	10.925	11.4	10.15833	8.95	8.585714	11.41538	7.488889	9.116667	8.25	9.327778
5	16.46364	14.2	13.38333	15.40833	16.55	11.98571	14.11333	13.82222	13.56111	15.60556	15.68889
6	19.00909	17.80833	18.86667	17.38333	19.54167	18.77143	17.73333	18.41667	18.70556	19.2	20.85556
7	20.27273	20.49231	21.36667	20.24167	19.65385	21.31429	21.23333	20.07778	19.72222	18.9	21.78889
8	20.14545	20.39167	20.2	20.73333	17.69231	21.20714	21.6875	21.84444	19.27778	19.55294	22.26667
9	16.64545	15.89231	19.28333	15.375	16.35	16.88571	15	17.36111	16.92222	18.07059	15.93333
10	9.72	7.315385	13.84167	9.408333	13.15714	9.342857	7.94375	11.6	9.027778	9.529412	7.638889
11	4.736364	5.369231	3.3	6.8	7.942857	4.171429	3.61875	3.411111	1.527778	4.347059	4.05
12	-3.68	3.016667	0.091667	-1.02727	-0.47857	-2.45714	0.2875	3.244444	1.116667	0.194118	-2.76667
corn	16.2979	16.20528	16.55769	16.17756	16.29068	15.62912	16.55182	15.48162	15.58419	15.80151	17.32692
cotton	17.33615	16.847	17.8424	16.90392	17.02159	16.9437	17.0822	17.15294	16.63268	17.12512	18.08301
soybean	18.30294	17.77456	19.4609	17.7391	17.91312	18.75989	18.06971	18.82308	17.91624	18.20769	19.24402

TABLE 1 Seasonal K_y values from *FAO Irrigation and Drainage Paper No. 33.*

Crop	K_y	Crop	K_y
Alfalfa	1.1	Safflower	0.8
Banana	1.2-1.35	Sorghum	0.9
Beans	1.15	Soybean	0.85
Cabbage	0.95	Spring wheat	1.15
Cotton	0.85	Sugarbeet	1.0
Groundnuts	0.70	Sugarcane	1.2
Maize	1.25	Sunflower	0.95
Onion	1.1	Tomato	1.05
Peas	1,15	Watermelon	1.1
Pepper	1.1	Winter wheat	1.05
Potato	1.1		

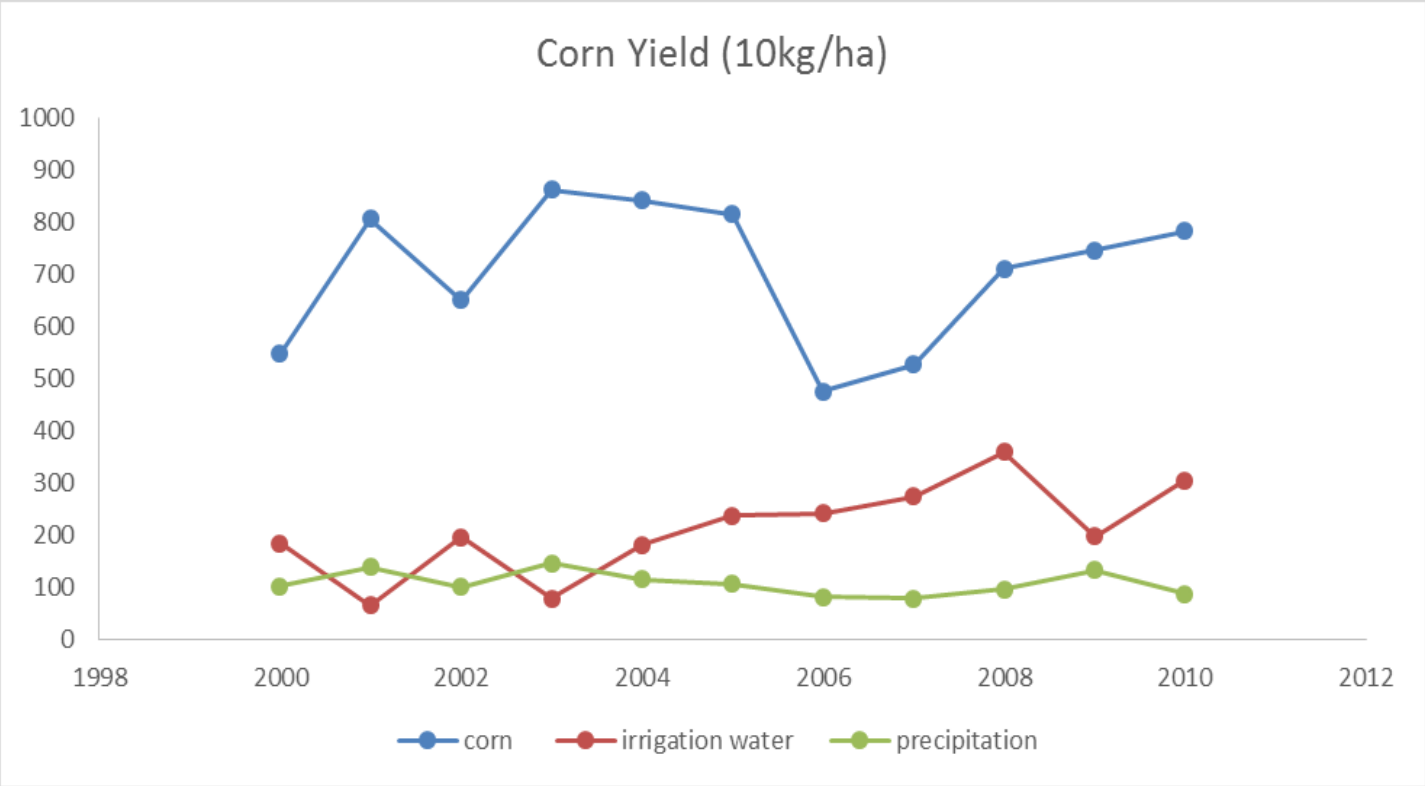
K>1:
sensitive


crop yield (ton/ha) & year
10
9
8
7
6
5
4
3
2
1
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
corn
cotton
soybean

Model Outputs

year	corn	irrigation water	precipitation	Tmax	Tmin
2000	5.483	185	103.1198	28.74	16.3
2001	8.073	67	140.4143	27.88	16.21
2002	6.521	198	101.2153	28.37	16.56
2003	8.639	80	147.1769	27.16	16.18
2004	8.434	183	116.0445	27.63	16.29
2005	8.166	239	108.18	27.58	15.63
2006	4.772	243	82.43122	29.64	16.55
2007	5.284	276	80.22745	28.86	15.48
2008	7.119	360	97.48614	28.2	15.58
2009	7.473	199	133.6786	27.37	15.8
2010	7.844	306	88.26637	29.78	17.33

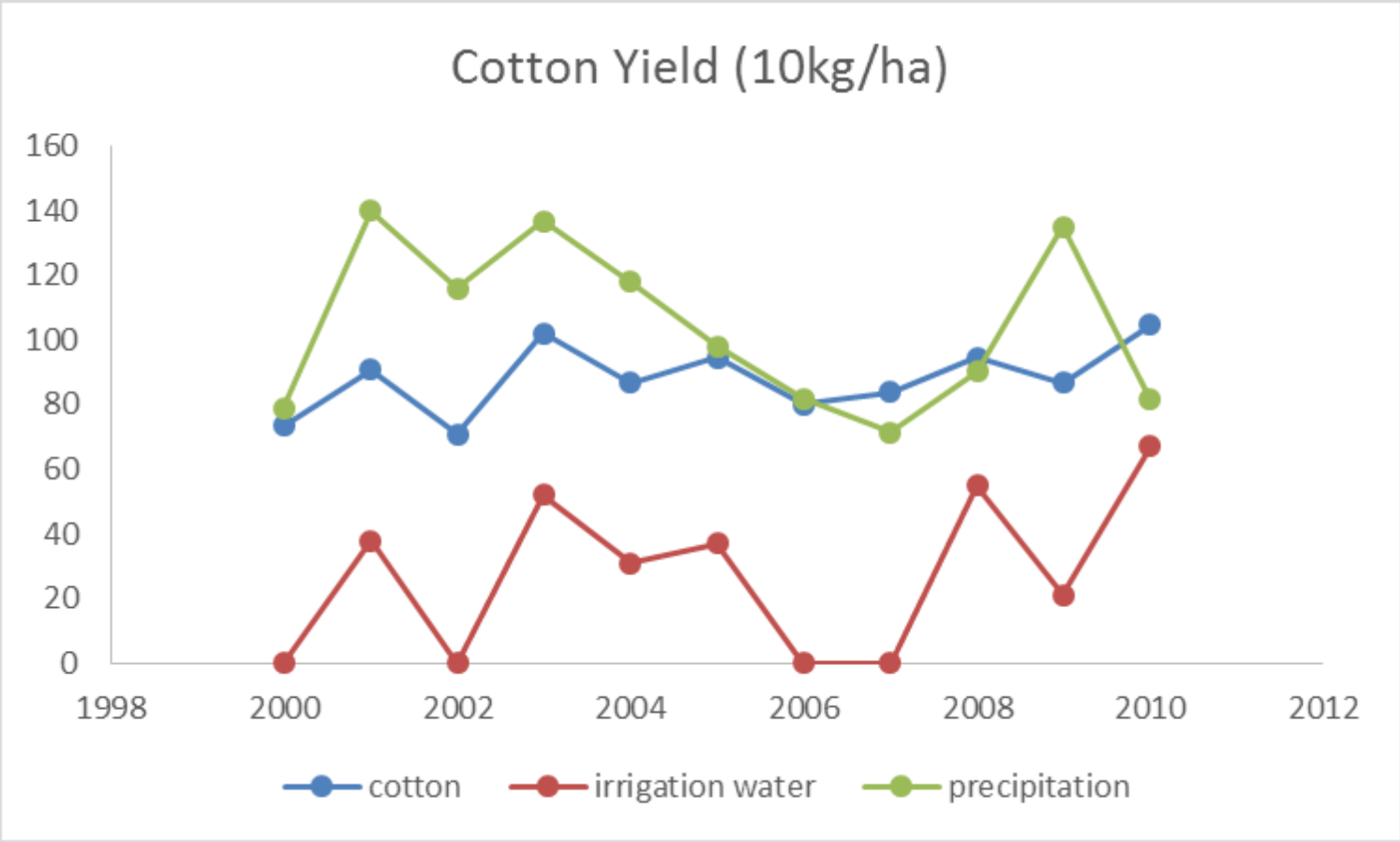
Model Outputs



Model Outputs

year	cotton	irrigation water	precipitation	Tmax	Tmin
2000	0.734	0	79.06389	29.93	17.34
2001	0.909	38	140.0767	28.17	16.85
2002	0.708	0	115.964	29.37	17.84
2003	1.022	52	136.7934	28.16	16.9
2004	0.866	31	118.0185	28.24	17.02
2005	0.945	37	98.08125	29.06	16.94
2006	0.802	0	81.75657	29.97	17.08
2007	0.838	0	71.37099	30.55	17.15
2008	0.944	55	90.3325	29.01	16.63
2009	0.866	21	135.0352	28.01	17.13
2010	1.046	67	81.43264	30.85	18.08

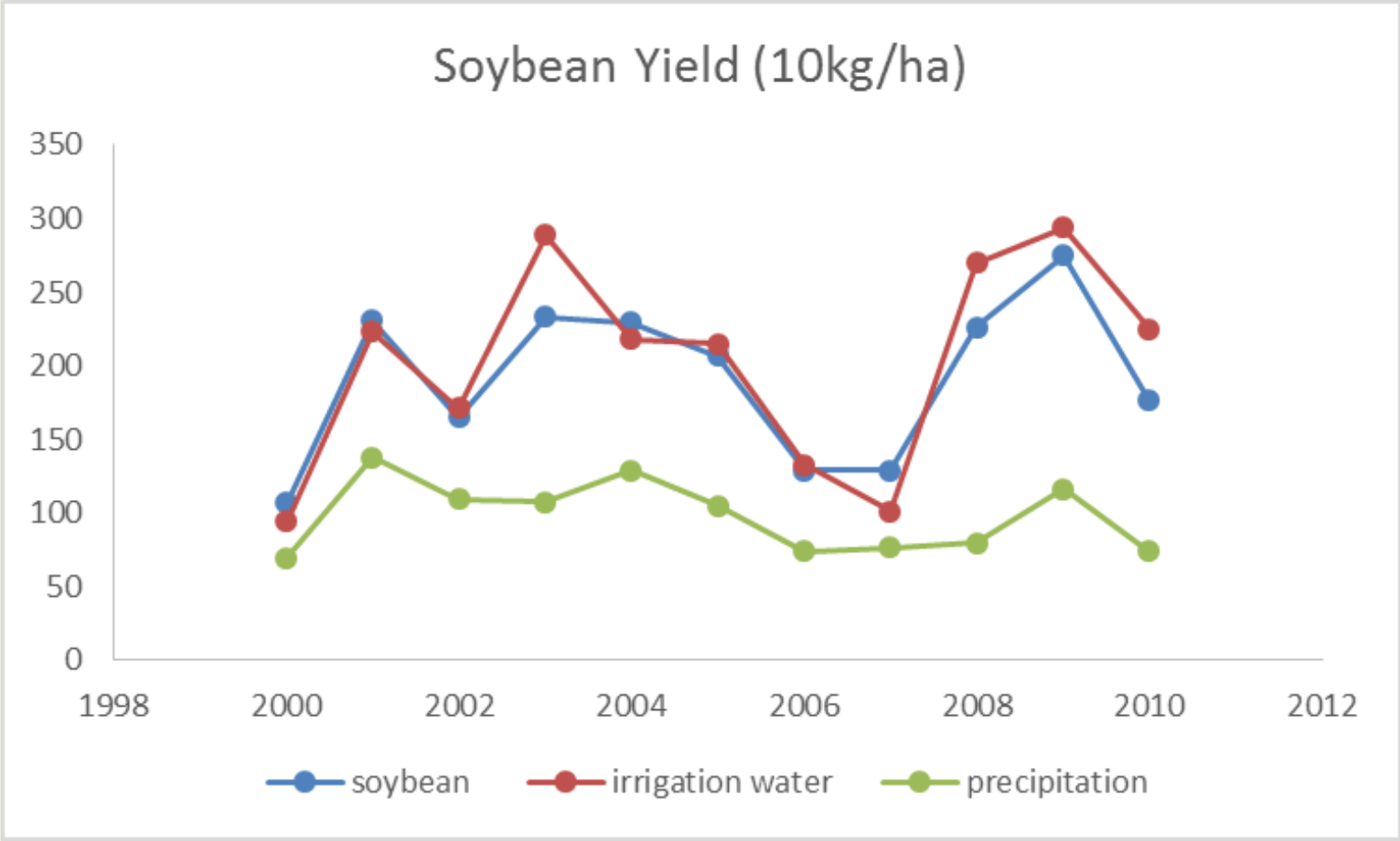
Model Outputs



Model Outputs

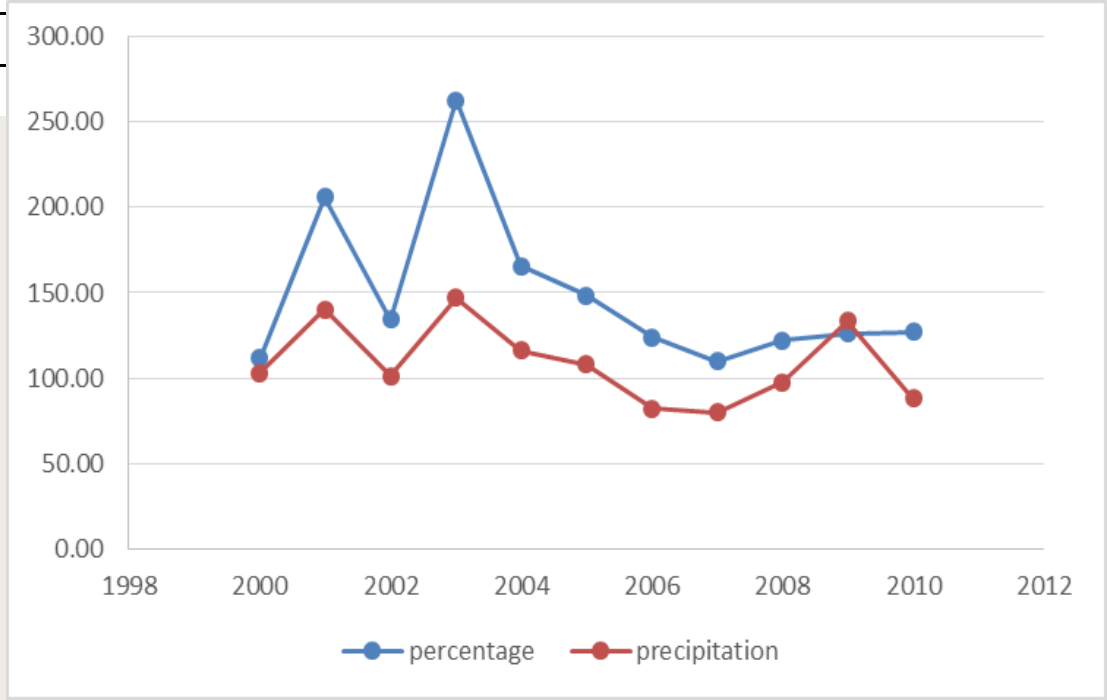
year	soybean	irrigation water	precipitation	Tmax	Tmin
2000	1.069	94	69.52996	31.16	18.3
2001	2.307	223	137.6445	28.8	17.77
2002	1.648	171	109.0524	30.65	19.46
2003	2.335	289	107.4538	29.18	17.74
2004	2.295	218	129.1705	28.8	17.91
2005	2.069	215	104.5925	30.39	18.76
2006	1.292	133	73.9593	30.99	18.07
2007	1.29	101	76.59879	31.84	18.82
2008	2.265	270	79.48436	30.36	17.92
2009	2.747	294	116.2484	29.14	18.21
2010	1.762	225	73.68493	32.12	19.24

Model Outputs

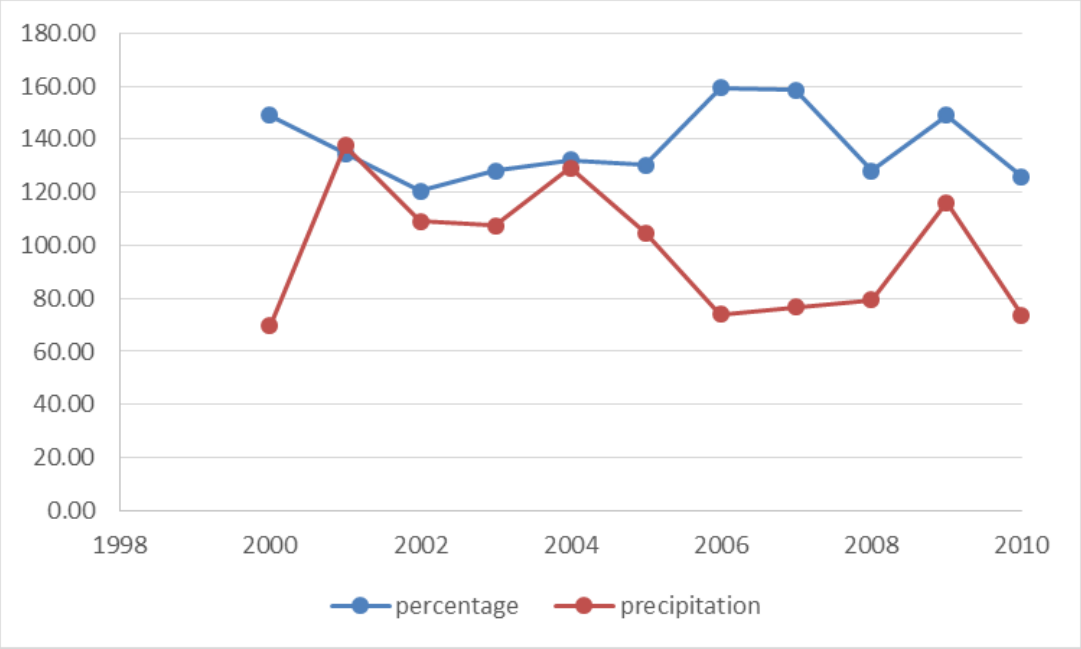


Sensitivity Analysis

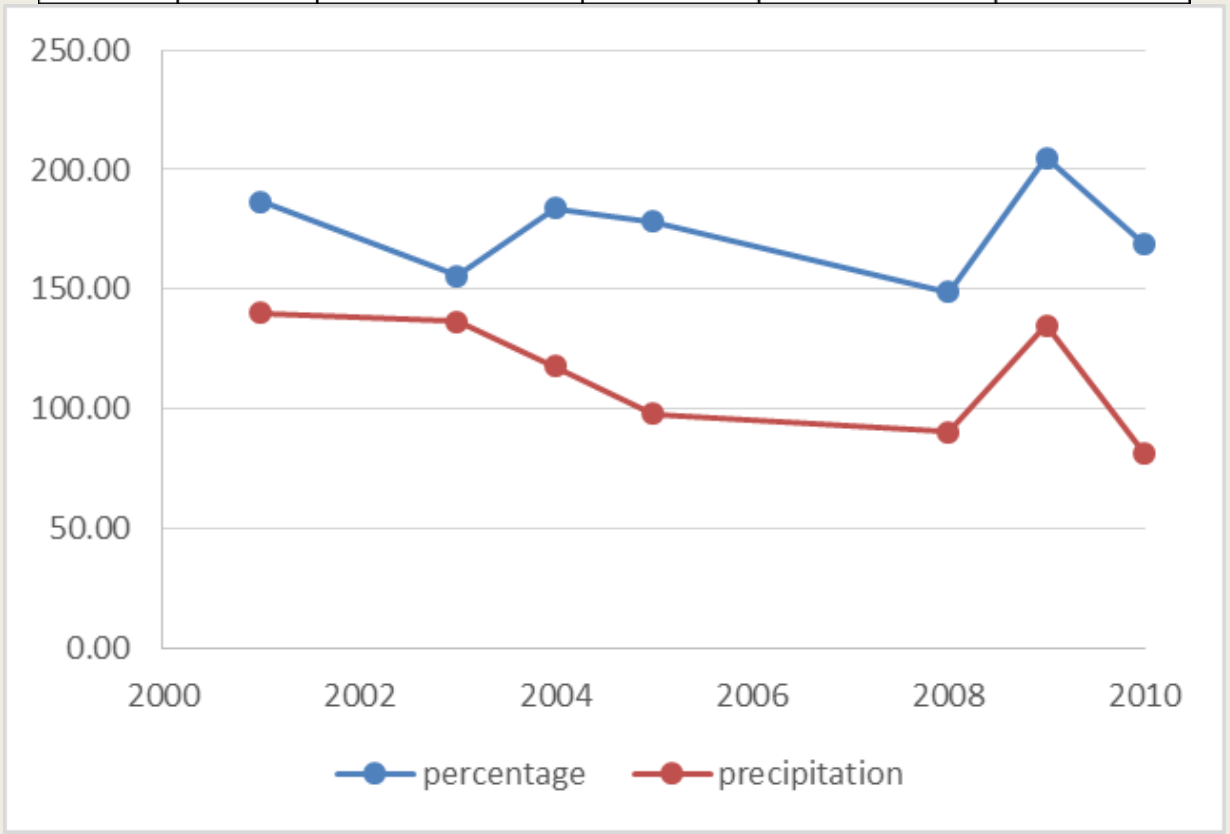
year	corn	irrigation water to achieve 120% production	percentage	irrigation water	precipitation
2000	5.483	207	111.89%	185	103.1198225
2001	8.073	138	205.97%	67	140.4142998
2002	6.5205	266	134.34%	198	101.215286
2003	8.638875	210	262.50%	80	147.1769231
2004	8.434125	303	165.57%	183	116.0445055
2005	8.166375	355	148.54%	239	108.18
2006	4.77225	301	123.87%	243	82.43122172
2007	5.284125	303	109.78%	276	80.22744939
2008	7.119	439	121.94%	360	97.4861425
2009	7.473375	251	126.13%		
2010	7.844288	389	127.12%		



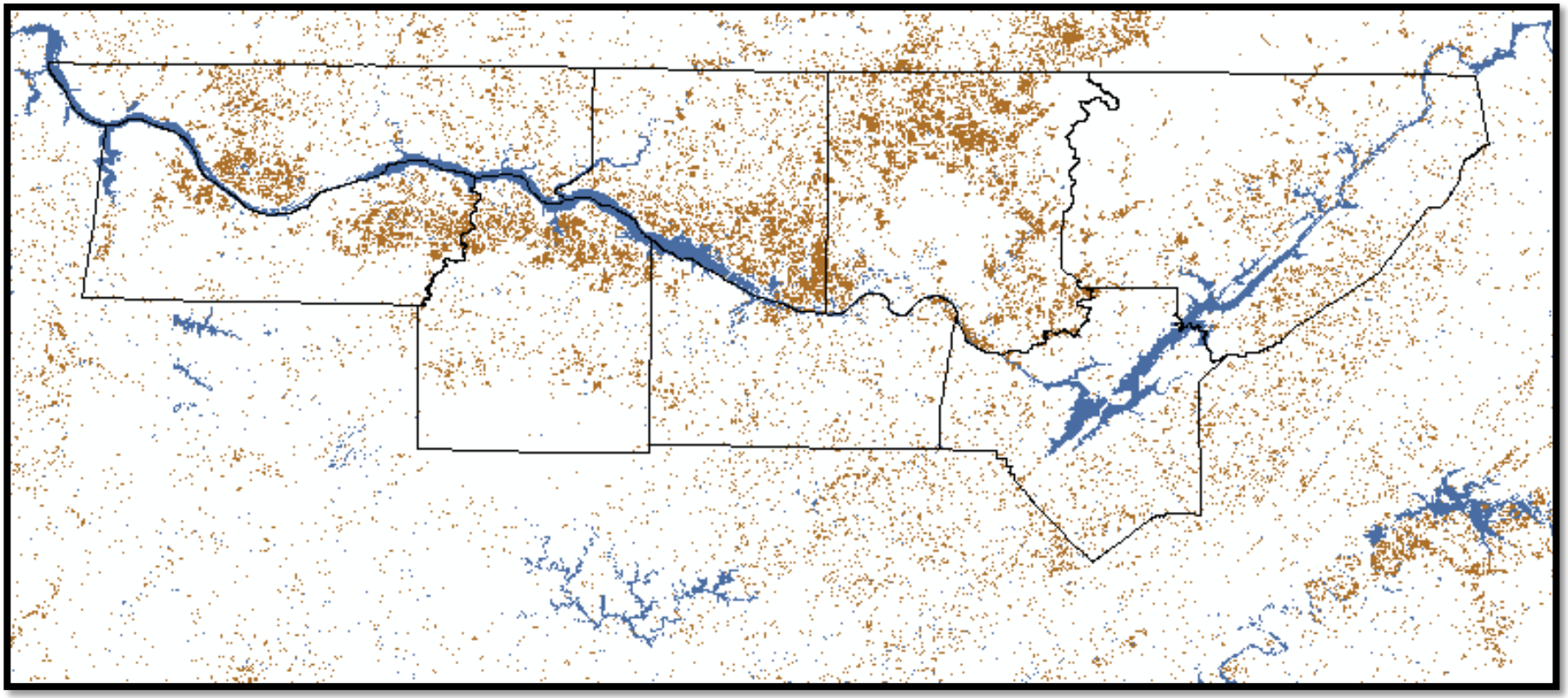
year	soybean	irrigation water to achieve 120% production	percentage	irrigation water	precipitation
2000	1.069	140	148.94%	94	69.52996235
2001	2.306714	300	134.53%	223	137.6445266
2002	1.648	206	120.47%	171	109.0523669
2003	2.335429	370	128.03%	289	107.4538462
2004	2.29475	288	132.11%	218	129.1704565
2005	2.068625	280	130.23%	215	104.5925
2006	1.292143	212	159.40%	133	73.9593043
2007	1.28975	160	158.42%	101	76.59878543
2008	2.265	346	128.15%	270	79.48435734
2009	2.747	438	148.98%	294	116.2484287
2010	1.762	283	125.78%	225	73.68492874



year	cotton	irrigation water to achieve 120% production	percentage	irrigation water	precipitation
2000	0.734287	48	X	0	79.06388832
2001	0.908507	71	186.84%	38	140.0766968
2002	0.707686	22	X	0	115.9640271
2003	1.022	81	155.77%	52	136.7934389
2004	0.866363	57	183.87%	31	118.0184939
2005	0.944673	66	178.38%	37	98.08125
2006	0.802	70	X	0	81.75657439
2007	0.838	57	X	0	71.37099071
2008	0.944384	82	149.09%	55	90.33249524
2009	0.866264	43	204.76%	21	135.0352005
2010	1.046353	113	168.66%	67	81.43264363



Water Resources and Croplands



Landcover Class

- Open Water
- Cultivated Crops

How to Regulate IBTs

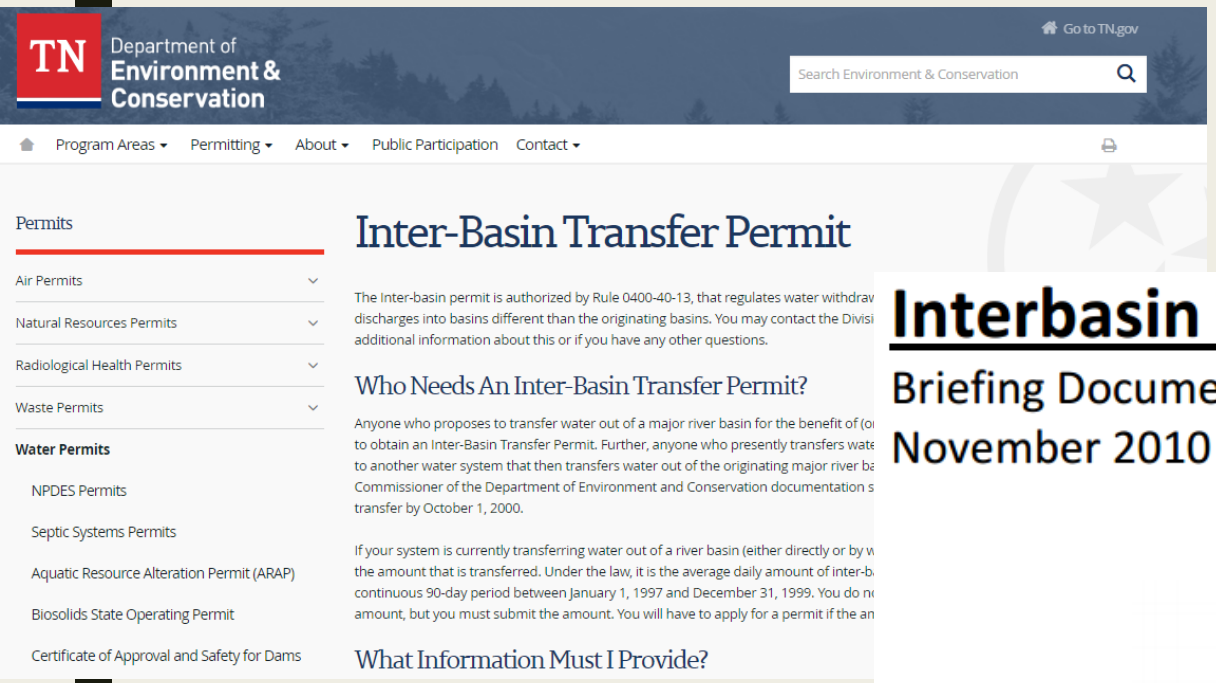
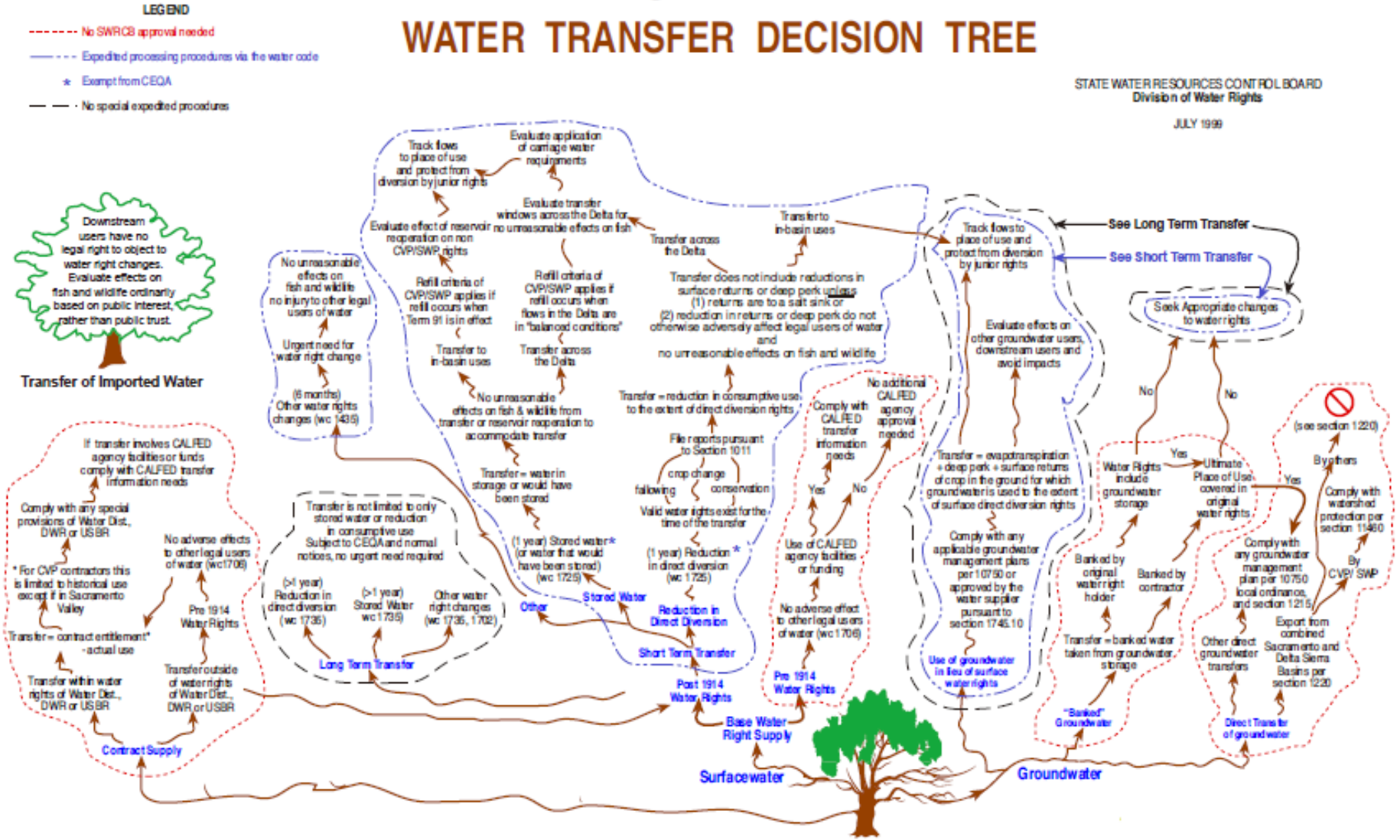


Figure 1

WATER TRANSFER DECISION TREE



Conclusions

- Interbasin Transfer projects have multiple impacts.
- Regulations for Interbasin Transfer are needed.
- Currently, the percentage of irrigated land is low in Alabama.
- Increase irrigation will increase agriculture production, different crop types have different sensitivity to irrigation.
- Factors should be considered when assess Interbasin Transfer Projects: water withdrawals, available water resources, hydraulic and environmental condition, climate, crop types, irrigation systems

Questions?
Thank You!