Conservation Study: Phase IV COHYST Model

The Flatwater Group, Inc.

7/12/2023

Project Background

- Conservation Study – Phase 3 preformed a survey of conservation practices to identify and quantify the prevalence of different tillage practices in the Twin Platte NRD, Central Platte NRD, and Tri-Basin NRD.
- The survey identified six predominant tillage practices based upon observations of residue coverage near the time of spring planting
- Each NRD then identified the relative occurrence of each tillage practice within the district
- Phase IV looks to implement the finding from Phase 3 into the watershed modeling process for the COHYST area

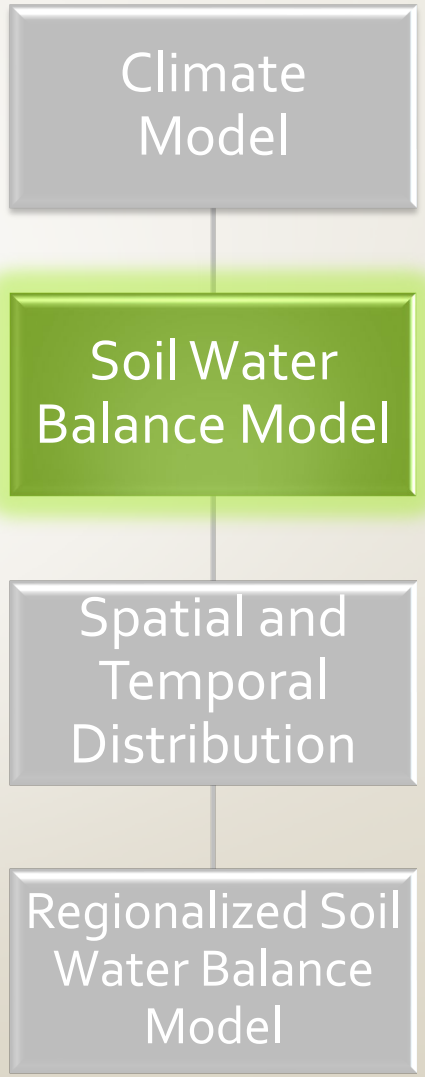
Project Background

- Conservation Study Phase IV also updated crop phenology and irrigation management
- The implementation of this information is in the format of a set of new CROPSIM ‘Simfiles’ input files collectively referred to as the 2020 set point
- The COHYST model was extended through 2020 in preparation for the 2023 Robust Review Modeling

Soil Water Balance Model

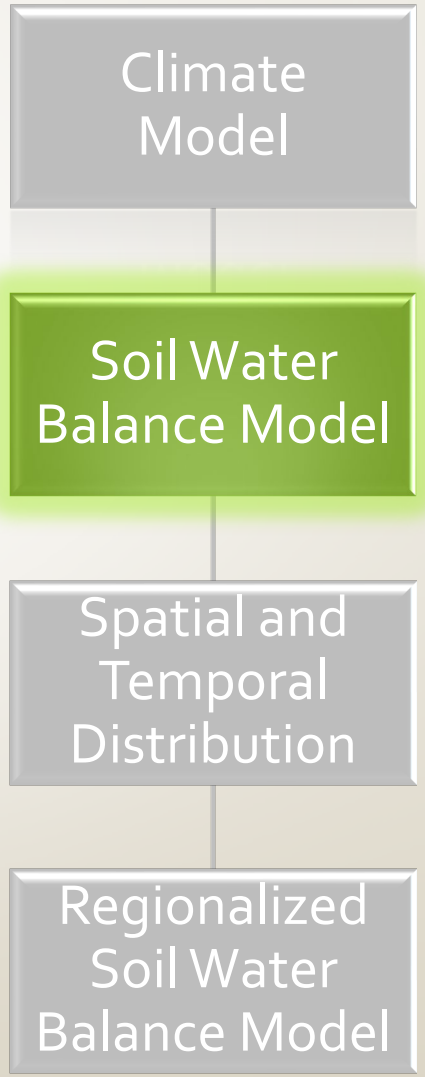
CROPSIM

- Developed by Dr. Martin at the University of Nebraska Lincoln
- Deterministic, water-driven, point source, multi-layered soil water balance model
- Uses weather data and representative system characteristics to model the daily soil water balance
  - Crop phenology
  - Soils
  - Management
  - Irrigation
  - Tillage



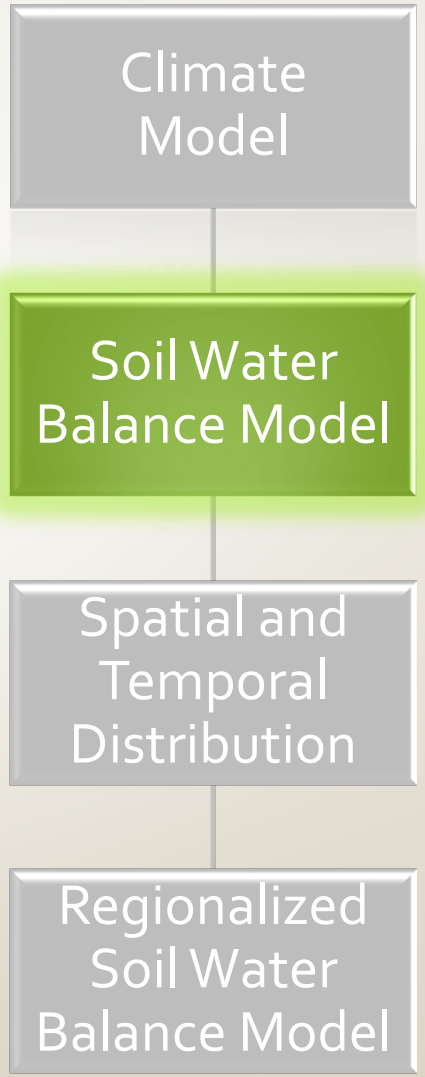
Existing implementation of CROPSIM into the watershed model

- CROPSIM is used to develop a series of estimates of the water balance at a given point – a weather station
  - Precipitation, NIR, ET, DP, RO
- At each weather station, multiple simulations are made over:
  - The historical weather record
  - 15 crops
  - 28 soil groups
  - Irrigated and non-irrigated scenarios
- Multiple sets of simulations depicting common farming practices over time (49, 73, 98)



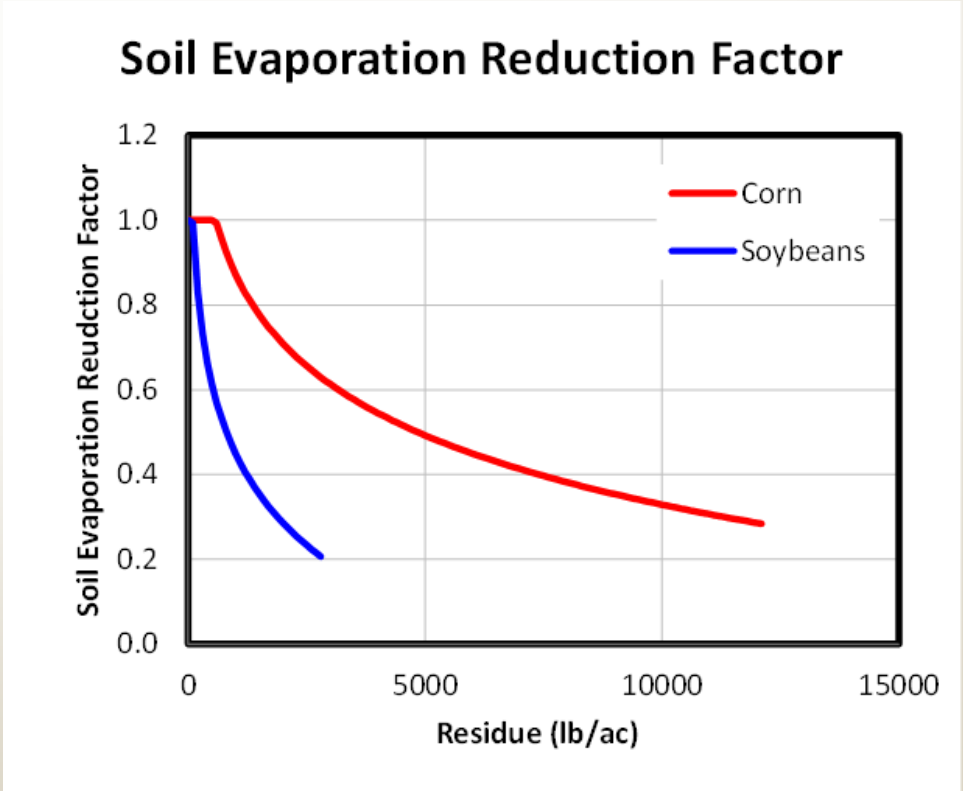
Conservation Study Phase IV: Updates to CROPSIM modeling for implementation into the COHYST Watershed Model

- Development of a current estimate of farming practices – circa 2020 CROPSIM set point
- Advancements in machinery, genetics, and farming practices have allowed producers to increasingly adapt reduced and no-tillage management practices
- This update includes implementing a variety of tillage management methods, and updating inputs related to crop phenology and irrigation management



Crop Residue

- Crop Residue is a portion of last years crop remaining on the soil surface
- Decreases the runoff potential
  - Modeled by modifying the curve number
- Reduces evaporation directly from the soil surface



Tillage Practices

1. Conventional Tillage
2. Reduced Tillage
3. Mulch Tillage
4. No Till
5. Ridge Till
6. Strip Till

1. Conventional Tillage

- Consists of multiple tillage events designed to open\turn over the soil surface, control weeds, and clean up the field to allow traditional machinery in the field without being intruded upon by excess amounts of residue
- The majority of remaining residue is buried under the soil surface
- Use of equipment such as disks, chisels, plows, and cultivators
- Residue coverage 0-15%

2. Reduced Tillage

- Characterized by less intensive and fewer tillage practices than conventional tillage, leaving a larger portion of residual residue on the soil surface
- Uses similar types of equipment to conventional tillage
- Residue coverage 15-30%

3. Mulch Tillage

- Characterized by even less intensive tillage operations and fewer passes than the Reduced Tillage category
- This method continues to use conventional tillage implements
- Residue coverage >30%

4. No Till

- Characterized by leaving the soil surface undisturbed between harvesting and planting
- Implemented with a single planting operation
- Most of the residual residue remains on the soil surface at planting time
- Residue coverage ~90%

5. Ridge Till

- Characterized by planting and growing the crop on a ridge formed from previous growing seasons
- Ridge tillage is subject to minimal soil disturbance between harvest and planting
- Often only an operation to remove residue from the top of the ridge to aid in planting
- Cultivating and hilling are common with ridge tillage
- Residue target > 30%

6. Strip Till

- Characterized by performing a tillage operation on only a portion of the soil surface prior to planting
- The tilled area is typically less than 1/3 of the land area and bounded by undisturbed soil on either side
  - The crop is later planted in the tilled areas
- Strip tilling is used to expose a portion of the soil surface allowing the soil to warm quicker or to dry wet soils
- Residue coverage >30%

COHYST Model: Crops

- Corn
- Soybeans
- Sorghum
- Alfalfa
- Winter Wheat
- Pasture
- Fallow
- Miscellaneous

Corn – 49 Set Point

- Tandem Disk 1 - Secondary
- Tandem Disk 2 - Secondary
- Moldboard Plow
- Harrow 1
- Harrow 2
- Finishing
- Planting
- Cultivator 1
- Cultivator 2

- Residue Planting: 0.6%
- Final Residue: 0.3%

Corn – 73 Set Point

- Knife Applicator
- Moldboard Plow
- Harrow
- Planting
- Cultivator 1
- Cultivator 2

- Residue Planting: 2%
- Final Residue: 1%

Corn – 98 Set Point

- Stalk Chopper
- Knife Applicator
- Tandem Disk 1 - Secondary
- Tandem Disk 2 - Light
- Planting
- Cultivator 1
- Cultivator 2

- Residue Planting: 24%
- Final Residue: 9%

Corn – Conventional Tillage

- Stalk Chopper
- Knife Applicator
- Disk 1 – Heavy
- Disk 2 – Primary
- Planting
- Cultivator 1
- Cultivator 2

- Residue Planting: 8%
- Residue Final: 3%

Corn – Reduced Tillage

- Stalk Chopper
- Knife Applicator
- Tandem Disk 1 - Secondary
- Tandem Disk 2 – Light
- Planting
- Cultivator 1

- Residue Planting: 24%
- Residue Final: 19%

Corn – Mulch Tillage

- Knife Applicator
- Field Cultivator 1
- Field Cultivator 2
- Planting

- Residue Planting: 43%
- Residue Final: 43%

Corn – Ridge Tillage

- Stalk Chopper
- Planting
- Cultivator 1
- Cultivator 2

- Residue Planting: 40%
- Residue Final: 10%

Corn – Strip Tillage

- Stalk Chopper
- Planting
- Cultivator 1
- Cultivator 2

- Residue Planting: 40%
- Residue Final: 10%

Crop Phenology

- UNL crop progress reports
- Extension Educators
  - Corn:
    - Planting: as early as April 10
    - Planting: April 23-25
    - Maturity: Mid September
  - Soybeans
    - Planting: A lot of variability April to June, dependent upon producer's management goals
    - Planting: potentially earlier than corn to capture additional growing degree days in the cooler early season
    - Planting: May 1-3
    - Maturity: Mid September
  - Sorghum
    - Lots of variability, highly producer dependent
    - Planting: May 13-15
    - Maturity: Mid September

Crop Phenology

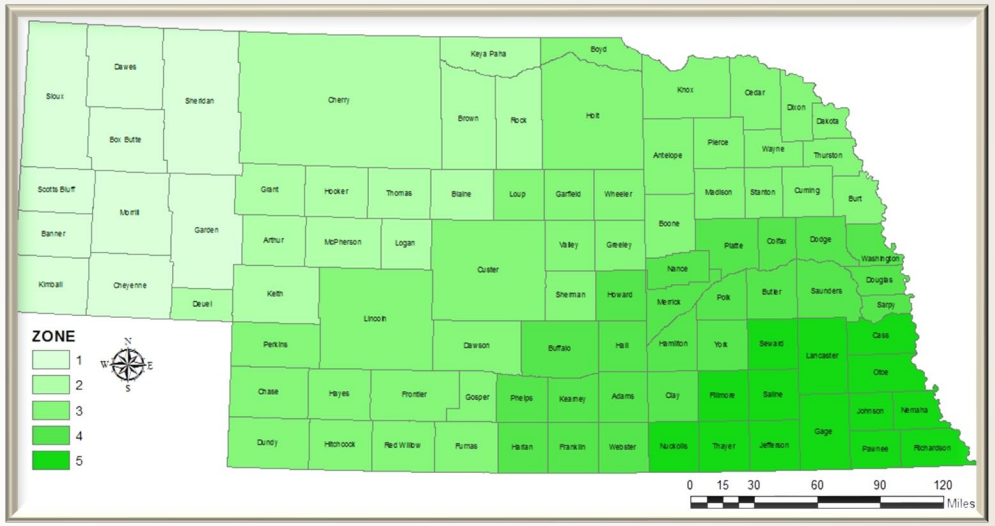
- Winter Wheat
  - Planting: Mid to Late September
  - Planting: September 22-24
  - Maturity: June

Crop Phenology - GDD

- Annual growing degree days (GDD) were calculated for the growing season from 2002-2020.
- The average value was used as the GDD to maturity
- Crop growth stages were defined by the existing proportional distribution applied to the new average GDD to maturity
- Growth stages include emergence, effective cover, flowering, ripening, yield formation, and maturity

Year	GDD_Corn	GDD_Soybeans	GDD_Sorghum (Milo)	GDD_Winter Wheat
2002	2,929	2,881	2,774	2,128
2003	2,670	2,614	2,515	2,376
2004	2,565	2,507	2,330	2,320
2005	2,859	2,840	2,699	2,663
2006	2,911	2,858	2,737	2,318
2007	2,998	2,925	2,699	2,087
2008	2,667	2,620	2,503	2,293
2009	2,553	2,483	2,355	1,859
2010	2,842	2,777	2,689	2,166
2011	2,798	2,755	2,581	2,862
2012	3,100	3,011	2,800	2,081
2013	2,870	2,794	2,695	2,347
2014	2,730	2,650	2,513	2,413
2015	2,713	2,661	2,508	2,591
2016	2,829	2,768	2,627	2,517
2017	2,729	2,696	2,536	2,306
2018	2,989	2,919	2,743	1,827
2019	2,746	2,687	2,604	2,109
2020	2,878	2,788	2,680	
Existing	2750	2500	2600	2250
Average	2,809	2,749	2,610	2,292

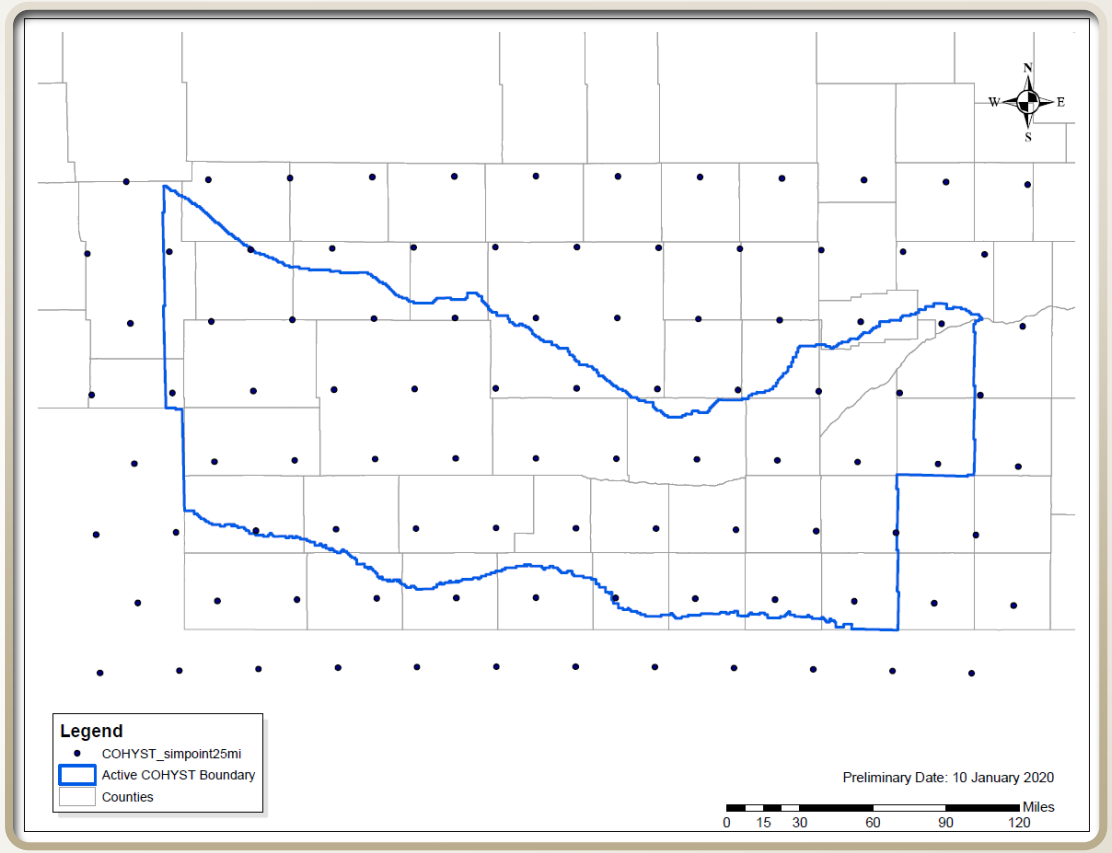
Simfile Development



- The 2020 set point consists of SIMFILES for 6 tillage categories and 5 CROPSIM Management Zones
  - 1 set of Simfiles for each of the tillage categories. Tillage operations vary from category to category, but within a single category they do not vary between management zones
  - 1 set of phenology for each management zone. Crop Phenology varies from management zone to zone, but within a single management zone the same crop phenology is applied to each tillage category

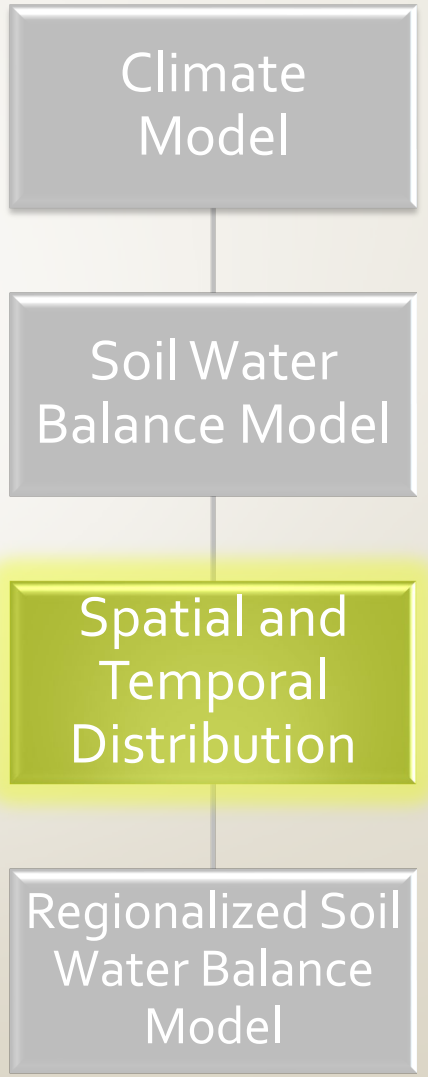
CROPSIM Simulations

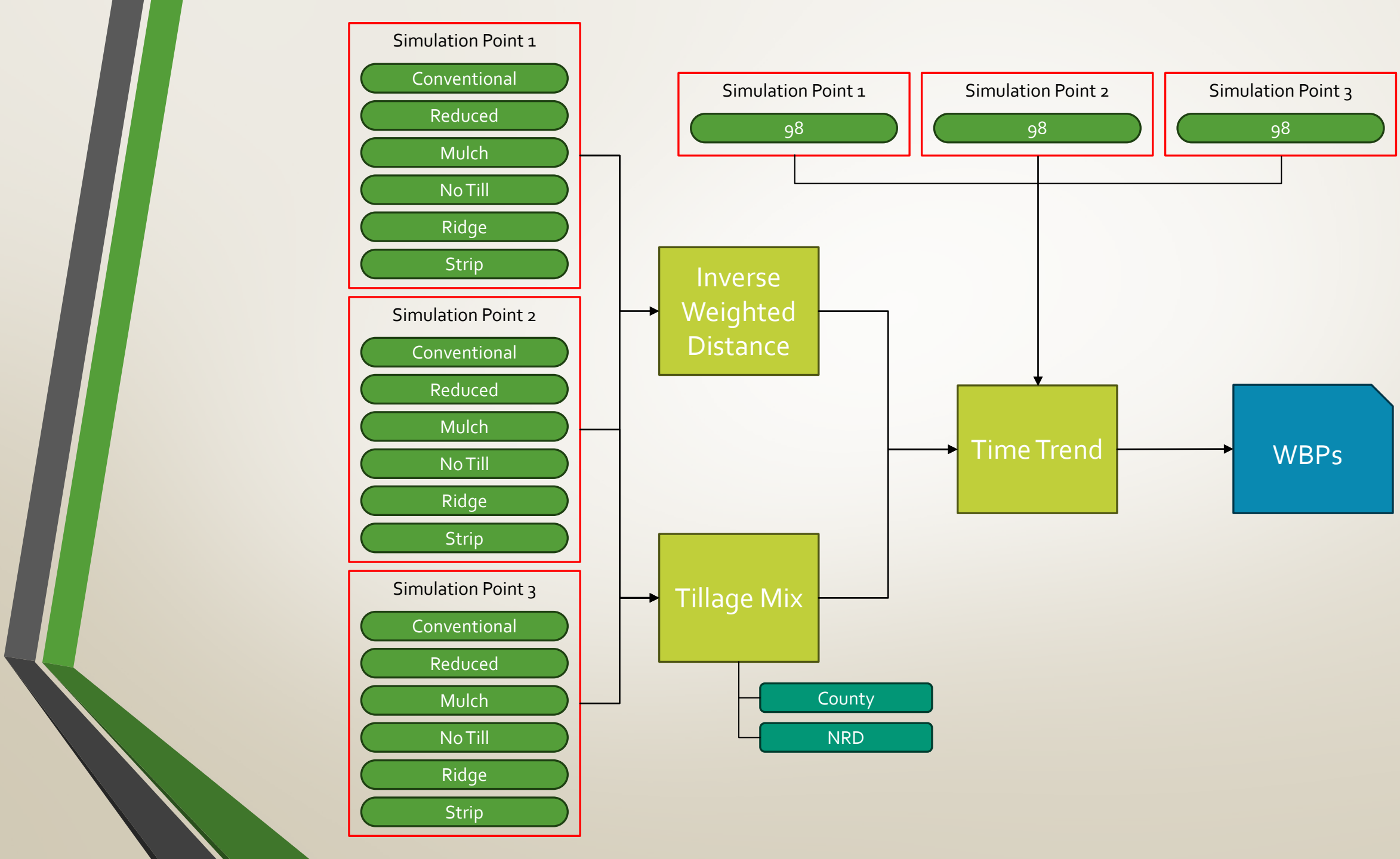
- The new SIMFILEs were used to create a system of soil water balance estimates. Estimates were created for each combination of:
  - Crop
  - Irrigation
  - Soil
  - Tillage category
- This was done at each simulation point in the COHYST 25 mile TIN for the period 1996-2020 using the weather data from ACIS grid 21 (PRISM) and ACIS grid 1.



Spatial and Temporal Distribution

- The next step in the process is to spatially distribute the CROPSIM results to the model grid cells. The CROPSIM output was:
  - Weighted proportional to the tillage definitions from the Phase 3 tillage survey. Tillage mix is defined by the location of the cell centroid relative to NRD and county. The tillage mix also varies by crop.
  - Weighted proportional to the inverse distance from the three nearest weather stations
  - Linearly time-trended with the results of the 98 practices for the period 1998-2020
- The result is a set of WBP inputs for the RSWB model




Simulation Point 1
Conventional
Reduced
Mulch
No Till
Ridge
Strip
Simulation Point 2
Conventional
Reduced
Mulch
No Till
Ridge
Strip
Simulation Point 3
Conventional
Reduced
Mulch
No Till
Ridge
Strip
Simulation Point 1
98
Simulation Point 2
98
Simulation Point 3
98
Inverse Weighted Distance
Tillage Mix
County
NRD
Time Trend
WBPs

Tillage Survey

Kearney County									
	<Null>	Conventional-Till <15%	Mulch-Till > 30%	No-Till	Reduced-Till 15-30%	Ridge-Till > 30%	Strip-Till > 30%	Unknown /NA	Grand Total
Corn	0%	10%	0%	29%	17%	2%	42%	0%	100%
Fallow	0%	100%	0%	0%	0%	0%	0%	0%	100%
Other	0%	0%	0%	82%	14%	0%	4%	0%	100%
Soybeans	0%	5%	2%	64%	11%	2%	17%	0%	100%
Wheat-Winter	0%	0%	0%	100%	0%	0%	0%	0%	100%
Grand Total	0%	8%	1%	45%	14%	1%	30%	0%	100%

NRD – County Tillage Mix

NRD	NRD_Name	County	County_Name	CropCode_RSWB	Crop_Name	Conventional	No Till	Reduced Till	Mulch Till	Ridge Till	Strip Till
17	TPNRD	439	Lincoln	1	Corn	0.03	0.42	0.07	0.23	0.03	0.21
17	TPNRD	439	Lincoln	9	Soybeans	0.01	0.54	0.09	0.22	0.05	0.10
17	TPNRD	439	Lincoln	5	WinterWheat	0.67	0.00	0.33	0.00	0.00	0.00
17	TPNRD	434	Keith	1	Corn	0.03	0.54	0.03	0.29	0.01	0.10
17	TPNRD	434	Keith	9	Soybeans	0.01	0.59	0.04	0.28	0.00	0.08
17	TPNRD	434	Keith	5	WinterWheat	0.66	0.02	0.30	0.02	0.00	0.00
24	TBNRD	420	Gosper	1	Corn	0.04	0.34	0.03	0.15	0.09	0.36
24	TBNRD	420	Gosper	9	Soybeans	0.02	0.55	0.01	0.07	0.03	0.32
24	TBNRD	420	Gosper	5	WinterWheat	0.00	1.00	0.00	0.00	0.00	0.00
24	TBNRD	452	Phelps	1	Corn	0.07	0.32	0.23	0.17	0.03	0.17
24	TBNRD	452	Phelps	9	Soybeans	0.02	0.48	0.23	0.10	0.03	0.14
24	TBNRD	452	Phelps	5	WinterWheat	0.00	0.50	0.17	0.00	0.00	0.00
24	TBNRD	433	Kearney	1	Corn	0.10	0.29	0.17	0.00	0.02	0.42
24	TBNRD	433	Kearney	9	Soybeans	0.05	0.64	0.11	0.02	0.02	0.17
24	TBNRD	433	Kearney	5	WinterWheat	0.00	1.00	0.00	0.00	0.00	0.00
18	CPNRD	393	Buffalo	1	Corn	0.19	0.14	0.13	0.08	0.08	0.36
18	CPNRD	393	Buffalo	9	Soybeans	0.09	0.42	0.11	0.06	0.06	0.26
18	CPNRD	393	Buffalo	7	Milo	0.33	0.00	0.33	0.33	0.00	0.00
18	CPNRD	393	Buffalo	5	WinterWheat	1.00	0.00	0.00	0.00	0.00	0.00
18	CPNRD	444	Merrick	1	Corn	0.18	0.14	0.04	0.05	0.16	0.44
18	CPNRD	444	Merrick	9	Soybeans	0.08	0.16	0.11	0.05	0.21	0.38
18	CPNRD	444	Merrick	7	Milo	1.00	0.00	0.00	0.00	0.00	0.00
18	CPNRD	444	Merrick	5	WinterWheat	0.00	0.50	0.00	0.00	0.00	0.00
18	CPNRD	407	Dawson	1	Corn	0.17	0.07	0.13	0.04	0.08	0.52
18	CPNRD	407	Dawson	9	Soybeans	0.10	0.14	0.09	0.04	0.16	0.48
18	CPNRD	407	Dawson	7	Milo	0.00	0.00	0.00	1.00	0.00	0.00
18	CPNRD	423	Hall	1	Corn	0.23	0.08	0.29	0.05	0.07	0.28
18	CPNRD	423	Hall	9	Soybeans	0.11	0.27	0.23	0.14	0.06	0.20

Tillage Mix - NRD

NRD	NRD_Name	CropCode_RSWB	Crop_Name	Conventional	No Till	Reduced Till	Mulch Till	Ridge Till	Strip Till
17	TPNRD	1	Corn	0.03	0.49	0.05	0.26	0.02	0.15
17	TPNRD	9	Soybeans	0.01	0.56	0.06	0.25	0.03	0.09
17	TPNRD	5	WinterWheat	0.66	0.02	0.3	0.02	0	0
24	TBNRD	1	Corn	0.09	0.29	0.2	0.1	0.04	0.28
24	TBNRD	9	Soybeans	0.06	0.51	0.16	0.07	0.04	0.16
24	TBNRD	5	WinterWheat	0.12	0.34	0.14	0.12	0.12	0.12
18	CPNRD	1	Corn	0.19	0.1	0.16	0.06	0.1	0.39
18	CPNRD	9	Soybeans	0.09	0.25	0.12	0.07	0.13	0.34
18	CPNRD	7	Milo	0.4	0	0.2	0.4	0	0
18	CPNRD	5	WinterWheat	0	0.5	0	0	0	0

Tillage Mix - Periphery

- 100% assigned the Mulch Tillage results

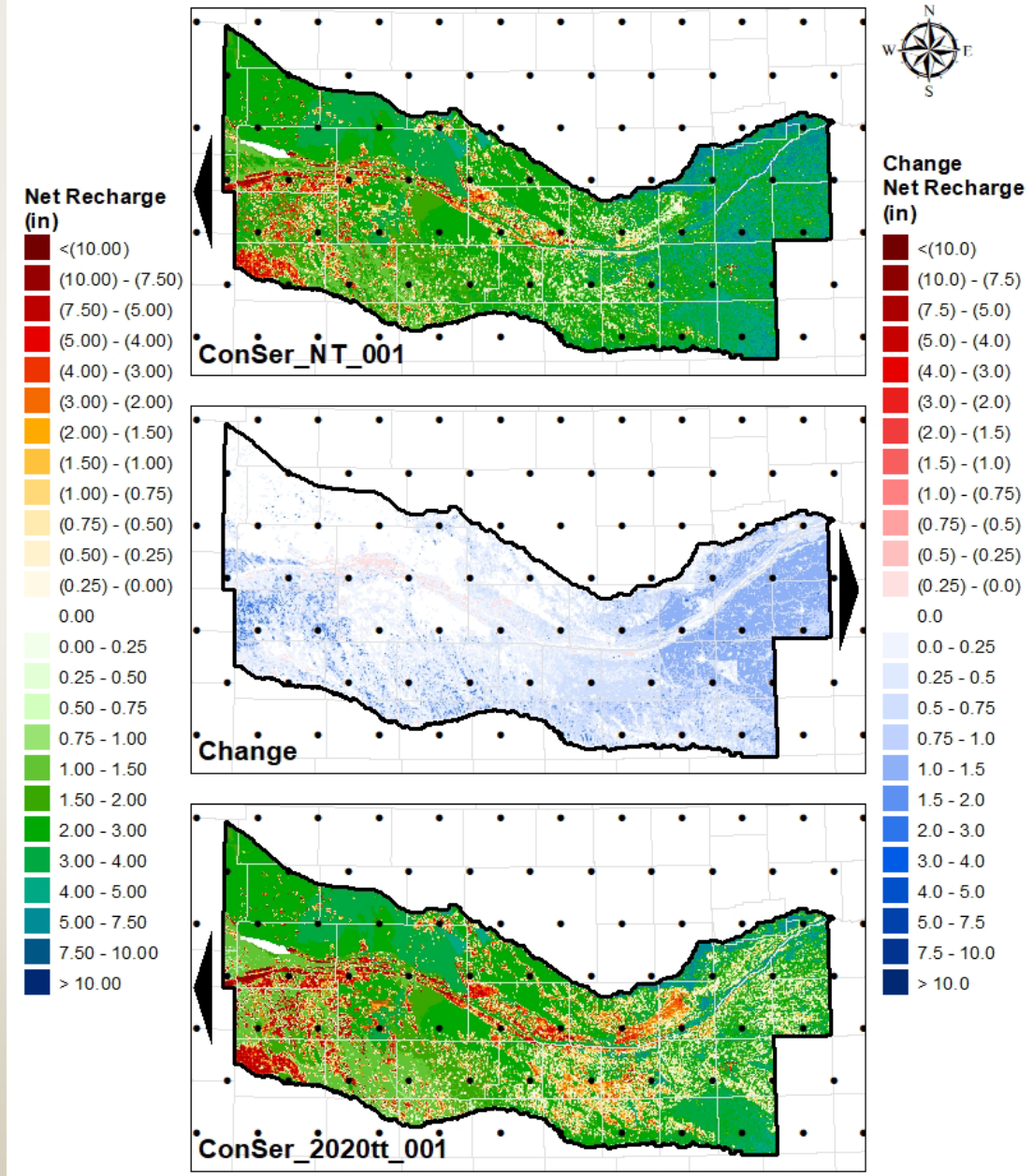
Water Balance Parameter Data Sets for 1998-2020

- Grid21_98
  - Gridded weather data, 98 Farming Practices
- Grid21_NT
  - Gridded weather data, No Till Farming Practices
- Grid21_2020
  - Gridded weather data, 2020 Tillage Mix
- Grid21_2020tt
  - Gridded weather data, Time Trend between 98 Farming Practices and 2020 Tillage Mix

Regionalized Soil Water Balance Model Setup

- Modeled Period 1998-2020
- Land Use and Groundwater Concentration Factor
  - 1998-2010 used 1998-2010
  - 2011-2020 used 2010
  - Used files from 2019 Robust Review
- Canal Recharge, M&I pumping, and Miscellaneous Pumping and Recharge were not included
- All model runs were demand or 'a' iteration runs. Canal Supply = Canal Demand
- One run was made for each of the WBP input data sets

Average Net Recharge
COHYST Model Area: 1998-2020



COHYST
Regional Water Balance

Conservation Study: COHYST	NRD (All)			County (All)			Crop			Irrigation		
	ConSer_2020tt_001			ConSer_2020_001			ConSer_NT_001			ConSer_98_001		
Parameter	AF	in	%	AF	in	%	AF	in	%	AF	in	%
Acres	12,336,000			12,336,000			12,336,000			12,336,000		
Precipitation	25,120,822	24.44	91.3%	25,120,822	24.44	92.6%	25,120,822	24.44	93.3%	25,120,822	24.44	90.1%
Groundwater Pumping	2,202,092	2.14	8.0%	1,844,404	1.79	6.8%	1,661,428	1.62	6.2%	2,558,436	2.49	9.2%
Surface Water Deliveries	181,709	0.18	0.7%	157,753	0.15	0.6%	142,027	0.14	0.5%	204,133	0.20	0.7%
Total Applied Water	27,504,623	26.76	100.0%	27,122,979	26.38	100.0%	26,924,277	26.19	100.0%	27,883,390	27.12	100.0%
Field Evapotranspiration	22,583,138	21.97	82.1%	22,092,108	21.49	81.5%	21,887,600	21.29	81.3%	23,087,050	22.46	82.8%
Field Deep Percolation	2,958,745	2.88	10.8%	2,939,132	2.86	10.8%	3,361,186	3.27	12.5%	2,947,377	2.87	10.6%
Field Runoff	1,802,519	1.75	6.6%	1,688,065	1.64	6.2%	1,827,747	1.78	6.8%	1,892,883	1.84	6.8%
Irrigation Surface Losses	115,556	0.11	0.4%	96,953	0.09	0.4%	87,332	0.08	0.3%	134,046	0.13	0.5%
Field Water Balance	44,665	0.04	0.2%	306,721	0.30	1.1%	(239,589)	(0.23)	-0.9%	(177,965)	(0.17)	-0.6%
Lateral Losses	11,462	0.01	0.0%	9,813	0.01	0.0%	8,732	0.01	0.0%	12,831	0.01	0.0%
Field Runoff	1,802,519	1.75	6.6%	1,688,065	1.64	6.2%	1,827,747	1.78	6.8%	1,892,883	1.84	6.8%
Runoff Contributions to Streamflow	1,015,268	0.99	3.7%	953,187	0.93	3.5%	1,026,695	1.00	3.8%	1,064,793	1.04	3.8%
Runoff Losses to Recharge	393,625	0.38	1.4%	367,439	0.36	1.4%	400,526	0.39	1.5%	414,045	0.40	1.5%
Runoff Losses to Evapotranspiration	393,625	0.38	1.4%	367,439	0.36	1.4%	400,526	0.39	1.5%	414,045	0.40	1.5%

COHYST
Regional Water Balance
Groundwater Only Corn

Parameter	ConSer_2020tt_001			ConSer_2020_001			ConSer_NT_001			ConSer_98_001		
	AF	in	%	AF	in	%	AF	in	%	AF	in	%
Acres	2,440,656			2,440,656			2,440,656			2,440,656		
Precipitation	5,281,339	25.97	77.6%	5,281,339	25.97	80.6%	5,281,339	25.97	82.2%	5,281,339	25.97	74.8%
Groundwater Pumping	1,524,502	7.50	22.4%	1,271,466	6.25	19.4%	1,147,359	5.64	17.8%	1,776,166	8.73	25.2%
Surface Water Deliveries	-	-	0.0%	-	-	0.0%	-	-	0.0%	-	-	0.0%
Total Applied Water	6,805,841	33.46	100.0%	6,552,805	32.22	100.0%	6,428,698	31.61	100.0%	7,057,505	34.70	100.0%
Field Evapotranspiration	5,483,896	26.96	80.6%	5,280,945	25.96	80.6%	5,027,513	24.72	78.2%	5,716,812	28.11	81.0%
Field Deep Percolation	607,793	2.99	8.9%	636,397	3.13	9.7%	762,108	3.75	11.9%	557,630	2.74	7.9%
Field Runoff	704,611	3.46	10.4%	660,180	3.25	10.1%	669,683	3.29	10.4%	735,891	3.62	10.4%
Irrigation Surface Losses	76,225	0.37	1.1%	63,573	0.31	1.0%	57,368	0.28	0.9%	88,808	0.44	1.3%
Field Water Balance	(66,684)	(0.33)	-1.0%	(88,290)	(0.43)	-1.3%	(87,973)	(0.43)	-1.4%	(41,636)	(0.20)	-0.6%
Lateral Losses	-	-	0.0%	-	-	0.0%	-	-	0.0%	-	-	0.0%
Field Runoff	704,611	3.46	10.4%	660,180	3.25	10.1%	669,683	3.29	10.4%	735,891	3.62	10.4%
Runoff Contributions to Streamflow	397,972	1.96	5.8%	373,824	1.84	5.7%	377,932	1.86	5.9%	415,229	2.04	5.9%
Runoff Losses to Recharge	153,319	0.75	2.3%	143,178	0.70	2.2%	145,875	0.72	2.3%	160,331	0.79	2.3%
Runoff Losses to Evapotranspiration	153,319	0.75	2.3%	143,178	0.70	2.2%	145,875	0.72	2.3%	160,331	0.79	2.3%

COHYST
Water Balance - CPNRD

Conservation Study: COHYST	NRD	Central Platte	County	(All)	Crop		Irrigation					
	ConSer_2020tt_001			ConSer_2020_001			ConSer_NT_001			ConSer_98_001		
Parameter	AF	in	%	AF	in	%	AF	in	%	AF	in	%
Acres	2,133,760			2,133,760			2,133,760			2,133,760		
Precipitation	4,675,706	26.30	88.7%	4,675,706	26.30	90.3%	4,675,706	26.30	91.4%	4,675,706	26.30	87.3%
Groundwater Pumping	542,581	3.05	10.3%	456,084	2.56	8.8%	401,028	2.26	7.8%	622,856	3.50	11.6%
Surface Water Deliveries	51,944	0.29	1.0%	47,023	0.26	0.9%	41,272	0.23	0.8%	57,074	0.32	1.1%
Total Applied Water	5,270,231	29.64	100.0%	5,178,813	29.12	100.0%	5,118,007	28.78	100.0%	5,355,636	30.12	100.0%
Field Evapotranspiration	4,191,883	23.57	79.5%	4,122,243	23.18	79.6%	3,984,350	22.41	77.8%	4,264,488	23.98	79.6%
Field Deep Percolation	654,104	3.68	12.4%	652,065	3.67	12.6%	728,268	4.10	14.2%	648,748	3.65	12.1%
Field Runoff	429,843	2.42	8.2%	414,319	2.33	8.0%	427,161	2.40	8.3%	440,025	2.47	8.2%
Irrigation Surface Losses	28,687	0.16	0.5%	24,215	0.14	0.5%	21,290	0.12	0.4%	32,855	0.18	0.6%
Field Water Balance	(34,287)	(0.19)	-0.7%	(34,029)	(0.19)	-0.7%	(43,062)	(0.24)	-0.8%	(30,481)	(0.17)	-0.6%
Lateral Losses	4,965	0.03	0.1%	4,498	0.03	0.1%	3,951	0.02	0.1%	5,424	0.03	0.1%
Field Runoff	429,843	2.42	8.2%	414,319	2.33	8.0%	427,161	2.40	8.3%	440,025	2.47	8.2%
Runoff Contributions to Streamflow	280,029	1.57	5.3%	270,273	1.52	5.2%	278,081	1.56	5.4%	286,377	1.61	5.3%
Runoff Losses to Recharge	74,907	0.42	1.4%	72,023	0.41	1.4%	74,540	0.42	1.5%	76,824	0.43	1.4%
Runoff Losses to Evapotranspiration	74,907	0.42	1.4%	72,023	0.41	1.4%	74,540	0.42	1.5%	76,824	0.43	1.4%

COHYST
Water Balance - CPNRD
Groundwater Only Corn

Conservation Study: COHYST	NRD	Central Platte		County	(All)		Crop	Corn		Irrigation	GW Only	
	ConSer_2020tt_001			ConSer_2020_001			ConSer_NT_001			ConSer_98_001		
Parameter	AF	in	%	AF	in	%	AF	in	%	AF	in	%
Acres	657,314			657,314			657,314			657,314		
Precipitation	1,470,076	26.84	78.7%	1,470,076	26.84	81.6%	1,470,076	26.84	83.6%	1,470,076	26.84	76.3%
Groundwater Pumping	397,283	7.25	21.3%	330,902	6.04	18.4%	287,768	5.25	16.4%	457,361	8.35	23.7%
Surface Water Deliveries	-	-	0.0%	-	-	0.0%	-	-	0.0%	-	-	0.0%
Total Applied Water	1,867,359	34.09	100.0%	1,800,978	32.88	100.0%	1,757,844	32.09	100.0%	1,927,437	35.19	100.0%
Field Evapotranspiration	1,470,122	26.84	78.7%	1,418,287	25.89	78.8%	1,331,833	24.31	75.8%	1,523,492	27.81	79.0%
Field Deep Percolation	192,087	3.51	10.3%	194,748	3.56	10.8%	241,453	4.41	13.7%	183,822	3.36	9.5%
Field Runoff	202,278	3.69	10.8%	192,658	3.52	10.7%	191,345	3.49	10.9%	207,846	3.79	10.8%
Irrigation Surface Losses	19,864	0.36	1.1%	16,545	0.30	0.9%	14,388	0.26	0.8%	22,868	0.42	1.2%
Field Water Balance	(16,992)	(0.31)	-0.9%	(21,260)	(0.39)	-1.2%	(21,175)	(0.39)	-1.2%	(10,591)	(0.19)	-0.5%
Lateral Losses	-	-	0.0%	-	-	0.0%	-	-	0.0%	-	-	0.0%
Field Runoff	202,278	3.69	10.8%	192,658	3.52	10.7%	191,345	3.49	10.9%	207,846	3.79	10.8%
Runoff Contributions to Streamflow	130,758	2.39	7.0%	124,786	2.28	6.9%	123,627	2.26	7.0%	134,095	2.45	7.0%
Runoff Losses to Recharge	35,760	0.65	1.9%	33,936	0.62	1.9%	33,859	0.62	1.9%	36,876	0.67	1.9%
Runoff Losses to Evapotranspiration	35,760	0.65	1.9%	33,936	0.62	1.9%	33,859	0.62	1.9%	36,876	0.67	1.9%

COHYST
Water Balance - TBNRD

Conservation Study: COHYST	NRD	Tri-Basin		County	(All)		Crop			Irrigation		
	ConSer_2020tt_001			ConSer_2020_001			ConSer_NT_001			ConSer_98_001		
Parameter	AF	in	%	AF	in	%	AF	in	%	AF	in	%
Acres	972,160			972,160			972,160			972,160		
Precipitation	2,073,844	25.60	86.8%	2,073,844	25.60	89.1%	2,073,844	25.60	90.2%	2,073,844	25.60	84.6%
Groundwater Pumping	267,636	3.30	11.2%	215,408	2.66	9.3%	193,258	2.39	8.4%	320,929	3.96	13.1%
Surface Water Deliveries	47,315	0.58	2.0%	37,332	0.46	1.6%	32,527	0.40	1.4%	55,159	0.68	2.3%
Total Applied Water	2,388,795	29.49	100.0%	2,326,584	28.72	100.0%	2,299,629	28.39	100.0%	2,449,932	30.24	100.0%
Field Evapotranspiration	1,913,139	23.62	80.1%	1,857,950	22.93	79.9%	1,809,978	22.34	78.7%	1,970,090	24.32	80.4%
Field Deep Percolation	255,375	3.15	10.7%	256,168	3.16	11.0%	287,956	3.55	12.5%	247,267	3.05	10.1%
Field Runoff	227,495	2.81	9.5%	216,195	2.67	9.3%	220,850	2.73	9.6%	235,422	2.91	9.6%
Irrigation Surface Losses	14,801	0.18	0.6%	11,890	0.15	0.5%	10,639	0.13	0.5%	17,701	0.22	0.7%
Field Water Balance	(22,015)	(0.27)	-0.9%	(15,620)	(0.19)	-0.7%	(29,793)	(0.37)	-1.3%	(20,548)	(0.25)	-0.8%
Lateral Losses	4,543	0.06	0.2%	3,574	0.04	0.2%	3,112	0.04	0.1%	5,275	0.07	0.2%
Field Runoff	227,495	2.81	9.5%	216,195	2.67	9.3%	220,850	2.73	9.6%	235,422	2.91	9.6%
Runoff Contributions to Streamflow	133,586	1.65	5.6%	126,989	1.57	5.5%	129,751	1.60	5.6%	138,397	1.71	5.6%
Runoff Losses to Recharge	46,954	0.58	2.0%	44,603	0.55	1.9%	45,550	0.56	2.0%	48,512	0.60	2.0%
Runoff Losses to Evapotranspiration	46,954	0.58	2.0%	44,603	0.55	1.9%	45,550	0.56	2.0%	48,512	0.60	2.0%

COHYST
Water Balance - TBNRD
Groundwater Only Corn

Conservation Study: COHYST	NRD	Tri-Basin		County	(All)		Crop	Corn		Irrigation	GW Only	
	ConSer_2020tt_001			ConSer_2020_001			ConSer_NT_001			ConSer_98_001		
Parameter	AF	in	%	AF	in	%	AF	in	%	AF	in	%
Acres	287,617			287,617			287,617			287,617		
Precipitation	621,687	25.94	78.3%	621,687	25.94	81.6%	621,687	25.94	83.3%	621,687	25.94	75.3%
Groundwater Pumping	171,965	7.17	21.7%	139,785	5.83	18.4%	124,726	5.20	16.7%	203,505	8.49	24.7%
Surface Water Deliveries	-	-	0.0%	-	-	0.0%	-	-	0.0%	-	-	0.0%
Total Applied Water	793,653	33.11	100.0%	761,472	31.77	100.0%	746,413	31.14	100.0%	825,192	34.43	100.0%
Field Evapotranspiration	645,782	26.94	81.4%	620,895	25.91	81.5%	595,491	24.85	79.8%	673,029	28.08	81.6%
Field Deep Percolation	63,085	2.63	7.9%	63,993	2.67	8.4%	75,862	3.17	10.2%	57,924	2.42	7.0%
Field Runoff	86,529	3.61	10.9%	81,913	3.42	10.8%	80,888	3.37	10.8%	90,515	3.78	11.0%
Irrigation Surface Losses	8,598	0.36	1.1%	6,989	0.29	0.9%	6,236	0.26	0.8%	10,175	0.42	1.2%
Field Water Balance	(10,342)	(0.43)	-1.3%	(12,319)	(0.51)	-1.6%	(12,064)	(0.50)	-1.6%	(6,451)	(0.27)	-0.8%
Lateral Losses	-	-	0.0%	-	-	0.0%	-	-	0.0%	-	-	0.0%
Field Runoff	86,529	3.61	10.9%	81,913	3.42	10.8%	80,888	3.37	10.8%	90,515	3.78	11.0%
Runoff Contributions to Streamflow	50,589	2.11	6.4%	47,947	2.00	6.3%	47,434	1.98	6.4%	52,982	2.21	6.4%
Runoff Losses to Recharge	17,970	0.75	2.3%	16,983	0.71	2.2%	16,727	0.70	2.2%	18,766	0.78	2.3%
Runoff Losses to Evapotranspiration	17,970	0.75	2.3%	16,983	0.71	2.2%	16,727	0.70	2.2%	18,766	0.78	2.3%

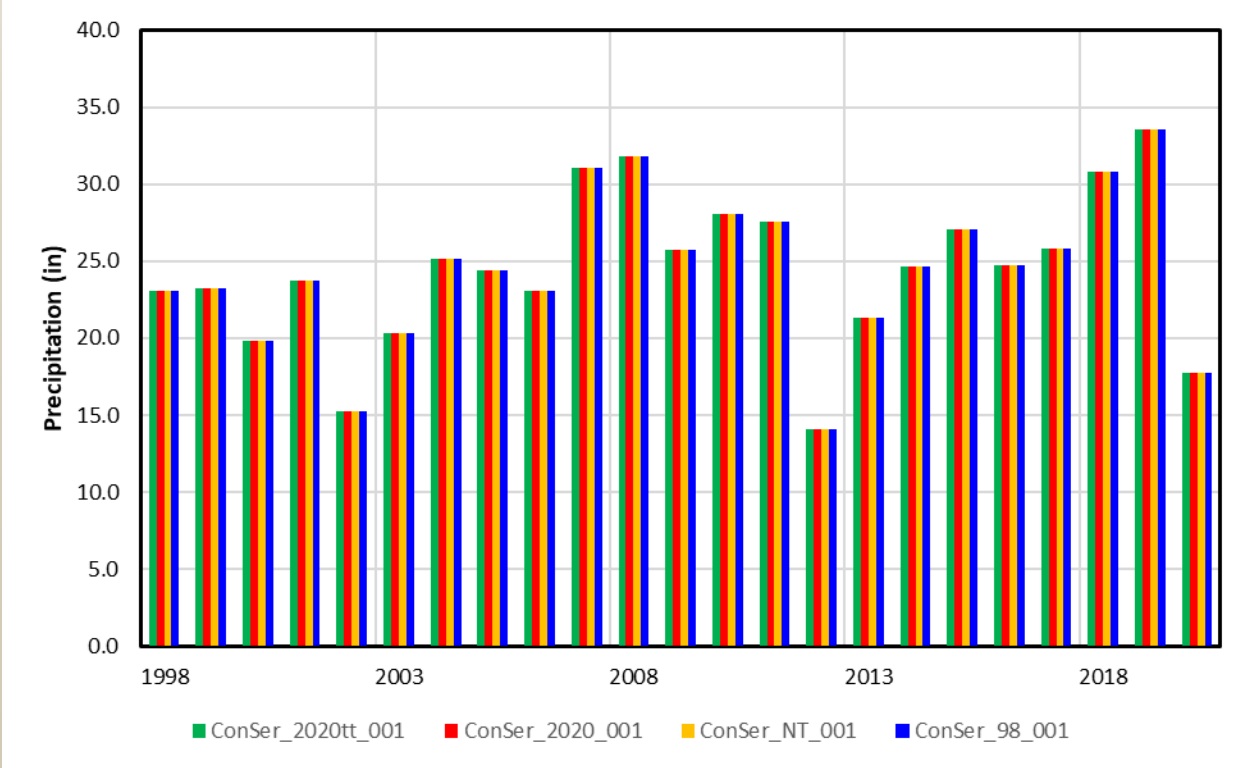
COHYST
Water Balance - TPNRD

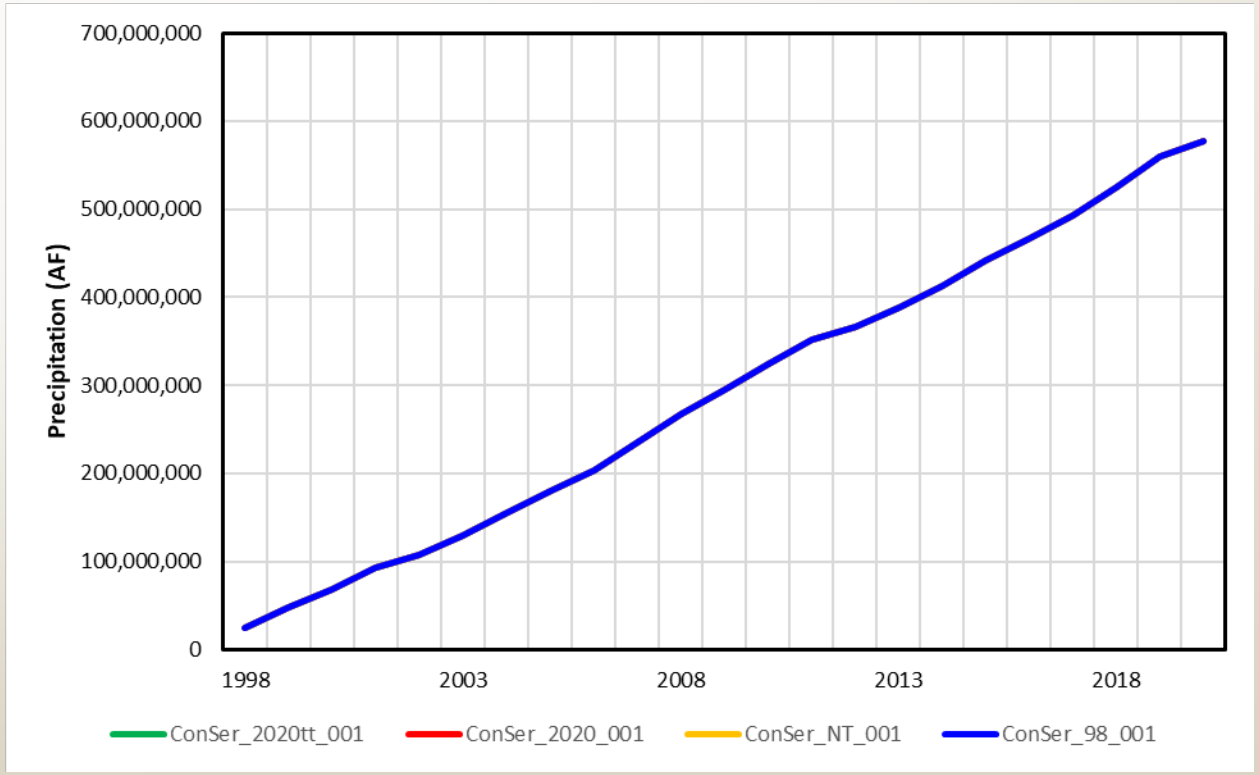
Conservation Study: COHYST	NRD	Twin Platte		County	(All)		Crop			Irrigation		
	ConSer_2020tt_001			ConSer_2020_001			ConSer_NT_001			ConSer_98_001		
Parameter	AF	in	%	AF	in	%	AF	in	%	AF	in	%
Acres	2,507,680			2,507,680			2,507,680			2,507,680		
Precipitation	4,604,316	22.03	93.5%	4,604,316	22.03	94.1%	4,604,316	22.03	94.3%	4,604,316	22.03	92.8%
Groundwater Pumping	286,042	1.37	5.8%	259,231	1.24	5.3%	248,541	1.19	5.1%	318,497	1.52	6.4%
Surface Water Deliveries	33,740	0.16	0.7%	30,428	0.15	0.6%	29,410	0.14	0.6%	36,180	0.17	0.7%
Total Applied Water	4,924,097	23.56	100.0%	4,893,975	23.42	100.0%	4,882,266	23.36	100.0%	4,958,993	23.73	100.0%
Field Evapotranspiration	4,209,939	20.15	85.5%	4,163,374	19.92	85.1%	4,192,924	20.06	85.9%	4,264,564	20.41	86.0%
Field Deep Percolation	555,200	2.66	11.3%	546,232	2.61	11.2%	570,948	2.73	11.7%	562,570	2.69	11.3%
Field Runoff	125,240	0.60	2.5%	118,267	0.57	2.4%	126,332	0.60	2.6%	134,316	0.64	2.7%
Irrigation Surface Losses	15,314	0.07	0.3%	13,874	0.07	0.3%	13,309	0.06	0.3%	17,010	0.08	0.3%
Field Water Balance	18,403	0.09	0.4%	52,228	0.25	1.1%	(21,247)	(0.10)	-0.4%	(19,467)	(0.09)	-0.4%
Lateral Losses	1,932	0.01	0.0%	1,720	0.01	0.0%	1,649	0.01	0.0%	2,108	0.01	0.0%
Field Runoff	125,240	0.60	2.5%	118,267	0.57	2.4%	126,332	0.60	2.6%	134,316	0.64	2.7%
Runoff Contributions to Streamflow	89,500	0.43	1.8%	84,425	0.40	1.7%	89,755	0.43	1.8%	96,004	0.46	1.9%
Runoff Losses to Recharge	17,870	0.09	0.4%	16,921	0.08	0.3%	18,288	0.09	0.4%	19,156	0.09	0.4%
Runoff Losses to Evapotranspiration	17,870	0.09	0.4%	16,921	0.08	0.3%	18,288	0.09	0.4%	19,156	0.09	0.4%

COHYST
Water Balance - TPNRD
Groundwater Only Corn

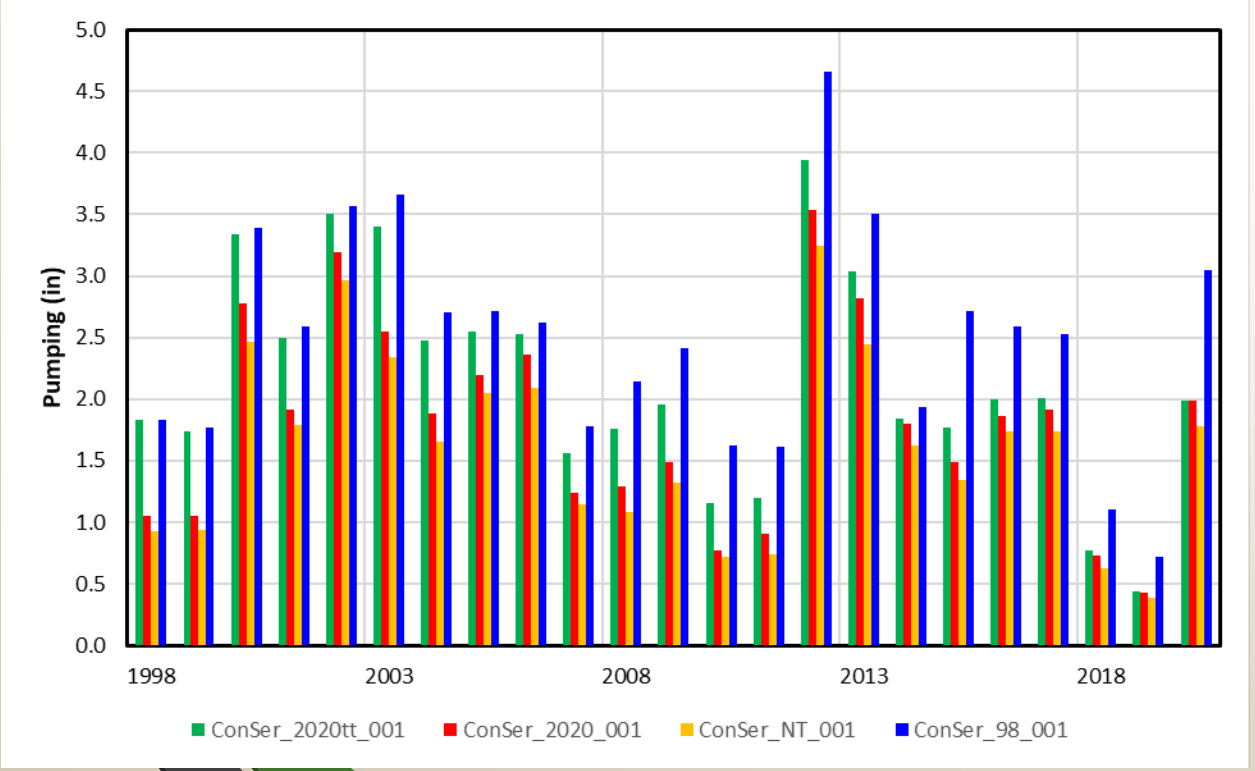
Conservation Study: COHYST	NRD	Twin Platte		County	(All)		Crop	Corn		Irrigation	GW Only	
	ConSer_2020tt_001			ConSer_2020_001			ConSer_NT_001			ConSer_98_001		
Parameter	AF	in	%	AF	in	%	AF	in	%	AF	in	%
Acres	177,233			177,233			177,233			177,233		
Precipitation	324,054	21.94	65.3%	324,054	21.94	68.0%	324,054	21.94	69.1%	324,054	21.94	62.4%
Groundwater Pumping	172,497	11.68	34.7%	152,770	10.34	32.0%	144,900	9.81	30.9%	195,630	13.25	37.6%
Surface Water Deliveries	-	-	0.0%	-	-	0.0%	-	-	0.0%	-	-	0.0%
Total Applied Water	496,550	33.62	100.0%	476,824	32.28	100.0%	468,954	31.75	100.0%	519,684	35.19	100.0%
Field Evapotranspiration	400,637	27.13	80.7%	387,333	26.23	81.2%	377,379	25.55	80.5%	418,277	28.32	80.5%
Field Deep Percolation	50,562	3.42	10.2%	47,180	3.19	9.9%	50,109	3.39	10.7%	51,311	3.47	9.9%
Field Runoff	39,383	2.67	7.9%	37,674	2.55	7.9%	37,157	2.52	7.9%	42,123	2.85	8.1%
Irrigation Surface Losses	8,625	0.58	1.7%	7,639	0.52	1.6%	7,245	0.49	1.5%	9,782	0.66	1.9%
Field Water Balance	(2,656)	(0.18)	-0.5%	(3,001)	(0.20)	-0.6%	(2,936)	(0.20)	-0.6%	(1,809)	(0.12)	-0.3%
Lateral Losses	-	-	0.0%	-	-	0.0%	-	-	0.0%	-	-	0.0%
Field Runoff	39,383	2.67	7.9%	37,674	2.55	7.9%	37,157	2.52	7.9%	42,123	2.85	8.1%
Runoff Contributions to Streamflow	27,662	1.87	5.6%	26,432	1.79	5.5%	26,002	1.76	5.5%	29,671	2.01	5.7%
Runoff Losses to Recharge	5,860	0.40	1.2%	5,621	0.38	1.2%	5,577	0.38	1.2%	6,226	0.42	1.2%
Runoff Losses to Evapotranspiration	5,860	0.40	1.2%	5,621	0.38	1.2%	5,577	0.38	1.2%	6,226	0.42	1.2%

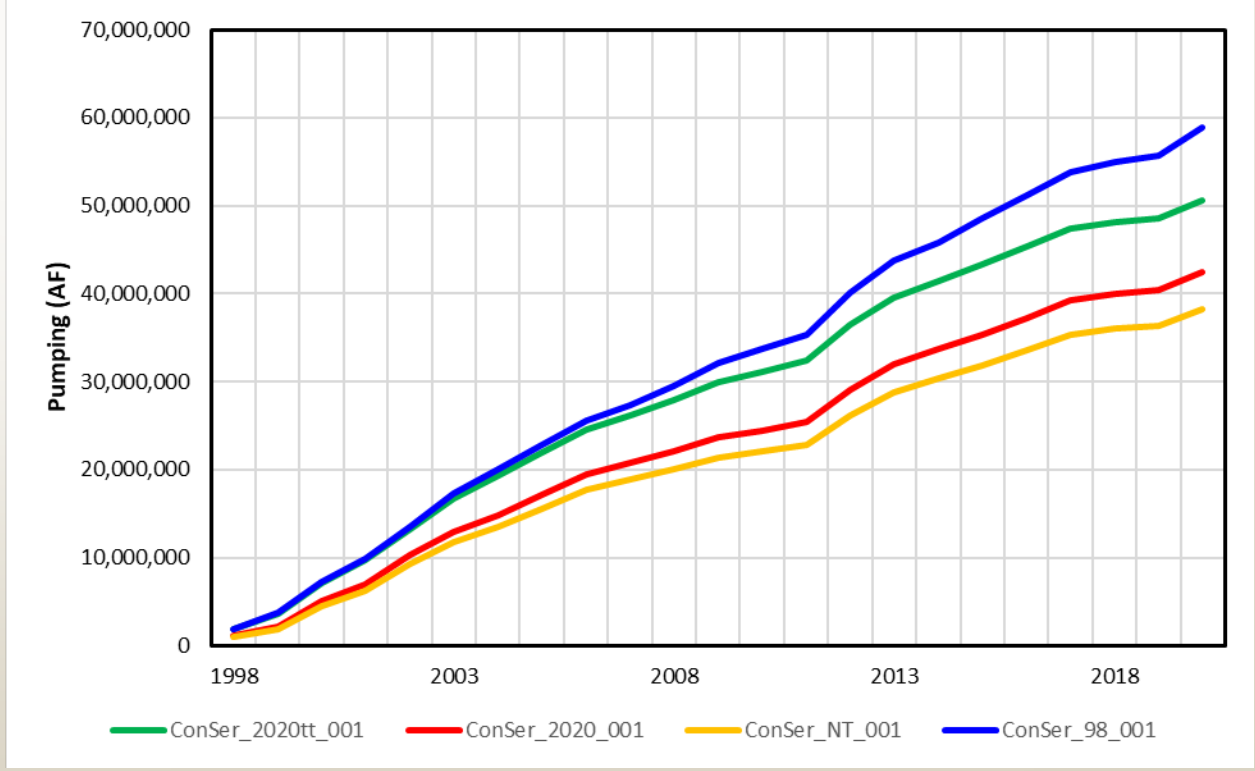
Annual Precipitation Model Domain



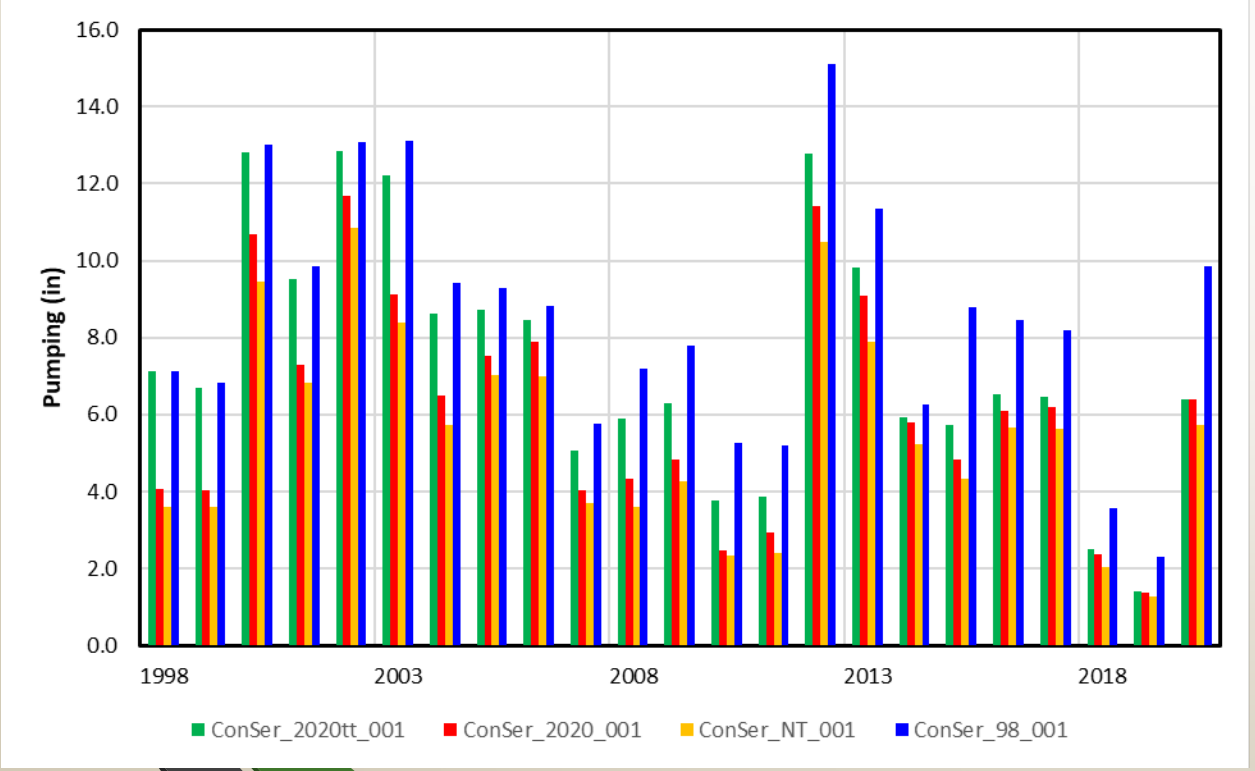


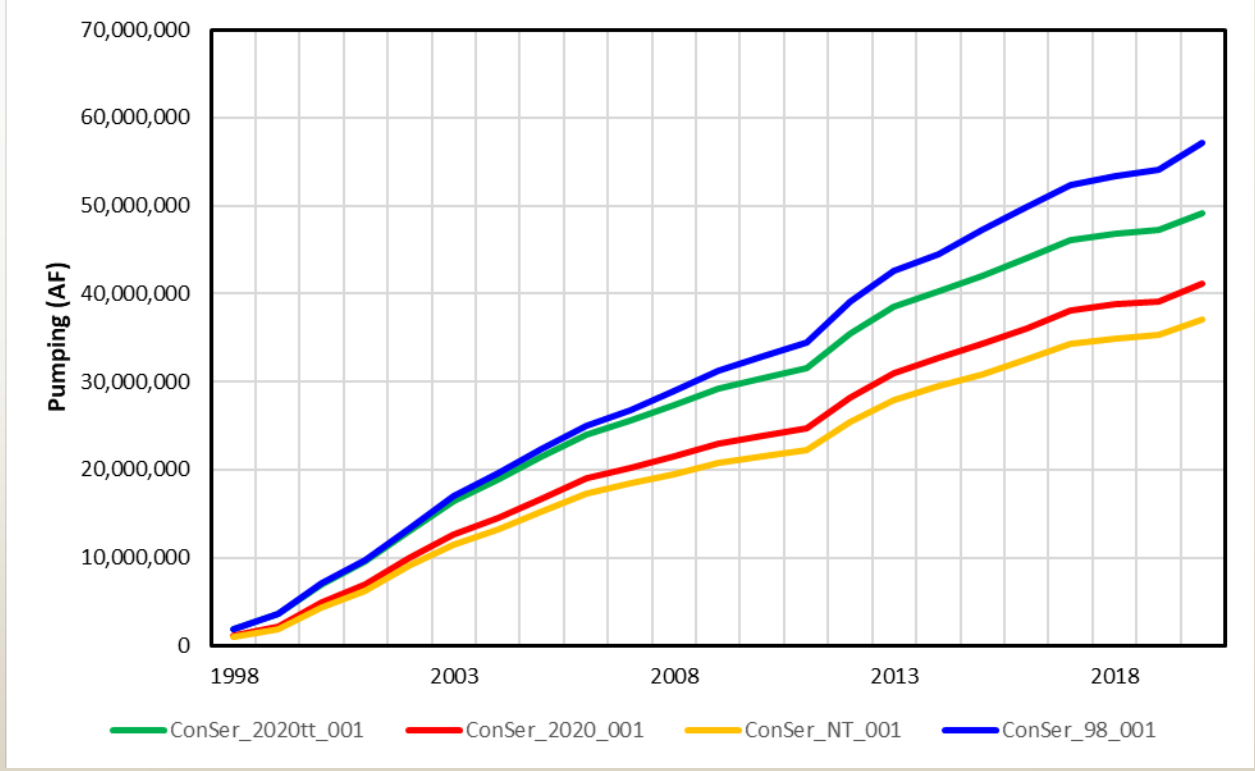
Ground Water Pumping Model Domain



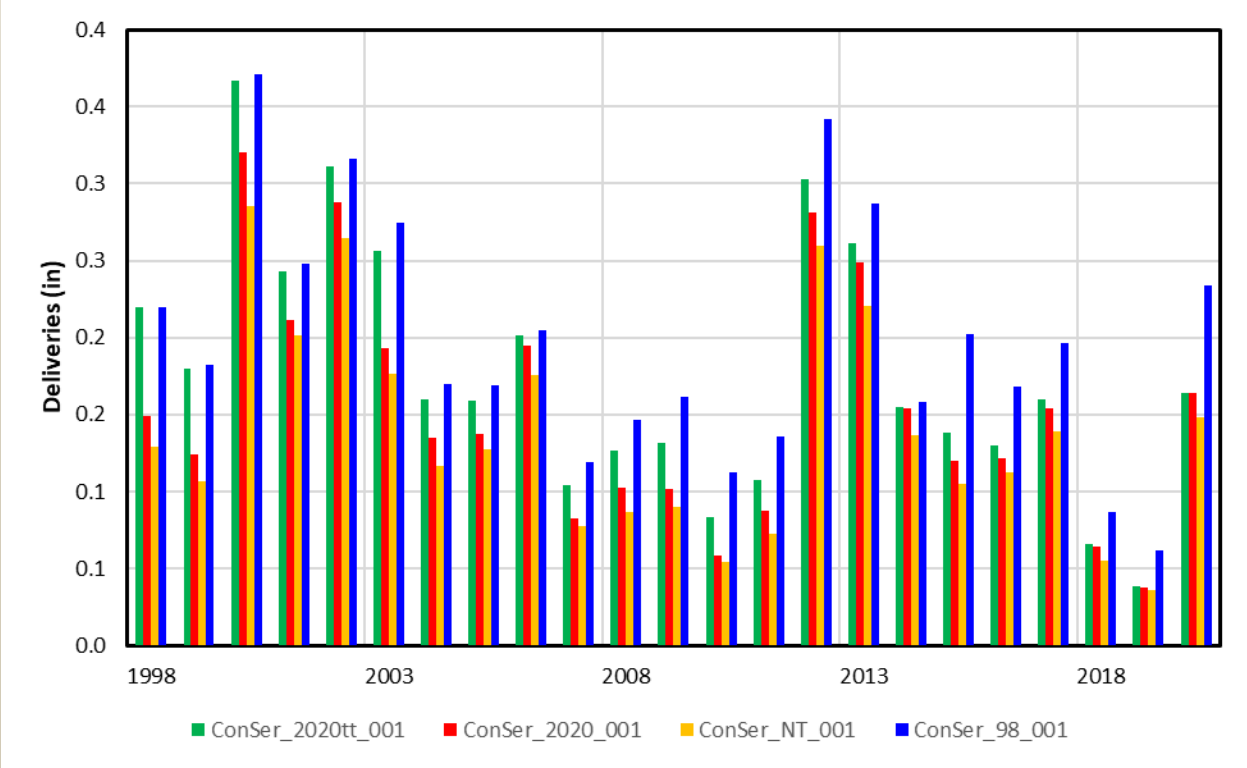


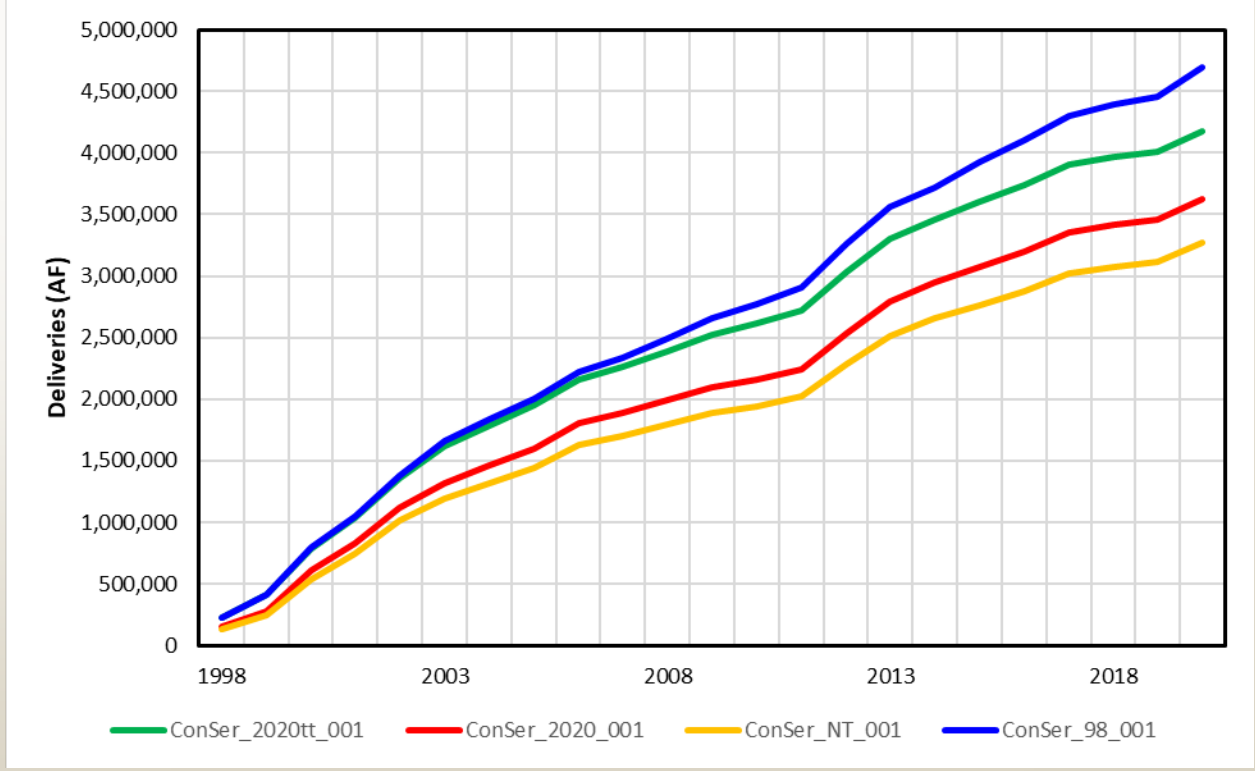
Groundwater Pumping
Model Domain
Groundwater Only Irrigated Lands



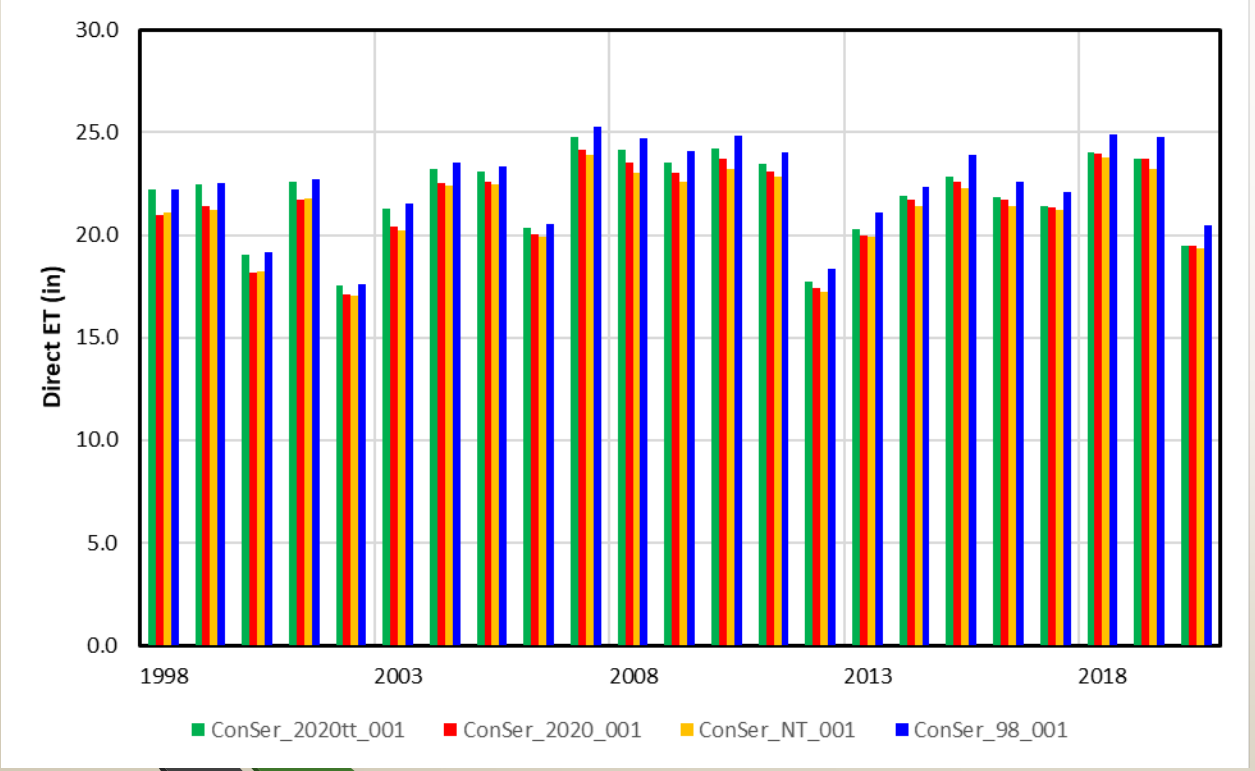


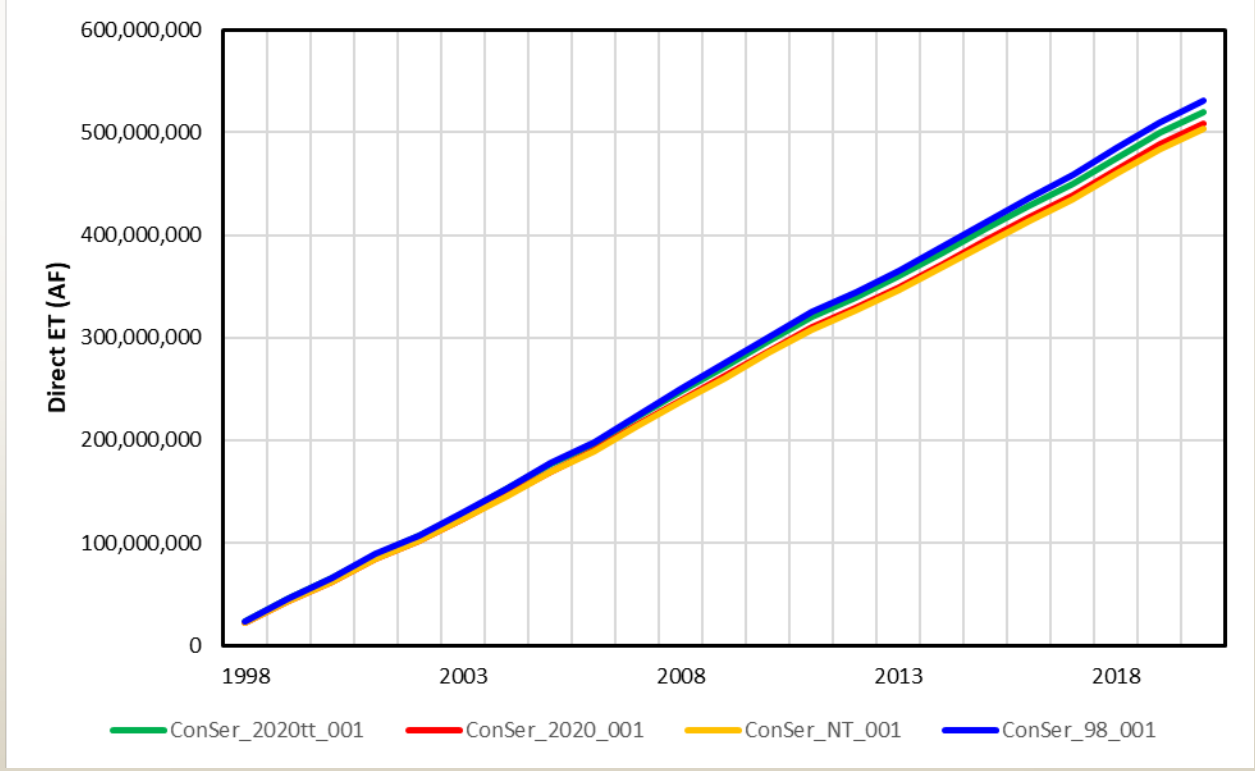
Surface Water Deliveries Model Domain



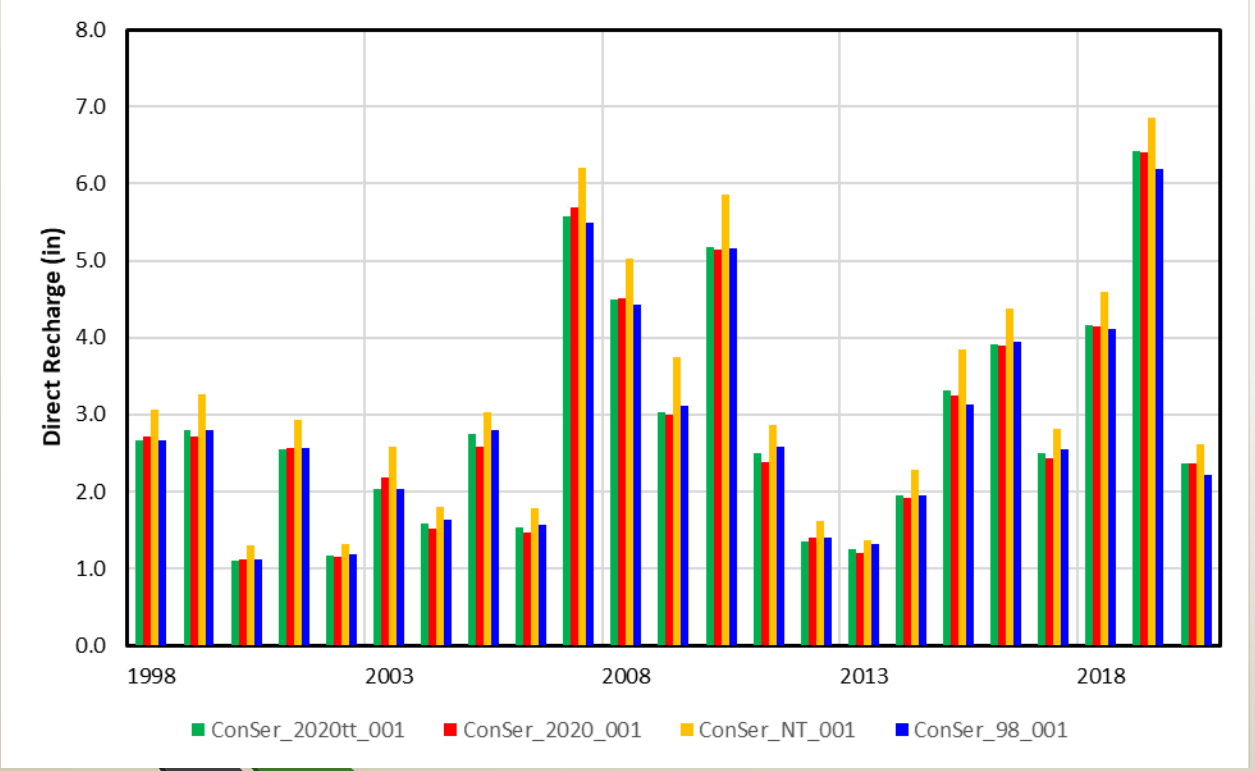


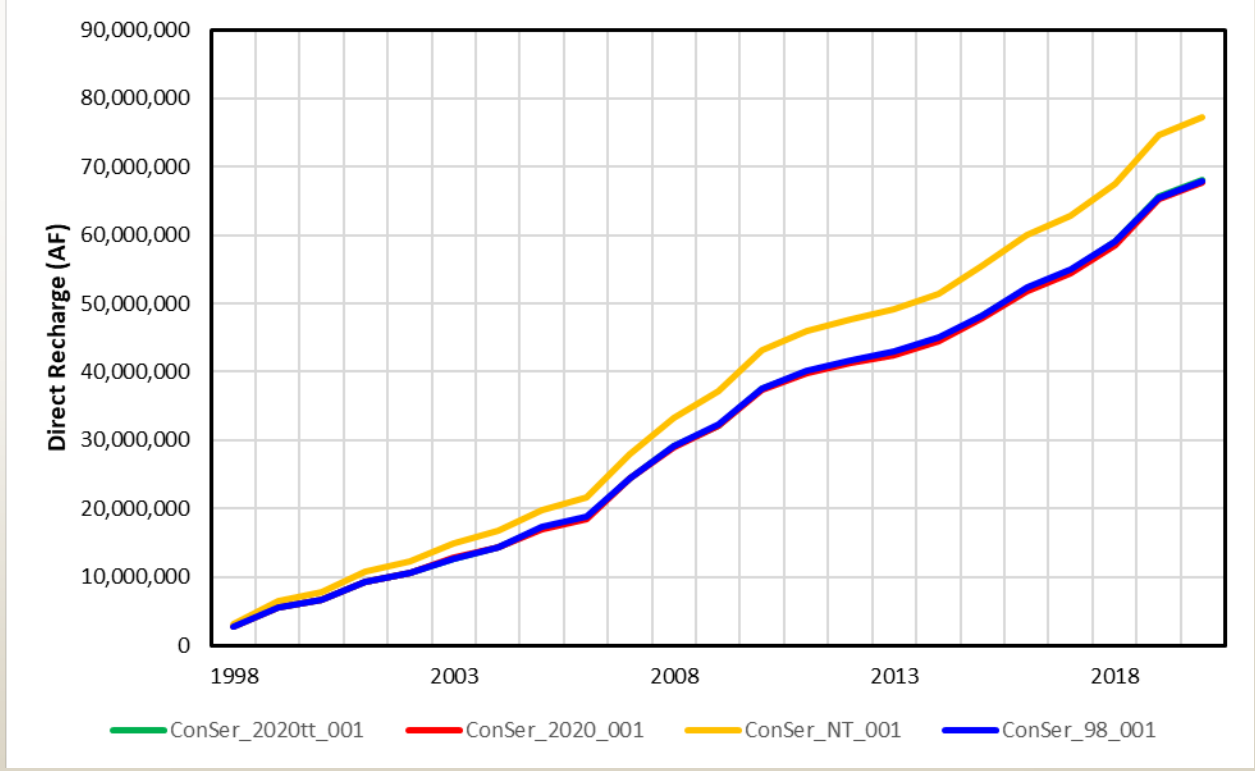
Direct Evapotranspiration Model Domain



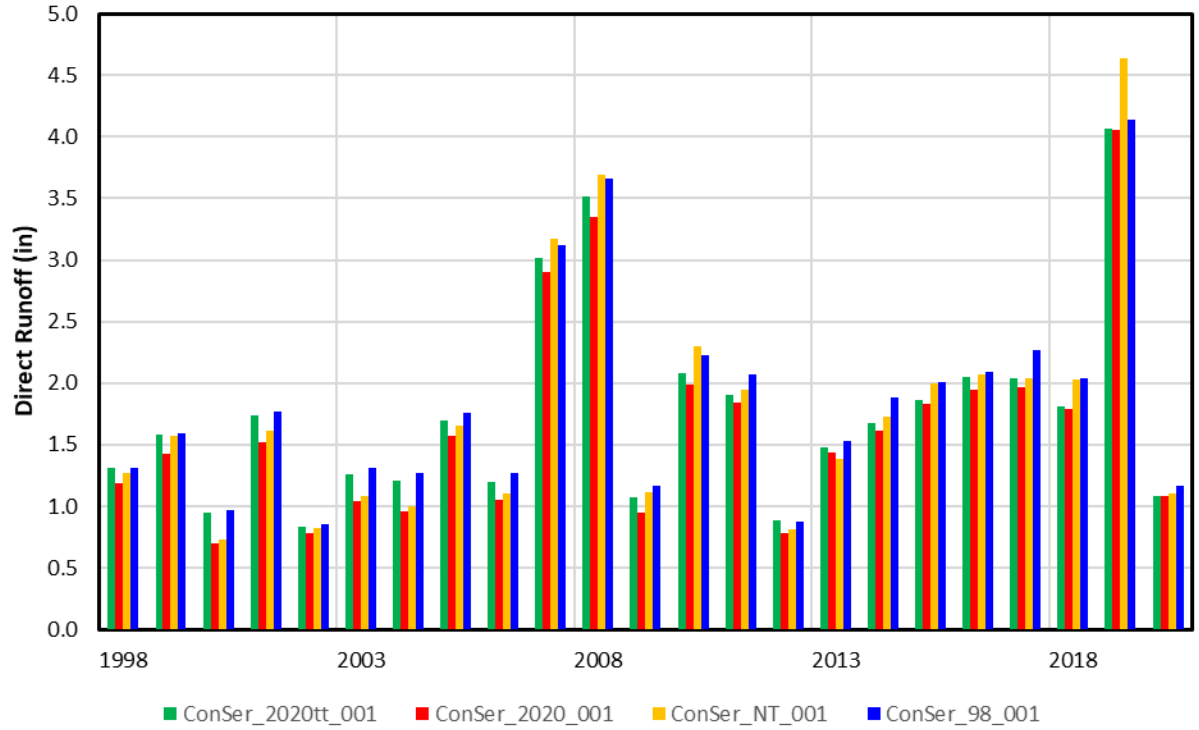


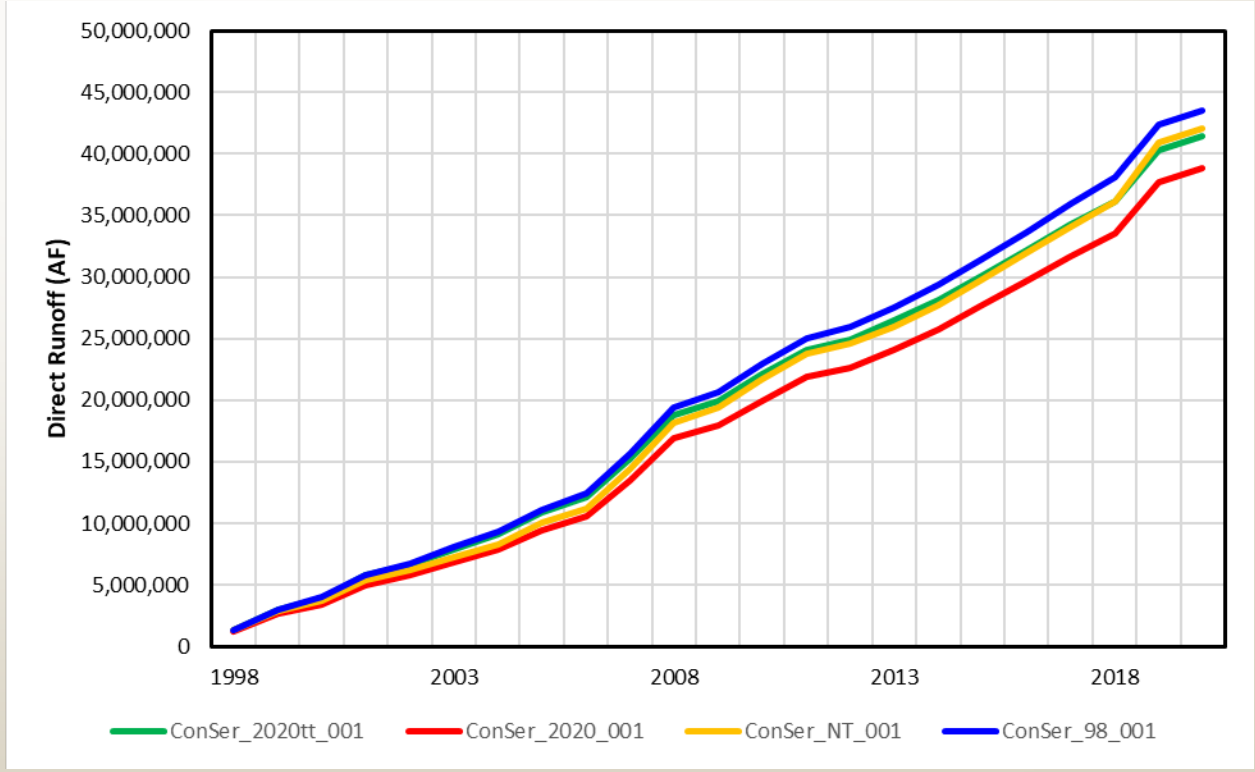
Direct Recharge Model Domain





Direct Runoff Model Domain





Runoff Contributions to Streamflow Model Domain