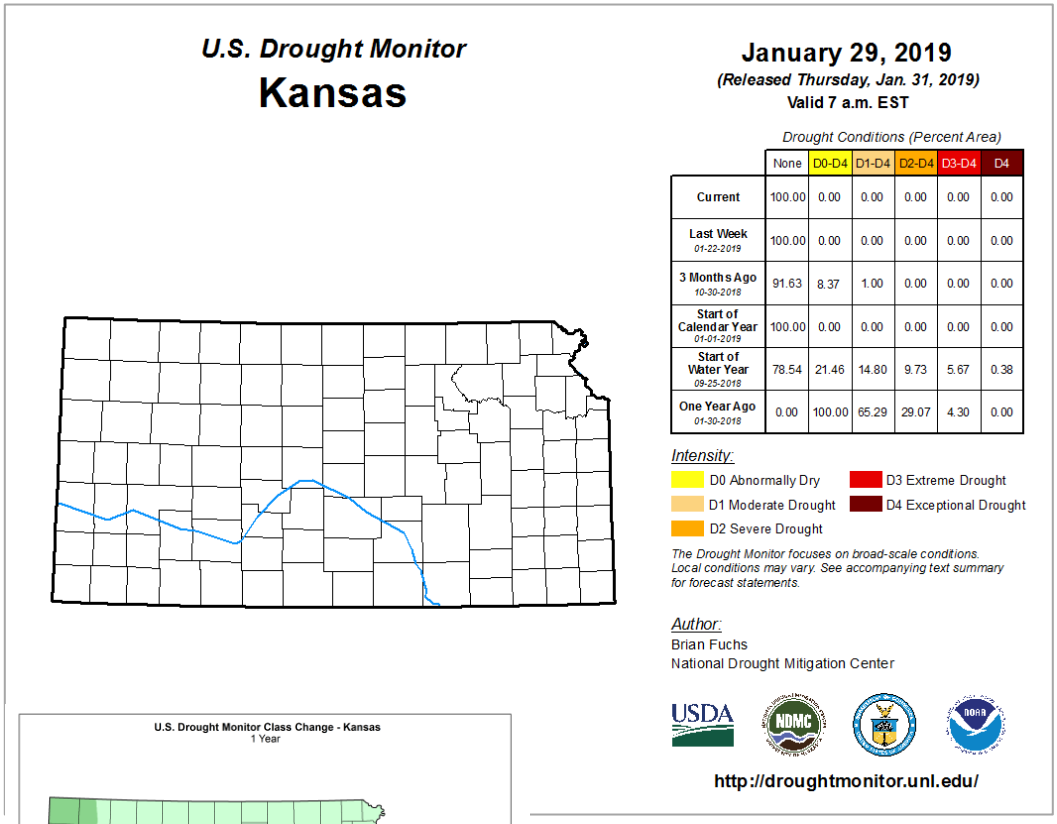
KANSAS CLIMATE and DROUGHT UPDATE
January 2019 Summary

Highlights

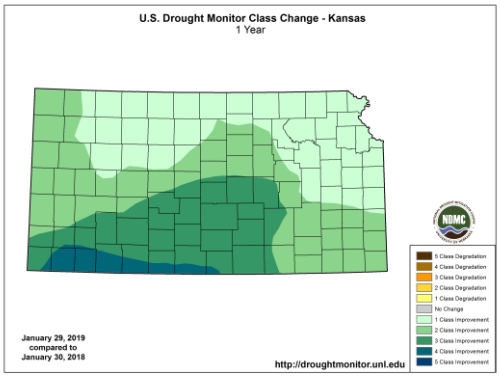
- Executive Orders 19-01 rescinded all drought declarations be the State of Kansas on January 8, 2019.
- U.S. Drought Monitor drought designations were removed for all of Kansas during the first days of the month.
- An El Niño Watch is in effect (as of Jan. 10), with El Niño expected to form and continue through the Northern Hemisphere spring 2019 (a 65% chance).

General Conditions

The state became drought free by the U.S. Drought Monitor and remained drought free all month. This was the 5th consecutive week without drought in Kansas.



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	100.00	0.00	0.00	0.00	0.00	0.00
Last Week 01-22-2019	100.00	0.00	0.00	0.00	0.00	0.00
3 Months Ago 10-30-2018	91.63	8.37	1.00	0.00	0.00	0.00
Start of Calendar Year 01-01-2019	100.00	0.00	0.00	0.00	0.00	0.00
Start of Water Year 09-25-2018	78.54	21.46	14.80	9.73	5.67	0.38
One Year Ago 01-30-2018	0.00	100.00	65.29	29.07	4.30	0.00

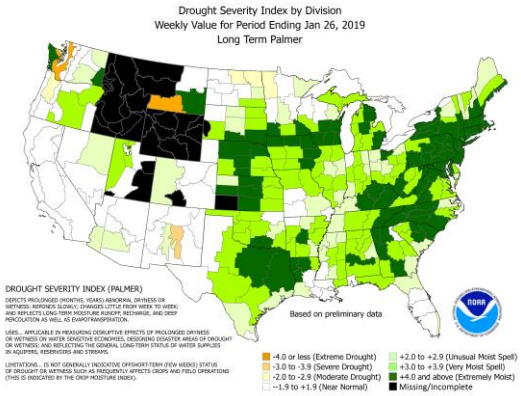


Changes in drought classification from one year ago are shown on the left for reference.

More information can be found on the U.S. Drought Monitor web site https://droughtmonitor.unl.edu/ .

Palmer Drought Severity Index (PDSI) - The Palmer Drought Severity Index is an indicator of relative dryness or wetness and is one factor used the U.S. Drought Monitor.

More information on the PDSI can be found at http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml



Climate Summary - Precipitation

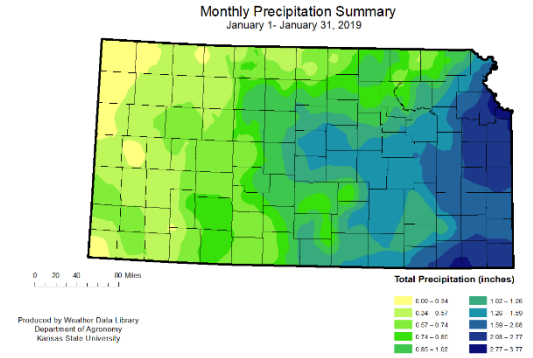
January continued the trend for wetter than normal conditions across most of the state. State-wide average precipitation for the month was 1.00 inches, 131 percent of normal. The Northwest Climate Division was the driest with an average of 0.36 inches. That is a deficit of 0.09 inches, 80 percent of normal. The East Central Division had the greatest percent of normal at 171 percent and an average precipitation of 1.67 inches. The Southeast Division had the greatest average precipitation with 1.70 inches, 137 percent of normal. The highest 24-hour rainfall total for a National Weather Service Cooperative station was 2.03 inches at Coffeyville Water Works, Montgomery County on the 12th. The greatest 24-hour rainfall total for a Community Collaborative Rain, Hail and Snow network station was 2.21 inches at Ottawa 5.6 SW, Franklin County on the 13th. The greatest monthly precipitation totals for January: 3.77 inches at Coffeyville Water Works, Montgomery County (NWS) and 3.76 inches at Leavenworth 3.8 SSW, Leavenworth County (CoCoRaHS). Most precipitation was in the form of snow. Monthly totals ranging from trace amounts in southern Kansas to 18.3 inches at the CoCoRaHS station of Hunter 2.1 NNW in Mitchell County.

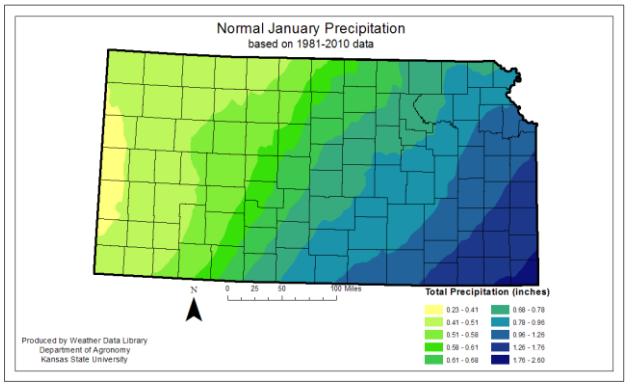
Information in this summary is taken from information generated by Kansas State University Department of Agronomy (KSU) along with data tables and maps. (Maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library.) Weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.

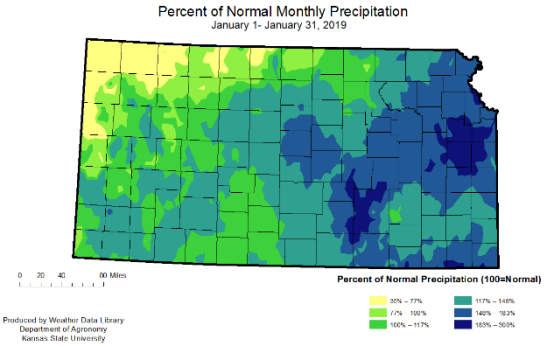
Kansas Climate Division Precipitation Summary (inches)

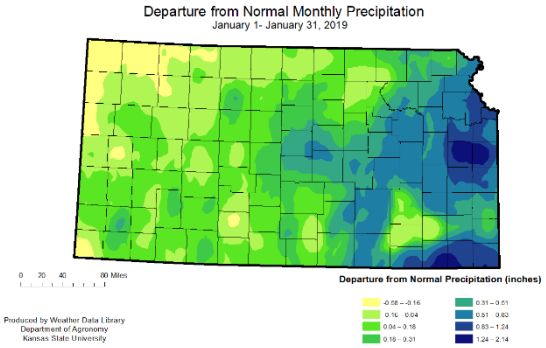
Climate Division	January 1-31 2019			January 1- 31, 2019			April 1, 2018- Jan 31, 2019			Sept 1, 2018- Jan 31, 2018		
	Actual	Depart Normal	Percent Normal	Actual	Depart Normal	Percent Normal	Actual	Depart Normal	Percent Normal	Actual	Depart Normal	Percent Normal
Northwest	0.36	-0.09	80	0.36	-0.09	80	23.63	4.12	120	7.47	2.55	149
West Central	0.69	0.19	138	0.69	0.19	138	25.67	6.90	135	9.82	4.85	195
Southwest	0.69	0.22	143	0.69	0.22	143	26.69	8.70	148	9.29	4.36	188
North Central	0.84	0.21	130	0.84	0.21	130	32.75	7.56	130	14.54	7.18	198
Central	1.03	0.34	149	1.03	0.34	149	32.60	6.57	126	15.12	7.61	204
South Central	0.91	0.08	106	0.91	0.08	106	35.73	8.20	130	15.70	7.02	184
Northeast	1.06	0.25	123	1.06	0.25	123	33.29	1.69	106	16.25	6.11	162
East Central	1.67	0.73	171	1.67	0.73	171	30.99	-2.95	90	14.66	3.40	128
Southeast	1.70	0.45	137	1.70	0.45	137	38.08	1.33	103	16.51	3.17	126
STATE	1.00	0.26	131	1.00	0.26	131	31.23	4.95	122	13.26	5.14	171

The maps below summarize precipitation for the month. (Sources: Normal map-K-State Weather Data Library; Precipitation, percent of normal and departure maps are from the High Plains Reginal Climate Center, NOAA.)









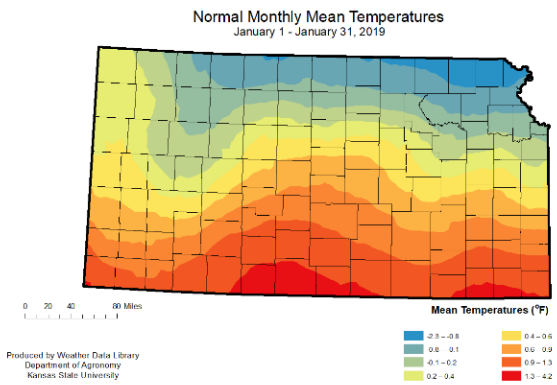
Climate Summary-Temperature

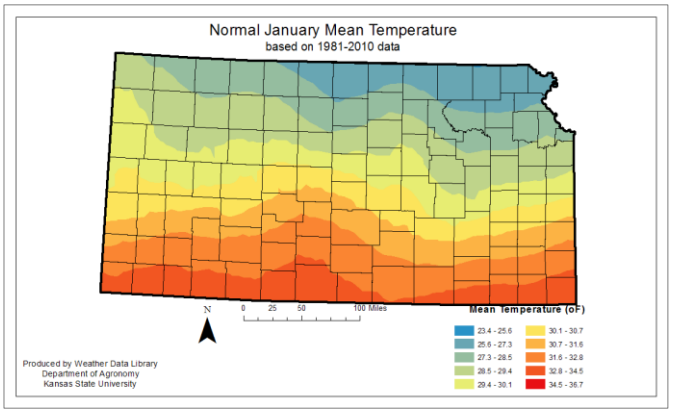
Temperatures varied wildly over the month, but averaged just slightly warmer than normal in January. State-wide average temperature for the month was 30.3 ^{o}F, which is 0.3 degrees warmer than normal. Only the Northeast Division was cooler than normal, with an average of 27.1 ^{o}F, or 0.4 degrees cooler than normal. The South Central Division was the warmest with an average of 33.3 ^{o}F or 1.1 degrees warmer than normal. The variability showed in the range of temperatures. The warmest maximum temperature was 71 ^{o}F at Ashland, Clark County, on the 7th. The coldest minimum temperature at a NWS station was recorded at Marysville, Washington County, on the 25th as -10 ^{o}F. The coldest reading at a Kansas Mesonet station was -10.0 ^{o}F recorded at the Brown County station near Hiawatha on the 31st.

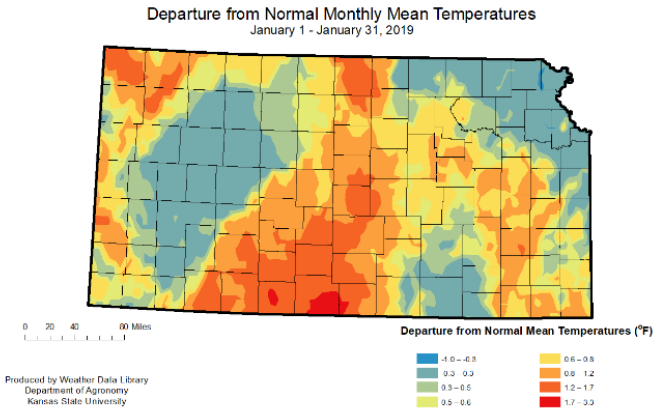
Information in this summary is taken from information generated by Kansas State University Department of Agronomy along with data tables and maps. (Maps based data from the Cooperative Observer and Kansas Mesonet, provided by KSU Weather Data Library.) The maps provide a glimpse at the temperature variation from normal. Weekly maps of information can be accessed at http://climate.k-state.edu/maps/weekly/.

Climate Division	Kansas Climate Division Temperature Summary (^{o}F)							
	January 2019							
	Maximum	Minimum	Average	Departure	High	Date	Low	Date
Northwest	40.8	17.5	29.2	0.7	65	28	1	2
West Central	41.3	18.8	30.1	0.4	66	5	1	3
Southwest	44.1	21.2	32.7	0.6	71	7	1	2
North Central	37.7	19.0	28.4	0.5	66	6	-8	25
Central	40.6	20.8	30.7	0.8	67	6	0	30
South Central	44.0	22.6	33.3	1.2	70	7	7	29
Northeast	36.0	18.3	27.1	-0.4	64	6	-10	25
East Central	38.1	20.6	29.3	0.2	63	6	-5	30
Southeast	41.6	22.9	32.3	0.6	68	8	4	30
STATE	40.5	20.2	30.3	0.5	71	7th	-10	25th
Data Source: KSU Weather Library								

The maps below summarize temperature for the month. (Sources: Normal map-K-State Weather Data Library; Temperature, percent of normal and departure maps are from the High Plains Reginal Climate Center, NOAA.)

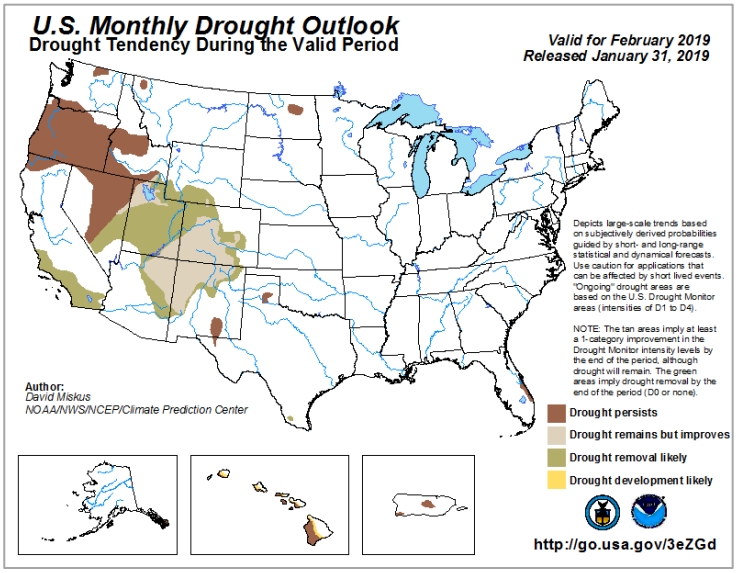


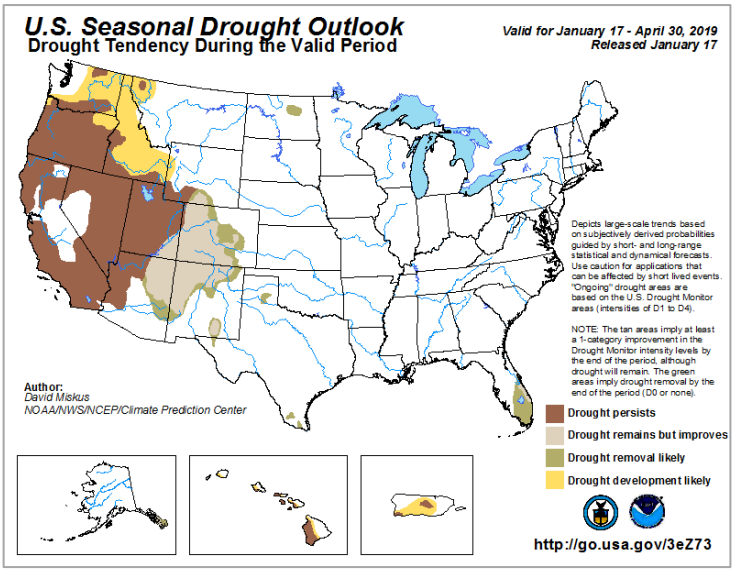




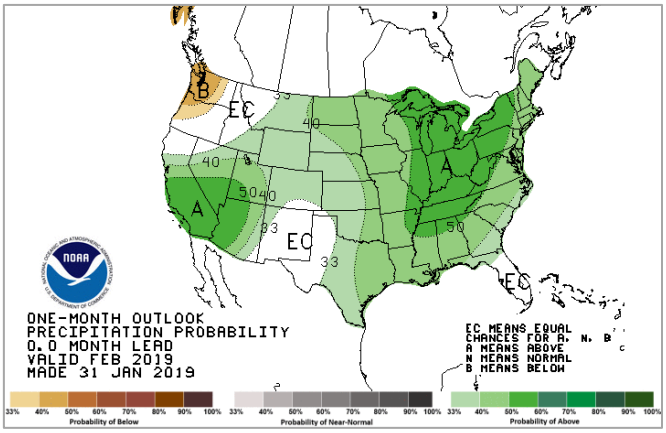
Future Outlook

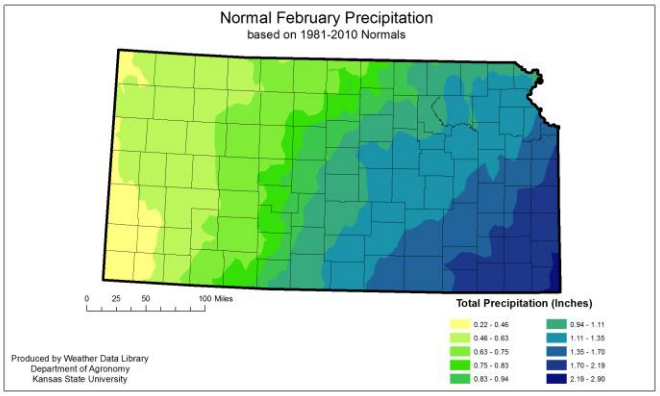
The Monthly Drought Outlook for February 2019 indicates no drought conditions in Kansas.
Seasonal Outlook (3-month) favors no drought in Kansas. The individual temperature and precipitation outlooks that contribute to these outlooks are available below. Others time intervals are also available from the climate prediction center.

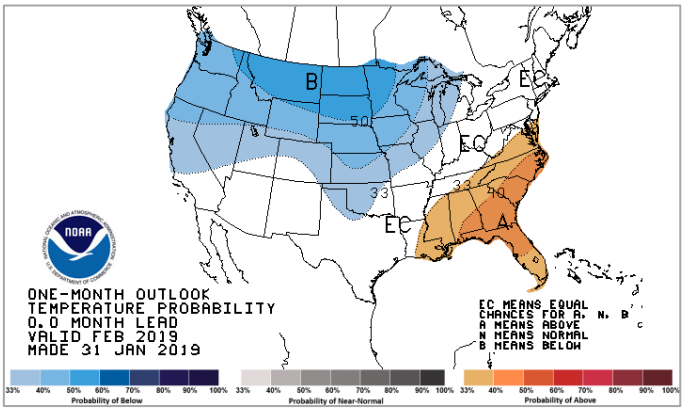


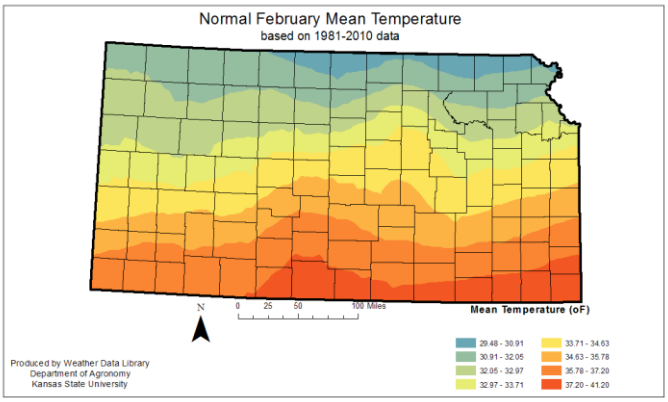


The February precipitation outlook favors above normal precipitation across Kansas and well as below normal temperatures.



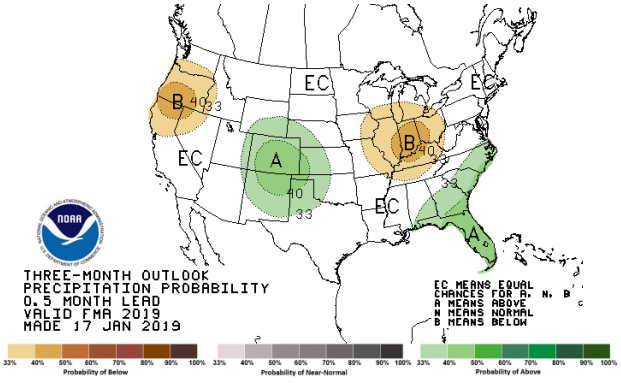


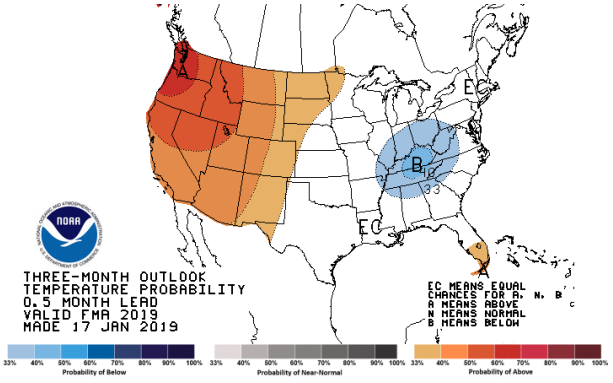




A mild winter could be in store for much of the United States this winter according to NOAA's Climate Prediction Center. The U.S. three month outlook for February through April favors above-average precipitation for western half of Kansas with equal chances of below, above or normal temperatures for all of Kansas.

Additionally, El Nino neutral conditions are present but is expected to form and continue in the northern hemisphere spring 2019 according to NOAA's Climate Prediction Center. The anticipated weak El Nino may influence the winter season by bringing wetter conditions across the southern United States, and warmer, drier conditions to parts of the North.





Additional outlooks for various timeframes are available from the national CPC for up to 13 months. (http://www.cpc.ncep.noaa.gov/products/predictions/90day/)

Water

Public Water Supply Conditions

Cities and rural water districts are encouraged to measure their current water supply as well as review and use their conservation and drought emergency plans as needed. Many updates and new plans are developed when drought conditions exist. Individual system stage designation and corresponding conservation measures are defined by each water supplier, so requirements to conserve and conservation measures are not uniform among public water suppliers. There are an increasing number of systems that restrict summertime outdoor water use to times of day of lower evaporation.

Surface Water Supply Conditions

Kansas River basin: Milford, Tuttle Creek, Perry, and Clinton reservoirs all experienced higher than normal inflows in January. With high inflows, all system reservoirs had healthy storage and the only reason Milford, Tuttle Creek, and Clinton were below the top of normal pool at the end of the month is due to intentional drawdown for a planned lower winter target elevation.

Marais des Cygnes basin: Melvern, Pomona, and Hillsdale reservoirs all experienced higher than normal inflows in January and flood pool storage. All reservoirs were drawn down to winter target elevations. Flows in the Marais des Cygnes River greatly exceeded historic median values throughout the month.

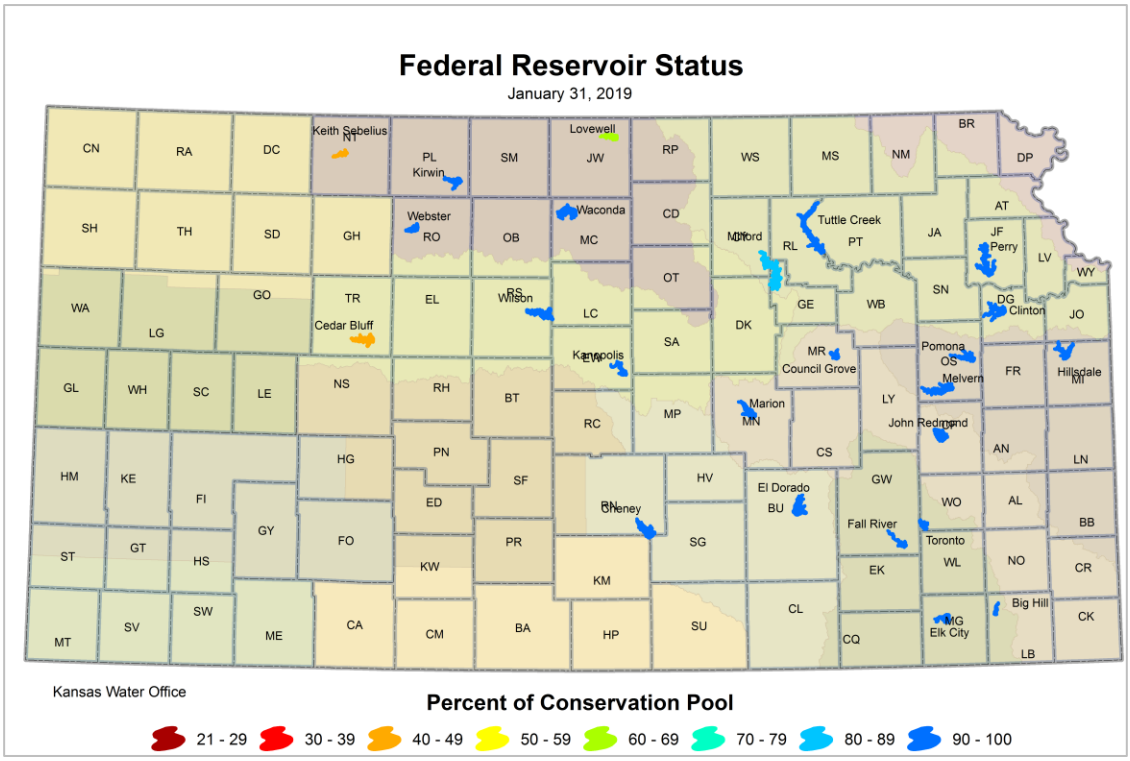
Cottonwood/Neosho basin: All system reservoirs experienced higher than normal inflows. Flood pool releases were necessary from all three reservoirs. Both the Cottonwood River and all reaches of the Neosho River experienced unseasonably high flows throughout the month.

Verdigris basin: Inflows to Toronto, Fall River, Elk City, and Big Hill reservoirs were well above normal in January. Stream flows in the Verdigris and Fall Rivers were maintained above normal due to flood pool releases and generally healthy tributary gains.

Saline basin: The elevation at Wilson Lake was lowered to near normal pool. Inflow remained above normal and releases in excess of low flow settings were necessary to manage lake level.

Smoky Hill basin: The middle Smoky Hill River maintained higher than normal flows from baseflow and tributary gains in January. Kanopolis Lake made significant releases through the main service gates. The U.S. Army Corps of Engineers has drawn the pool down below the top of conservation to facilitate maintenance work this winter. Cedar Bluff Reservoir also received some inflow and gained elevation over the month due to steady higher than normal inflow.

Surface Water Supply Conditions
Reservoir Storage



Kansas Federal Reservoir Conservation Pool Levels

Reservoir	Top of Multipurpose / Conservation Pool (Feet MSL)	Multipurpose/Conservation Pool Elevation (Feet MSL)	Change from Top of Pool (Feet)	Percent of Conservation Pool Full
Kansas River Basin		**01/31/2019**		
Keith Sebelius Lake[1]	2304.3	2294.40	-9.90	49.4
Harlan County Lake NE	1945.73	1942.14	-3.59	85.4
Lovewell Reservoir[1]	1582.6	1578.15	-4.45	66.9
Webster Reservoir[1]	1892.45	1892.76	0.31	100.0
Kirwin Reservoir	1729.25	1730.07	0.82	100.0
Waconda Lake[1]	1455.6	1454.57	-1.03	94.2
Cedar Bluff Reservoir	2144	2123.34	-20.66	39.7
Kanopolis Lake[1]	1463	1461.82	-1.18	92.8
Wilson Lake[1]	1516	1515.92	-0.08	99.7
Milford Lake[1]	1144.4	1141.14	-3.26	87.2
Tuttle Creek Lake[1]	1075	1072.74	-2.26	90.8
Perry Lake[1]	891.5	891.67	0.17	100.0
Clinton Lake[1]	875.5	874.95	-0.55	96.7
Melvern Lake[1]	1036	1035.02	-0.98	95.5
Pomona Lake[1]	974	973.13	-0.87	93.9
Hillsdale Lake[1]	917	916.20	-0.80	95.1
Arkansas River Basin		**01/31/2019**		
Marion Reservoir[1]	1350.5	1350.89	0.39	100.0
Council Grove Lake[1]	1274	1274.34	0.34	100.0
John Redmond Reservoir	1041	1042.78	1.78	100.0
Toronto Lake	901.5	901.82	0.32	100.0
Fall River Lake	948.5	949.14	0.64	100.0
Elk City Lake	796	796.25	0.25	100.0
Big Hill Lake	858	858.16	0.16	100.0
Cheney Reservoir	1421.6	1421.72	0.12	100.0
El Dorado Lake	1339	1339.1	0.10	100.0

[1]Lake level management plan in place — Source: U.S. Army Corps of Engineers

Note: The conservation pool is the water storage for non-flood purposes of the reservoir, set by the elevation of the top of the pool.

Harmful Blue-Green Algal Blooms (lake water safety)

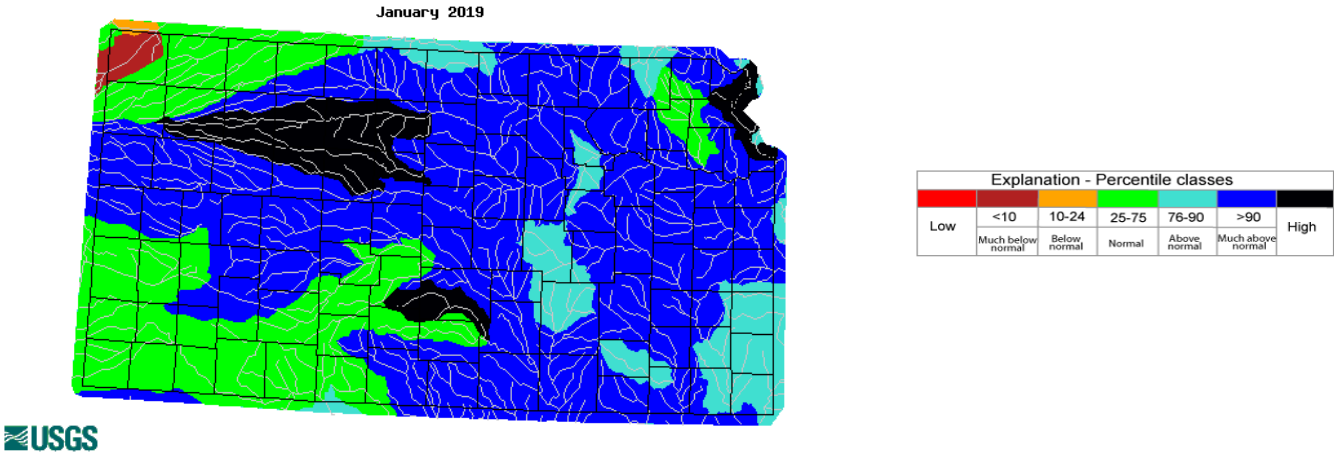
KDHE issues two levels of public health protection notifications for blue-green algae (BGA) Blooms: a Public Health Watch and Public Health Warning. Public Health Watch–Notifies public that a hazardous condition may exist, that the water may be unsafe for humans and animals and contact with the water is discouraged. Public Health Warning–Notifies public that conditions are unsafe, that contact with the water should not occur, and all conditions of Public Health Watch remain in effect. More information can be found at http://www.kdheks.gov/algae-illness/index.htm.

The 2018 HAB monitoring ended October 31st. At that time two water bodies remained in active bloom: Frazier Lake, in Grant County was at a Warning status; and South Lake, in Johnson County was at a Watch status. The next harmful algal bloom season will begin again on April 1, 2019.

Streamflow Conditions

WaterWatch summarizes streamflow conditions in a region (state or hydrologic unit) in terms of the long-term typical condition at stream gages in the region. In general, a streamflow which is greater than the 75 percentile is considered *above normal*, a streamflow which is between 25 and 75 percentiles is considered *normal* and a streamflow which is less than the 25 percentile is considered *below normal*. Color codes are for basins with streamflow averages less than 25 percent of historic values. This comparison aids in evaluating water resources conditions for a time period.

December Streamflow compared to historical streamflow is reflected in the map below.



Water Right Administration/Minimum Desirable Streamflow (MDS)

Minimum Desirable Streamflow (MDS) is not being administered in Kansas. MDS administration requires water rights junior to MDS, usually with priority dates after April 12, 1984, to stop diverting water. Administration is ordered when streamflow drops below MDS for more than seven days. To rescind orders at most gages, daily average flow must be above MDS for 14 days.

The table below provides a snapshot of conditions for streams of interest to the Kansas Department of Agriculture, Division of Water Resources.

Streamflows as of January 28, 2019			
Gaging Station	**Current Flow**	**Jan MDS**	**Comment**
Little Blue River near Barnes	***	100	Temporarily Unavailable
Rattlesnake Creek near Macksville	4	5	No surface water diversions junior to MDS above gage
South Fork Ninnescah River near Pratt	10	10	No surface water diversions junior to MDS above gage

Vegetation and Soil Moisture

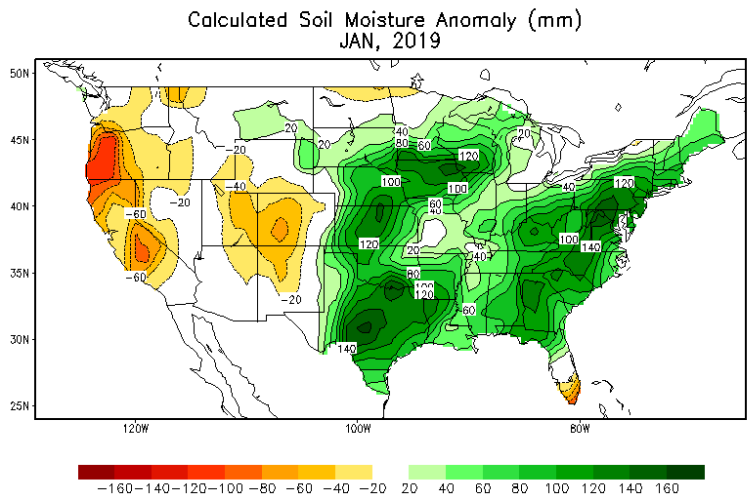
Vegetative Conditions

The Vegetative Condition map provides current conditions related to drought effects on vegetation. It is produced using satellite data. Areas in yellow, orange and red indicate areas of vegetative stress. The green areas are considered to be in good or excellent condition. No current GreenReport is available

Soil Moisture and Rangeland

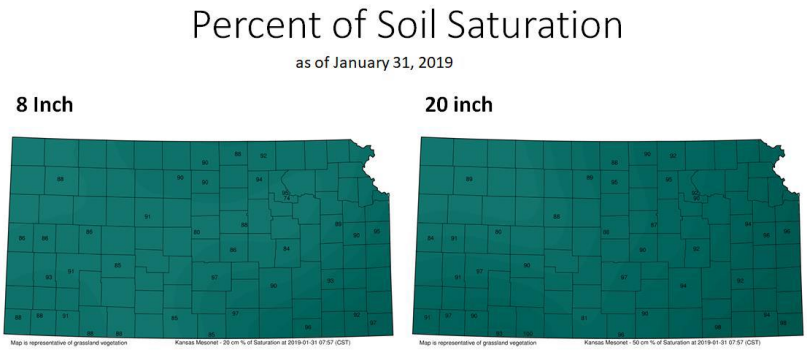
USDA Crop Progress and Condition provide a summary of the climatic effects on soil, and livestock feed. A summary is normally found here. However no current data was available at the time of this report.

The Climate Prediction Center (CPC), also monitors soil moisture and predicts future soil moisture. Anomalies are defined as deviations from the 1971-2000 monthly climatology. The soil anomaly is provided below. (.http://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)



Kansas soil moisture monitoring occurs through Kansas State University Mesonet at four depths, 5 cm, 10 cm, 20 cm and 50 cm measuring percentage of saturation and volumetric water content at about 36 stations. Installation of sensors began in mid-2017 and were completed early 2018. Maps and data are found at http://mesonet.k-state.edu/agriculture/soilmoist/ .

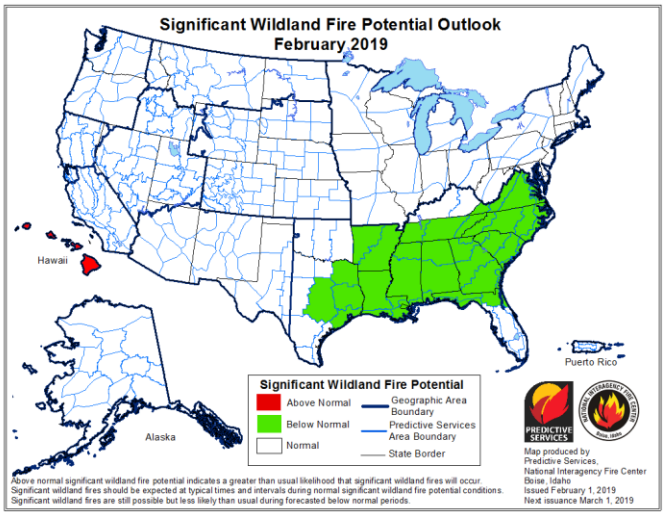
Figures below shows the 8-inch and 20-inch soil moisture on January 31, 2019.

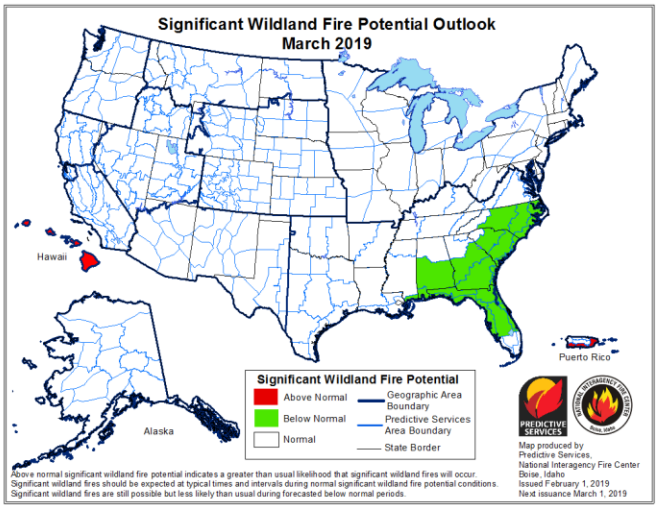


Fire

Periods of concern will be wind events coupled with low humidity that impact fire activity. Kansas Forest Service provides a grassland fire danger index at**:** http://www.kansasforests.org/fire_management/grasslandfireindex.html .

Significant Wildland Fire Potential Outlook is issued monthly for the United States, https://www.predictiveservices.nifc.gov/outlooks/monthly_seasonal_outlook.pdf . Those below were issued December 1, 2018. Due to federal government shutdown the January 1, 2019 predictions were unavailable.





Kansas Climate Summary

The Kansas Weekly Climate Summary and Drought Report are compiled at least monthly, more frequently when conditions warrant, by the KWO. Information from various federal, state, local and academic sources is used. Some of the data is preliminary and subject to change once final data is available. The KWO web site, http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response , contains additional drought information including links to other agencies with drought information and past issues of the Kansas Climate Summary and Drought Report. Kansas State Climatologist, Mary Knapp, is the primary source of the narrative on weather. She works closely with meteorologists throughout the state and region. Details of current conditions at Evapotranspiration (ET) and Mesonet sites across Kansas are available at http://mesonet.k-state.edu/

RESOURCES and REFERENCES

Kansas climate data is provided by Kansas State University, Weather Data Library through the Kansas Mesonet. (http://www.ksre.k-state.edu/wdl/). Soil moisture data was added in 2018 (http://mesonet.k-state.edu/agriculture/soilmoist)

The U.S. Drought Monitor, from the National Drought Mitigation Center at the University of Nebraska-Lincoln, provides a "big picture" perspective of conditions across the nation. In the Kansas county drought stage scheme, a Drought Watch equates roughly to moderate drought in the U.S. Drought Monitor, while a Drought Warning is the equivalent of severe drought. A Drought Emergency is reserved for extreme or exceptional drought. Palmer Drought Severity Index - The Palmer Index (PDSI) is one indicator used in the U.S. Drought Monitor.

The High Plains Regional Climate Center (https://hprcc.unl.edu/) has precipitation and temperature summary maps available at the state, region and nation.

The U.S. Geological Survey (USGS) Drought Watch provides information average streamflow measured at long-term gaging stations and compares them to normal flows.

The Kansas Department of Agriculture-Division of Water Resources monitors stream flow using the USGS gages for determination of administrative needs. Administration may be needed due to Minimum Desirable Streamflow (MDS) requirements, impairments and reservoir release protection. (https://agriculture.ks.gov/divisions-programs/dwr/water-appropriation/minimum-desirable-streamflow.)

The water levels of the federal lakes fluctuate during a year according to the management plan. Lake level Management plans are posted on the Kansas Water Office web site www.kwo.ks.gov .

The Kansas Applied Remote Sensing Program (KARS) at the University of Kansas produces a Kansas Green Report each week during the growing season. For a full set of national and regional ***GreenReport***® maps, go to: http://www.kars.ku.edu/products/greenreport/greenreport.shtml. This Kansas Vegetation Drought Response Index map is developed weekly by the Kansas Biological Survey using state drought triggers as its key. In addition the VegDRI maps may be found at http://vegdri.unl.edu/

The National Weather Service (NWS) provides fire weather products and services for Kansas that include the Rangeland Fire Danger Index, Fire Weather Forecasts, Red Flag Watches/Warnings and Spot Forecasts. The five NWS offices that serve Kansas websites may be accessed from the NWS Offices' page.

The Monthly and Seasonal Drought Outlooks, developed by the NOAA Climate Prediction Center, assess the likelihood for improvement, persistence or deterioration in drought conditions for areas currently experiencing drought as identified by the U.S. Drought Monitor. (http://www.cpc.ncep.noaa.gov/) Also see: http://www.noaa.gov/.

Responding to Drought: A Guide for City, County and Water System Officials provides an overview of Kansas county drought stage declarations, local planning and coordination, disaster declarations and available state and federal assistance. The 2007 Municipal Water Conservation Plan Guidelines and the Drought Vulnerability Assessment Report, both by KWO, provide guidance regarding drought preparedness and response. These are available at http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response.

USDA Drought Programs and Assistance website (https://www.usda.gov/topics/disaster/drought/usda-drought-programs-and-assistance) listing the various USDA programs and agencies to assist with drought issues.

The National Interagency Coordination Center in Boise, Idaho, produces wildfire potential outlook maps monthly. (https://www.predictiveservices.nifc.gov/outlooks/outlooks.htm)

Please contact Diane Knowles at the Kansas Water Office (785) 296-3185 or diane.knowles@kwo.ks.gov should you have any questions or suggestions.

APPENDIX A

January 2019 Summary	Precipitation (inches)			Temperature °F			
						Extreme (Date)	
Station[1]	Total	Departure	Percent Normal	Mean	Departure	Highest	Lowest
West							
Burlington, CO	0.48	0.10	126%	31.6	2.2	65 (5)	2 (1)
Dodge City	0.73	0.15	126%	33.5	1.3	64 (6)	8 (30)
Garden City	0.09	-0.25	26%	30.4	-0.5	59 (27)	4 (2)
Goodland	0.33	-0.05	87%	32.1	2.5	65 (5)	5 (1)
Guymon, OK	0.23	-0.17	58%	36.6	1.0	74 (21)	6 (2)
Hill City	0.86	0.41	191%	30.0	0.7	62 (5)	4 (23)
Lamar, CO	0.47	0.17	157%	31.6	2.6	70 (6)	-1 (2, 1)
McCook, NE	0.10	-0.41	20%	29.6	2.4	64 (27)	4 (30,1)
Springfield, CO	0.65	0.28	176%	33.7	1.5	66 (21,5)	2 (1)
Central							
Concordia	0.62	0.04	107%	28.5	-0.1	61 (5)	0 (30)
Hebron, NE				27.2	1.6	62 (5)	-4 (25,24)
Medicine Lodge	0.87	0.16	123%	34.5	1.1	64 (27,7)	12 (30)
Ponca City, OK	2.15	1.15	215%	36.0	1.1	63 (7,6)	13 (30)
Salina	1.20	0.57	190%	31.3	0.3	61 (5)	5 (30)
Wichita (ICT)	1.32	0.49	159%	33.4	1.2	62 (7)	9 (30)
East							
Bartlesville, OK	2.83	1.21	175%	35.1	0.1	69 (7)	10 (25)
Chanute	1.56	0.30	124%	33.3	0.7	67 (7)	7 (30)
Falls City, NE	0.33	-0.32	51%	26.1	-0.4	62 (5)	-10 (30)
Johnson Co. Exec. Apt	0.99	-0.13	88%	28.6	-1.5	60 (6)	-5 (30)
Joplin, MO	2.72	0.69	134%	35.0	0.1	66 (7)	6 (25)
Kansas City (MCI), MO	1.70	0.71	172%	28.1	-0.7	61 (7)	-6 (30)
St. Joseph, MO	0.77	0.21	138%	26.6	-0.6	58 (7,6)	-9 (30)
Topeka (TOP)	1.66	0.80	193%	29.6	-0.1	62 (5)	-3 (30)

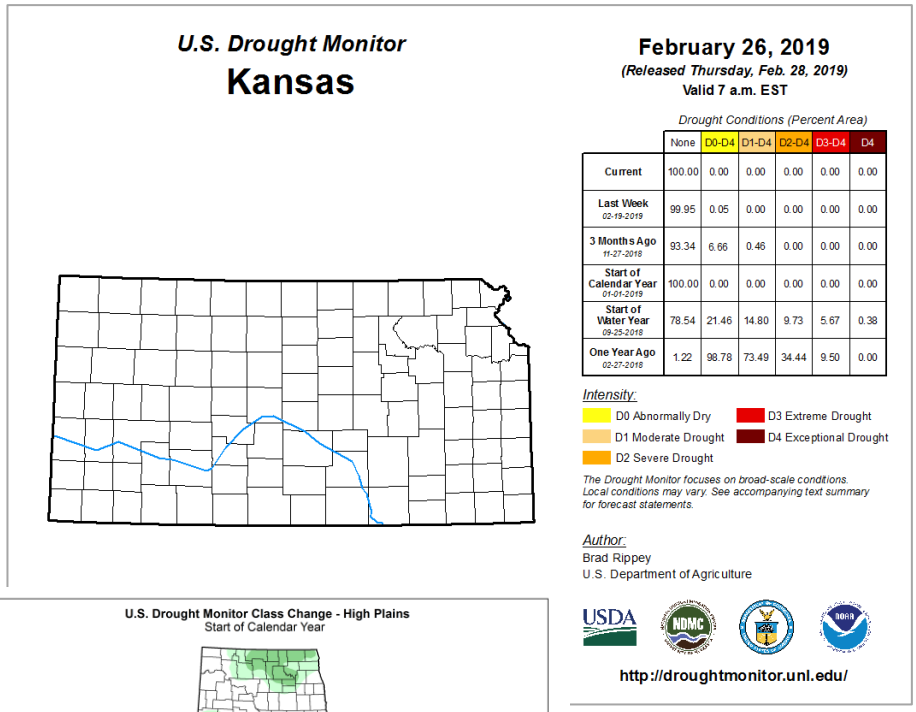
1. Airport Automated Observation Stations (NWS/FAA)
2. Departure from 1981-2010 normal value
T - Trace; M - Missing; --- no normal value from which to calculate departure or percent of normal
Source: National Weather Service F-6 Climate Summaries

KANSAS CLIMATE and DROUGHT UPDATE
February 2019 Summary

Highlights

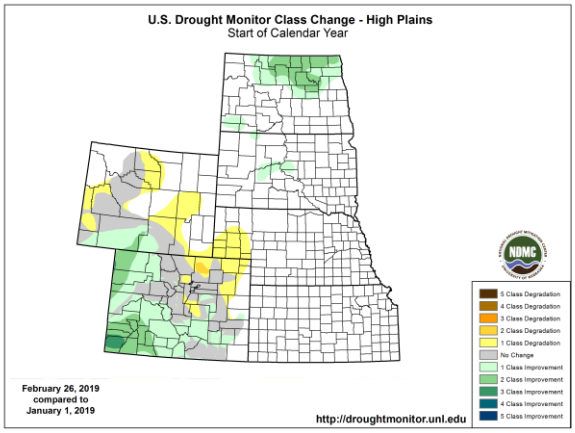
- With the colder than normal temperatures and near normal to above normal precipitation, February continued drought free. Given the wet soil conditions and the increased amounts of precipitation normal at this time of the year, drought conditions are unlikely.
- An El Niño Advisory is in effect (as of Feb. 25), with El Niño conditions present. Weak El Nino conditions expected to continue in the Northern Hemisphere through spring 2019 (a 55% chance). This often means a warmer than normal winter in Kansas.
- The March precipitation outlook favors a slightly increased chance of above normal precipitation across the state.
- The temperature outlook is for cooler than normal temperature across the state, which will lessen demand and further reduce the chances for a rapid onset of drought.

General Conditions



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	100.00	0.00	0.00	0.00	0.00	0.00
Last Week 02-19-2019	99.95	0.05	0.00	0.00	0.00	0.00
3 Months Ago 11-27-2018	93.34	6.66	0.46	0.00	0.00	0.00
Start of Calendar Year 01-01-2019	100.00	0.00	0.00	0.00	0.00	0.00
Start of Water Year 09-25-2018	78.54	21.46	14.80	9.73	5.67	0.38
One Year Ago 02-27-2018	1.22	98.78	73.49	34.44	9.50	0.00

The state became drought free by the U.S. Drought Monitor in January and remained drought free all the February.

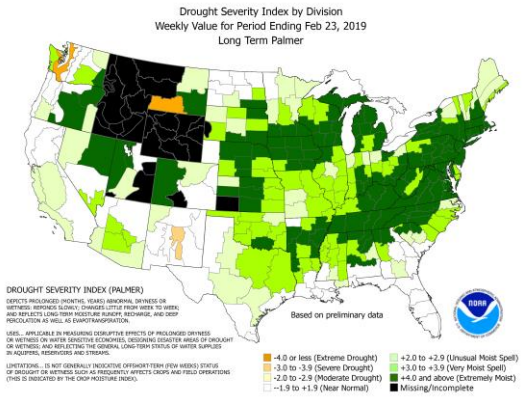


Changes in drought classification since the beginning of 2019 for the High Plains, including Kansas are shown on the left for reference.

More information can be found on the U.S. Drought Monitor web site https://droughtmonitor.unl.edu/ .

Palmer Drought Severity Index (PDSI) - The Palmer Drought Severity Index is an indicator of relative dryness or wetness and is one factor used the U.S. Drought Monitor.

More information on the PDSI can be found at http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml



Climate Summary - Precipitation

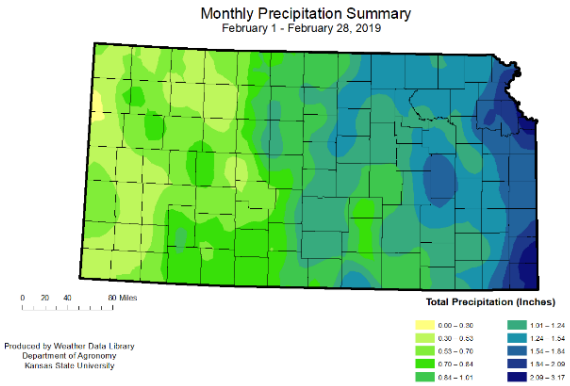
State-wide average precipitation for the month was 1.01 inches, 102 percent of normal. The Northwest Climate Division was the driest with an average of 0.33 inches. That is a deficit of 0.22 inches, 61 percent of normal. The East Central Division had the greatest average precipitation at 1.55 inches. That is 117 percent of normal and a surplus of 0.22 inches. The North Central Division had the greatest percent of normal at 122 percent, with 1.01 inches and a surplus of 0.18 inches. The highest 24-hour rainfall total for a National Weather Service Cooperative station was 2.50 inches at Caldwell, Sumner County, on the 20th. The greatest 24-hour rainfall total for a Community Collaborative Rain, Hail and Snow network station was 1.72 inches at Russell 8.1 NW, Russell County, on the 24th. The greatest monthly precipitation totals for February: 3.17 inches at Emporia 3NW, Lyons County (NWS) and 2.68 inches at Cherokee 0.3 N, Crawford County (CoCoRaHS). Most precipitation was in the form of snow. Monthly totals ranged from around an inch in southern Kansas to 19.5 inches at the CoCoRaHS station at Belleville 4.2 N, Republic County.

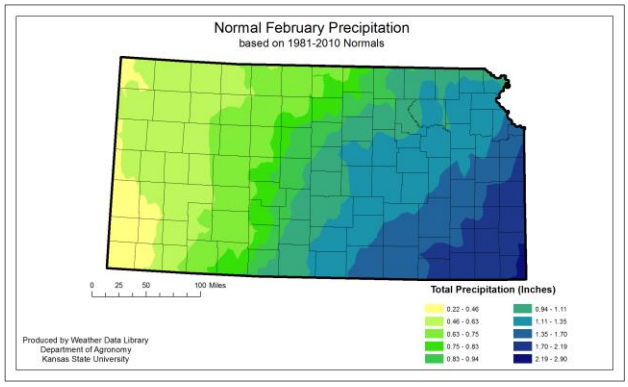
Information in this summary is taken from information generated by Kansas State University Department of Agronomy (KSU) along with data tables and maps. (Maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library.) Weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.

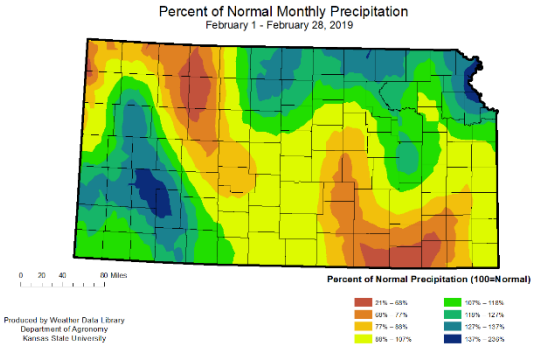
Kansas Climate Division Precipitation Summary (inches)

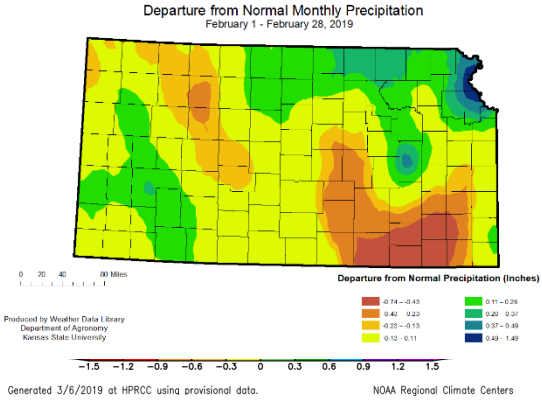
Climate Division	February 1-28 2019			January 1- Feb 28, 2019			April 1, 2018- Feb 28, 2019			Sept 1, 2018- Feb 28, 2018		
	Actual	Depart Normal	Percent Normal	Actual	Depart Normal	Percent Normal	Actual	Depart Normal	Percent Normal	Actual	Depart Normal	Percent Normal
Northwest	0.33	-0.21	61	0.69	-0.30	70	23.96	3.91	120	7.79	2.33	143
West Central	0.60	0.01	102	1.29	0.19	117	26.28	6.92	136	10.42	4.85	187
Southwest	0.82	0.27	149	1.48	0.46	145	27.48	8.94	148	10.09	4.61	184
North Central	1.01	0.18	122	1.75	0.29	120	33.66	7.64	129	15.45	7.26	189
Central	1.01	0.00	100	2.00	0.30	118	33.58	6.54	124	16.10	7.58	189
South Central	1.09	-0.07	94	2.08	0.09	105	36.90	8.21	129	16.88	7.04	172
Northeast	1.12	0.00	100	2.37	0.45	123	34.57	1.85	106	17.54	6.28	156
East Central	1.55	0.22	117	3.23	0.95	142	32.58	-2.69	92	16.25	3.66	129
Southeast	1.42	-0.30	83	3.14	0.17	106	39.52	1.05	103	17.95	2.89	119
STATE	1.01	0.02	102	2.02	0.29	117	32.25	4.98	118	14.28	5.17	157

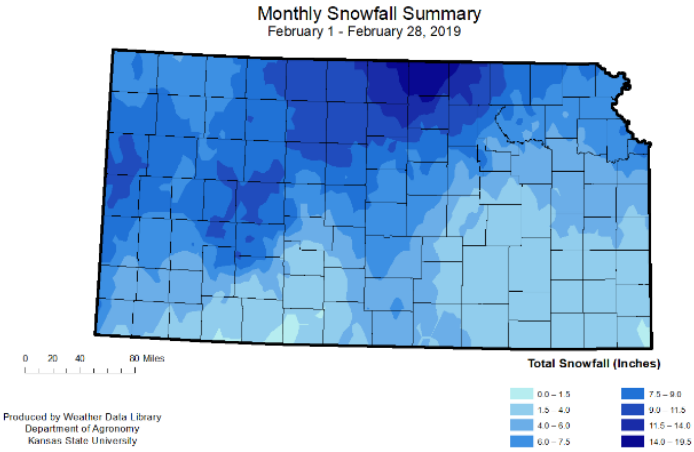
The maps below summarize precipitation for the month. (Sources: Normal map-K-State Weather Data Library; Precipitation, percent of normal and departure maps are from the High Plains Reginal Climate Center, NOAA.)











Climate Summary-Temperature

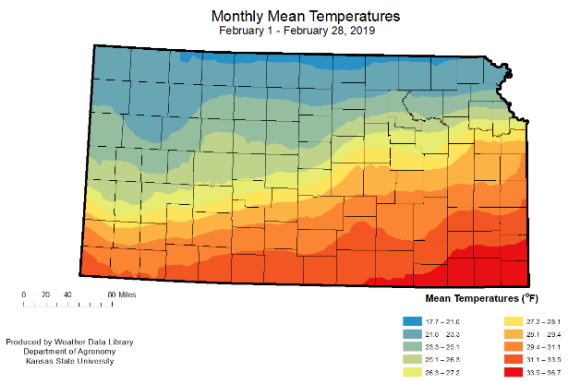
February was much colder than normal across the state. State-wide average temperature for the month was 26.6 ^{o}F, which is 7.3 degrees cooler than normal. This ranks as the 12th coldest February on record, with the coldest average at 19.0 ^{o}F set in 1899. The Northwest Climate Division was the coldest with an average of 22.0 ^{o}F, 9.6 degrees cooler than normal. The Southeast Division was the warmest with an average of 32.7 ^{o}F or 3.8 degrees cooler than normal. The variability showed in the range of temperatures. The warmest maximum temperature was 81 ^{o}F at Richfield 2NE, Morton County, on the 4th. The coldest minimum temperature at a NWS station was recorded at Oakley 4W, Logan County, on the 8th, as -7 ^{o}F. The coldest reading at a Kansas Mesonet station was -10.0 ^{o}F recorded at the Cheyenne County station near St. Francis on the 9th. Daily record low maximum temperatures were recorded on 47 occasions, but 31 daily record warm minimums were also established in February 2019.

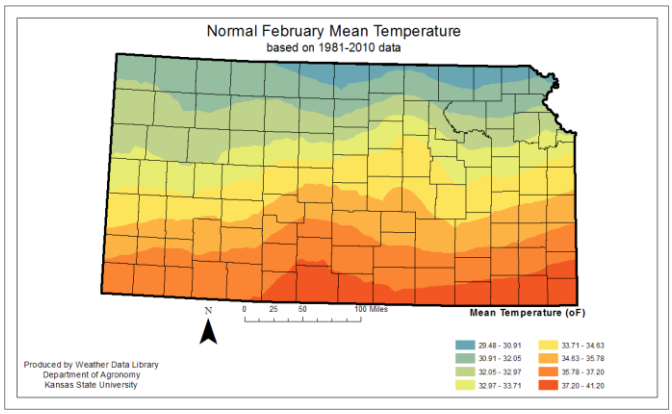
Information in this summary is taken from information generated by Kansas State University Department of Agronomy along with data tables and maps. (Maps based data from the Cooperative Observer and Kansas Mesonet, provided by

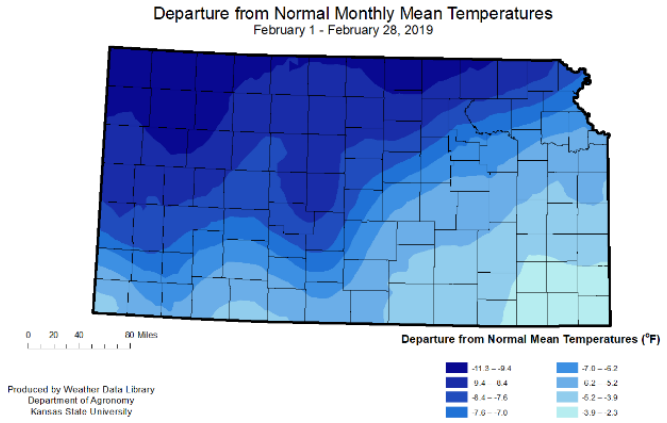
KSU Weather Data Library.) The maps provide a glimpse at the temperature variation from normal. Weekly maps of information can be accessed at http://climate.k-state.edu/maps/weekly/.

Climate Division	Kansas Climate Division Temperature Summary (°F)							
	February 2019							
	Maximum	Minimum	Average	Departure	High	Date	Low	Date
Northwest	33.6	10.4	22.0	-9.6	71	3	-6	8
West Central	36.2	12.3	24.2	-8.8	73	4	-7	9
Southwest	42.6	16.3	29.5	-6.2	81	4	-3	28
North Central	32.3	13.2	22.8	-9.4	67	4	-4	8
Central	35.7	16.6	26.2	-7.9	70	3	-3	8
South Central	40.5	20.7	30.6	-5.9	70	4	1	8
Northeast	32.6	15.3	24.0	-8.3	70	4	1	8
East Central	36.5	18.9	27.7	-6.0	71	4	3	8
Southeast	42.0	23.5	32.7	-3.8	71	4	4	8
STATE	36.9	16.4	26.6	-7.3	81	4th	-7	9th
Data Source: KSU Weather Library								

The maps below summarize temperature for the month. (Sources: Normal map-K-State Weather Data Library; Temperature, percent of normal and departure maps are from the High Plains Reginal Climate Center, NOAA.)



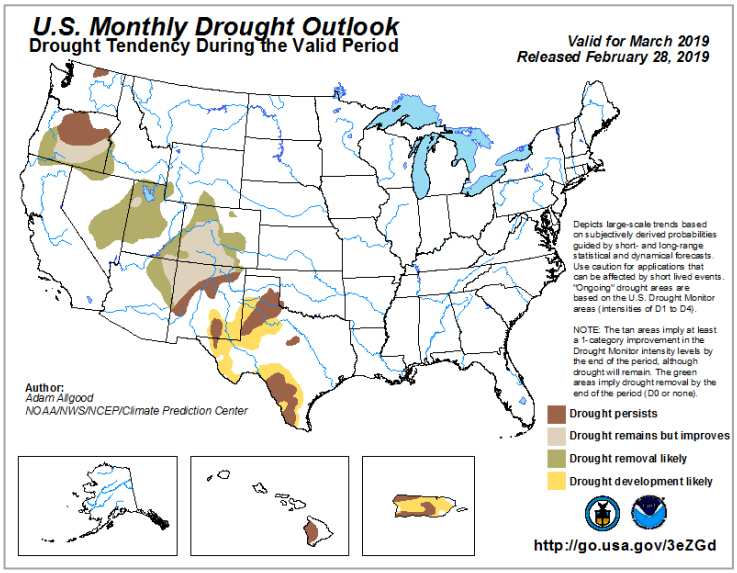


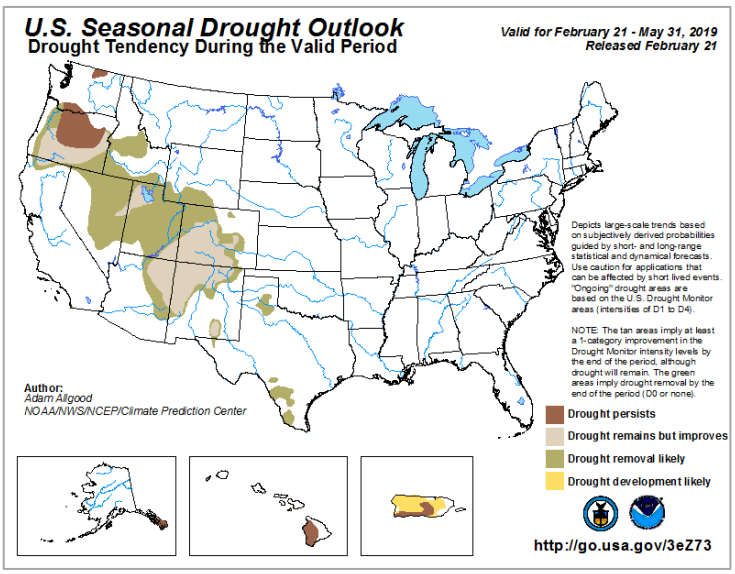


Severe storm reports were limited in Kansas during February. The first hail reports of the year occurred on February 6th, with quarter-size hail reported in Cherokee County on the 6th, while Harper County saw hail up to 1 inch on the same date. No reports of tornadoes or damaging winds were received. Severe winter weather was the main feature for the month, with winter storm conditions across most of the state every weekend. Sadly, there were several fatal traffic accidents due to the snowy road conditions.

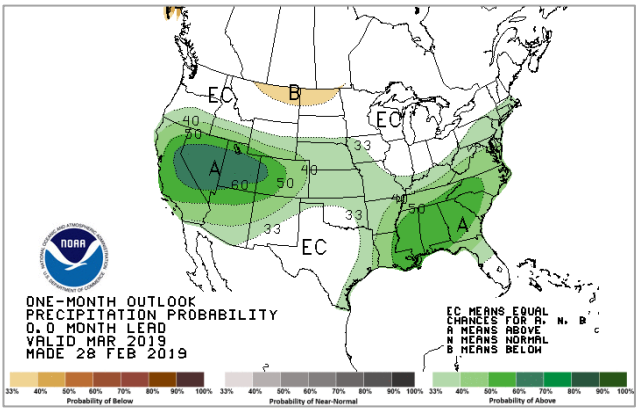
Future Outlook

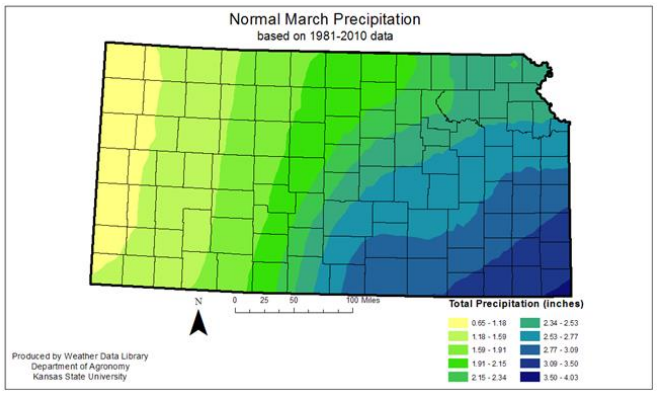
The Monthly Drought Outlook for March 2019 indicates no drought conditions in Kansas. The Seasonal Outlook (3-month) favors no drought in Kansas. The individual temperature and precipitation outlooks that contribute to these outlooks are available below. Others time intervals are also available from the climate prediction center.

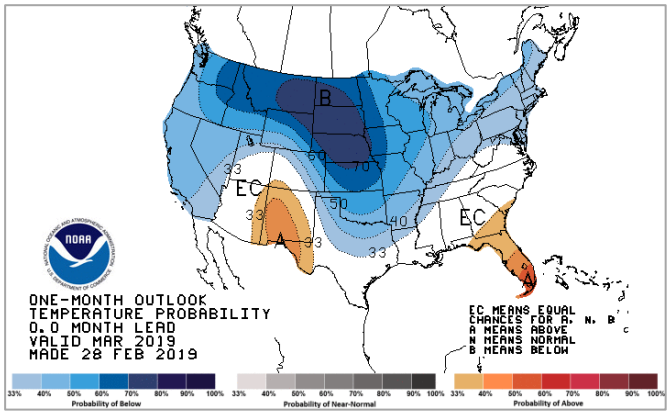


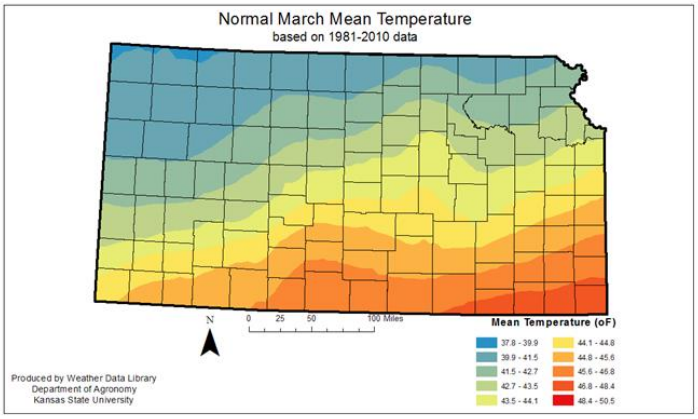


The outlook for March (the first part of the month) calls for an increased chance of cooler than normal temperatures across the state. The signal is strongest in the Northeast, and weakest in the Southwest. The precipitation pattern for March also favors above normal conditions.



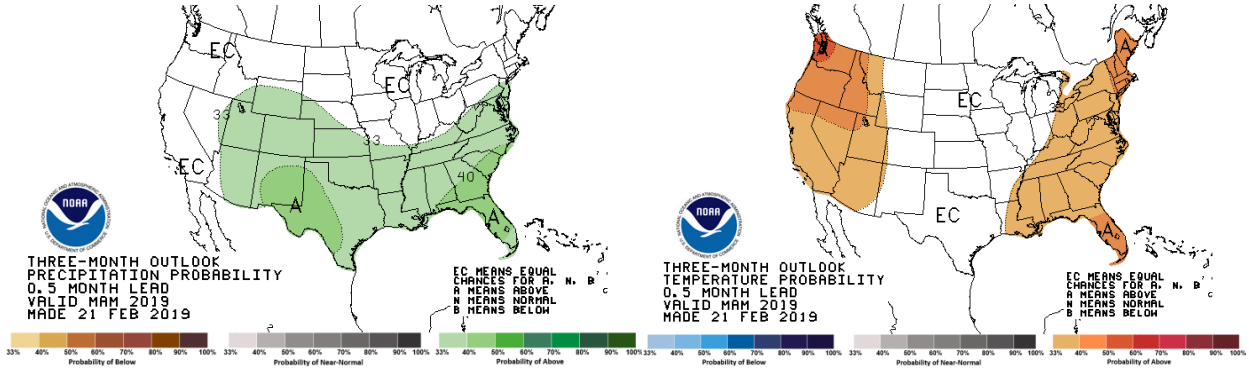






The U.S. three month outlook for March through May favors above-average precipitation for most of Kansas with equal chances of below, above or normal temperatures for all of Kansas.

Additionally, El Nino conditions are present and expected to continue in the northern hemisphere spring 2019 according to NOAA's Climate Prediction Center. An El Niño generally favors wetter than normal conditions in the Central Plains. However, the El Niño signal has its weakest correlation in the spring season. Impacts are more likely to be the result of an active Madden Julian Oscillation, which results in increased frequency of storm systems. This increases the chance of normal to above normal precipitation in Kansas. Additionally, the positive pattern in the Arctic Oscillation makes cold intrusions into the Plains more likely and is known to phase polar/subtropical jet streams across the US resulting in stronger storm systems.



Additional outlooks for various timeframes are available from the national CPC for up to 13 months. (http://www.cpc.ncep.noaa.gov/products/predictions/90day/)

Water

Public Water Supply Conditions

Cities and rural water districts are encouraged to measure their current water supply as well as review and use their conservation and drought emergency plans as needed. Many updates and new plans are developed when drought conditions exist. Individual system stage designation and corresponding conservation measures are defined by each water supplier, so requirements to conserve and conservation measures are not uniform among public water suppliers. There are an increasing number of systems that restrict summertime outdoor water use to times of day of lower evaporation.

Surface Water Supply Conditions

Kansas River basin: Milford, Tuttle Creek, Perry, and Clinton reservoirs all experienced higher than normal inflows in February. With high inflows, all system reservoirs had healthy storage and the only reason Milford, Tuttle Creek, and Clinton were below the top of normal pool is due to intentional drawdown for a planned lower winter target elevation.

Marais des Cygnes basin: Melvern, Pomona, and Hillsdale reservoirs all experienced higher than normal inflows in February and flood pool storage. Pool elevations were maintained near lower winter target levels for most of the month, requiring higher than normal releases. Flows in the Marais des Cygnes River greatly exceeded historic median values throughout the month.

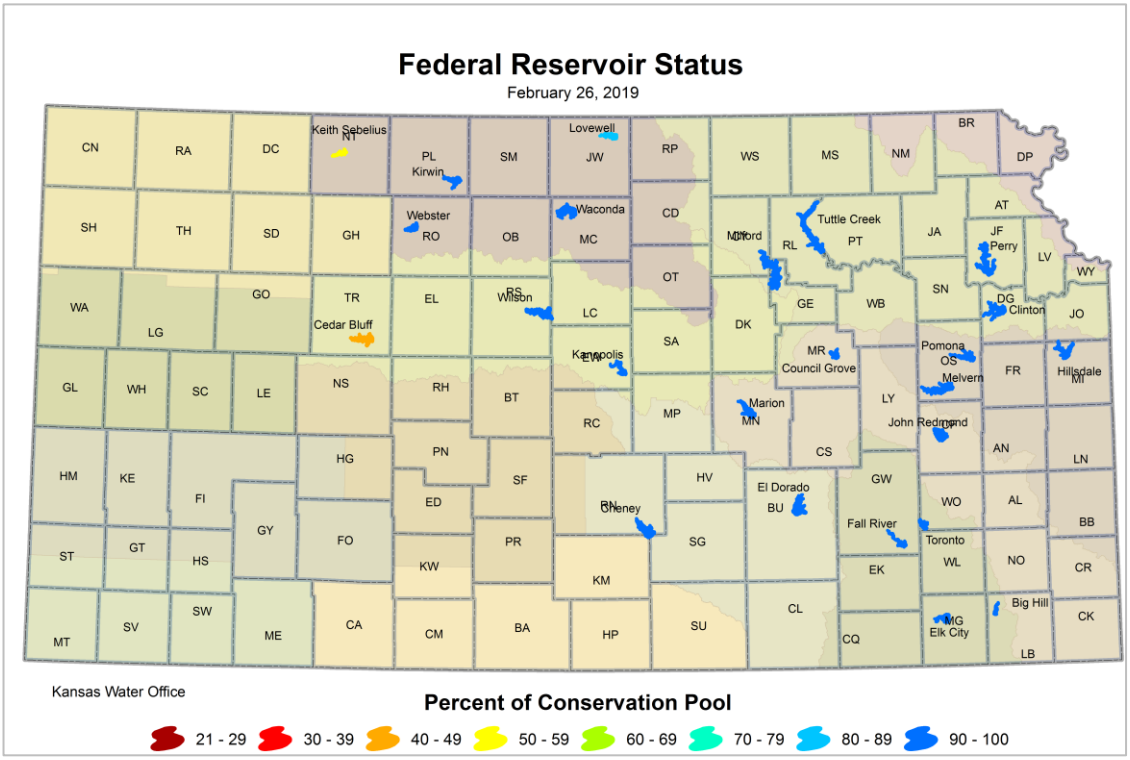
Cottonwood/Neosho basin: All system reservoirs experienced higher than normal inflows. Flood pool releases were necessary from all three reservoirs. Both the Cottonwood River and all reaches of the Neosho River experienced unseasonably high flows throughout the month.

Verdigris basin: Inflows to Toronto, Fall River, Elk City, and Big Hill reservoirs were well above normal in February. Stream flows in the Verdigris and Fall Rivers were maintained above normal due to flood pool releases and generally healthy tributary gains.

Saline basin: The elevation at Wilson Lake was maintained near normal pool. Inflow remained above normal and releases in excess of low flow settings were necessary to manage lake level.

Smoky Hill basin: The middle Smoky Hill River maintained higher than normal flows from baseflow and tributary gains in February. Kanopolis Lake made significant releases through the main service gates. The U.S. Army Corps of Engineers has drawn the pool down below the top of conservation to facilitate maintenance work this winter. Cedar Bluff Reservoir also received some inflow and gained elevation over the month due to steady higher than normal inflow.

Surface Water Supply Conditions
Reservoir Storage



Kansas Federal Reservoir Conservation Pool Levels

Reservoir	Top of Multipurpose / Conservation Pool (Feet MSL)	Multipurpose/Conservation Pool Elevation (Feet MSL)	Change from Top of Pool (Feet)	Percent of Conservation Pool Full
Kansas River Basin		**2/26/2019 2:00 PM**		
Keith Sebelius Lake[1]	2304.3	2294.74	-9.56	50.8
Harlan County Lake NE	1945.73	1942.92	-2.81	88.5
Lovewell Reservoir[1]	1582.6	1580.39	-2.21	82.6
Webster Reservoir[1]	1892.45	1892.36	-0.14	99.6
Kirwin Reservoir	1729.25	1729.89	0.59	100
Waconda Lake[1]	1455.6	1454.66	-0.94	94.7
Cedar Bluff Reservoir	2144	2123.94	-20.06	41
Kanopolis Lake[1]	1463	1461.71	-1.29	92.2
Wilson Lake[1]	1516	1516.06	0.06	100
Milford Lake[1]	1144.4	1141.82	-2.58	89.7
Tuttle Creek Lake[1]	1075	1080.04	5.04	100
Perry Lake[1]	891.5	893.53	2.03	100
Clinton Lake[1]	875.5	875.83	0.33	100
Melvern Lake[1]	1036	1036.43	0.43	100
Pomona Lake[1]	974	975.82	1.82	100
Hillsdale Lake[1]	917	917.23	0.23	100
Arkansas River Basin		**2/26/2019 8:00 AM**		
Marion Reservoir[1]	1350.5	1350.78	0.28	100.0
Council Grove Lake[1]	1274	1274.28	1.78	100.0
John Redmond Reservoir	1041	1042.93	1.93	100.0
Toronto Lake	901.5	905.29	3.79	100.0
Fall River Lake	948.5	950.01	1.51	100.0
Elk City Lake	796	796.86	0.86	100.0
Big Hill Lake	858	858.34	0.34	100.0
Cheney Reservoir	1421.6	1422.15	0.55	100
El Dorado Lake	1339	1339.42	0.42	100

[1]Lake level management plan in place — Source: U.S. Army Corps of Engineers

Note: The conservation pool is the water storage for non-flood purposes of the reservoir, set by the elevation of the top of the pool.

Harmful Blue-Green Algal Blooms (lake water safety)

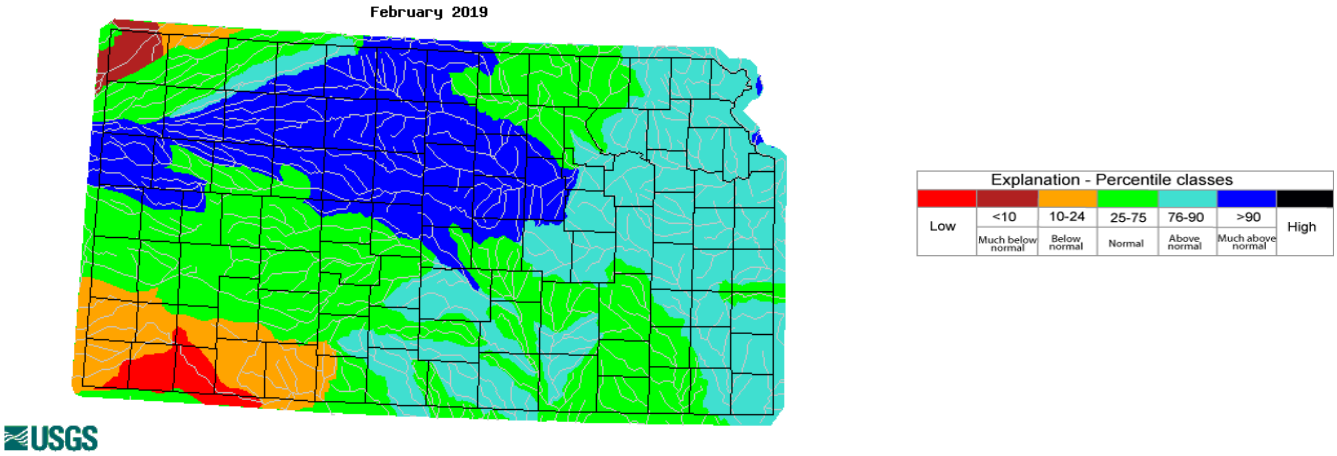
KDHE issues two levels of public health protection notifications for blue-green algae (BGA) Blooms: a Public Health Watch and Public Health Warning. Public Health Watch–Notifies public that a hazardous condition may exist, that the water may be unsafe for humans and animals and contact with the water is discouraged. Public Health Warning–Notifies public that conditions are unsafe, that contact with the water should not occur, and all conditions of Public Health Watch remain in effect. More information can be found at http://www.kdheks.gov/algae-illness/index.htm.

The 2018 HAB monitoring ended October 31st. At that time two water bodies remained in active bloom: Frazier Lake, in Grant County was at a Warning status; and South Lake, in Johnson County was at a Watch status. The next harmful algal bloom season will begin again on April 1, 2019.

Streamflow Conditions

WaterWatch summarizes streamflow conditions in a region (state or hydrologic unit) in terms of the long-term typical condition at stream gages in the region. In general, a streamflow which is greater than the 75 percentile is considered *above normal*, a streamflow which is between 25 and 75 percentiles is considered *normal* and a streamflow which is less than the 25 percentile is considered *below normal*. Color codes are for basins with streamflow averages less than 25 percent of historic values. This comparison aids in evaluating water resources conditions for a time period.

December Streamflow compared to historical streamflow is reflected in the map below.



Water Right Administration/Minimum Desirable Streamflow (MDS)

Minimum Desirable Streamflow (MDS) is not being administered in Kansas. MDS administration requires water rights junior to MDS, usually with priority dates after April 12, 1984, to stop diverting water. Administration is ordered when streamflow drops below MDS for more than seven days. To rescind orders at most gages, daily average flow must be above MDS for 14 days.

The table below provides a snapshot of conditions for streams of interest to the Kansas Department of Agriculture, Division of Water Resources.

Streamflows as of February 26, 2019			
Gaging Station	**Current Flow**	**Feb MDS**	**Comment**
Saline River near Russell	Ice	5	Iced
Big Blue River at Marysville	Ice	100	Iced
Rattlesnake Creek near Macksville	3	5	No surface water diversions junior to MDS above gage
South Fork Ninnescah River near Pratt	10	10	No surface water diversions junior to MDS above gage

Vegetation and Soil Moisture

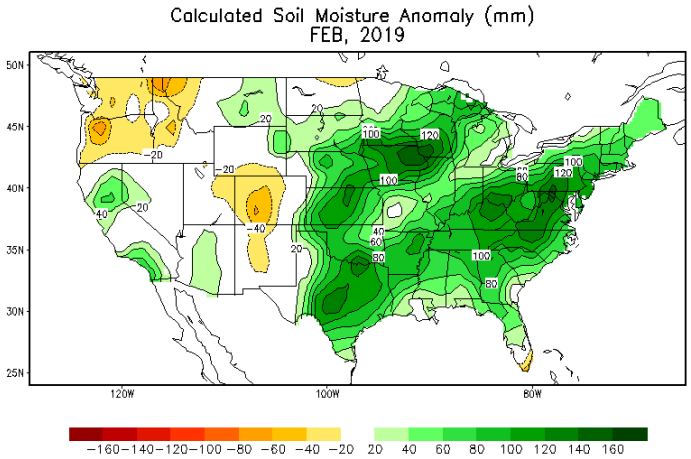
Vegetative Conditions

The Vegetative Condition map provides current conditions related to drought effects on vegetation. It is produced using satellite data. Areas in yellow, orange and red indicate areas of vegetative stress. The green areas are considered to be in good or excellent condition. No current GreenReport is available

Soil Moisture and Rangeland

USDA Crop Progress and Condition provide a summary of the climatic effects on soil, and livestock feed. A summary is normally found here. However no current data was available at the time of this report.

The Climate Prediction Center (CPC), also monitors soil moisture and predicts future soil moisture. Anomalies are defined as deviations from the 1971-2000 monthly climatology. The soil anomaly is provided below. (.http://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

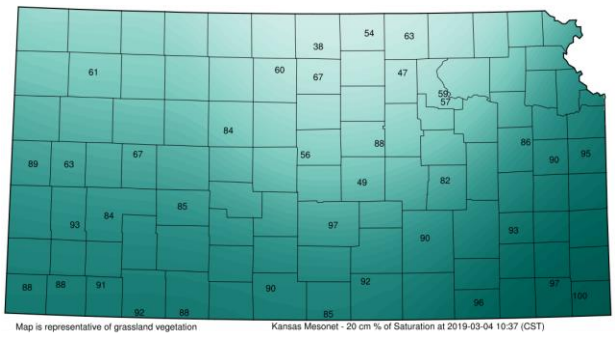


Kansas soil moisture monitoring occurs through Kansas State University Mesonet at four depths, 5 cm, 10 cm, 20 cm and 50 cm measuring percentage of saturation and volumetric water content at about 36 stations. Installation of sensors began in mid-2017 and were completed early 2018. Maps and data are found at http://mesonet.k-state.edu/agriculture/soilmoist/.

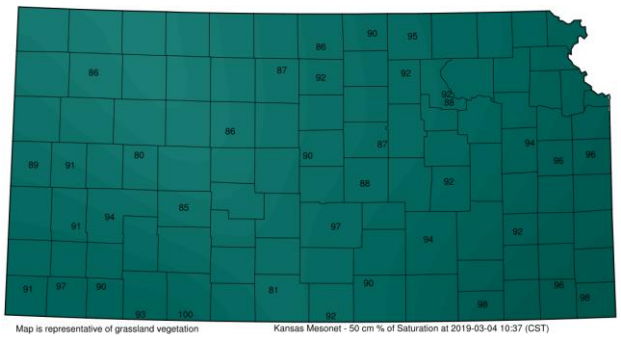
Figures below shows the 8-inch (20 cm) and 20-inch (50cm) soil moisture saturation on March 4, 2019.

Percent of Soil Saturation
March 4, 2019

8-inch

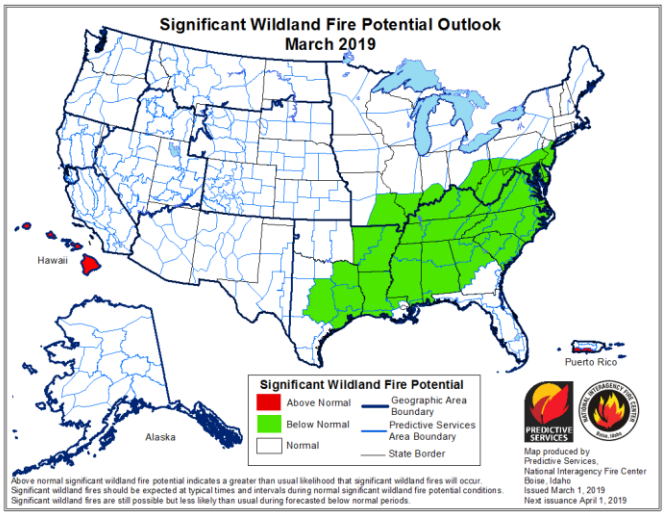


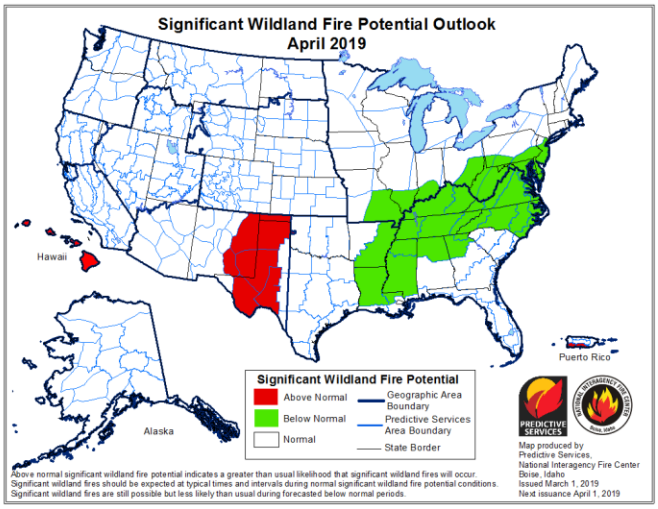
20-inch



Fire

Significant Wildland Fire Potential Outlook is issued monthly for the United States, https://www.predictiveservices.nifc.gov/outlooks/monthly_seasonal_outlook.pdf . Those below were issued December 1, 2018.





Kansas Forest Service provides a grassland fire danger index at**:** http://www.kansasforests.org/fire_management/grasslandfireindex.html .

Kansas Climate Summary

The Kansas Weekly Climate Summary and Drought Report are compiled at least monthly, more frequently when conditions warrant, by the KWO. Information from various federal, state, local and academic sources is used. Some of the data is preliminary and subject to change once final data is available. The KWO web site, http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response , contains additional drought information including links to other agencies with drought information and past issues of the Kansas Climate Summary and Drought Report. Kansas State Climatologist, Mary Knapp, is the primary source of the narrative on weather. She works closely with meteorologists throughout the state and region. Details of current conditions at Evapotranspiration (ET) and Mesonet sites across Kansas are available at http://mesonet.k-state.edu/

RESOURCES and REFERENCES

Kansas climate data is provided by Kansas State University, Weather Data Library through the Kansas Mesonet. (http://www.ksre.k-state.edu/wdl/). Soil moisture data was added in 2018 (http://mesonet.k-state.edu/agriculture/soilmoist)

The U.S. Drought Monitor, from the National Drought Mitigation Center at the University of Nebraska-Lincoln, provides a "big picture" perspective of conditions across the nation. In the Kansas county drought stage scheme, a Drought Watch equates roughly to moderate drought in the U.S. Drought Monitor, while a Drought Warning is the equivalent of severe drought. A Drought Emergency is reserved for extreme or exceptional drought. Palmer Drought Severity Index - The Palmer Index (PDSI) is one indicator used in the U.S. Drought Monitor.

The High Plains Regional Climate Center (https://hprcc.unl.edu/) has precipitation and temperature summary maps available at the state, region and nation.

The U.S. Geological Survey (USGS) Drought Watch provides information average streamflow measured at long-term gaging stations and compares them to normal flows.

The Kansas Department of Agriculture-Division of Water Resources monitors stream flow using the USGS gages for determination of administrative needs. Administration may be needed due to Minimum Desirable Streamflow (MDS) requirements, impairments and reservoir release protection. (https://agriculture.ks.gov/divisions-programs/dwr/water-appropriation/minimum-desirable-streamflow.)

The water levels of the federal lakes fluctuate during a year according to the management plan. Lake level Management plans are posted on the Kansas Water Office web site www.kwo.ks.gov .

The Kansas Applied Remote Sensing Program (KARS) at the University of Kansas produces a Kansas Green Report each week during the growing season. For a full set of national and regional ***GreenReport***® maps, go to: http://www.kars.ku.edu/products/greenreport/greenreport.shtml. This Kansas Vegetation Drought Response Index map is developed weekly by the Kansas Biological Survey using state drought triggers as its key. In addition the VegDRI maps may be found at http://vegdri.unl.edu/

The National Weather Service (NWS) provides fire weather products and services for Kansas that include the Rangeland Fire Danger Index, Fire Weather Forecasts, Red Flag Watches/Warnings and Spot Forecasts. The five NWS offices that serve Kansas websites may be accessed from the NWS Offices' page.

The Monthly and Seasonal Drought Outlooks, developed by the NOAA Climate Prediction Center, assess the likelihood for improvement, persistence or deterioration in drought conditions for areas currently experiencing drought as identified by the U.S. Drought Monitor. (http://www.cpc.ncep.noaa.gov/) Also see: http://www.noaa.gov/.

Responding to Drought: A Guide for City, County and Water System Officials provides an overview of Kansas county drought stage declarations, local planning and coordination, disaster declarations and available state and federal assistance. The 2007 Municipal Water Conservation Plan Guidelines and the Drought Vulnerability Assessment Report, both by KWO, provide guidance regarding drought preparedness and response. These are available at http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response.

USDA Drought Programs and Assistance website (https://www.usda.gov/topics/disaster/drought/usda-drought-programs-and-assistance) listing the various USDA programs and agencies to assist with drought issues.

The National Interagency Coordination Center in Boise, Idaho, produces wildfire potential outlook maps monthly. (https://www.predictiveservices.nifc.gov/outlooks/outlooks.htm)

Please contact Diane Knowles at the Kansas Water Office (785) 296-3185 or diane.knowles@kwo.ks.gov should you have any questions or suggestions.

APPENDIX A

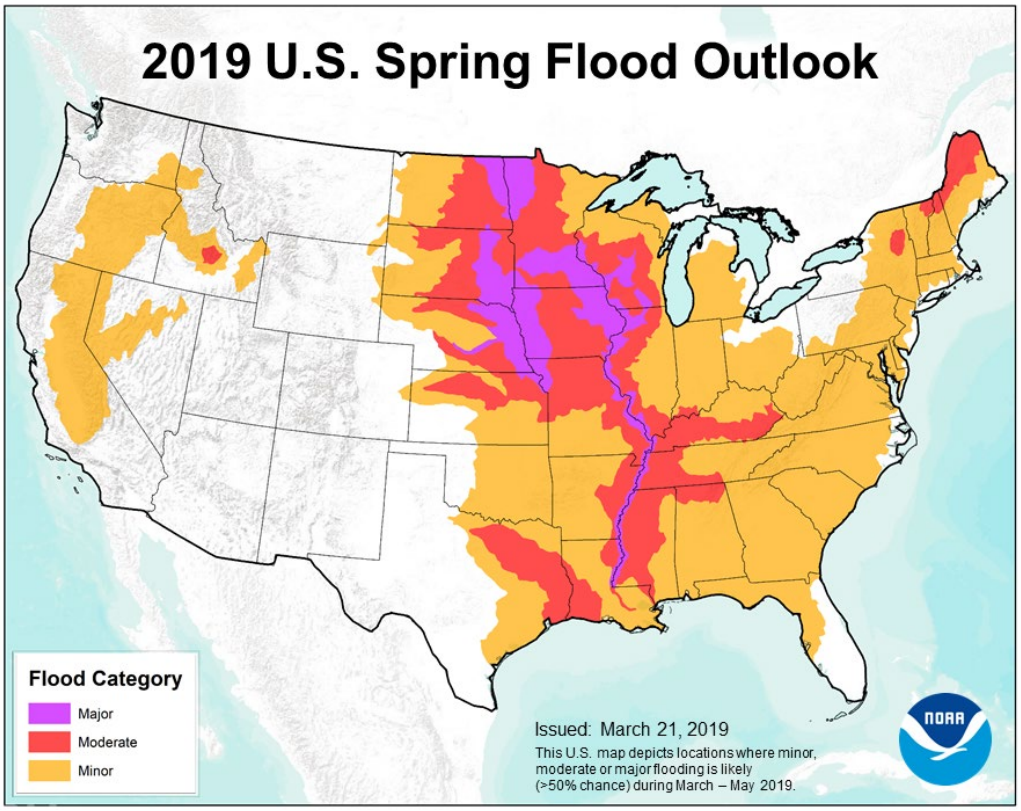
February 2019 Summary	Precipitation (inches)			Temperature °F			
						Extreme (Date)	
Station[1]	Total	Departure	Percent Normal	Mean	Departure	Highest	Lowest
West							
Burlington, CO	0.42	0.00	100%	25.6	-6.8	72 (3)	-6 (7)
Dodge City	0.88	0.20	129%	29.1	-6.8	70 (2)	1 (8,7)
Garden City	0.66	0.12	122%	26.4	-8.4	70 (3)	-3 (28)
Goodland	0.44	-0.05	90%	24.3	-8.0	71 (3)	-2 (7)
Guymon, OK	0.50	0.03	106%	36.1	-2.5	80 (3)	5 (8)
Hill City	0.16	-0.36	31%	24.3	-8.6	65 (3)	-4 (8)
Lamar, CO	0.41	0.04	111%	29.4	-4.2	75 (3)	-3 (24)
McCook, NE	0.71	0.09	115%	21.0	-9.9	63 (1)	-5 (8,7)
Springfield, CO	0.61	0.17	139%	30.6	-4.8	75 (3)	3 (7)
Central							
Concordia	1.25	0.46	158%	23.1	-9.6	65 (3)	1 (8)
Hebron, NE				21.8	-8.2	63 (3)	-3 (25)
Medicine Lodge	1.17	0.13	113%	32.7	-5.5	70 (3)	6 (8)
Ponca City, OK	0.68	-0.66	51%	36.8	-3.0	72 (3)	10 (8)
Salina	1.13	-0.04	97%	27.9	-7.6	68 (3)	4 (8)
Wichita (ICT)	0.72	-0.46	61%	33.1	-4.1	70 (3)	8 (8)
East							
Bartlesville, OK	1.50	-0.47	76%	36.9	-2.9	70 (14, 3)	9(8)
Chanute	1.30	-0.60	68%	34.5	-3.0	69 (3)	8 (8)
Falls City, NE	0.12	-0.82	13%	21.8	-9.1	62 (3)	0 (16)
Johnson Co. Exec. Apt	1.09	-0.48	69%	28.7	-6.1	64 (3)	5 (8)
Joplin, MO	1.87	-0.45	81%	36.7	-3.1	65 (23,3)	9 (8)
Kansas City (MCI), MO	2.15	0.69	147%	27.6	-5.9	64 (3)	4 (8)
St. Joseph, MO	2.07	1.14	223%	25.2	-6.8	62 (3)	1 (16)
Topeka (TOP)	1.03	0.51	198%	28.8	-5.7	68 (3)	6 (8)

1. Airport Automated Observation Stations (NWS/FAA)
2. Departure from 1981-2010 normal value
T - Trace; M - Missing; --- no normal value from which to calculate departure or percent of normal
Source: National Weather Service F-6 Climate Summaries

KANSAS CLIMATE and DROUGHT UPDATE
March 2019 Summary

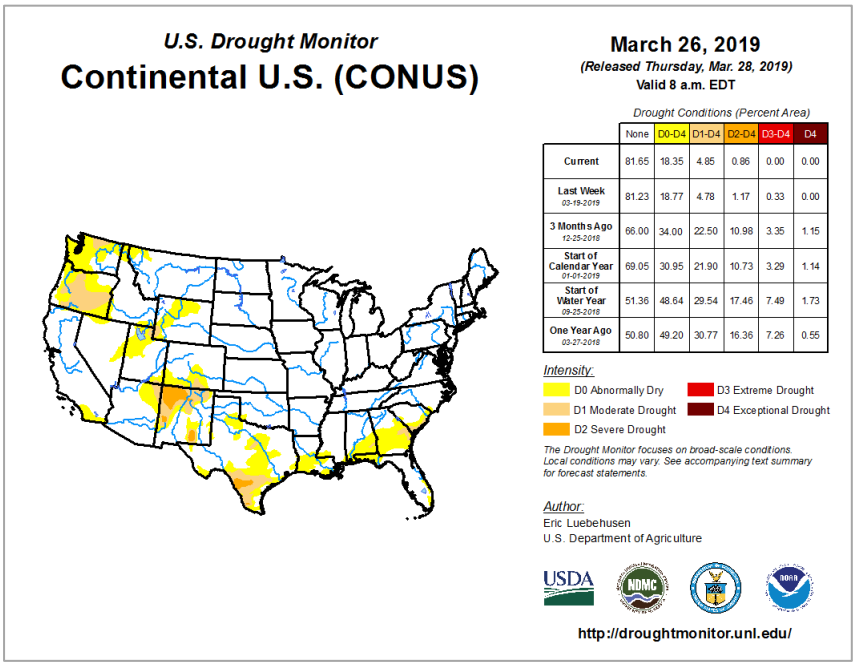
Highlights

- Kansas continued drought free in March.
- An El Niño Advisory is in effect, with El Niño conditions present. Weak El Nino conditions are expected to continue in the Northern Hemisphere through spring 2019 (a 55% chance).
- The April precipitation outlook favors above normal precipitation across the state.
- The April temperature outlook favors warmer than normal temperature across the state**.**
- Flooding occurred at 14 USGS stream gages on 13 rivers or streams in March for as many as 20 days. The worst flooding was on the Missouri River.
- Flooding is predicted by National Weather Service for parts of Kansas through May 2019.

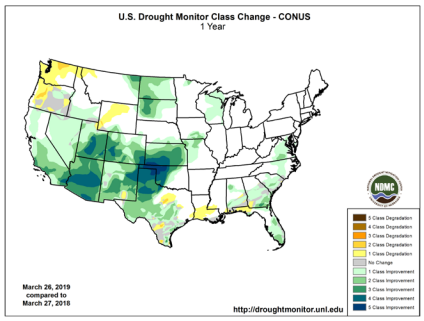


General Conditions

Kansas became drought free by the U.S. Drought Monitor in January 2019 and remained drought free through March. Changes in drought classification since one year ago for the United States, including Kansas are also shown for reference.



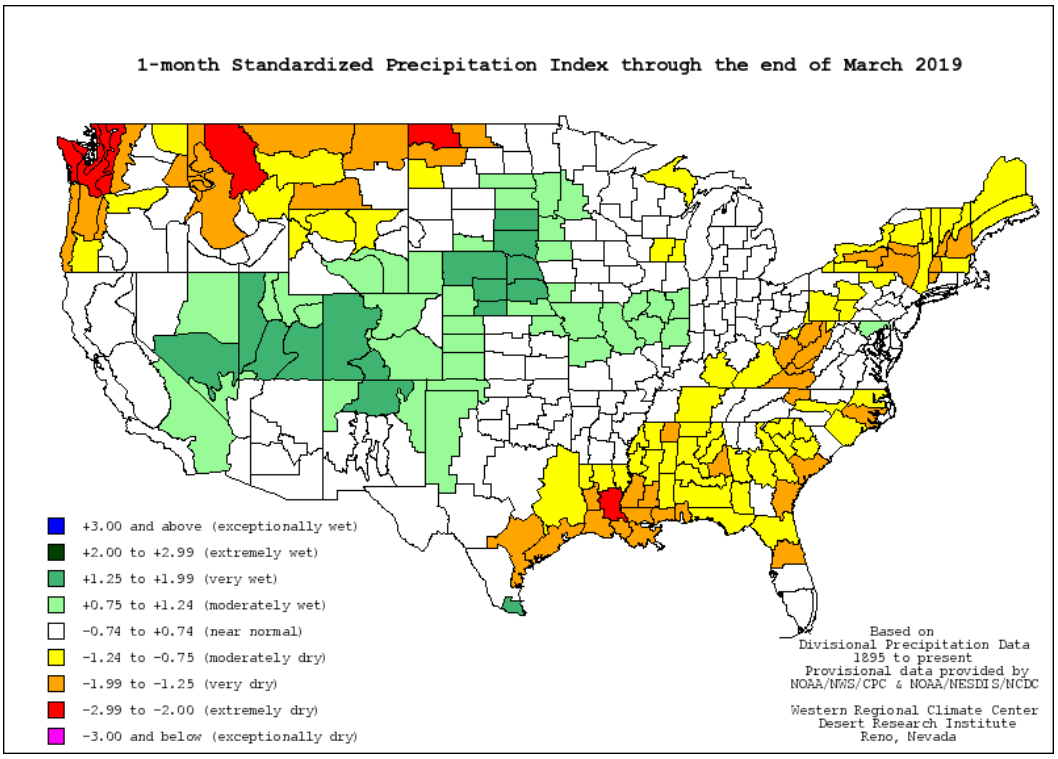
	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	81.65	18.35	4.85	0.86	0.00	0.00
Last Week 03-19-2019	81.23	18.77	4.78	1.17	0.33	0.00
3 Months Ago 12-25-2018	66.00	34.00	22.50	10.98	3.35	1.15
Start of Calendar Year 01-01-2019	69.05	30.95	21.90	10.73	3.29	1.14
Start of Water Year 09-25-2018	51.36	48.64	29.54	17.46	7.49	1.73
One Year Ago 03-27-2018	50.80	49.20	30.77	16.36	7.26	0.55



More information can be found on the U.S. Drought Monitor web site https://droughtmonitor.unl.edu/ .

Palmer Drought Severity Index (PDSI) - The Palmer Drought Severity Index is an indicator of relative dryness or wetness and is one factor used the U.S. Drought Monitor. More information on the PDSI can be found at http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml. Under current wet conditions is may not be useful however a new product, Standardized Precipitation Index (SPI) may provide an analysis that will aid some industries.

The SPI is a relatively new drought index, based only on precipitation (accumulated, accumulated departure, and percentile). The SPI can be calculated for a variety of time scales. This flexibility allows the SPI to be useful in both short-term agricultural and long-term hydrological applications. The product displayed here is based on data from the National Climatic Data Center and on analysis by the Western Regional Climate Center. Additional information can be found at https://wrcc.dri.edu/cgi-bin/spiFmap.pl?spi01



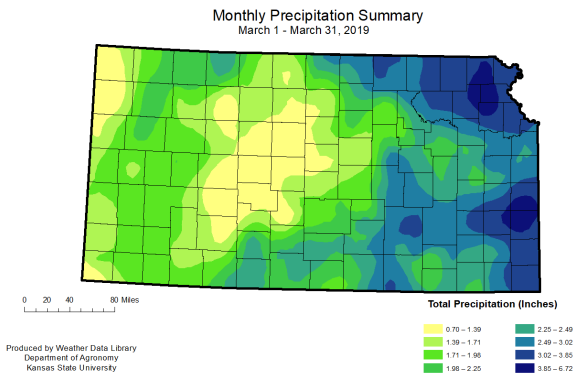
Climate Summary - Precipitation

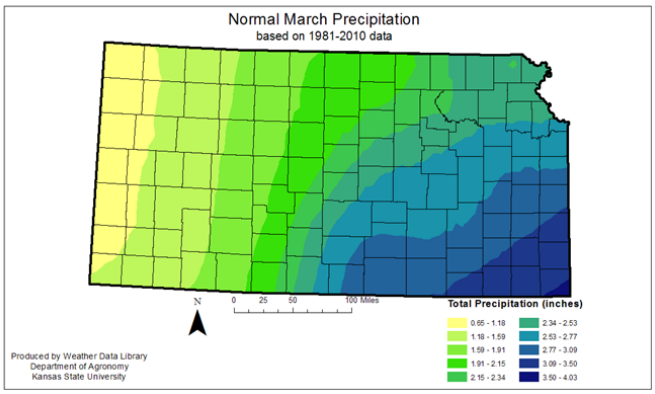
March 2019 ranked as the 30th wettest on record for Kansas according to the National Centers for Environmental Information. February-March 2019 period was the 33rd wettest, January through March the 26th wettest. March county precipitation ranged from 1.36 inches in Cheyenne County to 3.91 inches in Jackson County. This was above the normal of 1.1 and 2.5 inches, respectively. State-wide average precipitation for the month was 2.17 inches. (NOAA National Centers for Environmental information, Climate at a Glance: Statewide Time Series, published April 2019, retrieved on April 11, 2019 from https://www.ncdc.noaa.gov/cag/). Please note Kansas data varies slightly as the data set used is different.

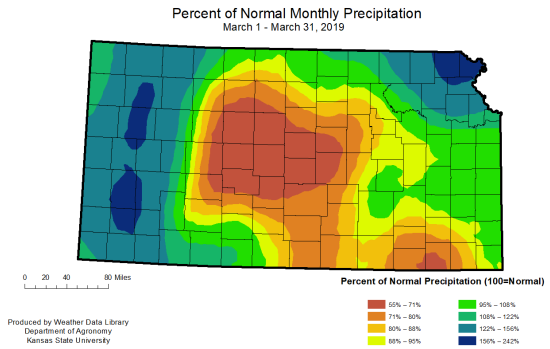
Kansas Climate Division Precipitation Summary (inches)											
Climate Division	March 1-31 2019			January 1- Mar 31, 2019			April 1, 2018- Mar 31, 2019			Sept 1, 2018- Mar 31, 2019	
	Actual	Depart Normal*		Actual	Depart Normal*		Actual	Depart Normal*		Actual	Depart Normal*
Northwest	1.76	0.58		2.62	0.5		25.59	5.43		9.77	3.53
West Central	1.86	0.75		3.27	1.23		25.47	6.29		11.18	5.18
Southwest	1.93	0.85		3.49	1.4		28.98	9.83		11.75	5.35
North Central	1.90	0.36		3.66	0.75		35.63	9.46		17.34	8.09
Central	1.63	-0.02		3.64	0.50		35.31	8.30		17.62	7.66
South Central	2.04	0.30		3.95	0.59		37.09	10.22		18.04	7.58
Northeast	3.23	1.18		5.88	1.94		37.21	3.40		20.70	7.34
East Central	2.68	0.36		5.90	1.39		38.03	2.09		20.89	5.99
Southeast	2.76	0.21		5.91	0.76		41.79	4.57		20.58	4.27
STATE	2.17	0.48		4.35	0.98		34.04	6.93		16.39	6.10

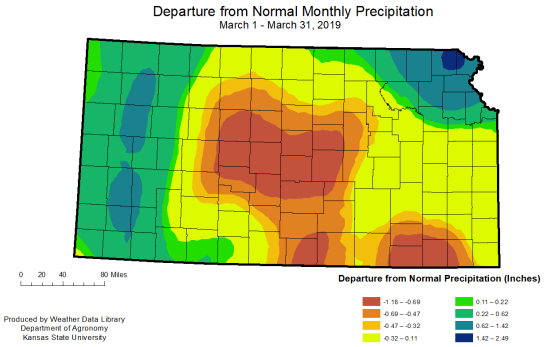
*Departure from normal is departure from the base period of 1901-2000, NOAA data.

The maps below summarizing precipitation for the month are from K-State Weather Data Library. (Maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. Weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)







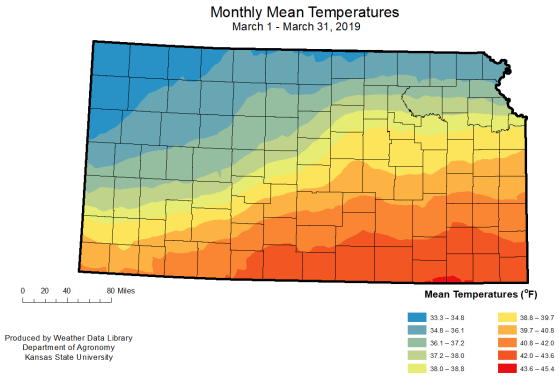


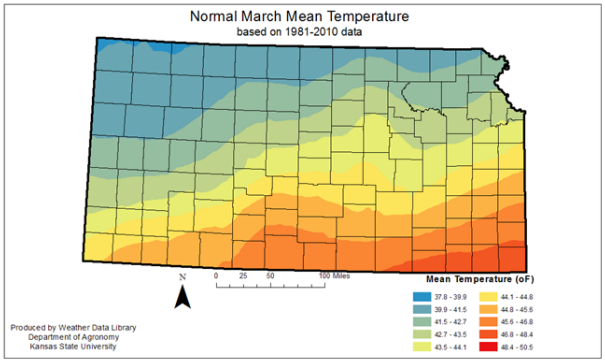
Climate Summary-Temperature

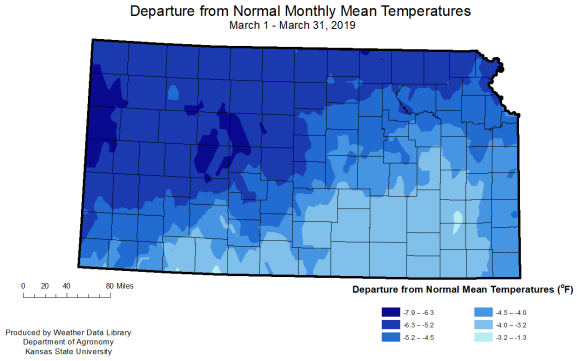
March 2019 ranked as the 35th coolest March on record according to the National Center for Environmental Information data. (NOAA National Centers for Environmental information, Climate at a Glance: Statewide Time Series, published April 2019, retrieved on April 11, 2019 from https://www.ncdc.noaa.gov/cag/)

Climate Division	Kansas Climate Division Temperature Summary (ºF)			
	March 2019			
	Maximum	Minimum	Average	Departure
Northwest	48.8	25.1	37.0	-2.1
West Central	50.5	26.4	38.4	-21.
Southwest	53.6	28.7	41.2	-1.6
North Central	48.6	27.5	38.1	-2.5
Central	51.0	28.7	39.9	-2.4
South Central	53.9	30.7	42.3	-2.0
Northeast	47.8	29.0	38.4	-2.8
East Central	50.6	31.7	41.1	-2.1
Southeast	54.2	33.8	44.0	-1.6
STATE	51.4	29.3	40.3	-2.1

The maps below summarize information generated by Kansas State University Department of Agronomy, Weather Data Library. (Maps based data from the Cooperative Observer and Kansas Mesonet, provided by KSU Weather Data Library. Weekly maps of information can be accessed at http://climate.k-state.edu/maps/weekly/.)

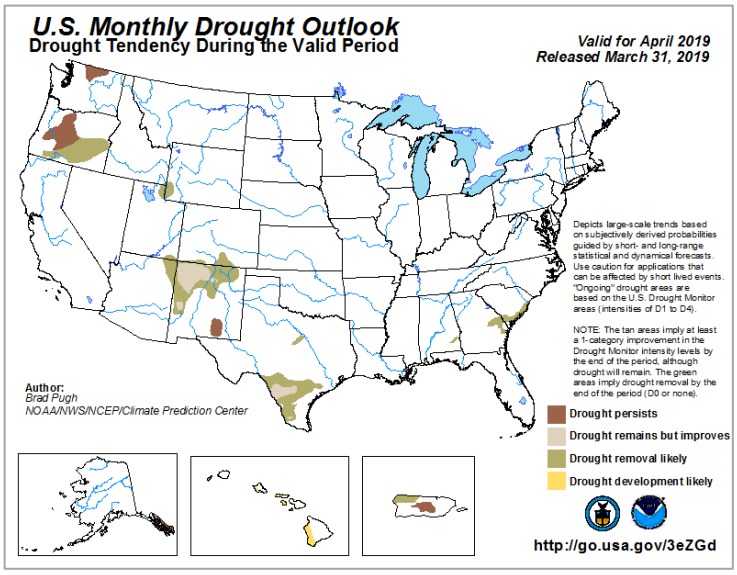


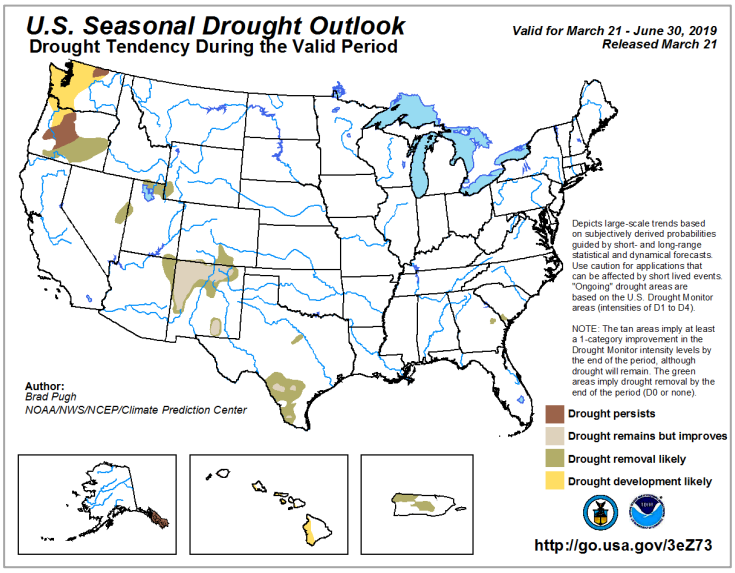




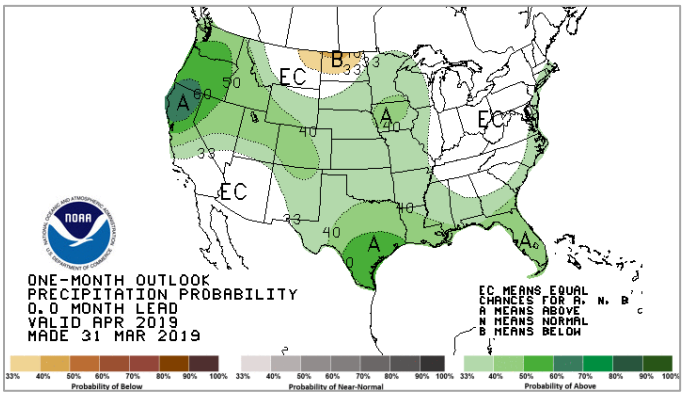
Future Outlook

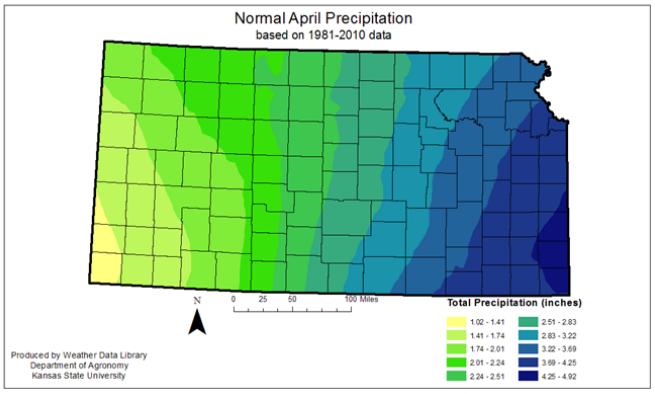
The Monthly Drought Outlook for April 2019 indicates no drought conditions in Kansas. The Seasonal Outlook (3-month) also favors no drought in Kansas. The individual temperature and precipitation outlooks that contribute to these outlooks are available below.

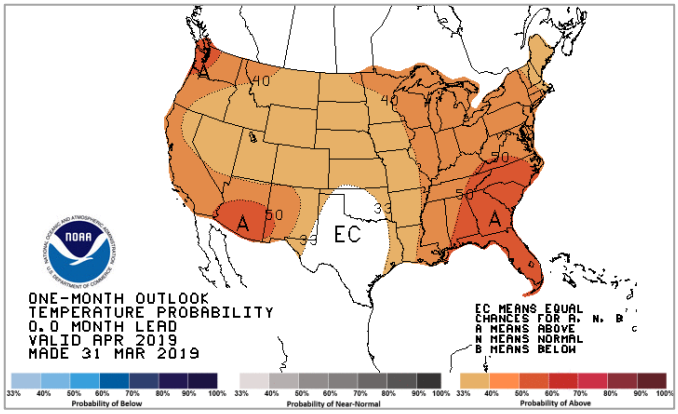


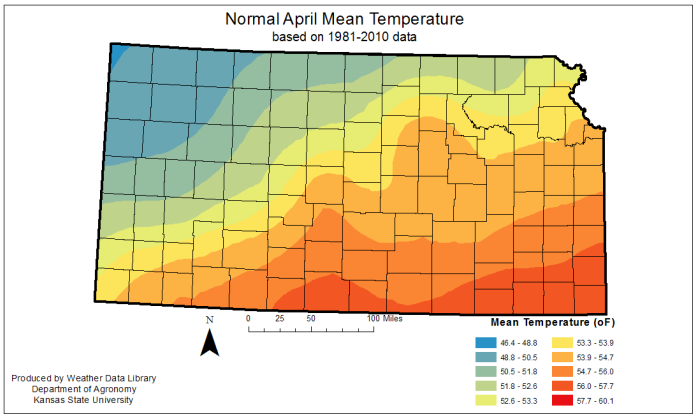


The outlook for April favors warmer than normal temperatures and above normal precipitation across the state.

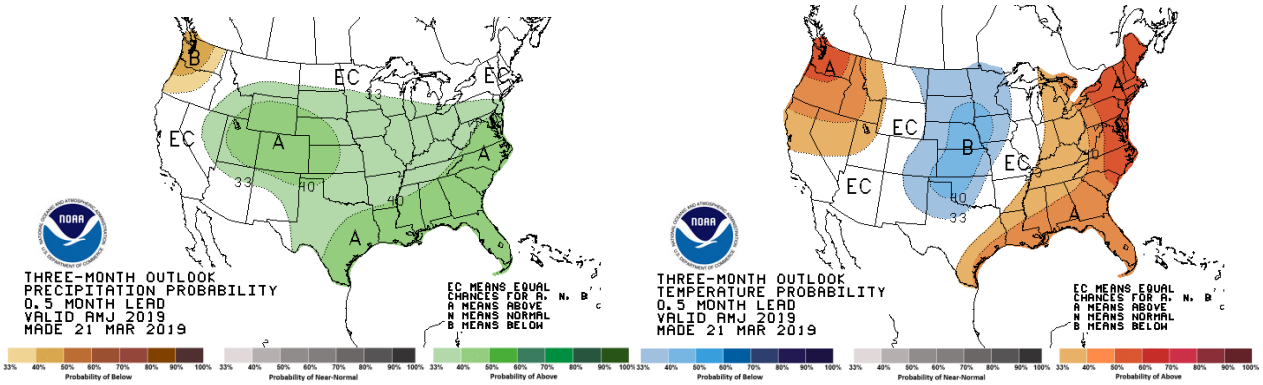








The U.S. three month outlook for April through June favors above-average precipitation for all of Kansas below, above or normal temperatures favored.



El Nino conditions are present and expected to continue in the northern hemisphere through spring and summer 2019 according to NOAA's Climate Prediction Center. El Nino favors wetter than normal conditions in the Central Plains.

Additional outlooks for various timeframes are available from the national CPC for up to 13 months. (http://www.cpc.ncep.noaa.gov/products/predictions/90day/)

Water

Surface Water Supply Conditions

Kansas River basin: Milford, Tuttle Creek, Perry, and Clinton reservoirs all experienced higher than normal inflows in March. Due to flooding conditions on the Missouri River, all basin reservoirs are retaining substantial flood storage.

Marais des Cygnes basin: Melvern, Pomona, and Hillsdale reservoirs all experienced higher than normal inflows in March. Empty conservation storage from winter drawn downs was refilled and elevations are within the flood pool. Flows in the Marais des Cygnes River exceeded historic median values throughout the month.

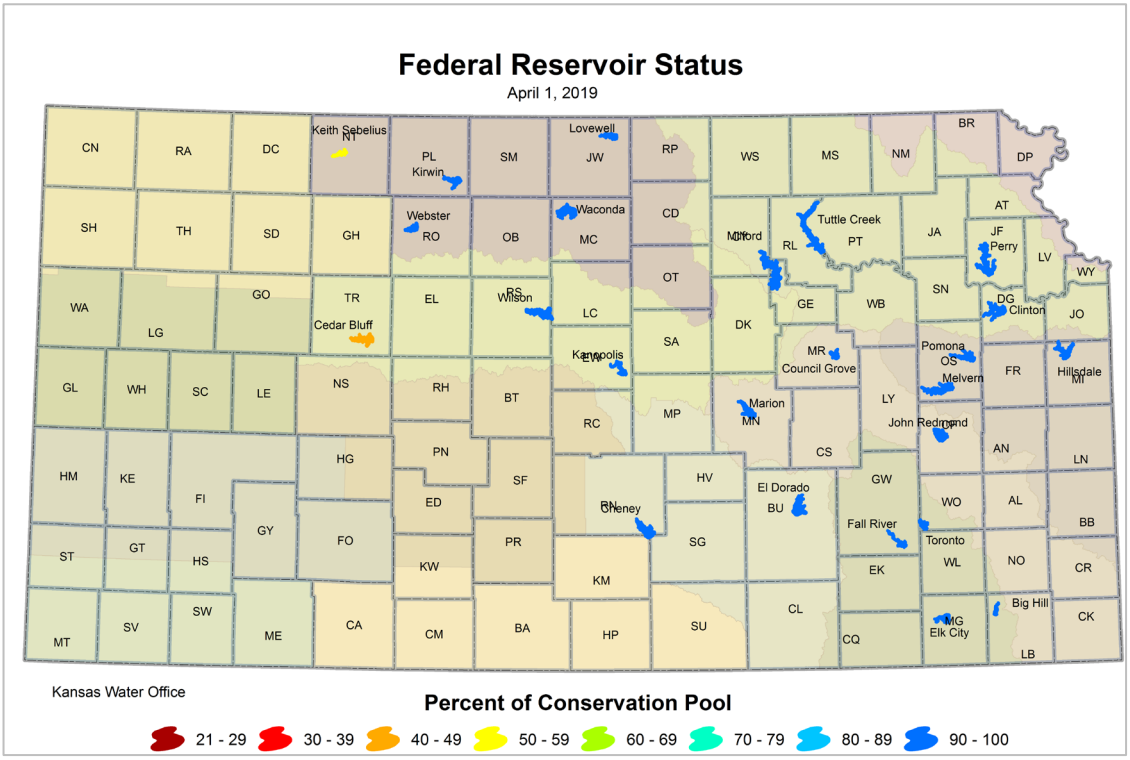
Cottonwood/Neosho basin: All system reservoirs experienced higher than normal inflows. Flood pool releases were necessary from all three reservoirs. Both the Cottonwood River and all reaches of the Neosho River experienced unseasonably high flows throughout the month.

Verdigris basin: Inflows to Toronto, Fall River, Elk City, and Big Hill reservoirs were well above normal in March. Stream flows in the Verdigris and Fall Rivers were maintained above normal due to flood pool releases and generally healthy tributary gains.

Saline basin: The elevation at Wilson Lake was maintained near or above normal pool. Inflow remained above normal and releases in excess of low flow settings were necessary to manage lake level.

Smoky Hill basin: The middle Smoky Hill River maintained higher than normal flows from baseflow and tributary gains in March. Kanopolis Lake made significant releases through the main service gates. The U.S. Army Corps of Engineers intermittently drew the pool down below the top of conservation to facilitate maintenance work. Cedar Bluff Reservoir also received some inflow and gained elevation over the month due to steady higher than normal inflow.

Reservoir Storage



Kansas Federal Reservoir Conservation Pool Levels

Reservoir	Top of Multipurpose / Conservation Pool (Feet MSL)	Multipurpose/Conservation Pool Elevation (Feet MSL)	Change from Top of Pool (Feet)	Percent of Conservation Pool Full
Kansas River Basin		**4/01/2019 7:30 AM**		
Keith Sebelius Lake[1]	2304.3	2296.52	-7.78	58.4
Harlan County Lake NE	1945.73	1947.21	1.48	100.0
Lovewell Reservoir[1]	1582.6	1583.16	0.56	100.0
Webster Reservoir[1]	1892.45	1893.24	0.79	100.0
Kirwin Reservoir	1729.25	1730.72	1.47	100.0
Waconda Lake[1]	1455.6	1457.11	1.51	100.0
Cedar Bluff Reservoir	2144	2125.16	-18.84	43.4
Kanopolis Lake[1]	1463	1461.52	-1.48	91.0
Wilson Lake[1]	1516	1516.03	0.03	100.0
Milford Lake[1]	1144.4	1152.67	8.27	100.0
Tuttle Creek Lake[1]	1075	1112.64	37.64	100.0
Perry Lake[1]	891.5	902.87	11.37	100.0
Clinton Lake[1]	875.5	877.00	1.50	100.0
Melvern Lake[1]	1036	1037.61	1.61	100.0
Pomona Lake[1]	974	977.87	3.87	100.0
Hillsdale Lake[1]	917	917.32	0.32	100.0
Arkansas River Basin		**4/01/2019 7:00 AM**		
Marion Reservoir[1]	1350.5	1350.92	0.42	100.0
Council Grove Lake[1]	1274	1273.22	-0.78	95.0
John Redmond Reservoir	1041	1041.99	0.99	100.0
Toronto Lake	901.5	902.35	0.85	100.0
Fall River Lake	948.5	948.85	0.35	100.0
Elk City Lake	796	796.54	0.54	100.0
Big Hill Lake	858	858.25	0.25	100.0
Cheney Reservoir	1421.6	1421.94	0.34	100.0
El Dorado Lake	1339	1339.26	0.26	100.0

[1]Lake level management plan in place Source: U.S. Army Corps of Engineers, U.S. Bureau of Reclamation and U.S. Geological Survey

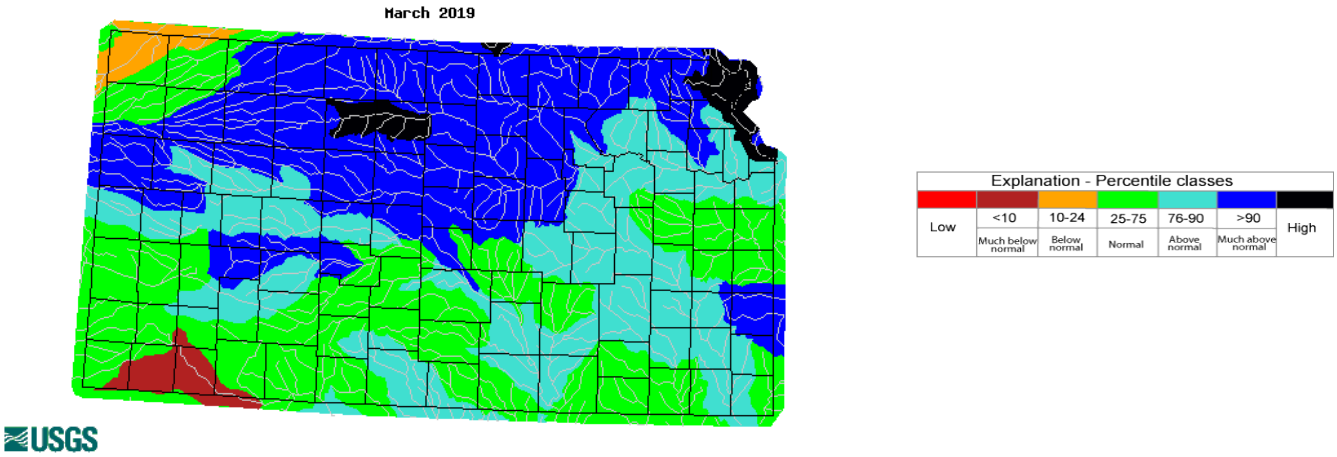
Note: The conservation pool is the water storage for non-flood purposes of the reservoir, set by the elevation of the top of the pool.

Harmful Blue-Green Algal Blooms (lake water safety)
KDHE issues two levels of public health protection notifications for blue-green algae (BGA) Blooms: a Public Health Watch and Public Health Warning. Public Health Watch–Notifies public that a hazardous condition may exist, that the water may be unsafe for humans and animals and contact with the water is discouraged. Public Health Warning–Notifies public that conditions are unsafe, that contact with the water should not occur, and all conditions of Public Health Watch remain in effect. More information can be found at http://www.kdheks.gov/algae-illness/index.htm.

The 2018 HAB monitoring ended October 31st. At that time two water bodies remained in active bloom: Frazier Lake, in Grant County was at a Warning status; and South Lake, in Johnson County was at a Watch status. The next harmful algal bloom season will begin again on April 1, 2019.

Streamflow Conditions
WaterWatch summarizes streamflow conditions in a region (state or hydrologic unit) in terms of the long-term typical condition at stream gages in the region. In general, a streamflow which is greater than the 75 percentile is considered *above normal*, a streamflow which is between 25 and 75 percentiles is considered *normal* and a streamflow which is less than the 25 percentile is considered *below normal*. Color codes are for basins with streamflow averages less than 25 percent of historic values. This comparison aids in evaluating water resources conditions for a time period.

Streamflow compared to historical streamflow is reflected in the map below.



Water Right Administration/Minimum Desirable Streamflow (MDS)

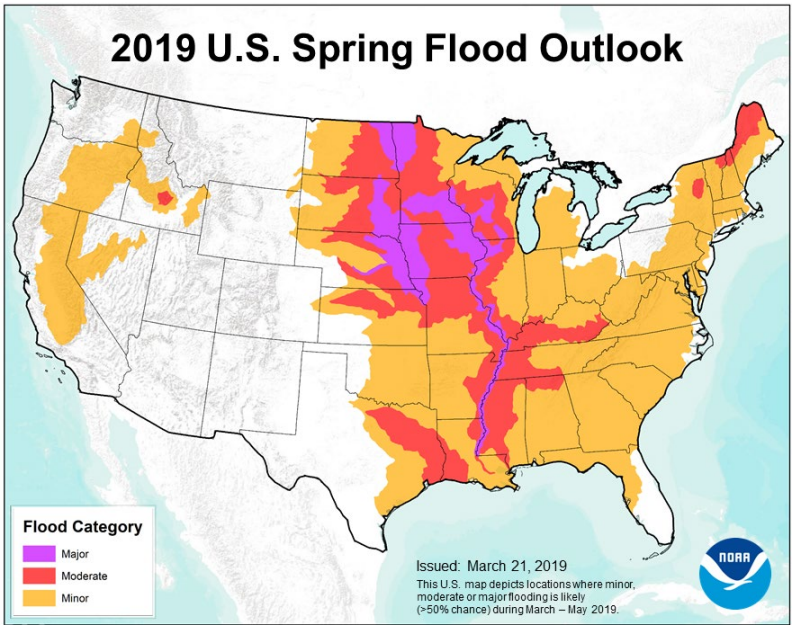
Minimum Desirable Streamflow (MDS) is not being administered in Kansas. MDS administration requires water rights junior to MDS, usually with priority dates after April 12, 1984, to stop diverting water. Administration is ordered when streamflow drops below MDS for more than seven days. To rescind orders at most gages, daily average flow must be above MDS for 14 days.

The table below provides a snapshot of conditions for streams of interest to the Kansas Department of Agriculture, Division of Water Resources.

Streamflows as of March 25, 2019			
Gaging Station	**Current Flow**	**Mar MDS**	**Comment**
Rattlesnake Creek near Macksville	8	10	No surface water diversions junior to MDS above gage
South Fork Ninnescah River near Pratt	13	10	No surface water diversions junior to MDS above gage

Flooding

March 21, 2019 the National Spring Flood Risk issued by NOAA (below) indicates potential flooding in parts of Kansas. Spring flood risk is higher than normal for the lower Missouri River Basin. This is driven by above normal snowpack across the Plains, saturated soil conditions, and the presence of deeply frozen soils. (https://www.nws.noaa.gov/oh/2019NHA.html)



Due to above normal winter precipitation in much of the United States, including snow, significant flooding occurred in March. As a result, Disaster Declarations were issued for Doniphan, Marshall, Jefferson Osage, Atchison Leavenworth Wyandotte counties during the period of March 12-25.

Flooding information can be found for USGS stream gage sites at https://waterwatch.usgs.gov/?m=flood&r=ks&w=flood%2Ctable for current stage. Severity and duration by location can also be obtained through USGS WaterWatch Flood information. The Table below provides an overview of flooding March 1 - March 31, 2019 at USGS stream gages in the WaterWatch system.

Summary of March Flooding and High Flows

["--", no data; "<", less than all historical peaks]

USGS station number	USGS station name	Drain. area [mi²]	NWS flood stage (ft)	No. Days above flood stage	NWS flood class	Highest peak from 2019-03-01 to 2019-03-31: Date	Stage [ft]	Stream flow (date) [ft³/s]	Rank	Historical Peaks: No. of years	Max. (year) [ft³/s]
6818300	MISSOURI R AT ATCHISON, KS	426865	22	19	Major	3/22/2019	31.2	--	--	--	--
6820475	MISSOURI R AT LEAVENWORTH, KS	427200	20	18	Major	3/23/2019	31.3	--	--	--	--
6856600	REPUBLICAN R AT CLAY CENTER, KS	24542	15	5	Minor	3/14/2019	18.38	10500	61	102	195000 (1935)
6872500	NF SOLOMON R AT PORTIS, KS	2315	15	2	Minor	3/14/2019	17.13	3560	35	72	35700 (1951)
6884200	MILL C AT WASHINGTON, KS	344	18	2	Moderate	3/14/2019	21.82	7260	15	59	14600 (1993)
6884400	L BLUE R NR BARNES, KS	3351	21	2	Minor	3/15/2019	21.11	22400	11	60	56000 (2015)
6884700	BIG BLUE R AT BLUE RAPIDS, KS	8342	26	20	Minor	3/31/2019	38.36	--	--	--	--
6885500	BLACK VERMILLION R NR FRANKFORT, KS	410	19	4	Minor	3/13/2019	21.58	5840	42	66	38300 (1959)
6891850	STRANGER C AT EASTON, KS	216	17	5	Moderate	3/30/2019	18.83	4280	3	3	10213 (2016)
6892950	KANSAS R AT KANSAS CITY, KS	60098	33	6	Minor	3/24/2019	36.38	--	--	--	--
6917000	L OSAGE R AT FULTON, KS	314	22	3	Minor	3/30/2019	25.42	8410	34	69	62800 (1986)
7143310	COW C NR HUTCHINSON, KS	859.5	9.5	7	Moderate	3/13/2019	10.85	--	--	--	--
7183500	NEOSHO R NR PARSONS, KS	4905	21	2	Minor	3/14/2019	22.38	23100	67	96	410000 (1951)
7186055	COW C NR SCAMMON, KS	222	13	1	Minor	3/13/2019	13.99	2860	4	4	12649 (2017)

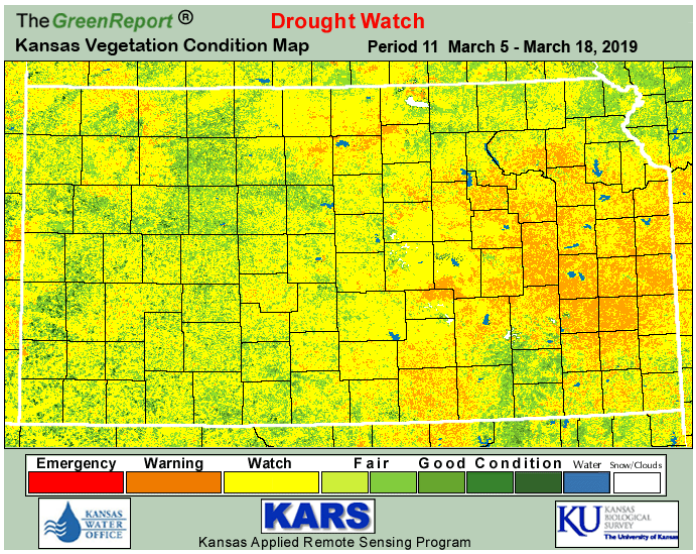
Major Flooding	extensive inundation of structures and roads
Moderate Flooding	some inundation of structures and roads
Minor Flooding	mininal or no property damage

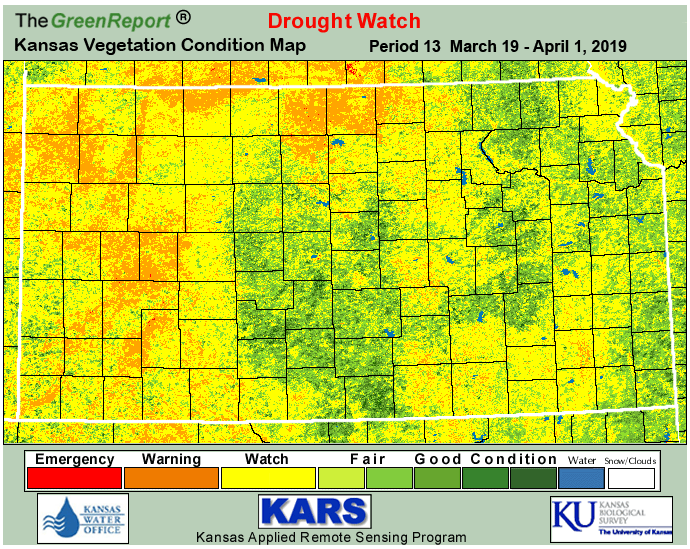
Source: USGS WaterWatch

Vegetation and Soil Moisture

Vegetative Conditions

The Vegetative Condition map provides current conditions related to drought effects on vegetation. It is produced using satellite data. Areas in yellow, orange and red indicate areas of vegetative stress. The green areas are considered to be in good or excellent condition. Change can be seen comparing the two GreenReports below from early and late March.



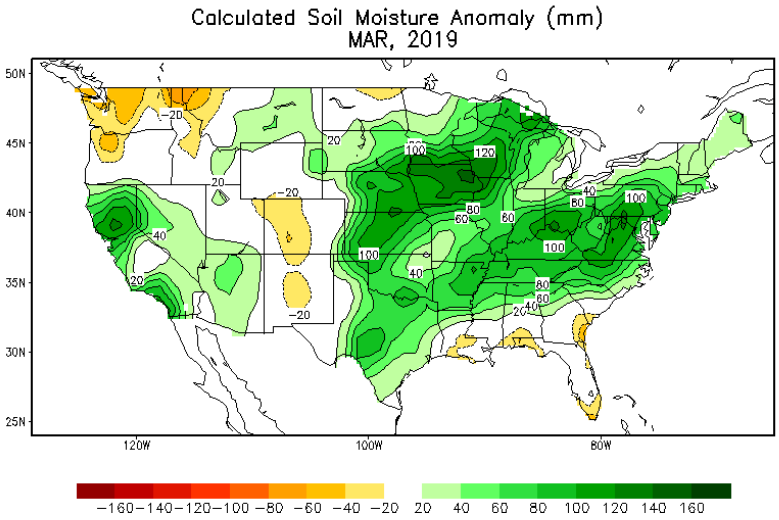


Soil Moisture and Rangeland

The National Agricultural Statistics Service, USDA Crop Progress and Condition provides a summary of the climatic effects on soil, and livestock feed. For the week ending March 31, 2019, topsoil moisture supplies rated 0 percent very short, 1 short, 63 adequate, and 36 surplus. Subsoil moisture supplies rated 1 percent very short, 1 short, 72 adequate, and 26 surplus.

Field Crops Report: Winter wheat condition rated 2 percent very poor, 7 poor, 36 fair, 46 good, and 9 excellent. Winter wheat jointed was 2 percent.

The Climate Prediction Center (CPC), also monitors soil moisture and predicts future soil moisture. Anomalies are defined as deviations from the 1971-2000 monthly climatology. The soil anomaly is provided below. (.http://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

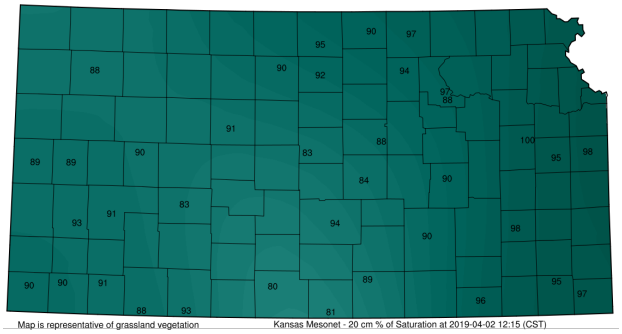


Kansas soil moisture monitoring occurs through Kansas State University Mesonet at four depths, 5 cm, 10 cm, 20 cm and 50 cm measuring percentage of saturation and volumetric water content at about 36 stations. Installation of sensors began in mid-2017 and were completed early 2018. Maps and data are found at http://mesonet.k-state.edu/agriculture/soilmoist/.

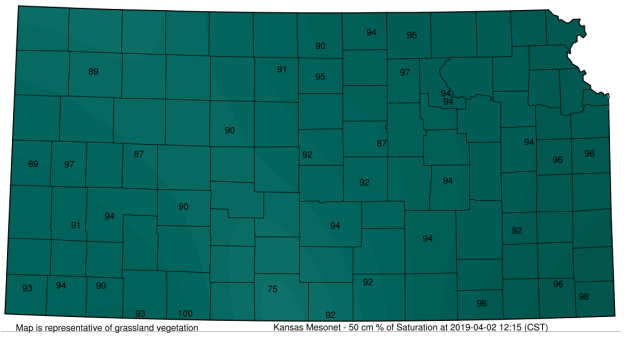
Figures below shows the 8-inch (20 cm) and 20-inch (50cm) soil moisture saturation.

Percent of Soil Saturation
April 2, 2019

8-inch

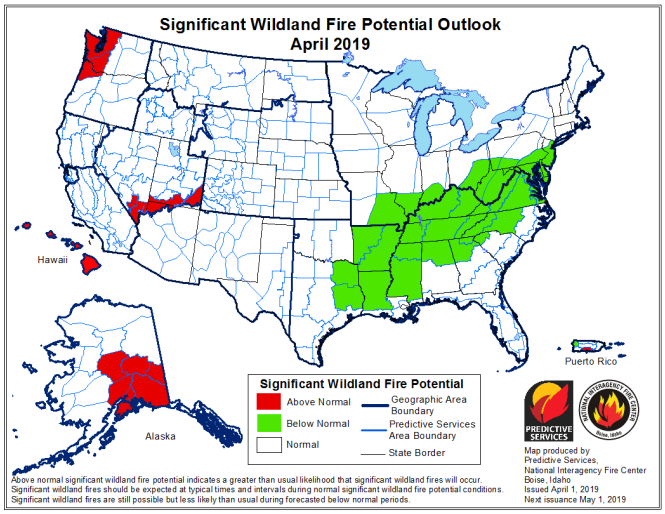


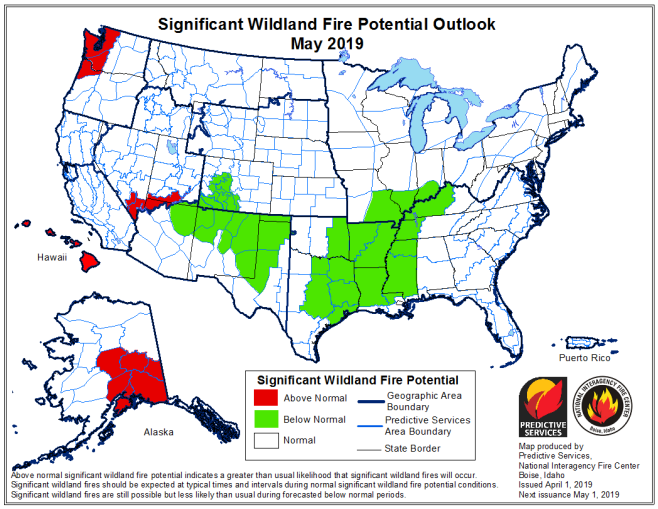
20-inch



Fire

Significant Wildland Fire Potential Outlook is issued monthly for the United States, https://www.predictiveservices.nifc.gov/outlooks/monthly_seasonal_outlook.pdf .





Kansas Forest Service provides a grassland fire danger index at**:** http://www.kansasforests.org/fire_management/grasslandfireindex.html .

Kansas Climate Summary

The Kansas Weekly Climate Summary and Drought Report are compiled at least monthly, more frequently when conditions warrant, by the KWO. Information from various federal, state, local and academic sources is used. Some of the data is preliminary and subject to change once final data is available. The KWO web site, http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response , contains additional drought information including links to other agencies with drought information and past issues of the Kansas Climate Summary and Drought Report. Kansas State Climatologist, Mary Knapp, is the primary source of the narrative on weather. She works closely with meteorologists throughout the state and region. Details of current conditions at Evapotranspiration (ET) and Mesonet sites across Kansas are available at http://mesonet.k-state.edu/

RESOURCES and REFERENCES

Kansas climate data is provided by Kansas State University, Weather Data Library through the Kansas Mesonet. (http://www.ksre.k-state.edu/wdl/). Soil moisture data was added in 2018 (http://mesonet.k-state.edu/agriculture/soilmoist)

The U.S. Drought Monitor, from the National Drought Mitigation Center at the University of Nebraska-Lincoln, provides a "big picture" perspective of conditions across the nation. In the Kansas county drought stage scheme, a Drought Watch equates roughly to moderate drought in the U.S. Drought Monitor, while a Drought Warning is the equivalent of severe drought. A Drought Emergency is reserved for extreme or exceptional drought. Palmer Drought Severity Index - The Palmer Index (PDSI) is one indicator used in the U.S. Drought Monitor.

The High Plains Regional Climate Center (https://hprcc.unl.edu/) has precipitation and temperature summary maps available at the state, region and nation.

The U.S. Geological Survey (USGS) Drought Watch provides information average streamflow measured at long-term gaging stations and compares them to normal flows.

The Kansas Department of Agriculture-Division of Water Resources monitors stream flow using the USGS gages for determination of administrative needs. Administration may be needed due to Minimum Desirable Streamflow (MDS) requirements, impairments and reservoir release protection. (https://agriculture.ks.gov/divisions-programs/dwr/water-appropriation/minimum-desirable-streamflow.)

The water levels of the federal lakes fluctuate during a year according to the management plan. Lake level Management plans are posted on the Kansas Water Office web site www.kwo.ks.gov .

The Kansas Applied Remote Sensing Program (KARS) at the University of Kansas produces a Kansas Green Report each week during the growing season. For a full set of national and regional ***GreenReport***® maps, go to: http://www.kars.ku.edu/products/greenreport/greenreport.shtml. This Kansas Vegetation Drought Response Index map is developed weekly by the Kansas Biological Survey using state drought triggers as its key. In addition the VegDRI maps may be found at http://vegdri.unl.edu/

The National Weather Service (NWS) provides fire weather products and services for Kansas that include the Rangeland Fire Danger Index, Fire Weather Forecasts, Red Flag Watches/Warnings and Spot Forecasts. The five NWS offices that serve Kansas websites may be accessed from the NWS Offices' page.

The Monthly and Seasonal Drought Outlooks, developed by the NOAA Climate Prediction Center, assess the likelihood for improvement, persistence or deterioration in drought conditions for areas currently experiencing drought as identified by the U.S. Drought Monitor. (http://www.cpc.ncep.noaa.gov/) Also see: http://www.noaa.gov/.

Responding to Drought: A Guide for City, County and Water System Officials provides an overview of Kansas county drought stage declarations, local planning and coordination, disaster declarations and available state and federal assistance. The 2007 Municipal Water Conservation Plan Guidelines and the Drought Vulnerability Assessment Report, both by KWO, provide guidance regarding drought preparedness and response. These are available at http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response.

USDA Drought Programs and Assistance website (https://www.usda.gov/topics/disaster/drought/usda-drought-programs-and-assistance) listing the various USDA programs and agencies to assist with drought issues.

The National Interagency Coordination Center in Boise, Idaho, produces wildfire potential outlook maps monthly. (https://www.predictiveservices.nifc.gov/outlooks/outlooks.htm)

Please contact Diane Knowles at the Kansas Water Office (785) 296-3185 or diane.knowles@kwo.ks.gov should you have any questions or suggestions.

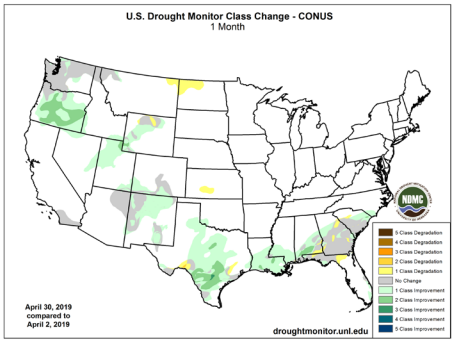
KANSAS CLIMATE and DROUGHT UPDATE
April 2019 Summary

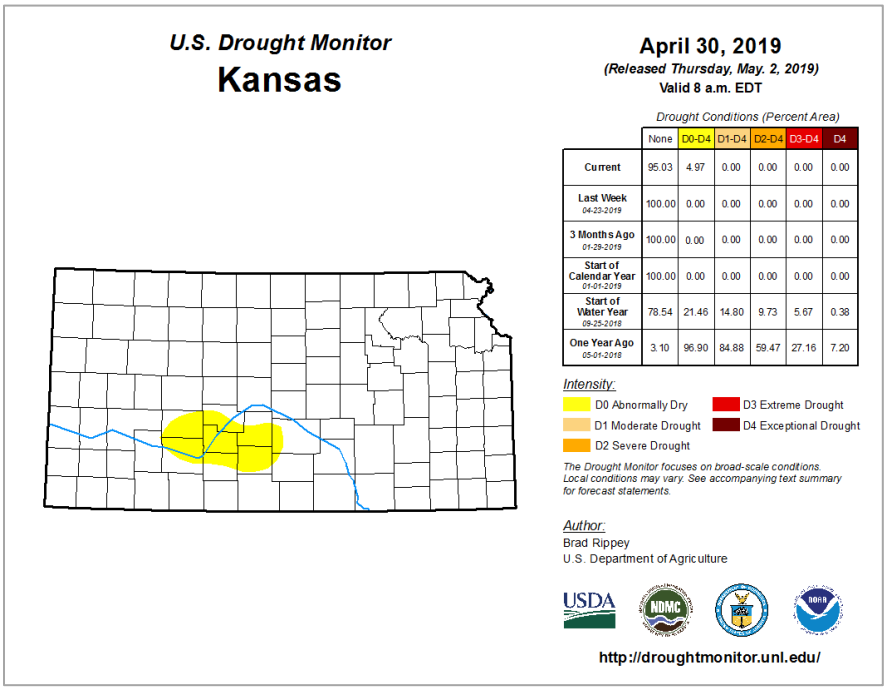
Highlights

- Kansas continued drought free in April, although an abnormally dry area in the south west developed late in the month in nearly five percent of the state.
- The May precipitation outlook favors above normal precipitation across the state.
- The May temperature outlook favors warmer than normal temperature across the state**.**
- Flooding occurred at 20 USGS stream gages on 12 rivers or streams in April for as many as 31 days.
- Flooding is predicted by National Weather Service for parts of Kansas through May 2019.
- An El Niño Advisory is in effect, with weak El Niño conditions present. Weak El Nino conditions are expected to continue in the Northern Hemisphere through summer and possibly into the fall of 2019.

General Conditions

Kansas became drought free by the U.S. Drought Monitor in January 2019 and remained drought free through most of April. Given the wet conditions that were present at the beginning of April, the drier than normal pattern in western Kansas resulted in only a slight change in the drought status. Abnormally dry conditions now cover just under 5 percent of the state in potions of Edwards, Ford, Hodgeman, Kiowa, Pawnee, Pratt and Stafford counties in south western Kansas. Changes in drought classification since one year ago for the United States, including Kansas are also shown for reference.

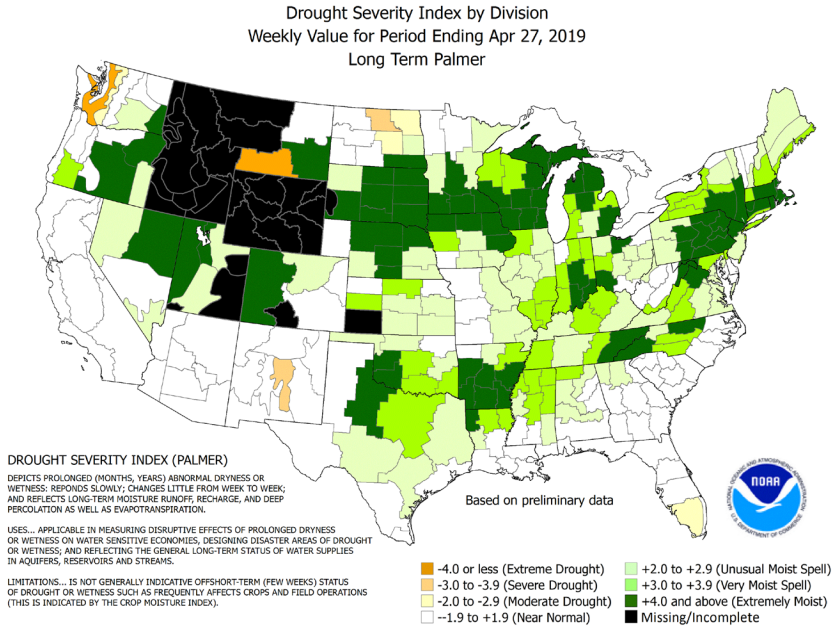




	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	95.03	4.97	0.00	0.00	0.00	0.00
Last Week 04-23-2019	100.00	0.00	0.00	0.00	0.00	0.00
3 Months Ago 01-29-2019	100.00	0.00	0.00	0.00	0.00	0.00
Start of Calendar Year 01-01-2019	100.00	0.00	0.00	0.00	0.00	0.00
Start of Water Year 09-25-2018	78.54	21.46	14.80	9.73	5.67	0.38
One Year Ago 05-01-2018	3.10	96.90	84.88	59.47	27.16	7.20

More information can be found on the U.S. Drought Monitor web site https://droughtmonitor.unl.edu/ .

Palmer Drought Severity Index (PDSI) - The Palmer Drought Severity Index is an indicator of relative dryness or wetness and is one factor used the U.S. Drought Monitor. More information on the PDSI can be found at http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml.



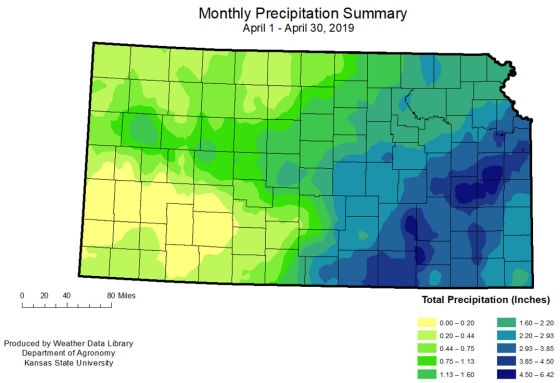
Climate Summary - Precipitation

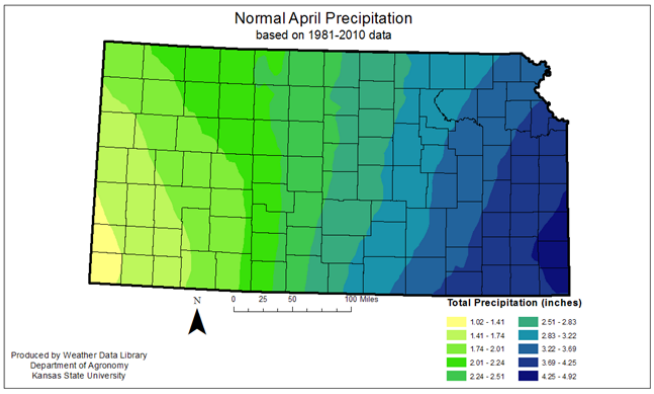
The normal gradient of wet in the east versus dry in the wet was amplified in April. State-wide average precipitation for the month was 2.33 inches, 87 percent of normal. However, all three western divisions reported less than half of normal for the period. The Northwest Division was the driest with an average of 0.38 inches, 18 percent of normal. In contrast, the Southeast Division averaged 5.84 inches, 140 percent of normal. The highest 24-hour rainfall total for a National Weather Service Cooperative station 3.63 inches at Eudora 1S, on the 30th. The greatest 24-hour rainfall total for a Community Collaborative Rain, Hail and Snow network station was 3.91 inches at Burlington 0.9 NNE, Coffey County on the 18th. The greatest monthly precipitation totals for April: 6.42 inches at Johnson County Executive Airport, Johnson County (NWS) and 6.35 inches at Burlington 0.9 NNE, Coffey County (CoCoRaHS). Monthly snowfall was largely confined to the Northwest Division, with the highest amount reported 2.3 inches at Goodland, Sherman County (NWS) and 2.8 inches at Traer 2.5 NNW, Decatur County. (KSU Weather Data Library)

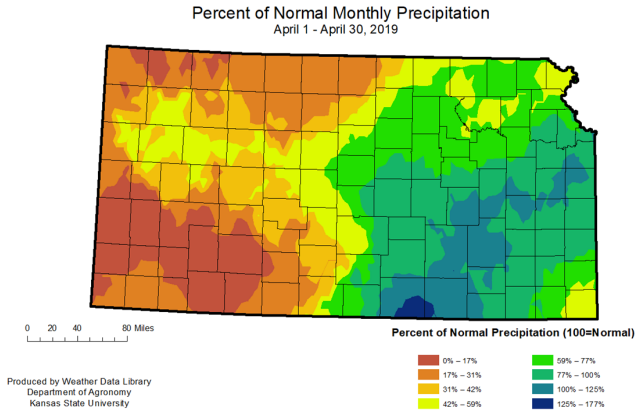
Kansas Climate Division Precipitation Summary (inches)												
Climate Division	April 1-30, 2019			January 1- April 30, 2019			April 1, 2019- April 30, 2019			Sept 1, 2018- Apr 30, 2019		
	Actual	Depart Normal*		Actual	Depart Normal*		Actual	Depart Normal*		Actual	Depart Normal*	
Northwest	0.38	-1.69	18	2.74	-1.63	63	0.38	-1.69	18	9.85	1.00	111
West Central	0.84	-1.07	44	4.13	-0.28	94	0.84	-1.07	44	13.26	4.38	149
Southwest	0.37	-1.27	23	3.66	-0.36	91	0.37	-1.27	23	12.27	3.78	145
North Central	1.30	-1.22	52	4.93	-1.08	82	1.30	-1.22	52	18.63	5.89	146
Central	2.33	-0.33	88	6.10	-0.51	92	2.33	-0.33	88	20.19	6.77	150
South Central	2.95	0.25	109	6.96	-0.36	95	2.95	0.25	109	21.75	6.58	143
Northeast	2.48	-0.77	76	7.89	0.43	106	2.48	-0.77	76	23.07	6.28	137
East Central	4.54	0.98	128	10.13	1.65	119	4.54	0.98	128	23.15	4.36	123
Southeast	5.47	1.60	141	11.54	1.67	117	5.47	1.60	141	26.34	4.38	120
STATE	2.33	-0.34	87	6.48	-0.04	99	2.33	-0.34	87	18.74	4.84	135

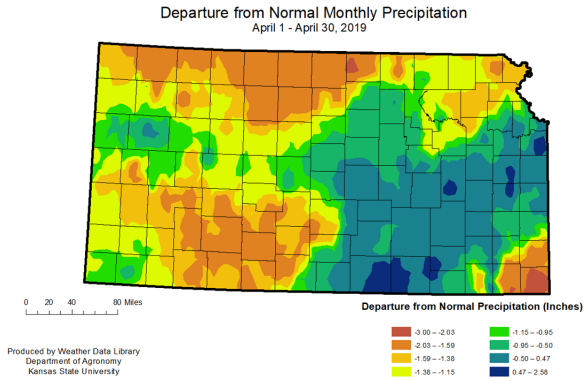
*Departure from normal is departure from the base period of 1981-2010, KSU Weather Data Library.

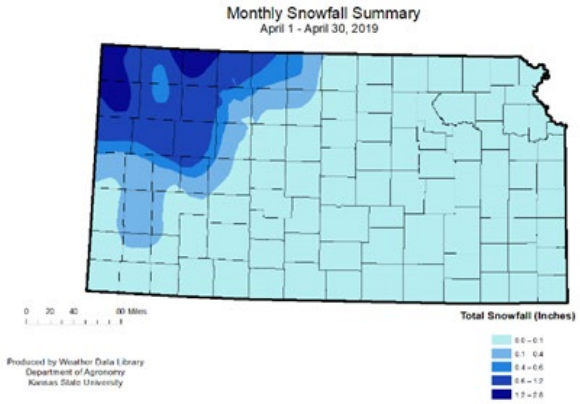
The maps below summarizing normal precipitation for the month are from the K-State Weather Data Library and / or the High Plans Regional Climate Center. (National Weather Service maps use data from the Applied Climate Information Network. State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)











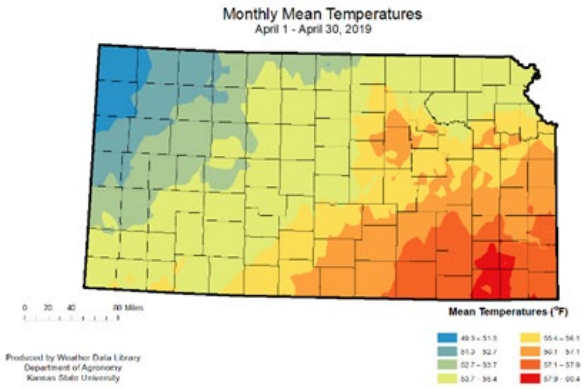
Climate Summary-Temperature

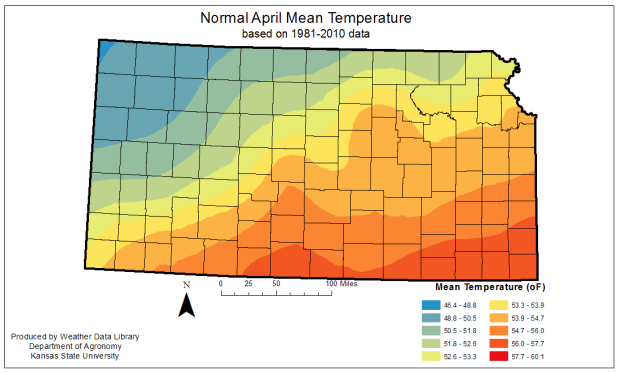
April broke the cooler-than-normal trend that dominated winter. State-wide average temperature for the month was 54.7 ºF, which is 1.4 degrees warmer than normal. This ranks as the 48th warmest on record, a stark contrast from last year which was the coldest April on record. The South Central Division came closest to normal with an average of 56.0 ºF, 0.7 degrees warmer than normal. The West Central Division had the largest departure with an average of 53.2 ºF, 2.3 degrees warmer than normal. The variability showed in the range of temperatures. The warmest maximum temperature was 93 ºF at Hays 1S, Ellis County and Larned No.2, Pawnee County, on the 22nd. The coldest minimum temperature was 17 ºF reported at Atwood, Rawlins County, on the 1st. The coldest reading at a Kansas Mesonet station was 14.8 oF recorded at the Meade County station near Meade on the 1st. A daily record low maximum temperature was set at one station: Wallace, Wallace County with 38 ºF reported on the 12th. Still, record warm temperatures also occurred. There were 19 daily record warm minimums and 17 record warm maximum temperatures in April. (KSU Weather Data Library)

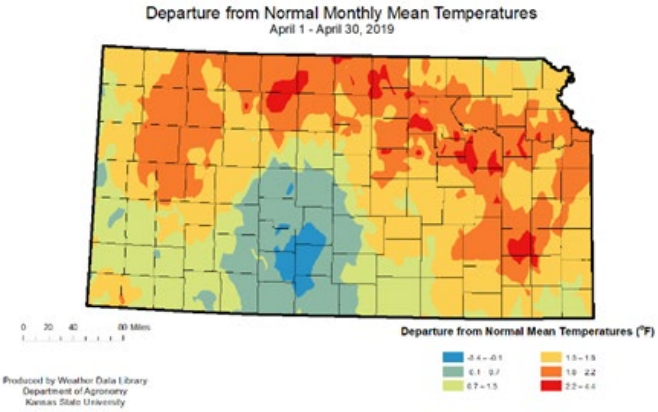
Climate Division	Kansas Climate Division Temperature Summary (ºF)							
	April 2019							
	Maximum	Minimum	Average	Departure	High	Date	Low	Date
Northwest	67.7	35.2	51.4	1.7	92	21	17	1
West Central	69.8	36.7	53.2	2.3	90	21	19	12
Southwest	71.4	38.4	54.9	1.4	92	22	19	12
North Central	69.0	39.8	54.4	1.6	91	22	19	1
Central	69.7	40.6	55.2	1.3	93	22	20	1
South Central	69.7	42.2	56.0	0.7	90	10	23	1
Northeast	67.0	42.4	54.7	1.2	87	11	22	1
East Central	67.6	43.9	55.7	1.6	88	11	23	1
Southeast	69.1	44.9	57.0	1.2	89	10	22	1
STATE	69.0	40.5	54.7	1.4	93	27th	17	4th

The 2019 Kansas tornado season began on April 17th, when two of the 6 tornadoes for the month were reported in South Central KS. The most destructive tornado of the month occurred in Miami County on the 28th, when a church lost part of its roof. There were no reports of deaths or injuries with any of the tornadoes. Hail and damaging winds made the bulk of the severe weather this month. There were 59 reports of large hail and 69 reports of damaging wind.

The maps below summarizing temperature for the month are from the K-State Weather Data Library and / or the High Plans Regional Climate Center. (National Weather Service maps use data from the Applied Climate Information Network. State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)

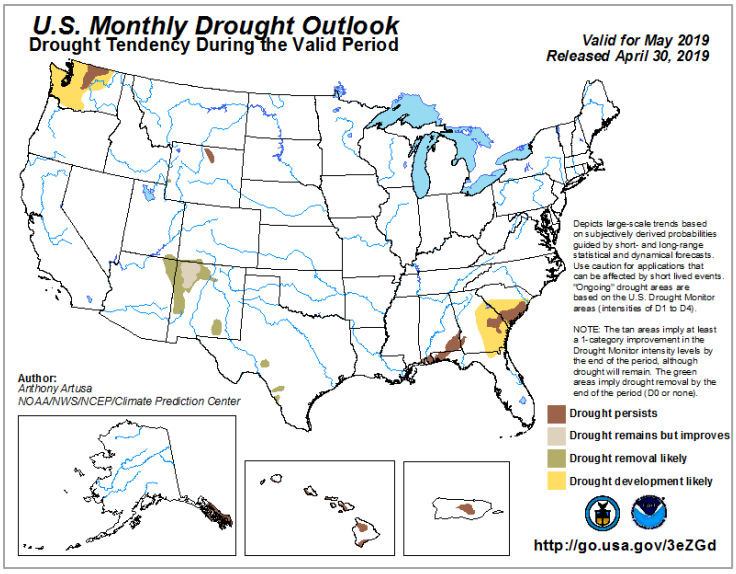


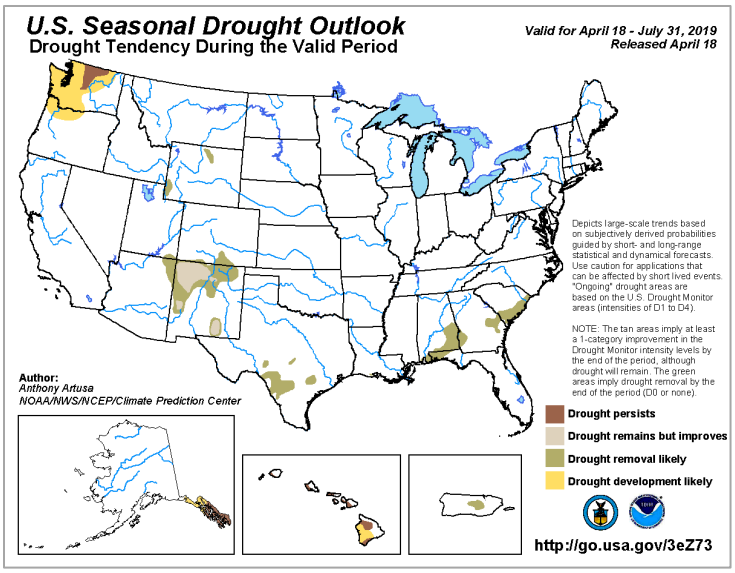




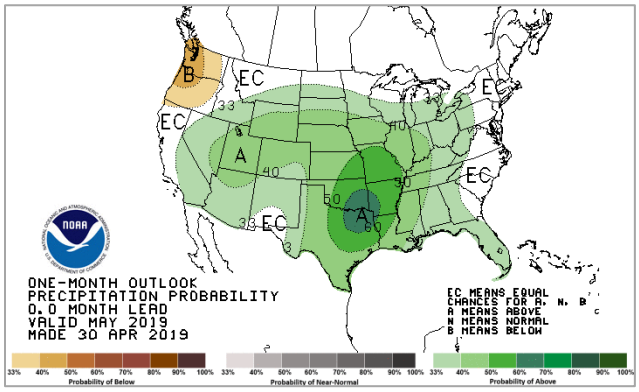
Future Outlook

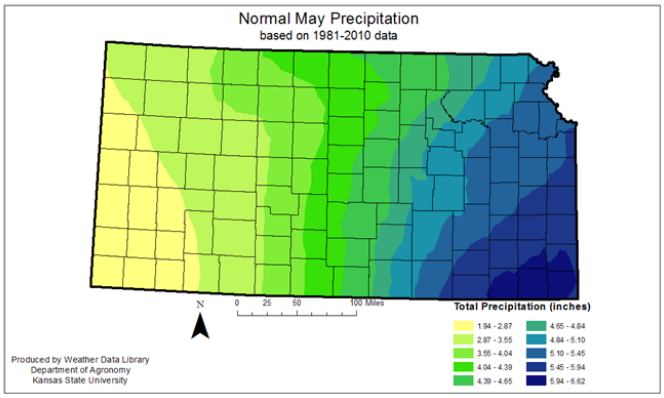
The Monthly Drought Outlook for May 2019 indicates no drought conditions in Kansas. The Seasonal Outlook (3-month) also favors no drought in Kansas. The individual temperature and precipitation outlooks that contribute to these outlooks are available below.

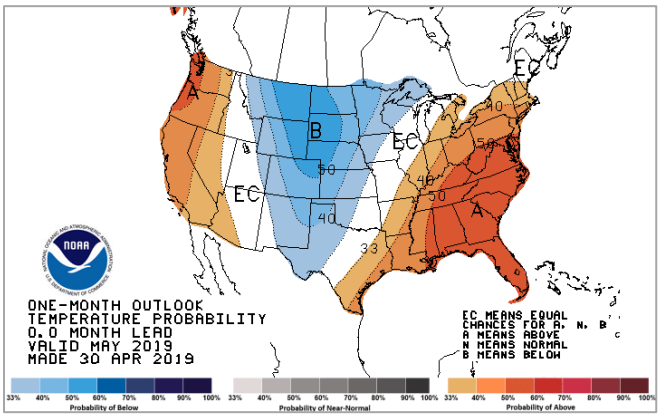


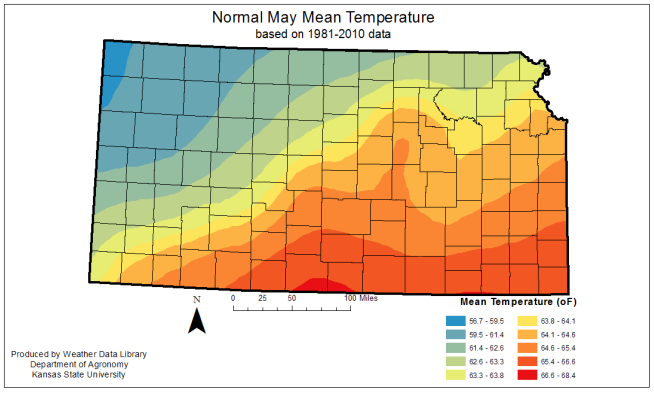


The May precipitation outlook favors a slightly increased chance of above normal precipitation across the state. With the limited dry conditions and the increased amounts of precipitation normal at this time of the year, drought conditions are unlikely. The temperature outlook is for cooler than normal temperature in the western and central parts of the state, and equal chances for above or below normal temperatures for the remainder of the state. Largest concerns will be for flooding, particularly in the eastern parts of the state.

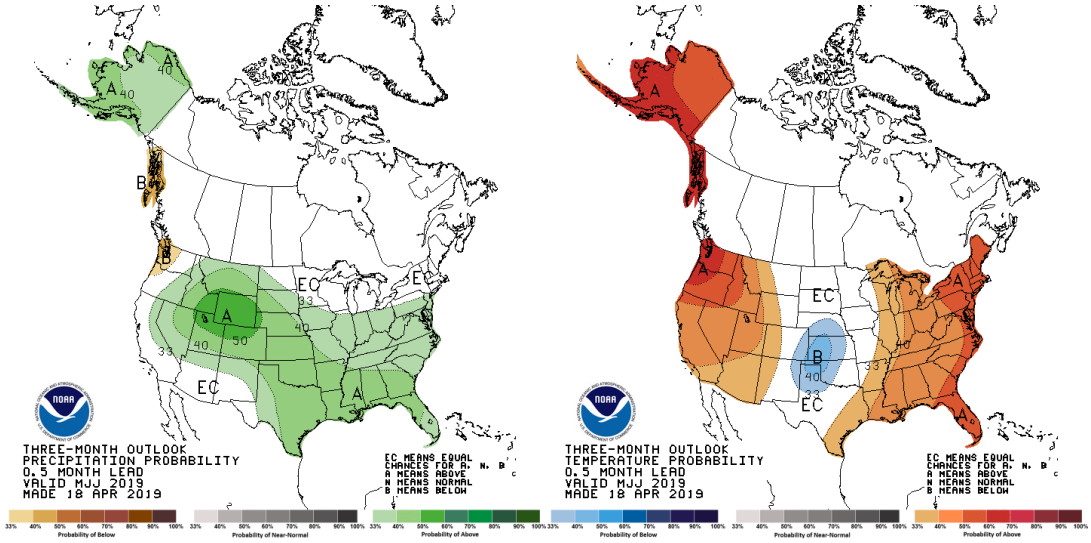








The U.S. three month outlook for May through July favors above-average precipitation for all of Kansas and below normal temperatures for all but the eastern part of Kansas.



El Nino conditions are present and expected to continue in the northern hemisphere through spring and summer 2019 according to NOAA's Climate Prediction Center. El Nino favors wetter than normal conditions in the Central Plains.

Additional outlooks for various timeframes are available from the national CPC for up to 13 months. (http://www.cpc.ncep.noaa.gov/products/predictions/90day/)

Water

Surface Water Supply Conditions

Kansas River basin: Milford, Tuttle Creek, Perry, and Clinton reservoirs experienced near normal inflows in April. However, due to flooding conditions on the Missouri River, all basin reservoirs are set to minimum discharge and retaining substantial flood storage. With the lack of reservoir releases, flows in the Kansas River declined to below historic median values by the end of the month but well above low flow targets.

Marais des Cygnes basin: Melvern, Pomona, and Hillsdale reservoirs experienced moderate inflows in April and maintained pool elevations slightly above normal pool. Flows in the Marais des Cygnes River remained healthy throughout the month and exceeded historic median values due to intermittent reservoir releases.

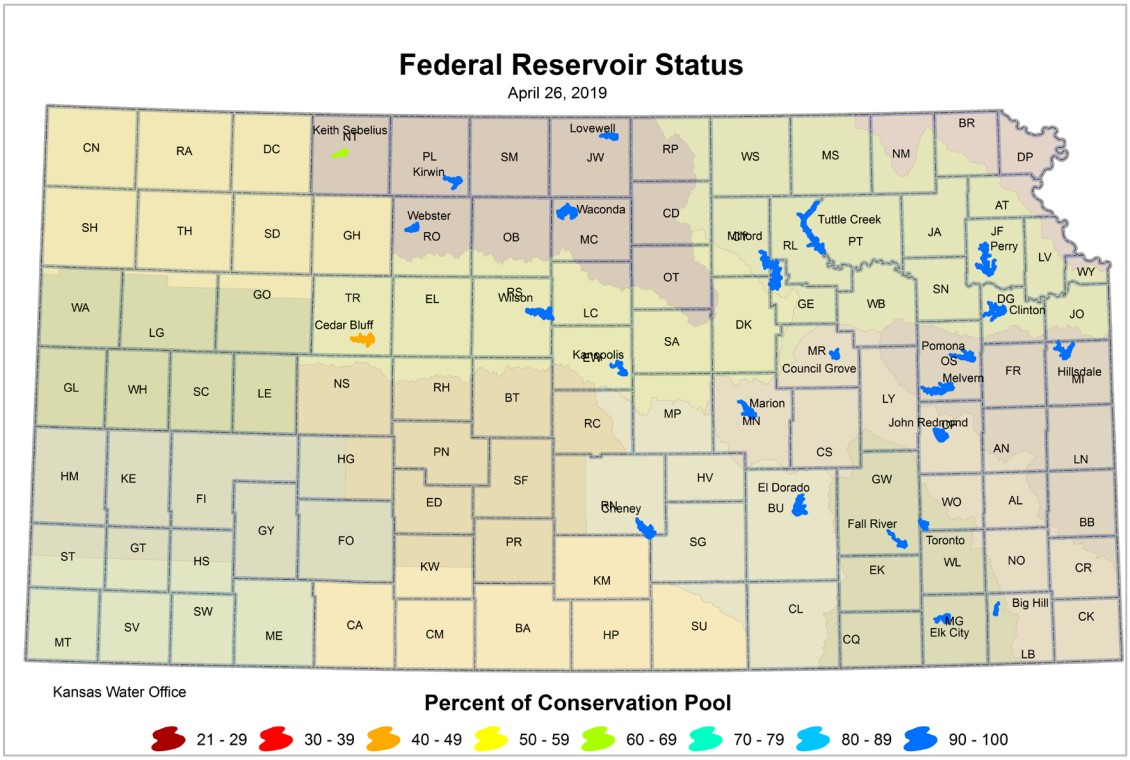
Cottonwood/Neosho basin: All system reservoirs experienced moderate inflows, sufficient to maintain normal pool levels. Council Grove maintained an elevation less than normal pool for most of the month in accordance with the approved seasonal management plan but refilled on April 30th. River flow throughout the system remained healthy and slightly above historic median values.

Verdigris basin: Inflows to Toronto, Fall River, Elk City, and Big Hill reservoirs were not substantial but healthy. Reservoir pool elevations remained relatively static throughout the month. Stream flows in the Verdigris and Fall Rivers were near normal with some fluctuations from reservoir releases.

Saline basin: The elevation at Wilson Lake was maintained near normal pool in April. Inflow remained above normal and releases in excess of low flow settings were necessary to manage lake level.

Smoky Hill basin: The middle Smoky Hill River maintained higher than normal flows from baseflow and tributary gains in April. Kanopolis Lake experienced consistent healthy inflow and recovered conservation storage that was released to facilitate maintenance work near the dam. Cedar Bluff Reservoir also received some inflow and gained elevation over the month due to steady higher than normal inflow.

Reservoir Storage



Kansas Federal Reservoir Conservation Pool Levels

Reservoir	Top of Multipurpose / Conservation Pool (Feet MSL)	Multipurpose/Conservation Pool Elevation (Feet MSL)	Change from Top of Pool (Feet)	Percent of Conservation Pool Full
Kansas River Basin		**4/26/2019**		
Keith Sebelius Lake[1]	2304.3	2296.68	-7.62	59.1%
Harlan County Lake NE	1945.73	1948.08	2.35	100.0%
Lovewell Reservoir[1]	1582.6	1582.63	0.03	100.0%
Webster Reservoir[1]	1892.45	1893.24	0.79	100.0%
Kirwin Reservoir	1729.25	1730.56	1.31	100.0%
Waconda Lake[1]	1455.6	1456.16	0.56	100.0%
Cedar Bluff Reservoir	2144	2125.47	-18.53	44.0%
Kanopolis Lake[1]	1463	1465.67	2.67	100.0%
Wilson Lake[1]	1516	1515.95	-0.05	99.8%
Milford Lake[1]	1144.4	1155.54	11.14	100.0%
Tuttle Creek Lake[1]	1075	1116.24	41.24	100.0%
Perry Lake[1]	891.5	904.14	12.64	100.0%
Clinton Lake[1]	875.5	877.95	2.45	100.0%
Melvern Lake[1]	1036	1037.17	1.17	100.0%
Pomona Lake[1]	974	976.41	2.41	100.0%
Hillsdale Lake[1]	917	917.58	0.58	100.0%
Arkansas River Basin		**4/26/2019**		
Marion Reservoir[1]	1350.5	1350.49	-0.01	99.9%
Council Grove Lake[1]	1274	1273.26	-0.74	95.3%
John Redmond Reservoir	1041	1041.49	0.49	100.0%
Toronto Lake	901.5	901.62	0.12	100.0%
Fall River Lake	948.5	948.82	0.32	100.0%
Elk City Lake	796	796.86	0.86	100.0%
Big Hill Lake	858	858.11	0.11	100.0%
Cheney Reservoir	1421.6	1421.65	0.05	100.0%
El Dorado Lake	1339	1339.22	0.22	100.0%

[1]Lake level management plan in place — Source: U.S. Army Corps of Engineers, U.S. Bureau of Reclamation and U.S. Geological Survey

Note: The conservation pool is the water storage for non-flood purposes of the reservoir, set by the elevation of the top of the pool.

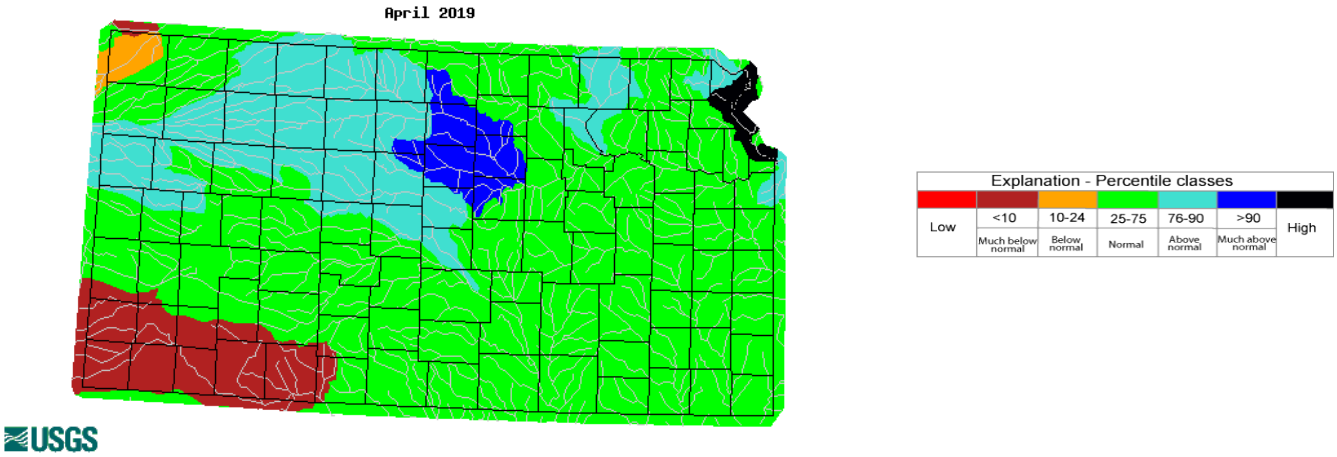
Harmful Blue-Green Algal Blooms (lake water safety)
The 2019 HAB monitoring began on April 1, 2019. KDHE samples public use lakes only in response to complaints of human or animal illness or visual sighting of possible blue-green algae by the public or lake officials.

KDHE issues three levels of public health protection notifications for blue-green algae (BGA) Blooms. Public Health Watch–Notifies public that a harmful algae may be present, that the water may be unsafe for humans and animals and contact with the water is discouraged. Public Health Warning–Notifies public that harmful algae is present of expected, that contact with the water should not occur, and all conditions of Public Health Watch remain in effect. Lake Closure –Notifies the public that a portion of the lake or the entire lake be closed to public because harmful algae is present and extreme conditions exist. More information can be found at http://www.kdheks.gov/algae-illness/index.htm.

No Health advisories were issued in April 2019.

Streamflow Conditions
WaterWatch summarizes streamflow conditions in a region (state or hydrologic unit) in terms of the long-term typical condition at stream gages in the region. In general, a streamflow which is greater than the 75 percentile is considered *above normal*, a streamflow which is between 25 and 75 percentiles is considered *normal* and a streamflow which is less than the 25 percentile is considered *below normal*. Color codes are for basins with streamflow averages less than 25 percent of historic values. This comparison aids in evaluating water resources conditions for a time period. A summary of flooding in April is found later in this report.

Streamflow compared to historical streamflow is reflected in the map below.



Water Right Administration/Minimum Desirable Streamflow (MDS)

Minimum Desirable Streamflow (MDS) is not being administered in Kansas. MDS administration requires water rights junior to MDS, usually with priority dates after April 12, 1984, to stop diverting water. Administration is ordered when streamflow drops below MDS for more than seven days. To rescind orders at most gages, daily average flow must be above MDS for 14 days.

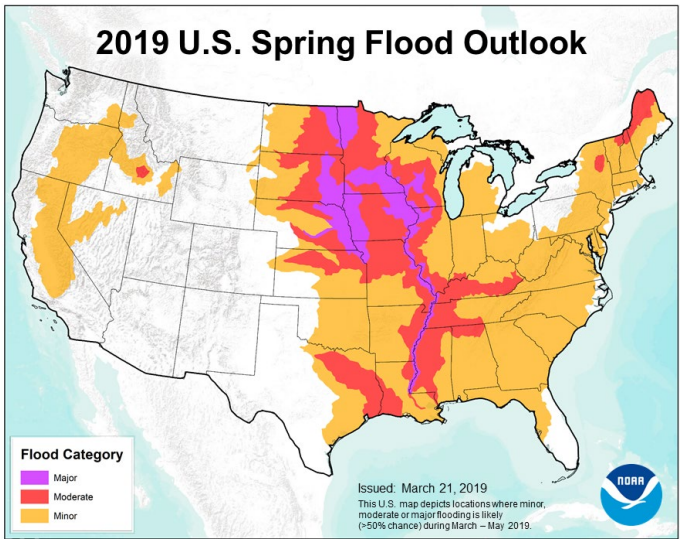
The table below provides a snapshot of conditions for streams of interest to the Kansas Department of Agriculture, Division of Water Resources.

Streamflows as of April 29, 2019			
Gaging Station	**Current Flow**	**Mar MDS**	**Comment**
Rattlesnake Creek near Macksville	7	10	No surface water diversions junior to MDS above gage

Flooding

March 21, 2019 the National Spring Flood Risk issued by NOAA (below) indicates potential flooding in parts of Kansas. Spring flood risk is higher than normal for the lower Missouri River Basin. This is driven by above normal snowpack across the Plains, saturated soil conditions, and the presence of deeply frozen soils. (https://www.nws.noaa.gov/oh/2019NHA.html)

Flooding information can be found for USGS stream gage sites at https://waterwatch.usgs.gov/?m=flood&r=ks&w=flood%2Ctable for current stage. Severity and duration by location can also be obtained through USGS WaterWatch Flood information. The Table below provides an overview of flooding April 1 – May 1, 2019 at USGS stream gages in the WaterWatch system.



Summary of April Flooding and High Flows

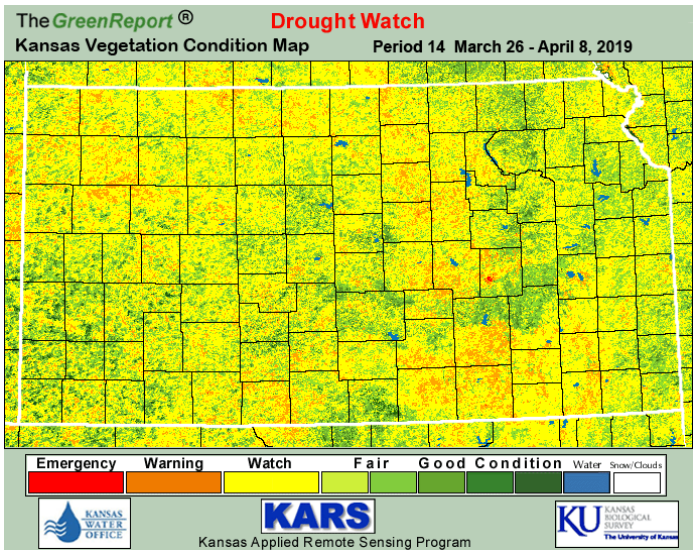
["--", no data; "<", less than all historical peaks]

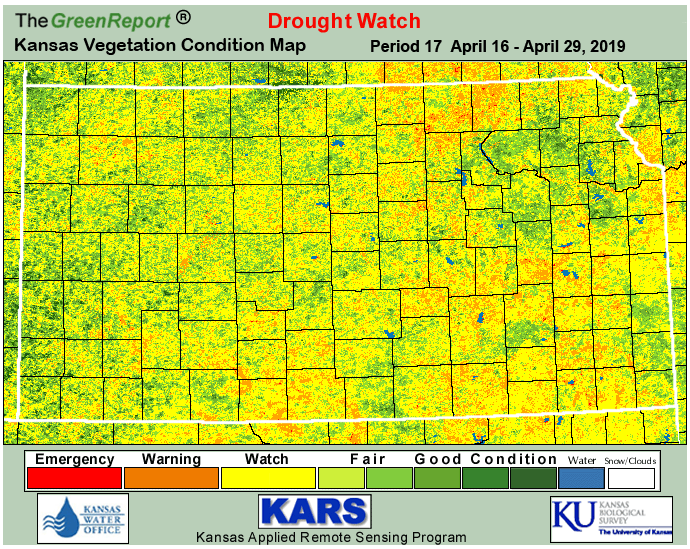
USGS station number	USGS station name	Drain. area [mi^2]	NWS flood stage (ft)	No. Days above flood stage	NWS flood class	Highest peak from 2019-04-01 to 2019-05-01: Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	Historical Peaks: No. of years	Max. (year) [ft^3/s]
6818300	MISSOURI R AT ATCHISON, KS	426865	22	7	Minor	4/1/2019	25.4	--	--	--	--
6820475	MISSOURI R AT LEAVENWORTH, KS	427200	20	3	Minor	4/1/2019	23.52	--	--	--	--
6884700	BIG BLUE R AT BLUE RAPIDS, KS	8342	26	30	Minor	4/22/2019	41.69	--	--	--	--
6893390	INDIAN C AT STATE LINE RD, LEAWOOD, KS	64.17	20	1	Minor	4/30/2019	21.17	8180	11	14	23573 (2017)
6910800	MARAIS DES CYGNES R NR READING, KS	177	19	2	Moderate	5/1/2019	21.33	4470	35	49	67400 (1982)
6911490	SALT C AT LYNDON, KS	97.8	10	2	Minor	4/30/2019	15.65	12000	2	18	16400 (2007)
6913000	MARAIS DES CYGNES R NR POMONA, KS	1040	20	2	Minor	5/1/2019	27.51	13100	19	64	69400 (1928)
6913500	MARAIS DES CYGNES R NR OTTAWA, KS	1250	31	1	Moderate	5/1/2019	33.73	16900	30	110	142000 (1951)
6914000	POTTAWATOMIE C NR GARNETT, KS	334	26	2	Minor	5/1/2019	27.86	11200	36	63	57000 (1961)
6915800	MARAIS DES CYGNES R AT LA CYGNE, KS	2669	25	2	Minor	5/1/2019	29.44	21100	16	33	131000 (2007)
6916600	MARAIS DES CYGNES R NR KS-MO ST LINE, KS	3250	27	1	Moderate	5/1/2019	29.01	24200	26	59	137000 (2007)
6917000	L OSAGE R AT FULTON, KS	314	22	2	Moderate	5/1/2019	27.3	10900	26	69	62800 (1986)
7169500	FALL R AT FREDONIA, KS	827	17	2	Minor	5/1/2019	19.32	10900	47	83	77800 (2007)
7182260	COTTONWOOD R AT EMPORIA, KS	1833	20	1	Minor	5/1/2019	22.54	15000	4	4	18672 (2017)
7182390	NEOSHO R AT NEOSHO RAPIDS, KS	2753	22	1	Moderate	5/1/2019	23.67	18900	6	8	26451 (2016)
7183000	NEOSHO R NR IOLA, KS	3723	15	2	Minor	5/1/2019	18.94	24700	52	111	436000 (1951)
7183300	NEOSHO R NR ERIE, KS	4547	29	1	Moderate	5/1/2019	32.22	--	--	--	--
7183500	NEOSHO R NR PARSONS, KS	4905	21	1	Moderate	5/1/2019	24.31	26400	58	96	410000 (1951)
7184000	LIGHTNING C NR MCCUNE, KS	197	12	2	Minor	5/1/2019	15.42	4920	42	67	67500 (1993)
7187600	SPRING R NR BAXTER SPRINGS, KS	2448	14	1	Minor	5/1/2019	18.03	49000	5	8	145714 (2015)

Vegetation and Soil Moisture

Vegetative Conditions

The Vegetative Condition map provides current conditions related to drought effects on vegetation. It is produced using satellite data. Areas in yellow, orange and red indicate areas of vegetative stress. The green areas are considered to be in good or excellent condition. Change can be seen comparing the two GreenReports below from early and late April.





Soil Moisture and Rangeland

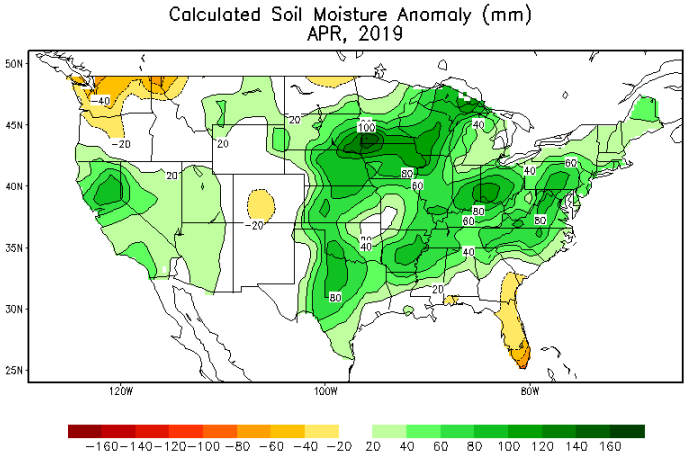
The National Agricultural Statistics Service, USDA Crop Progress and Condition provides a summary of the climatic effects on soil, and livestock feed. For the week ending April 28, 2019, topsoil moisture supplies rated 1 percent very short, 14 short, 77 adequate, and 8 surplus. Subsoil moisture supplies rated 1 percent very short, 6 short, 83 adequate, and 10 surplus.

Field Crops Report: Winter wheat condition rated 3 percent very poor, 8 poor, 31 fair, 48 good, and 10 excellent. Winter wheat jointed was 64 percent.

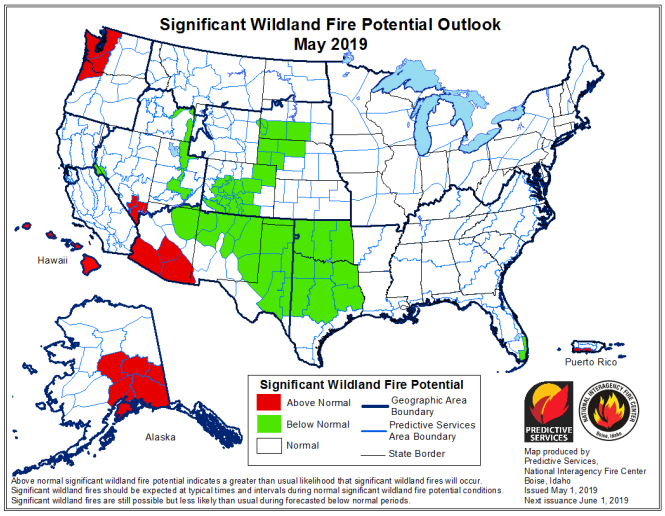
Soybeans planted was 2 percent, equal to last year and the five-year average.

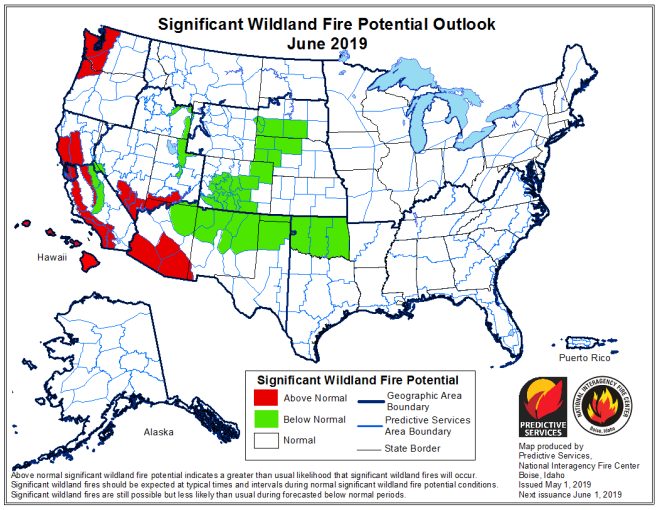
Corn planted was 31 percent, behind average of 36 but ahead of last year's 25 percent.

The Climate Prediction Center (CPC), also monitors soil moisture and predicts future soil moisture. Anomalies are defined as deviations from the 1971-2000 monthly climatology. The soil anomaly is provided below. (.http://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)



Significant Wildland Fire Potential Outlook is issued monthly for the United States, https://www.predictiveservices.nifc.gov/outlooks/monthly_seasonal_outlook.pdf .





Kansas Forest Service provides a grassland fire danger index at**:** http://www.kansasforests.org/fire_management/grasslandfireindex.html .

Kansas Climate Summary

The Kansas Weekly Climate Summary and Drought Report are compiled at least monthly, more frequently when conditions warrant, by the KWO. Information from various federal, state, local and academic sources is used. Some of the data is preliminary and subject to change once final data is available. The KWO web site, http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response , contains additional drought information including links to other agencies with drought information and past issues of the Kansas Climate Summary and Drought Report. Kansas State Climatologist, Mary Knapp, is the primary source of the narrative on weather. She works closely with meteorologists throughout the state and region. Details of current conditions at Evapotranspiration (ET) and Mesonet sites across Kansas are available at http://mesonet.k-state.edu/

RESOURCES and REFERENCES

Kansas climate data is provided by Kansas State University, Weather Data Library through the Kansas Mesonet. (http://www.ksre.k-state.edu/wdl/). Soil moisture data was added in 2018 (http://mesonet.k-state.edu/agriculture/soilmoist)

The U.S. Drought Monitor, from the National Drought Mitigation Center at the University of Nebraska-Lincoln, provides a "big picture" perspective of conditions across the nation. In the Kansas county drought stage scheme, a Drought Watch equates roughly to moderate drought in the U.S. Drought Monitor, while a Drought Warning is the equivalent of severe drought. A Drought Emergency is reserved for extreme or exceptional drought. Palmer Drought Severity Index - The Palmer Index (PDSI) is one indicator used in the U.S. Drought Monitor.

The High Plains Regional Climate Center (https://hprcc.unl.edu/) has precipitation and temperature summary maps available at the state, region and nation.

The U.S. Geological Survey (USGS) Drought Watch provides information average streamflow measured at long-term gaging stations and compares them to normal flows.

The Kansas Department of Agriculture-Division of Water Resources monitors stream flow using the USGS gages for determination of administrative needs. Administration may be needed due to Minimum Desirable Streamflow (MDS) requirements, impairments and reservoir release protection. (https://agriculture.ks.gov/divisions-programs/dwr/water-appropriation/minimum-desirable-streamflow.)

The water levels of the federal lakes fluctuate during a year according to the management plan. Lake level Management plans are posted on the Kansas Water Office web site www.kwo.ks.gov .

The Kansas Applied Remote Sensing Program (KARS) at the University of Kansas produces a Kansas Green Report each week during the growing season. For a full set of national and regional ***GreenReport***® maps, go to: http://www.kars.ku.edu/products/greenreport/greenreport.shtml. This Kansas Vegetation Drought Response Index map is developed weekly by the Kansas Biological Survey using state drought triggers as its key. In addition the VegDRI maps may be found at http://vegdri.unl.edu/

The National Weather Service (NWS) provides fire weather products and services for Kansas that include the Rangeland Fire Danger Index, Fire Weather Forecasts, Red Flag Watches/Warnings and Spot Forecasts. The five NWS offices that serve Kansas websites may be accessed from the NWS Offices' page.

The Monthly and Seasonal Drought Outlooks, developed by the NOAA Climate Prediction Center, assess the likelihood for improvement, persistence or deterioration in drought conditions for areas currently experiencing drought as identified by the U.S. Drought Monitor. (http://www.cpc.ncep.noaa.gov/) Also see: http://www.noaa.gov/.

Responding to Drought: A Guide for City, County and Water System Officials provides an overview of Kansas county drought stage declarations, local planning and coordination, disaster declarations and available state and federal assistance. The 2007 Municipal Water Conservation Plan Guidelines and the Drought Vulnerability Assessment Report, both by KWO, provide guidance regarding drought preparedness and response. These are available at http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response.

USDA Drought Programs and Assistance website (https://www.usda.gov/topics/disaster/drought/usda-drought-programs-and-assistance) listing the various USDA programs and agencies to assist with drought issues.

The National Interagency Coordination Center in Boise, Idaho, produces wildfire potential outlook maps monthly. (https://www.predictiveservices.nifc.gov/outlooks/outlooks.htm)

Please contact Diane Knowles at the Kansas Water Office (785) 296-3185 or diane.knowles@kwo.ks.gov should you have any questions or suggestions.

APPENDIX A

April Summary							
	Precipitation (inches)			Temperature oF			
						Extreme (Date)	
Station[1]	Total	Departure	Percent Normal	Mean	Departure	Highest	Lowest
West							
Burlington, CO	0.23	-1.23	16%	50.8	2.9	87 (20)	20 (11)
Dodge City	0.44	-1.38	24%	55.8	1.9	90 (21)	21 (12)
Garden City	0.15	-1.57	9%	54.3	1.2	87 (21,20)	19 (12)
Goodland	0.38	-1.21	24%	51.5	2.3	87 (20)	21 (11)
Guymon, OK	0.17	-1.34	11%	57.1	1.9	91 (20)	25 (14)
Hill City	0.84	-1.28	40%	54.2	2.6	90 (20)	23 (14,13)
Lamar, CO	0.15	-1.17	11%	54.0	1.8	89 (28,20)	20 (14)
McCook, NE	0.24	-2.07	10%	52.2	2.7	91 (20)	23 (12)
Springfield, CO	0.27	-1.00	21%	51.1	-0.5	89 (20,9)	18 (11)
Central							
Concordia	1.63	-0.82	67%	57.0	3.9	87 (20)	27 (13)
Hebron, NE				54.8	3.8	87 (20)	25 (13)
Medicine Lodge	1.41	-1.02	58%	57.3	1.2	87 (10)	29 (12)
Ponca City, OK	3.24	-0.20	94%	60.3	1.9	87 (21,9)	31 (1)
Salina	2.24	-0.81	73%	56.2	1.0	85 (8)	27 (12, 1)
Wichita (ICT)	2.45	-0.14	95%	58.3	2.2	85 (10)	31 (12,11)
East							
Bartlesville, OK	3.90	-0.08	98%	60.1	1.3	90 (10)	27 (1)
Chanute	5.48	1.08	125%	60.4	3.6	89 (10)	28 (1)
Falls City, NE	3.40	0.22	107%	55.3	2.1	86 (21)	25 (13)
Johnson Co. Exec. Apt	6.42	2.43	161%	56.6	1.5	84 (10)	30 (1)
Joplin, MO	5.02	0.70	116%	59.0	3.2	85 (10)	29 (1)
Kansas City (MCI), MO	4.22	0.52	114%	56.5	1.7	85 (21)	28 (13,1)
St. Joseph, MO	2.41	-1.38	64%	56.1	1.9	87 (21)	28 (13)
Topeka (TOP)	2.96	-0.57	84%	57.8	2.7	87 (10)	28 (13)

1. Airport Automated Observation Stations (NWS/FAA)

2. Departure from 1981-2010 normal value

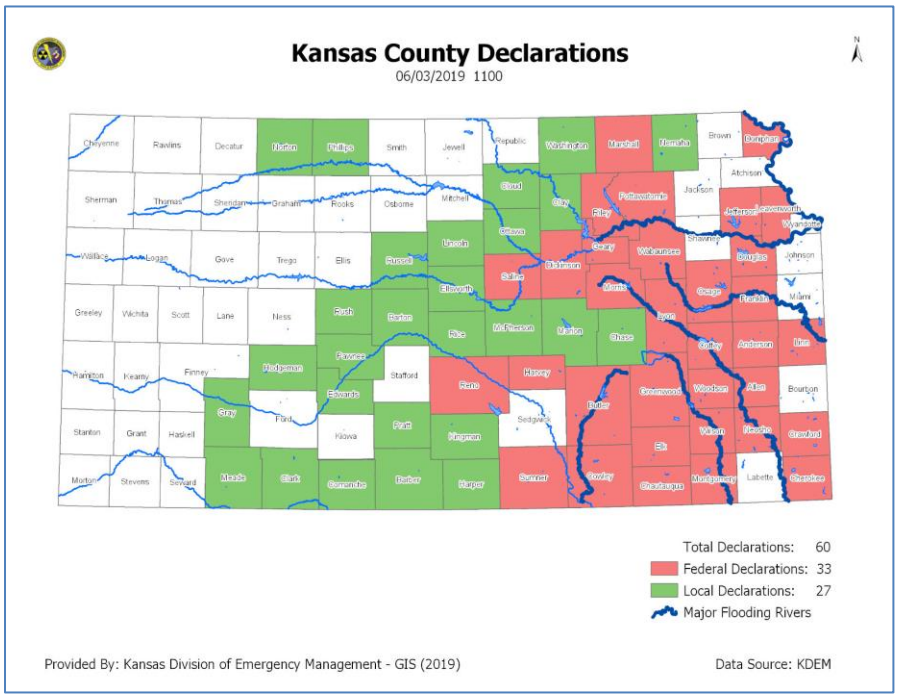
T - Trace; M - Missing; --- no normal value from which to calculate departure or percent of normal

Source: National Weather Service F-6 Climate Summaries

KANSAS CLIMATE UPDATE
May 2019 Summary

Highlights

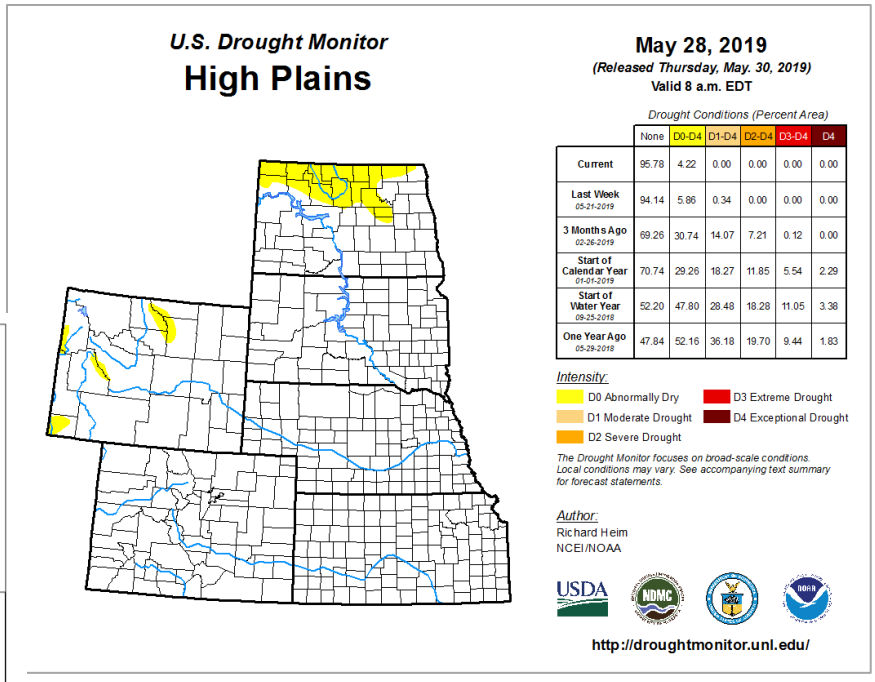
- May 2019 sets the record not only for the wettest May since 1895, but also the wettest month ever.
- Emergency declarations were made in May 2019 for flooding beginning May 9. County declarations were made locally for many counties in May and early June. Federal declarations are in place for 33 counties June 4, 2019 for the May flooding. FEMA-3412-EM allows for federal assistance to supplement state and local efforts.



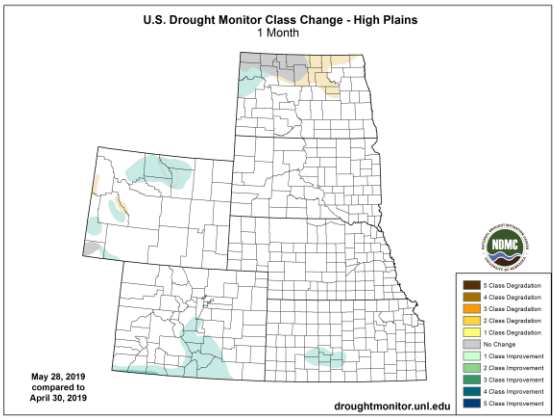
- May flooding occurred at over 90 USGS stream gages on at least 50 streams for one to as much as 31days in May.
- Major flood category was reached along the Neosho, Arkansas, Verdigris and Walnut rivers with numerous other rivers reaching moderate flood stage.
- Multiple Corps of Engineer flood control reservoirs reached over 90 percent of flood pool capacity
- May precipitation exceeded month total normal by mid-May in many locations particularly in the eastern third across the state. Monthly totals were 150% to over 300% of normal precipitation.
- An El Niño Advisory is in effect, with weak El Niño conditions present. Weak El Nino conditions are expected to continue in the Northern Hemisphere through summer and possibly into the fall of 2019.

General Drought Conditions

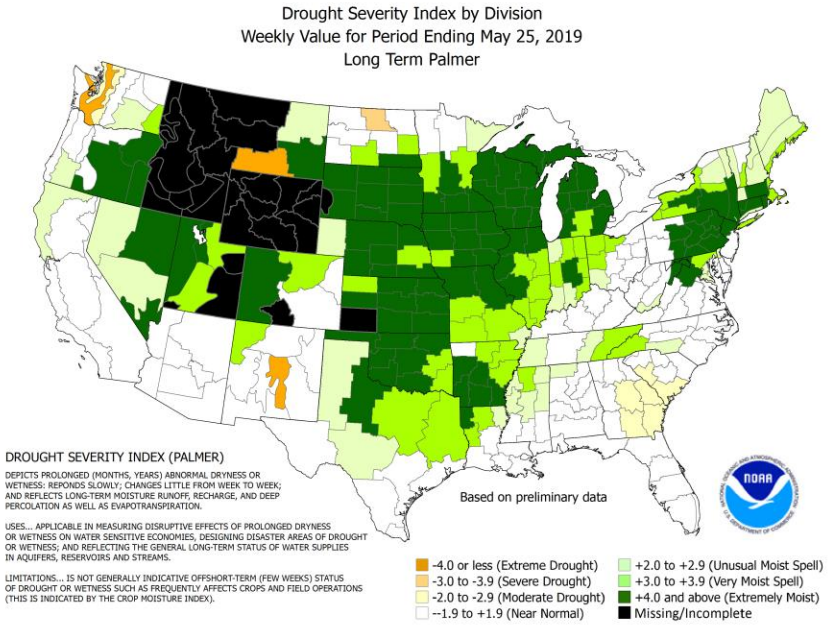
Kansas became drought free by the U.S. Drought Monitor in January 2019, but as the year has progressed it is flooding due to above normal rains that is the major climate issue. Minor pockets of abnormally dry conditions developed for a week or two in April and May. Changes in drought classification over the month for the High Plains, including Kansas is also shown for perspective.



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	95.78	4.22	0.00	0.00	0.00	0.00
Last Week 05-21-2019	94.14	5.86	0.34	0.00	0.00	0.00
3 Months Ago 02-26-2019	69.26	30.74	14.07	7.21	0.12	0.00
Start of Calendar Year 01-01-2019	70.74	29.26	18.27	11.85	5.54	2.29
Start of Water Year 09-25-2018	52.20	47.80	28.48	18.28	11.05	3.38
One Year Ago 05-29-2018	47.84	52.16	36.18	19.70	9.44	1.83



More information can be found on the U.S. Drought Monitor web site https://droughtmonitor.unl.edu/ .
Palmer Drought Severity Index (PDSI) - The Palmer Drought Severity Index is an indicator of relative dryness or wetness and is one factor used the U.S. Drought Monitor. More information on the PDSI can be found at http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml.



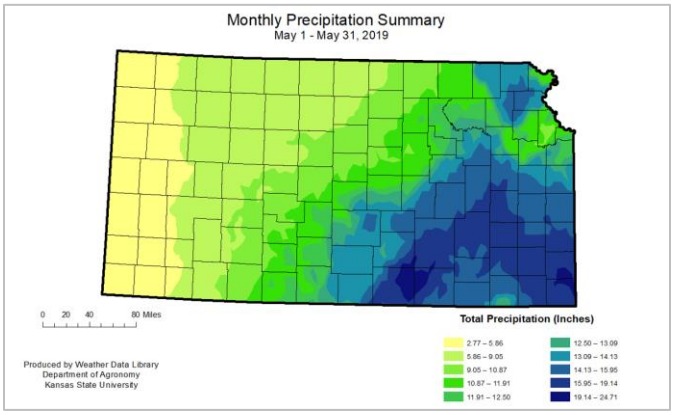
Climate Summary - Precipitation

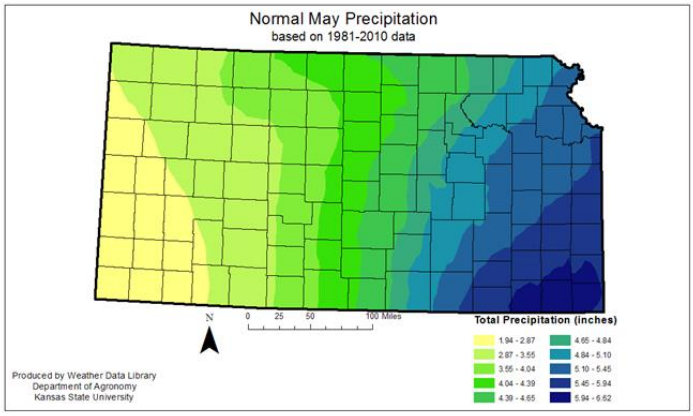
May 2019 sets the record not only for the wettest May since 1895, but also the wettest month ever. State-wide average precipitation for the month was 10.26 inches, 246 percent of normal. All divisions averaged above normal for the month. The Northwest Division was the driest, compared to normal, with an average of 5.46 inches, 158 percent of normal. In contrast, the Southeast Division averaged 17.00 inches, 294 percent of normal. The highest 24-hour rainfall total for a National Weather Service Cooperative station 9.42 inches at Horton, Brown County, on the 24th. The greatest 24-hour rainfall total for a Community Collaborative Rain, Hail and Snow network station was 9.32 inches at Rose Hill 2.7 ESE, Butler County on the 8th. The greatest monthly precipitation totals for May: 26.14 inches at Rock 3SW, Cowley County (NWS) and 30.08 inches at Rose Hill 2.7 ESE, Butler County (CoCoRaHS). Monthly snowfall was largely confined to the Northwest Division, with the highest amount reported 1.0 inches at Colby 1S, Thomas County (NWS). (KSU Weather Data Library)

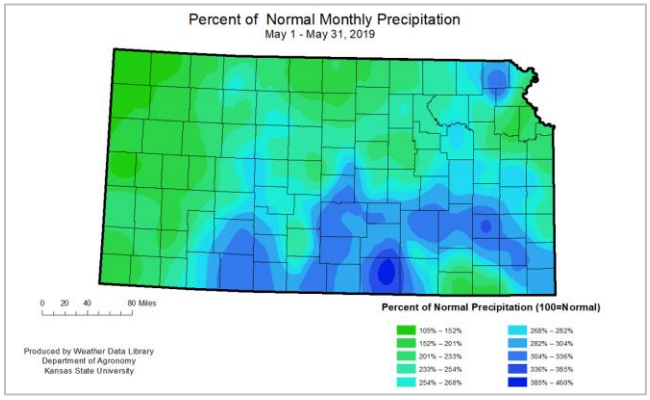
Kansas Climate Division Precipitation Summary (inches)												
Climate Division	May 1-31, 2019			January 1- May 31, 2019			April 1, 2019- May 31, 2019			Sept 1, 2018- May 31, 2019		
	Actual	Depart Normal*		Actual	Depart Normal*		Actual	Depart Normal*		Actual	Depart Normal*	
Northwest	5.46	2	158	8.19	0.36	105	5.83	0.30	105	15.30	2.99	124
West Central	5.31	2.28	175	9.47	2.04	127	6.17	1.23	125	18.59	6.68	156
Southwest	7.29	4.56	267	10.84	4.09	161	7.55	3.18	173	19.45	8.24	174
North Central	8.56	4.48	210	13.26	3.17	131	9.62	3.02	146	26.96	10.14	160
Central	10.30	6.03	241	15.96	5.08	147	12.18	5.25	176	30.05	12.35	170
South Central	14.33	9.94	326	20.47	8.76	175	16.46	9.37	232	35.27	15.70	180
Northeast	9.69	4.90	202	17.19	4.94	140	11.78	3.74	147	32.36	10.78	150
East Central	12.04	6.89	234	20.48	6.85	150	14.90	6.20	171	33.50	9.56	140
Southeast	17.00	11.21	294	26.40	10.74	169	20.31	10.65	210	41.20	13.45	148
STATE	10.26	6.09	246	16.06	5.37	150	11.91	5.07	174	28.33	10.26	157

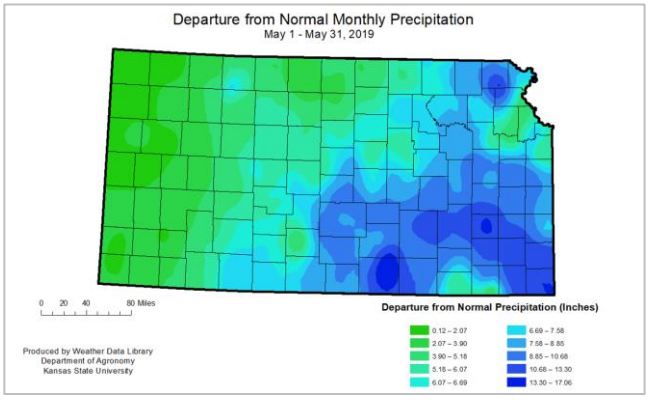
*Departure from normal is departure from the base period of 1981-2010, KSU Weather Data Library.

The maps below summarizing normal precipitation for the month are from the K-State Weather Data Library and / or the High Plans Regional Climate Center. (National Weather Service maps use data from the Applied Climate Information Network. State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)









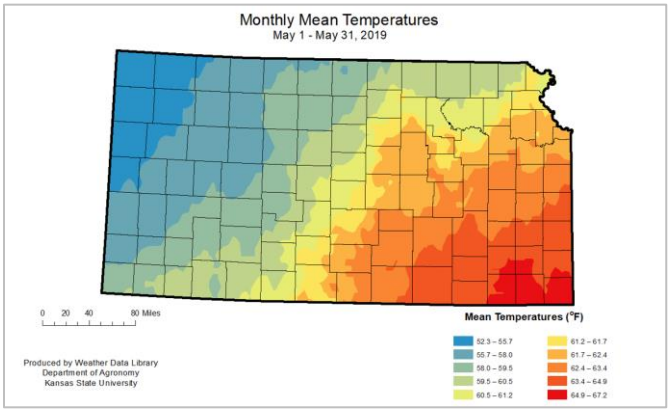
Climate Summary-Temperature

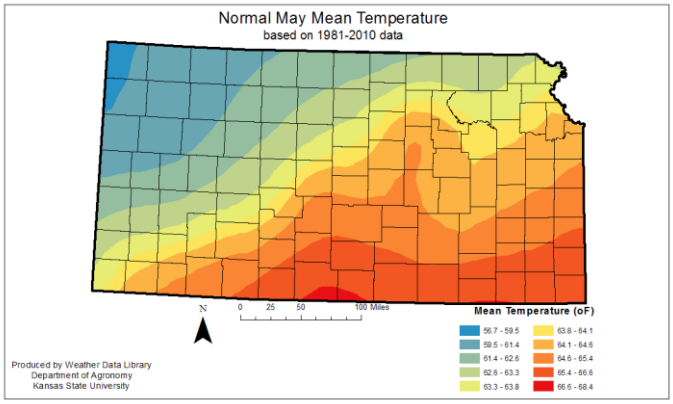
May returned to the cooler-than-normal trend that has been in place since the start of the year. State-wide average temperature for the month was 60.2 ºF, which is 3.3 degrees cooler than normal. This ranks as the 14th coolest on record. The Southeast Division came closest to normal with an average of 64.2 ºF, 1.2 degrees cooler than normal. The Northwest Division had the largest departure with an average of 55.0 ºF, 5.3 degrees cooler than normal. Despite the cooler pattern, the warmest maximum temperature was 97 ºF at Tribune 14N, Greeley County, on the 17th. The coldest minimum temperature was St. Francis, Cheyenne County, on the 2nd coming in at 25 ºF. Multiple warm daily records were set including four high temperatures and 95 lows. Cold daily records numbered less with only 8 high temperatures and 15 lows. (KSU Weather Data Library)

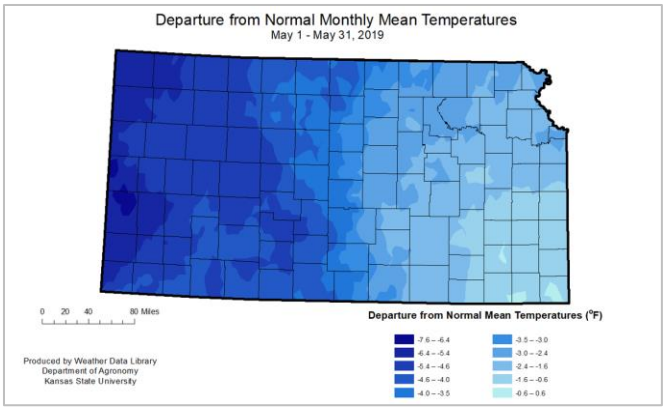
Climate Division	Kansas Climate Division Temperature Summary (ºF)							
	May 2019							
	Maximum	Minimum	Average	Departure	High	Date	Low	Date
Northwest	67.2	42.8	55.0	-5.3	95	17	25	2
West Central	69.4	44.3	56.8	-4.3	97	17	30	22
Southwest	72.0	47.0	59.5	-4.3	94	16	31	22
North Central	70.3	49.2	59.7	-3.5	95	17	31	10
Central	71.5	50.2	60.9	-3.4	93	17	31	10
South Central	72.3	51.9	62.1	-3.3	90	15	35	10
Northeast	70.4	51.6	61.0	-2.8	91	17	37	10
East Central	71.2	53.1	62.2	-2.0	92	16	37	10
Southeast	73.6	54.9	64.2	-1.2	89	16	37	10
STATE	70.9	49.4	60.2	-3.3	97	17th	25	2nd

The 2019 tornado season roared continued in May. There were 81 tornadoes reported during the month. Preliminary reports indicate 18 injured and no fatalities. May 28th was the most active day when 21 tornadoes were reported. Hail and damaging wind events were also numerous. There was one fatality reported in Leavenworth County, when strong winds toppled a tree on a house, killing the occupant. In addition to the severe storms, flooding was a major concern. The National Weather Service at Wichita at one time had river flood warning for 43 river points! Some rivers reached levels not seen in over a decade or even longer.

The maps below summarizing temperature for the month are from the K-State Weather Data Library and / or the High Plans Regional Climate Center. (National Weather Service maps use data from the Applied Climate Information Network. State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)

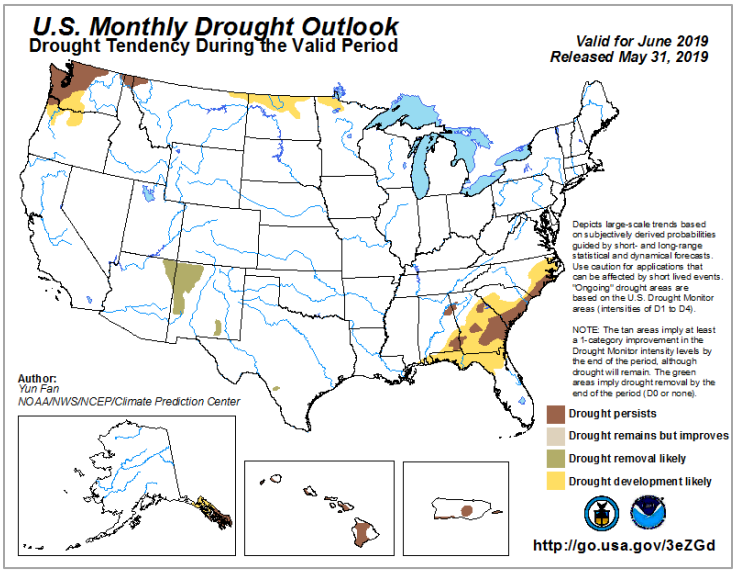

Monthly Mean Temperatures
May 1 - May 31, 2019
0 20 40 80 Miles
Mean Temperatures (°F)
52.3 – 55.7
55.7 – 58.0
58.0 – 59.5
59.5 – 60.5
60.5 – 61.2
61.2 – 61.7
61.7 – 62.4
62.4 – 63.4
63.4 – 64.9
64.9 – 67.2
Produced by Weather Data Library
Department of Agronomy
Kansas State University

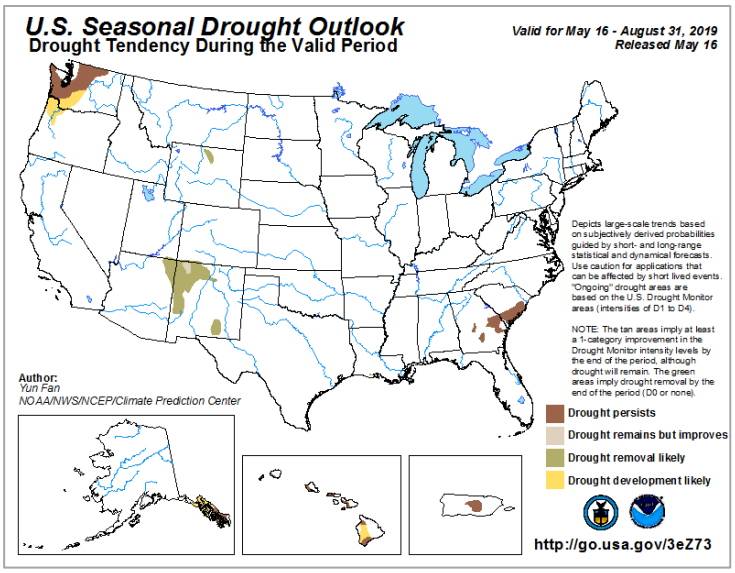

Normal May Mean Temperature
based on 1981-2010 data
N
0 25 50 100 Miles
Mean Temperature (oF)
56.7 - 59.5
59.5 - 61.4
61.4 - 62.6
62.6 - 63.3
63.3 - 63.8
63.8 - 64.1
64.1 - 64.6
64.6 - 65.4
65.4 - 66.6
66.6 - 68.4
Produced by Weather Data Library
Department of Agronomy
Kansas State University


Departure from Normal Monthly Mean Temperatures
May 1 - May 31, 2019
0 20 40 80 Miles
Departure from Normal Mean Temperatures (°F)
-7.6 – -6.4
-6.4 – -5.4
-5.4 – -4.6
-4.6 – -4.0
-4.0 – -3.5
-3.5 – -3.0
-3.0 – -2.4
-2.4 – -1.6
-1.6 – -0.6
-0.6 – 0.6
Produced by Weather Data Library
Department of Agronomy
Kansas State University

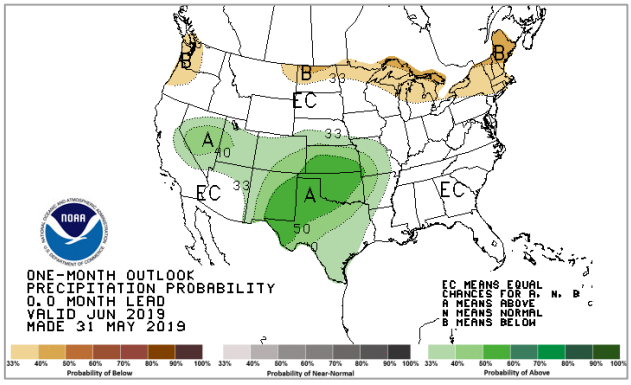
Future Outlook

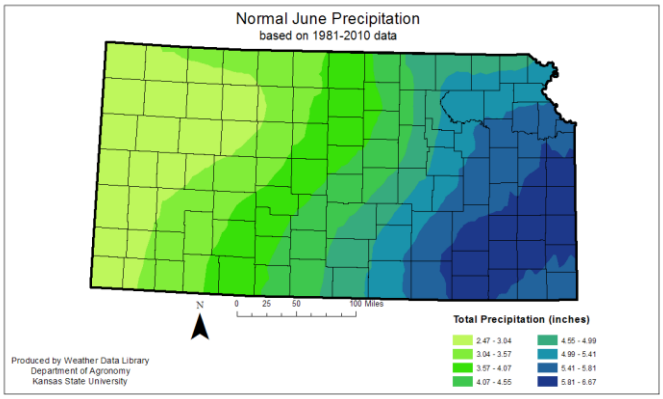
The Monthly Drought Outlook for June 2019 indicates no anticipated drought conditions in Kansas. The Seasonal Outlook (3-month) also favors no drought in Kansas through the summer. The individual temperature and precipitation outlooks that contribute to these outlooks are available below.

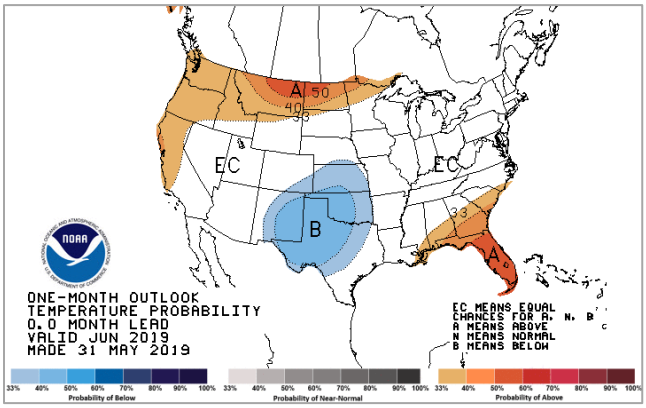


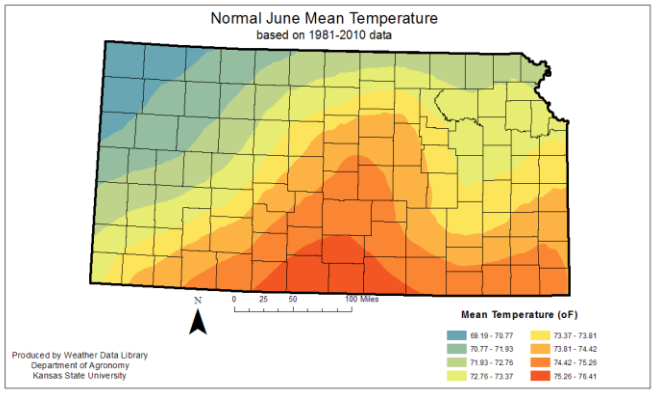


The June precipitation outlook favors a slightly increased chance of above normal precipitation across the state. With the limited dry conditions and the climatologically increased amounts of normal precipitation at this time of the year, drought conditions are unlikely. The temperature outlook is for cooler than normal temperature state-wide. Concerns for flooding continue into June along major rivers particularly in the eastern parts of the state as releases continue from reservoirs.

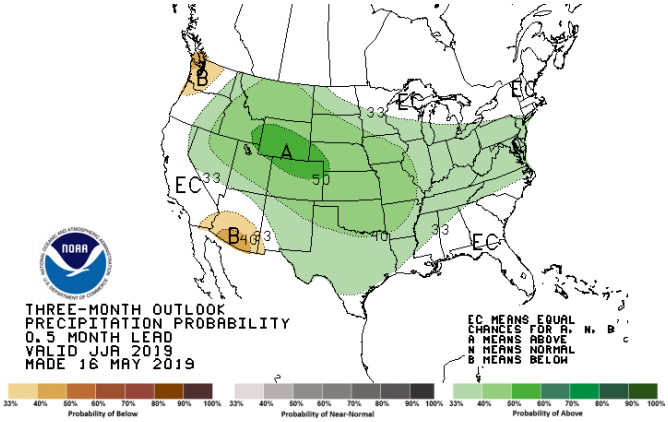


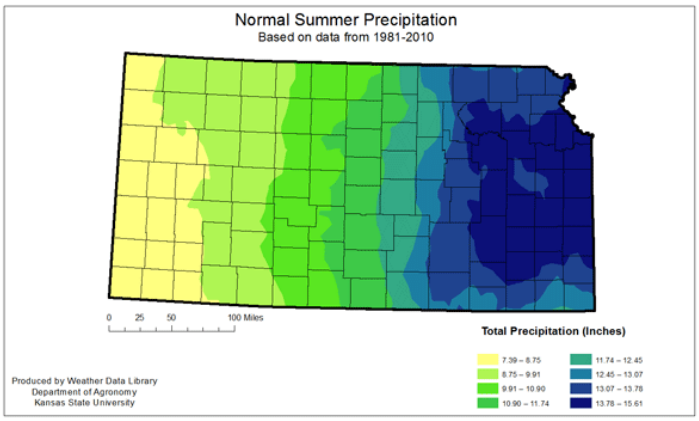


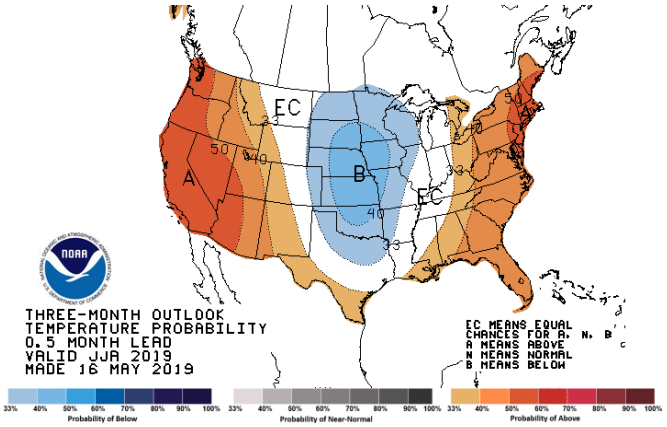


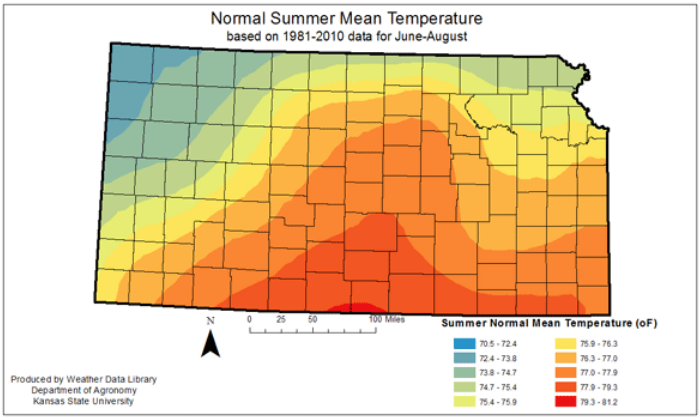


The U.S. three month outlook for June through August slightly favors above-average precipitation for almost all of Kansas and below normal temperatures for the entire state.









El Nino conditions are present and expected to continue in the northern hemisphere through spring and summer 2019 according to NOAA's Climate Prediction Center. El Nino favors wetter than normal conditions in the Central Plains.

Additional outlooks for various timeframes are available from the national CPC for up to 13 months. (http://www.cpc.ncep.noaa.gov/products/predictions/90day/)

Water

Public Water Supplies

Storm and flooding created known issues for at least 25 water and wastewater systems around the state as of May 29, 2019.

At least 17 boil orders were issued by KDHE in May to protect public health. The need to boil public water supply waters was primarily due to flood waters entering wells or loss of pressure in the systems. Once the systems are able to ensure the water is again safe the boil order is lifted.

Reservoir Storage

At the end of May all reservoir conservation pools were full except Keith Sebelius and Cedar Bluff, which have filled to over 75% and 55% of conservation pools respectively. As we enter June, all other reservoirs are into flood pool, with many releasing water to reduce those flood pools.

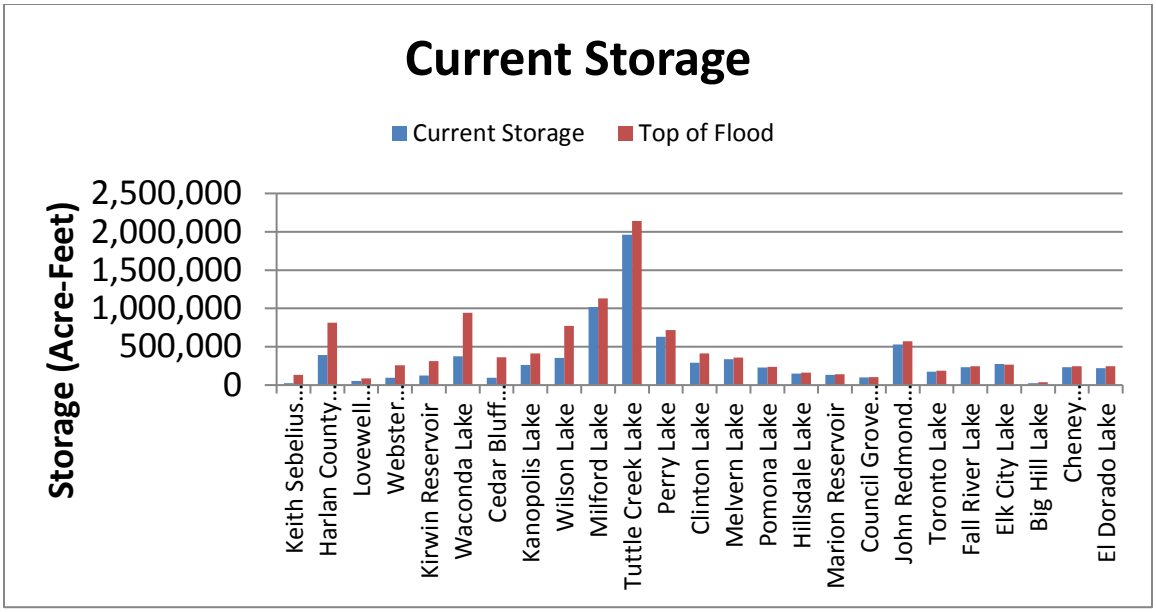
Kansas Federal Reservoir Conservation Pool Levels

Reservoir	Top of Multipurpose / Conservation Pool (Feet MSL)	Multipurpose/Conservation Pool Elevation (Feet MSL)	Change from Top of Pool (Feet)	Percent of Conservation Pool Full
Kansas River Basin		**6/6/19**		
Keith Sebelius Lake[1]	2304.3	2300.06	-4.24	75.5%
Harlan County Lake NE	1945.73	1951.12	5.39	100.0%
Lovewell Reservoir[1]	1582.6	1588.33	5.73	100.0%
Webster Reservoir[1]	1892.45	1897.00	4.55	100.0%
Kirwin Reservoir	1729.25	1734.02	4.77	100.0%
Waconda Lake[1]	1455.6	1465.88	10.28	100.0%
Cedar Bluff Reservoir	2144	2130.26	-13.74	55.0%
Kanopolis Lake[1]	1463	1495.48	32.48	100.0%
Wilson Lake[1]	1516	1526.98	10.98	100.0%
Milford Lake[1]	1144.4	1172.62	28.22	100.0%
Tuttle Creek Lake[1]	1075	1132.54	57.54	100.0%
Perry Lake[1]	891.5	917.04	25.54	100.0%
Clinton Lake[1]	875.5	893.67	18.17	100.0%
Melvern Lake[1]	1036	1055.55	19.55	100.0%
Pomona Lake[1]	974	1001.79	27.79	100.0%
Hillsdale Lake[1]	917	929.23	12.23	100.0%
Arkansas River Basin		**6/6/19**		
Marion Reservoir[1]	1350.5	1357.30	6.80	100.0%
Council Grove Lake[1]	1274	1287.96	13.96	100.0%
John Redmond Reservoir	1041	1066.54	25.54	100.0%
Toronto Lake	901.5	929.72	28.22	100.0%
Fall River Lake	948.5	986.50	38.00	100.0%
Elk City Lake	796	825.60	29.60	100.0%
Big Hill Lake	858	858.32	0.32	100.0%
Cheney Reservoir	1421.6	1427.77	6.17	100.0%
El Dorado Lake	1339	1345.67	6.67	100.0%

[1]Lake level management plan in place — Source: U.S. Army Corps of Engineers, U.S. Bureau of Reclamation and U.S. Geological Survey

Note: The conservation pool is the water storage for non-flood purposes of the reservoir, set by the elevation of the top of the pool.

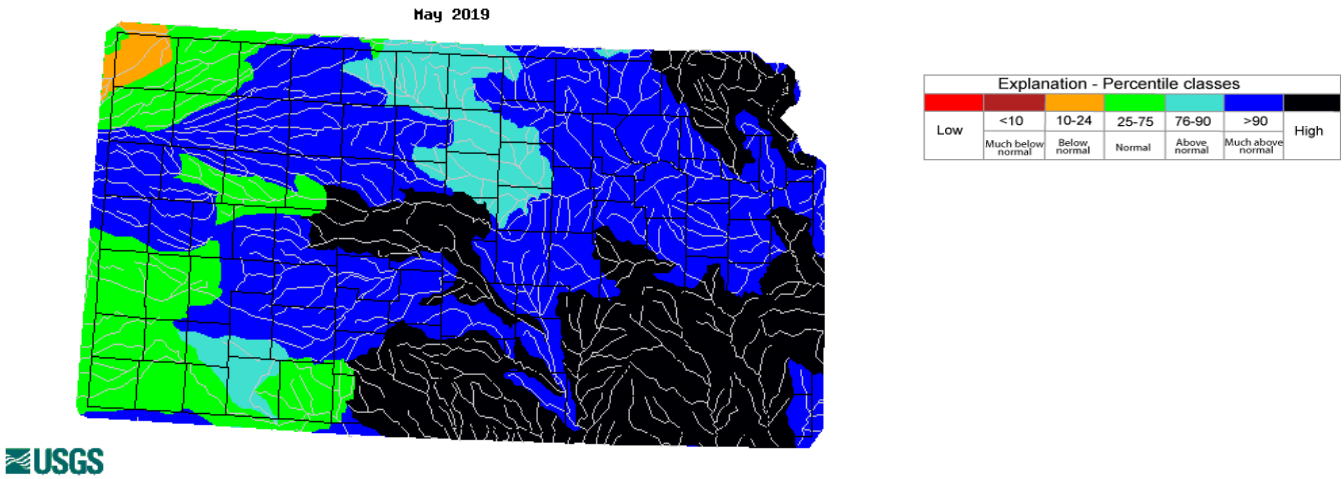
In the graph that follows blue bars indicate water in storage at that reservoir, with red bars indicate top of the flood pool storage. Some reservoirs have storage space remaining for flood flows but the available space varies. Reservoir releases continue to increase space for flood flows should they occur.



Streamflow Conditions

WaterWatch summarizes streamflow conditions in a region (state or hydrologic unit) in terms of the long-term typical condition at stream gages in the region. In general, a streamflow which is greater than the 75 percentile is considered *above normal*, a streamflow which is between 25 and 75 percentiles is considered *normal* and a streamflow which is less than the 25 percentile is considered *below normal*. Color codes are for basins with streamflow averages less than 25 percent of historic values. This comparison aids in evaluating water resources conditions for a time period. A summary of flooding in April is found later in this report.

May streamflow compared to historical streamflow



Water Right Administration/Minimum Desirable Streamflow (MDS)

Minimum Desirable Streamflow (MDS) is not being administered in Kansas. MDS administration requires water rights junior to MDS, usually with priority dates after April 12, 1984, to stop diverting water. Administration is ordered when streamflow drops below MDS for more than seven days. To rescind orders at most gages, daily average flow must be above MDS for 14 days.

There was no water right administration due to MDS in May by the Kansas Department of Agriculture, Division of Water Resources.

Flooding

In early May, the National Weather Service Wichita had river flood warnings out for 38 river points with 20 additional counties in an area flood warning! Significant flash flooding occurred during the night of May 8th, when areas southeast of Wichita picked-up between 7 and 10 inches of rainfall in a 24 hours period. Numerous water rescues took place across Mulvane, Augusta, Wellington and Rose Hill. In addition, several miles of the Kansas Turnpike was closed south of Mulvane due to the Slate Creek reaching record levels. Closing this much of the Kansas Turnpike due to flooding hasn't happened in over 30 years!

General flooding for May is shown in the USGS WaterWatch maps in the streamflow section of this report. However this does not provide all the specifics of severity of impacts and duration at specific locations. Additional flooding information can be found for USGS stream gage sites at https://waterwatch.usgs.gov/?m=flood&r=ks&w=flood%2Ctable for current stage. The USGS gage monitoring records indicate 94 gages in Kansas were at flood stage in May. Six gages were considered to have major, 48 moderate and 40 minor flooding in May. Major flooding was on the Marmaton River near Fort Scott, the Arkansas river near Hutchinson, Slate Creek at Wellington, the Walnut River at Winfield and Arkansas City and the Neosho River near Erie.

State Disaster Declarations were issued for 41 counties in May in response to flooding and storms. They are:

Original Declaration - 5/9/2019 – 07:42: Barber, Chase, Clark, Cowley, Geary, Greenwood, Harvey, Marion, Meade, Neosho, Osage, Ottawa, Reno, Rice, Sumner

Amendment - 5/20/2019: Barton, Pratt, Butler, Cloud, McPherson, Pottawatomie, Wabaunsee, Morris

Amendment –5/21/2019: Lincoln, Saline, Riley, Elk, Anderson, Crawford

Amendment –5/22/2019: Chautauqua, Clay, Coffey, Franklin, Jefferson, Montgomery

Amendment –5/24/2019: Rush

Amendment –5/29/2019: Phillips, Russell, Ellsworth, Washington, Leavenworth

Eighteen counties were identified in a Federal Emergency Declaration initialized on May 28, 2018, with additional counties added for a total of 33 counties in Kansas. The federal declarations authorize FEMA to identify, mobilize, and provide at its discretion, equipment and resources necessary to alleviate the impacts of the emergency. Emergency protective measures (Category B), limited to direct federal assistance under the Public Assistance program, will be provided at 75 percent federal funding. This assistance will be provided Allen, Anderson, Butler, Chautauqua, Cherokee, Coffey, Cowley, Crawford, Doniphan, Dickinson, Douglas, Elk, Franklin, Geary, Greenwood, Harvey, Jefferson, Leavenworth, Linn, Lyon, Marshall, Montgomery, Morris, Neosho, Osage, Pottawatomie, Reno, Riley, Saline, Sumner, Wabaunsee, Wilson, and Woodson counties.

Appendix B provides an overview of Kansas flooding in May 2019 at USGS stream gages in the WaterWatch system.

Harmful Blue-Green Algal Blooms (lake water safety)

The 2019 HAB monitoring began on April 1, 2019. KDHE samples public use lakes only in response to complaints of human or animal illness or visual sighting of possible blue-green algae by the public or lake officials.

KDHE issues three levels of public health protection notifications for blue-green algae (BGA) Blooms. Public Health Watch–Notifies public that a harmful algae may be present, that the water may be unsafe for humans and animals and contact with the water is discouraged. Public Health Warning–Notifies public that harmful algae is present of expected, that contact with the water should not occur, and all conditions of Public Health Watch remain in effect. Lake Closure –Notifies

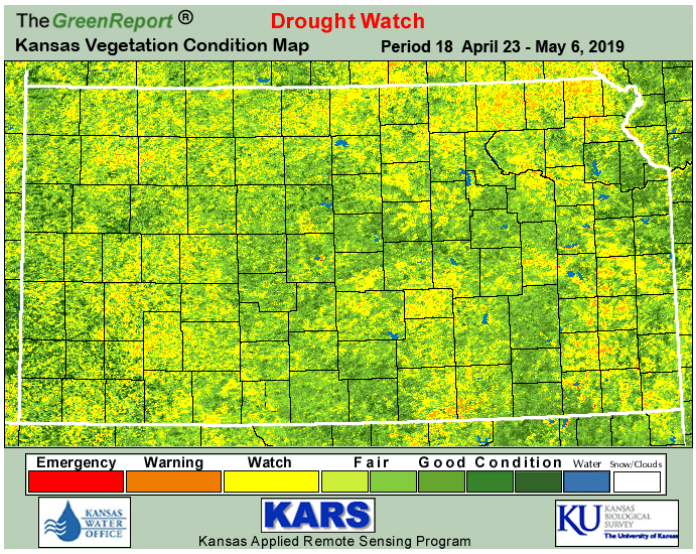
the public that a portion of the lake or the entire lake be closed to public because harmful algae is present and extreme conditions exist. More information can be found at http://www.kdheks.gov/algae-illness/index.htm.

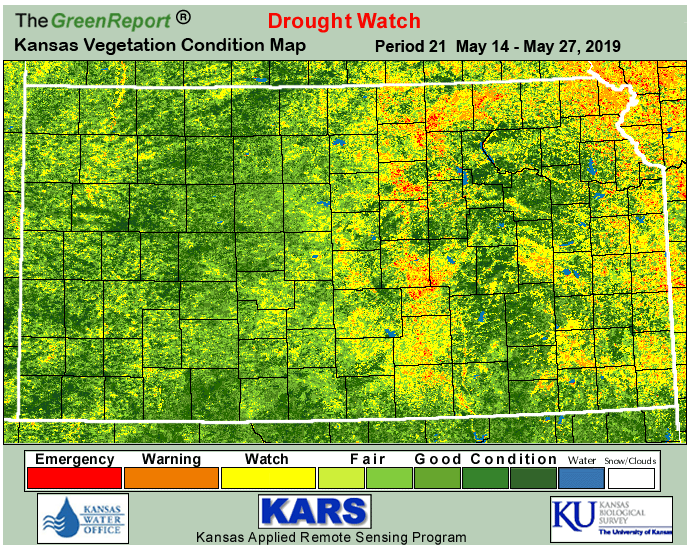
KDHE Lake Health Advisories issued in May 2019						
Lake	County	05/02/2019	05/9/2019	05/16/2019	05/23/2019	05/30/2019
Atchison County State Fishing Lake					Watch	Watch
Central Park	Shawnee			Watch	Watch	
Marion County Lake	Marion	Warning	Watch	Warning	Watch	Watch

Vegetation and Soil Moisture

Vegetative Conditions

The Vegetative Condition map provides current conditions related to drought effects on vegetation. It is produced using satellite data. Areas in yellow, orange and red indicate areas of vegetative stress. The green areas are considered to be in good or excellent condition. Change can be seen comparing the two GreenReports below from early and late May.





Soil Moisture and Rangeland

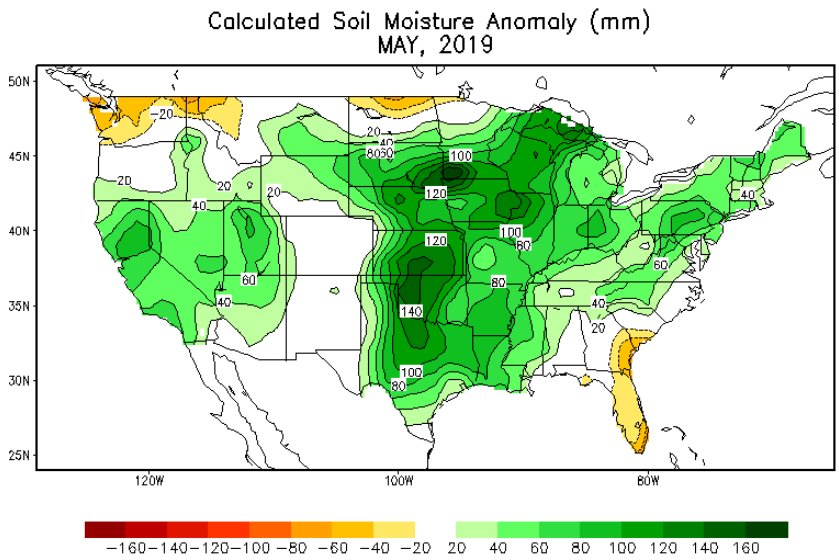
The National Agricultural Statistics Service, USDA Crop Progress and Condition provides a summary of the climatic effects on soil, and livestock feed. For the week ending May 26, 2019, topsoil moisture supplies rated 0 percent very short, 0 short, 51 adequate, and 49 surplus. Subsoil moisture supplies rated 0 percent very short, 1 short, 60 adequate, and 39 surplus.

Field Crops Report: Winter wheat condition rated 3 percent very poor, 9 poor, 33 fair, 45 good, and 10 excellent. Winter wheat jointed was 64 percent.

Soybeans planted was 22 percent, behind 63 last year and 41 average.

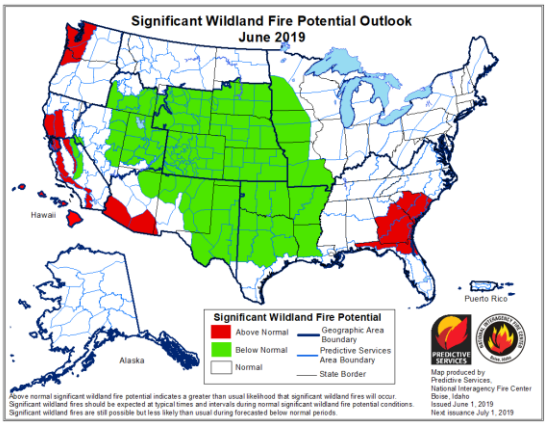
Corn planted was 70 percent, behind average of 88 and last year's 91 percent.

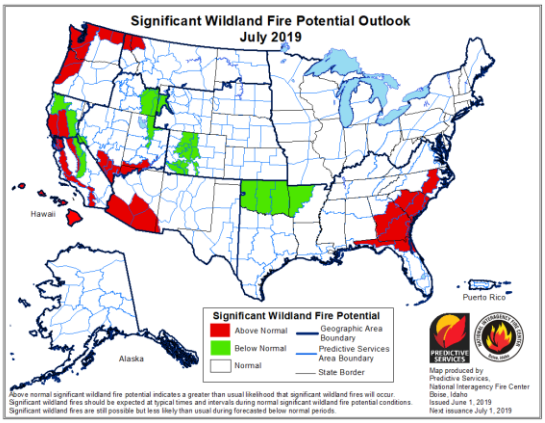
The Climate Prediction Center (CPC), also monitors soil moisture and predicts future soil moisture. Anomalies are defined as deviations from the 1971-2000 monthly climatology. The soil anomaly is provided below. (.http://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)



Fire

Significant Wildland Fire Potential Outlook is issued monthly for the United States, https://www.predictiveservices.nifc.gov/outlooks/monthly_seasonal_outlook.pdf .





Kansas Forest Service provides a grassland fire danger index at**:** http://www.kansasforests.org/fire_management/grasslandfireindex.html .

Kansas Climate Summary

The Kansas Weekly Climate Summary and Drought Report are compiled at least monthly, more frequently when conditions warrant, by the KWO. Information from various federal, state, local and academic sources is used. Some of the data is preliminary and subject to change once final data is available. The KWO web site, http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response , contains additional drought information including links to other agencies with drought information and past issues of the Kansas Climate Summary and Drought Report. Kansas State Climatologist, Mary Knapp, is the primary source of the narrative on weather. She works closely with meteorologists throughout the state and region. Details of current conditions at Evapotranspiration (ET) and Mesonet sites across Kansas are available at http://mesonet.k-state.edu/

RESOURCES and REFERENCES

Kansas climate data is provided by Kansas State University, Weather Data Library through the Kansas Mesonet. (http://www.ksre.k-state.edu/wdl/). Soil moisture data was added in 2018 (http://mesonet.k-state.edu/agriculture/soilmoist)

The U.S. Drought Monitor, from the National Drought Mitigation Center at the University of Nebraska-Lincoln, provides a "big picture" perspective of conditions across the nation. In the Kansas county drought stage scheme, a Drought Watch equates roughly to moderate drought in the U.S. Drought Monitor, while a Drought Warning is the equivalent of severe drought. A Drought Emergency is reserved for extreme or exceptional drought. Palmer Drought Severity Index - The Palmer Index (PDSI) is one indicator used in the U.S. Drought Monitor.

The High Plains Regional Climate Center (https://hprcc.unl.edu/) has precipitation and temperature summary maps available at the state, region and nation.

The U.S. Geological Survey (USGS) Drought Watch provides information average streamflow measured at long-term gaging stations and compares them to normal flows.

The Kansas Department of Agriculture-Division of Water Resources monitors stream flow using the USGS gages for determination of administrative needs. Administration may be needed due to Minimum Desirable Streamflow (MDS) requirements, impairments and reservoir release protection. (https://agriculture.ks.gov/divisions-programs/dwr/water-appropriation/minimum-desirable-streamflow.)

The water levels of the federal lakes fluctuate during a year according to the management plan. Lake level Management plans are posted on the Kansas Water Office web site www.kwo.ks.gov .

The Kansas Applied Remote Sensing Program (KARS) at the University of Kansas produces a Kansas Green Report each week during the growing season. For a full set of national and regional ***GreenReport***® maps, go to: http://www.kars.ku.edu/products/greenreport/greenreport.shtml. This Kansas Vegetation Drought Response Index map is developed weekly by the Kansas Biological Survey using state drought triggers as its key. In addition the VegDRI maps may be found at http://vegdri.unl.edu/

The National Weather Service (NWS) provides fire weather products and services for Kansas that include the Rangeland Fire Danger Index, Fire Weather Forecasts, Red Flag Watches/Warnings and Spot Forecasts. The five NWS offices that serve Kansas websites may be accessed from the NWS Offices' page.

The Monthly and Seasonal Drought Outlooks, developed by the NOAA Climate Prediction Center, assess the likelihood for improvement, persistence or deterioration in drought conditions for areas currently experiencing drought as identified by the U.S. Drought Monitor. (http://www.cpc.ncep.noaa.gov/) Also see: http://www.noaa.gov/.

Responding to Drought: A Guide for City, County and Water System Officials provides an overview of Kansas county drought stage declarations, local planning and coordination, disaster declarations and available state and federal assistance. The 2007 Municipal Water Conservation Plan Guidelines and the Drought Vulnerability Assessment Report, both by KWO, provide guidance regarding drought preparedness and response. These are available at http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response.

USDA Drought Programs and Assistance website (https://www.usda.gov/topics/disaster/drought/usda-drought-programs-and-assistance) listing the various USDA programs and agencies to assist with drought issues.

The National Interagency Coordination Center in Boise, Idaho, produces wildfire potential outlook maps monthly. (https://www.predictiveservices.nifc.gov/outlooks/outlooks.htm)

Please contact Diane Knowles at the Kansas Water Office (785) 296-3185 or diane.knowles@kwo.ks.gov should you have any questions or suggestions.

APPENDIX A
Monthly Weather Summary

May Summary							
	Precipitation (inches)			Temperature oF			
						Extreme (Date)	
Station[1]	Total	Departure[2]	Percent Normal	Mean	Departure[2]	Highest	Lowest
West							
Burlington, CO	3.72	1.14	144%	54.7	-3.9	92 (16)	32 (10)
Dodge City	8.42	5.57	295%	60.8	-3.4	89 (16)	36 (10)
Garden City	5.40	2.52	188%	58.5	-4.8	89 (16)	34 (22)
Goodland	5.10	2.15	173%	55.0	-4.4	91 (16)	32 (2)
Guymon, OK	3.88	1.44	159%	61.2	-3.2	92 (16)	36 (22,10)
Hill City	8.01	4.23	212%	58.9	-3.6	94 (16)	30 (10)
Lamar, CO	1.22	-1.80	40%	57.6	-4.6	96 (16)	26 (22)
McCook, NE	4.56	1.42	145%	56.0	-3.6	93 (16)	28 (22)
Springfield, CO	2.92	0.56	124%	55.6	-5.8	90 (16)	30 (22)
Central							
Concordia	8.76	4.60	211%	62.5	-0.6	93 (16)	39 (10)
Hebron, NE	7.61	2.81	159%	60.3	-1.4	93 (16)	37 (10)
Medicine Lodge	12.12	8.82	367%	63.6	-3.7	91 (15)	37 (10)
Ponca City, OK	10.82	6.01	225%	66.7	-0.9	89 (16,15)	41 (10)
Salina	8.72	3.97	184%	62.8	-2.5	91 (16)	39 (10)
Wichita (ICT)	12.64	8.07	277%	64.8	-1.2	89 (16)	43 (10)
East							
Bartlesville, OK	15.41	10.09	290%	67.0	-0.7	88 (16,15)	39 (10)
Chanute	18.01	12.21	311%	66.5	0.6	89 (16)	39 (10)
Falls City, NE	10.00	5.42	218%	61.8	-2.0	92 (16)	37 (10)
Johnson Co. Exec. Apt	9.24	3.81	170%	62.7	-2.1	87 (16)	38 (10)
Joplin, MO	14.17	8.46	248%	64.4	-0.6	85 (24,23)	40 (10)
Kansas City (MCI), MO	12.82	7.59	245%	62.9	-1.6	89 (16)	36 (10)
St. Joseph, MO	7.04	1.62	130%	62.7	-1.7	93 (16)	38 (13,10)
Topeka (TOP)	9.99	5.08	203%	64.0	-1.0	93 (16)	37 (10)

1. Airport Automated Observation Stations (NWS/FAA)
2. Departure from 1981-2010 normal value

T - Trace; M - Missing; --- no normal value from which to calculate departure or percent of normal

Source: National Weather Service F-6 Climate Summaries

APPENDIX B-Flooding

Data from WaterWatch-USGS

Summary of May Flooding and High Flows

["--", no data; "<", less than all historical peak]

USGS Station Name	No. Days above flood stage	NWS flood class	Highest peak 2019-05-01 to 2019-05-31				Historical Peaks	
			Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
TURKEY C NR SENECA, KS	5	Minor	5/24/2019	23.26	10400	24	69	21400 (1973)
MISSOURI R AT ATCHISON, KS	25	Moderate	5/31/2019	29.26	--	--	--	--
MISSOURI R AT LEAVENWORTH, KS	16	Moderate	5/31/2019	28.59	--	--	--	--
PRAIRIE DOG C AB KEITH SEBELIUS LAKE, KS	1	Moderate	5/27/2019	12.94	1220	13	56	65500 (1953)
PRAIRIE DOG C NR WOODRUFF, KS	1	Minor	5/27/2019	22.26	3200	10	77	15000 (1947)
REPUBLICAN R NR HARDY, NE	3	Minor	5/30/2019	11.99	6760	43	99	225000 (1935)
REPUBLICAN R AT CLAY CENTER, KS	16	Minor	5/8/2019	19.91	12600 (2019-05-09)	52	102	195000 (1935)
SMOKY HILL R BL SCHOENCHEN, KS	2	Minor	5/22/2019	12.26	3800	4	35	20500 (1993)
SMOKY HILL R NR RUSSELL, KS	2	Moderate	5/25/2019	20.48	10500	13	43	70000 (1938)
SMOKY HILL R AT ELLSWORTH, KS	3	Minor	5/26/2019	20.9	13400	25	110	61000 (1938)
SMOKY HILL R AT LINDSBORG, KS	7	Minor	5/22/2019	23.99	6530	11	44	32000 (1903)
SMOKY HILL R NR MENTOR, KS	5	Minor	5/22/2019	21.47	5060	33	83	32000 (1903)
SALINE R AT TESCOTT, KS	10	Moderate	5/23/2019	29.69	4730	28	99	61400 (1951)
MULBERRY C NR SALINA, KS	4	Moderate	5/8/2019	26.04	9380	3	56	29900 (2007)
SMOKY HILL R AT NEW CAMBRIA, KS	14	Moderate	5/23/2019	30.67	--	--	--	--
NF SOLOMON R AT GLADE, KS	2	Minor	5/28/2019	13.67	2960	20	65	23300 (1957)
BOW C NR STOCKTON, KS	1	Minor	5/28/2019	9.88	867	32	67	12900 (1951)
NF SOLOMON R AT PORTIS, KS	2	Minor	5/29/2019	18.81	3960	34	72	35700 (1951)
SF SOLOMON R AT WOODSTON, KS	4	Minor	5/28/2019	13.39	1810	8	39	8710 (1993)
SF SOLOMON R AT OSBORNE, KS	9	Minor	5/29/2019	16.9	2490 (2019-05-30)	27	72	81200 (1951)
SALT C NR ADA, KS	15	Moderate	5/24/2019	20.68	2880	14	58	16000 (1961)
SOLOMON R AT NILES, KS	14	Moderate	5/25/2019	29.1	10100	20	107	178000 (1951)
SMOKY HILL R AT ENTERPRISE, KS	18	Moderate	5/25/2019	30.52	28700	10	87	233000 (1951)
CHAPMAN C NR CHAPMAN, KS	11	Minor	5/22/2019	21.52	5800	18	65	46700 (1951)
LYON C NR JUNCTION CITY, KS	5	Minor	5/9/2019	28.17	9360	1	7	5957 (2015)
WILDCAT C AT KEATS, KS	2	Moderate	5/8/2019	21.17	--	--	--	--
WILDCAT C AT SCENIC DRIVE, MANHATTAN, KS	2	Moderate	5/8/2019	20.02	4400	1	6	3920 (2014)
KANSAS R AT MANHATTAN, KS	9	Minor	5/26/2019	19.29	--	--	--	--
MILL C AT WASHINGTON, KS	2	Moderate	5/25/2019	22.42	6740	18	59	14600 (1993)
L BLUE R NR BARNES, KS	7	Minor	5/31/2019	19.46	19000 (2019-05-29)	16	60	56000 (2015)
BIG BLUE R AT BLUE RAPIDS, KS	31	Moderate	5/31/2019	61.31	--	--	--	--

BLACK VERMILLION R NR FRANKFORT, KS	16	Moderate	5/31/2019	29.21	17000 (2019-05-08)	11	66	38300 (1959)
FANCY C AT WINKLER, KS	24	Moderate	5/31/2019	34.43	6900 (2019-05-08)	16	37	24000 (1972)
BIG BLUE R NR MANHATTAN, KS	3	Minor	5/31/2019	22.35	31200	6	65	93400 (1951)
MILL C NR PAXICO, KS	5	Minor	5/26/2019	27.64	22100	14	65	77200 (1951)
KANSAS R AT LECOMPTON, KS	5	Minor	5/9/2019	18.02	78300	28	104	483000 (1951)
KANSAS R AT LAWRENCE, KS	7	Minor	5/9/2019	19.06	73300	3	5	92600 (2016)
WAKARUSA R AT WAKARUSA, KS	2	Minor	5/8/2019	17.02	--	--	--	--
STRANGER C AT EASTON, KS	7	Moderate	5/22/2019	20.31	6220	3	3	10213 (2016)
STRANGER C NR TONGANOXIE, KS	3	Minor	5/21/2019	23.28	6770	42	89	40000 (2001)
KANSAS R AT KANSAS CITY, KS	12	Minor	5/31/2019	39	--	--	--	--
INDIAN C AT STATE LINE RD, LEAWOOD, KS	3	Minor	5/24/2019	21.87	9280	10	14	23573 (2017)
MARAIS DES CYGNES R NR READING, KS	5	Moderate	5/7/2019	23.45	8340	20	49	67400 (1982)
SALT C AT LYNDON, KS	3	Minor	5/1/2019	15.44	11400	2	18	16400 (2007)
DRAGOON C NR BURLINGAME, KS	3	Minor	5/8/2019	21.22	9450	14	58	25000 (2007)
MARAIS DES CYGNES R NR POMONA, KS	12	Minor	5/22/2019	29.31	18400	11	64	69400 (1928)
MARAIS DES CYGNES R NR OTTAWA, KS	6	Moderate	5/22/2019	34.2	19100	21	110	142000 (1951)
POTTAWATOMIE C NR GARNETT, KS	6	Minor	5/21/2019	30.92	21700	13	63	57000 (1961)
POTTAWATOMIE C AT LANE, KS	7	Moderate	5/22/2019	27.44	24300	7	28	75000 (1961)
MARAIS DES CYGNES R AT LA CYGNE, KS	23	Moderate	5/23/2019	33.18	36700	8	33	131000 (2007)
MARAIS DES CYGNES R NR KS-MO ST LINE, KS	21	Moderate	5/26/2019	38.55	51500	4	59	137000 (2007)
L OSAGE R AT FULTON, KS	9	Moderate	5/22/2019	28.96	19200	6	69	62800 (1986)
MARMATON R NR FORT SCOTT, KS	4	Major	5/21/2019	43.45	22500	14	59	38100 (1961)
PAWNEE R AT ROZEL, KS	5	Moderate	5/25/2019	34.53	5440	14	93	16300 (1958)
ARKANSAS R AT GREAT BEND, KS	7	Minor	5/28/2019	14.37	10200 (2019-05-29)	7	78	27800 (1965)
WALNUT C AT ALBERT, KS	7	Moderate	5/26/2019	25.11	2530 (2019-05-27)	12	60	12700 (1959)
RATTLESNAKE C NR ZENITH, KS	3	Minor	5/29/2019	17.24	761	12	45	29300 (1993)
COW C NR LYONS, KS	11	Minor	5/9/2019	19.45	9740	7	73	28000 (1929)
COW C NR HUTCHINSON, KS	21	Moderate	5/9/2019	12.38	--	--	--	--
ARKANSAS R NR HUTCHINSON, KS	17	Major	5/10/2019	12.99	16500 (2019-05-22)	5	58	24700 (1973)
L ARKANSAS R AT ALTA MILLS, KS	13	Moderate	5/9/2019	25.79	10800	9	45	30100 (1973)
L ARKANSAS R AT HWY 50 NR HALSTEAD, KS	13	Moderate	5/9/2019	27.12	9960	3	22	11000 (2007)
EMMA C AT SEDGWICK, KS	4	Minor	5/21/2019	20.14	7690	1	3	7308 (2016)
L ARKANSAS R NR SEDGWICK, KS	12	Moderate	5/22/2019	25.82	19400	1	24	17600 (1998)
COWSKIN C AT 119TH ST AT WICHITA, KS	5	Minor	5/8/2019	20.04	4020	3	17	5870 (2009)

ARKANSAS R AT DERBY, KS	13	Moderate	5/24/2019	15.53	40300 (2019-05-22)	7	49	58300 (1998)
ARKANSAS R AT MULVANE, KS	15	Moderate	5/25/2019	20.28	40800	1	3	28238 (2016)
SF NINNESCAH R NR PRATT, KS	1	Minor	5/8/2019	11.08	3350	6	37	26200 (1991)
SF NINNESCAH R NR MURDOCK, KS	9	Moderate	5/21/2019	11.02	11900	14	67	28700 (1979)
NINNESCAH R NR PECK, KS	9	Minor	5/9/2019	19.94	23700 (2019-05-22)	13	81	70000 (1923)
ARKANSAS R ON HWY 160 AT OXFORD, KS	18	Moderate	5/10/2019	21.67	51600	1	4	36449 (2016)
SLATE C AT WELLINGTON, KS	12	Major	5/8/2019	26.05	24400	2	58	28500 (1975)
ARKANSAS R AT ARKANSAS CITY, KS	21	Moderate	5/9/2019	20.91	65500	9	100	103000 (1923)
WB WALNUT R NR EL DORADO, KS	2	Minor	5/25/2019	21.41	6950	1	8	6469 (2016)
WHITEWATER R AT AUGUSTA, KS	11	Moderate	5/8/2019	29.23	--	--	--	--
WALNUT R AT WINFIELD, KS	16	Major	5/8/2019	36.84	77700	6	99	105000 (1944)
WALNUT R AT ARKANSAS CITY, KS	15	Major	5/9/2019	28.52	--	--	--	--
MEDICINE LODGE R NR KIOWA, KS	6	Moderate	5/9/2019	12.14	7350	11	74	16000 (1941)
CHIKASKIA R NR CORBIN, KS	12	Moderate	5/8/2019	19.53	25800	8	59	60000 (1923)
CROOKED C NR ENGLEWOOD, KS	1	Minor	5/30/2019	6.5	227	49	75	13600 (1955)
VERDIGRIS R NR ALTOONA, KS	10	Moderate	5/26/2019	21.79	29600	12	79	71000 (1951)
FALL R AT FREDONIA, KS	8	Moderate	5/26/2019	31.77	28700	11	83	77800 (2007)
VERDIGRIS R AT INDEPENDENCE, KS	12	Minor	5/27/2019	45.35	75900	10	103	168823 (2017)
NEOSHO R NR AMERICUS, KS	4	Moderate	5/8/2019	27.22	13500	6	54	17400 (1993)
COTTONWOOD R NR FLORENCE, KS	4	Moderate	5/8/2019	27.2	35300	5	57	73700 (1998)
COTTONWOOD R NR PLYMOUTH, KS	11	Moderate	5/9/2019	34.34	37700	5	55	92900 (1998)
COTTONWOOD R AT EMPORIA, KS	20	Moderate	5/9/2019	26.17	19000	1	4	18672 (2017)
NEOSHO R AT NEOSHO RAPIDS, KS	24	Moderate	5/10/2019	27.11	30700	1	8	26451 (2016)
NEOSHO R AT BURLINGTON, KS	9	Minor	5/26/2019	32.73	36500	1	57	26200 (1961)
NEOSHO R NR IOLA, KS	18	Moderate	5/25/2019	21.38	54800	9	111	436000 (1951)
NEOSHO R NR ERIE, KS	19	Major	5/27/2019	38.92	--	--	--	--
NEOSHO R NR PARSONS, KS	22	Moderate	5/28/2019	29.75	69900	6	96	410000 (1951)
LIGHTNING C NR MCCUNE, KS	15	Moderate	5/21/2019	17.8	19600	13	67	67500 (1993)
SPRING R NR BAXTER SPRINGS, KS	10	Moderate	5/23/2019	27.35	98500	3	8	145714 (2015)

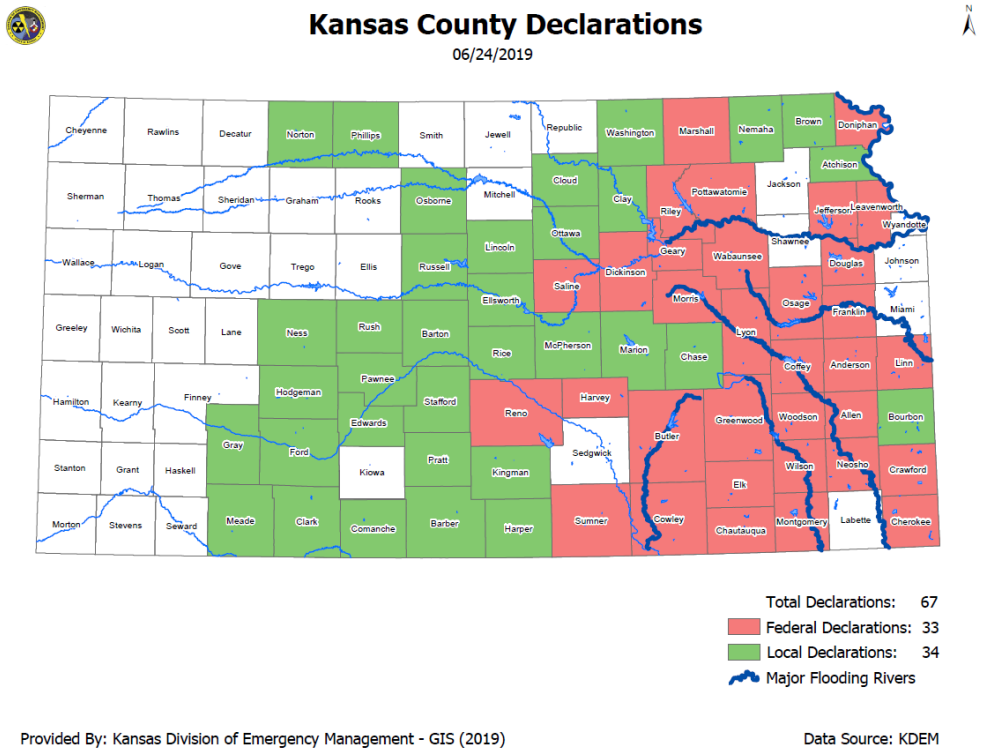
KANSAS CLIMATE UPDATE
June 2019 Summary

Highlights

- June continued drought free thanks to record May moisture and continued large precipitation events and storms resulting in flooding in many parts of Kansas.

- Large variations in soil moisture continued in June with excessively wet conditions across Kansas. According to the National Centers for Environmental Information, Kansas had its second wettest May-June.

- Kansas County Declarations continued for flooding in June, listing 67counties as of June 24. Federal declarations are in place for 33 of these counties. FEMA-3412-EM allows for federal assistance to supplement state and local efforts.



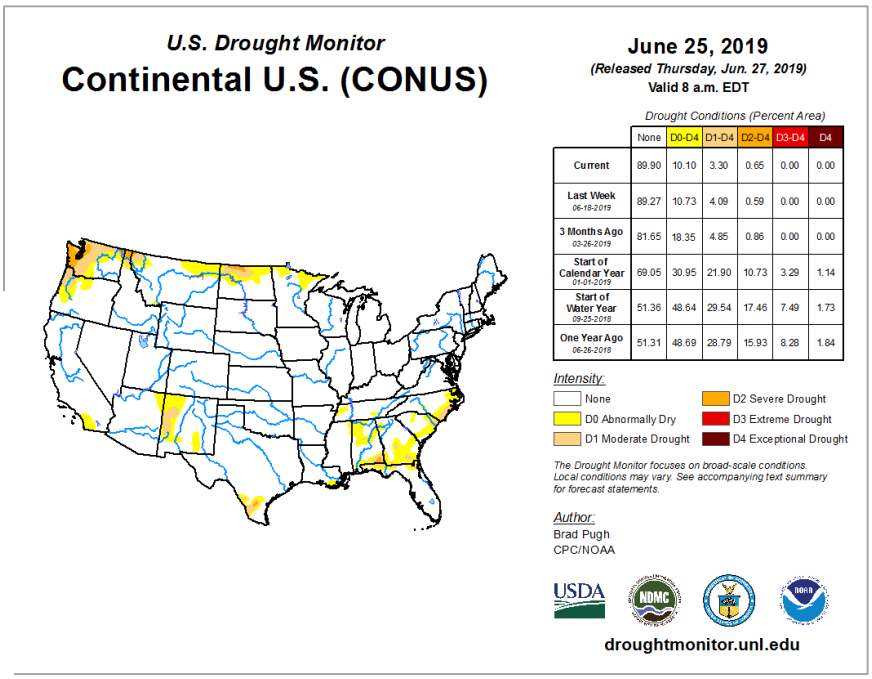
- June flooding occurred at 70 USGS stream gages on at least 38 streams for one to as much as 30 days.

- Major flood category of the National Weather Service was reached along the Arkansas, near Hutchinson in June. The Missouri, Smoky Hill, Big Blue, Black Vermillion, Kansas Marais des Cygnes Little Arkansas, Cottonwood and Neosho rivers and Fancy, Soldier, Stranger Cow creeks reaching moderate flood stage in June.

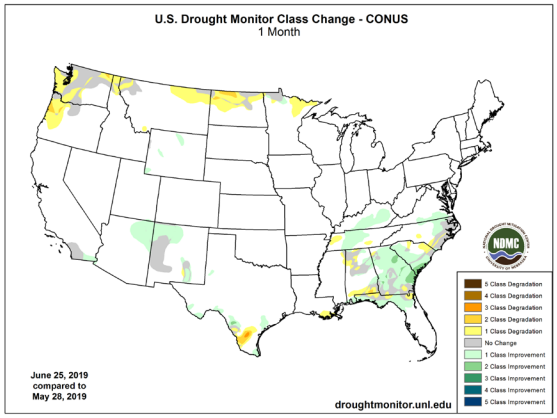
- Multiple Federal flood control reservoirs reached over 90 percent of flood pool capacity in June.

General Drought Conditions

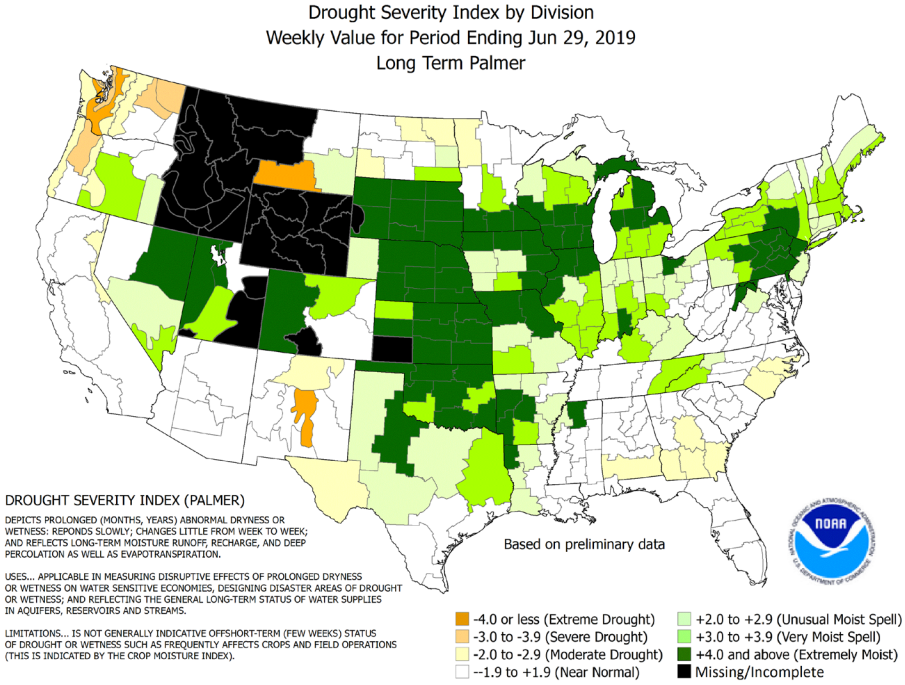
Kansas became drought free by the U.S. Drought Monitor in January 2019, but as the year has progressed it is flooding due to above normal rains that is the major climate issue. Minor pockets of abnormally dry conditions developed for a week or two in April and May. Changes in drought classification over the month for the High Plains, including Kansas is also shown.



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	89.90	10.10	3.30	0.65	0.00	0.00
Last Week 06-18-2019	89.27	10.73	4.09	0.59	0.00	0.00
3 Months Ago 03-26-2019	81.65	18.35	4.85	0.86	0.00	0.00
Start of Calendar Year 01-01-2019	69.05	30.95	21.90	10.73	3.29	1.14
Start of Water Year 09-25-2018	51.36	48.64	29.54	17.46	7.49	1.73
One Year Ago 06-26-2018	51.31	48.69	28.79	15.93	8.28	1.84



More information can be found on the U.S. Drought Monitor web site https://droughtmonitor.unl.edu/ .
Palmer Drought Severity Index (PDSI) - The Palmer Drought Severity Index is an indicator of relative dryness or wetness and is one factor used the U.S. Drought Monitor. More information on the PDSI can be found at http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml.

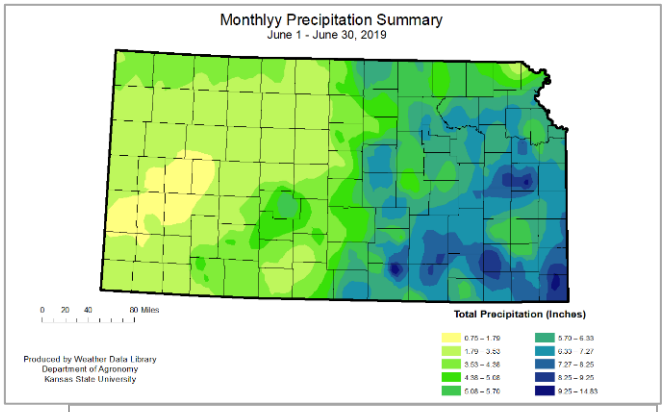


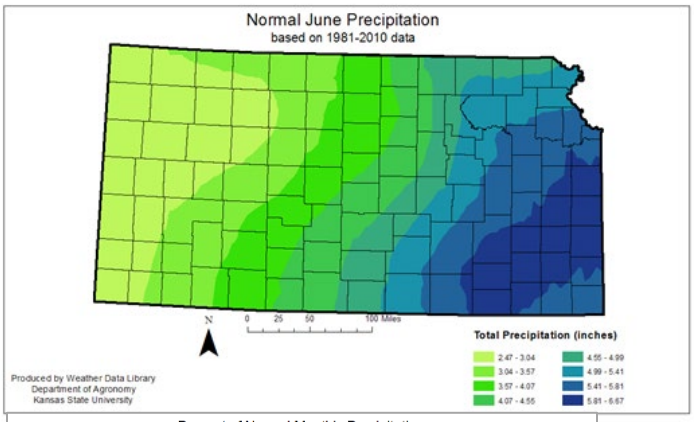
Climate Summary - Precipitation

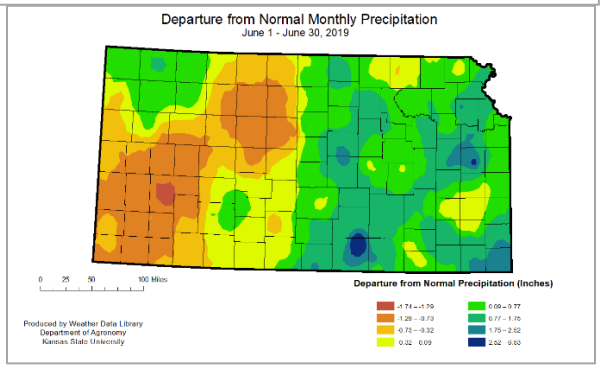
While, not a record setter like May, June continued the wetter than normal pattern that has dominated the year. State-wide average precipitation for the month was 4.41 inches, 104 percent of normal. Above normal precipitation was reported in the Central, East Central, South Central and Southeastern Climate Divisions. The remaining divisions were below normal for the month. The West Central Division was the driest, compared to normal, with an average of 2.83 inches, 83 percent of normal. In contrast, the Southeast Division averaged 7.09 inches, 119 percent of normal. The highest 24-hour rainfall total for a National Weather Service Cooperative station was 10.00 at Belle Plaine 4W, Summer County, on the 12th. The greatest 24-hour rainfall total for a Community Collaborative Rain, Hail and Snow network station was 6.15 inches at Neodesha 5.0 WSW, Wilson County, on the 16th. The greatest monthly precipitation totals for June: 14.83 at Belle Plaine 4W, Summer County (NWS) and 10.75 inches at Ottawa 5.6 SW, Franklin County (CoCoRaHS). (KSU Weather Data Library)

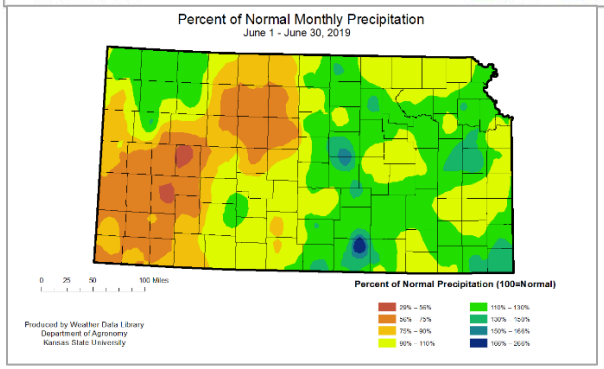
Kansas Climate Division Precipitation Summary (inches)												
	June 1 - 30, 2019			January 1 - June 30, 2019			April 1, 2019 - June 30, 2019			Sept 1, 2018 - June 30, 2019		
Climate Division	Actual	Depart Normal*	%	Actual	Depart Normal*	%	Actual	Depart Normal*	%	Actual	Depart Normal*	%
Northwest	2.52	-0.31	89	12.07	1.40	113	9.72	1.35	116	19.18	4.04	127
West Central	2.32	-0.49	83	12.68	2.43	124	9.39	1.64	121	21.80	7.08	148
Southwest	2.77	-0.44	86	13.32	3.36	134	10.03	2.45	132	21.93	7.51	152
North Central	3.63	-0.20	95	17.48	3.56	126	13.85	3.41	133	31.18	10.53	151
Central	4.47	0.39	110	20.40	5.43	136	16.63	5.62	151	34.50	12.72	158
South Central	5.73	0.94	120	25.86	9.36	157	21.86	9.98	184	40.66	16.31	167
Northeast	4.69	-0.45	91	23.99	6.60	138	18.58	5.40	141	39.16	12.43	147
East Central	5.90	0.32	106	26.65	7.44	139	21.07	6.78	147	39.68	10.16	134
Southeast	7.09	1.15	119	33.55	11.95	155	27.46	11.85	176	48.35	14.66	144
STATE	4.41	0.15	104	20.86	5.92	140	16.71	5.61	151	33.13	10.80	148

The maps below summarizing normal precipitation for the month are from the K-State Weather Data Library and / or the High Plans Regional Climate Center. (National Weather Service maps use data from the Applied Climate Information Network. State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)









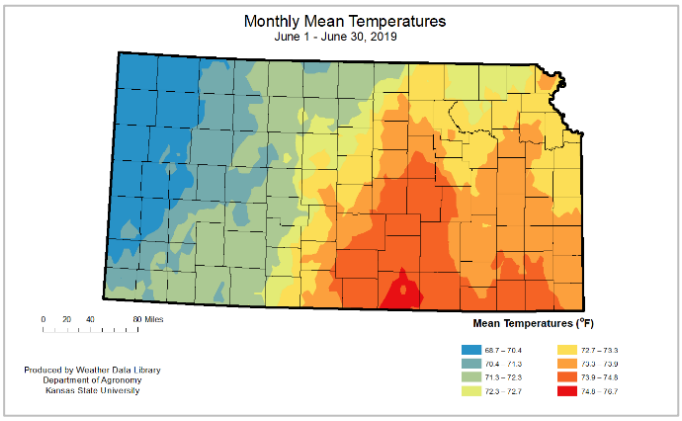
Climate Summary-Temperature

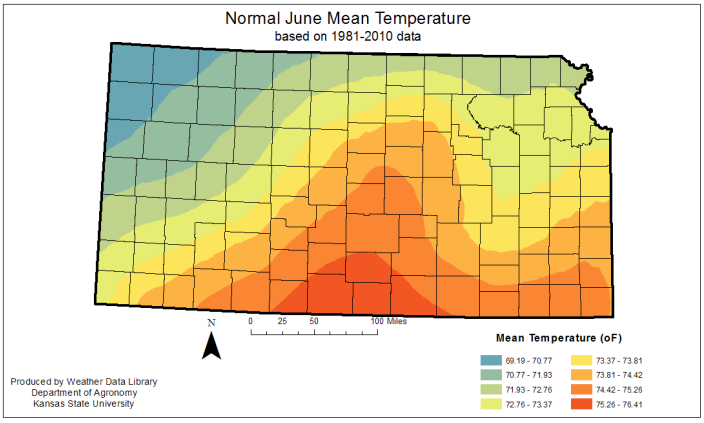
June temperatures fell in the middle of the distribution for the period of record. State-wide average temperature for the month was 72.7 ºF, which is 0.8 degrees cooler than normal. This ranks as the 46th coolest on record. The East Central Climate Division averaged exactly normal at 73.2 ºF. The remaining divisions were all cooler than normal. The Southwest Division had the largest departure with an average of 71.8 ºF, 1.7 degrees cooler than normal. Despite the cooler pattern, only the eastern divisions failed to break the century mark for maximum temperatures. The warmest maximum temperature was 105 ºF at Oakley 4W, Logan County, on the 28th. The coldest minimum temperature was 36 ºF at Syracuse 1NE, Hamilton County, on the 10th. There were no record maximum temperatures, but one new record warm minimum was established: 78 ºF at the Wichita Dwight D. Eisenhower National Airport on the 21st. Cold daily records were more numerous, with 2 record low maximums and 27 record low minimums. (KSU Weather Data Library)

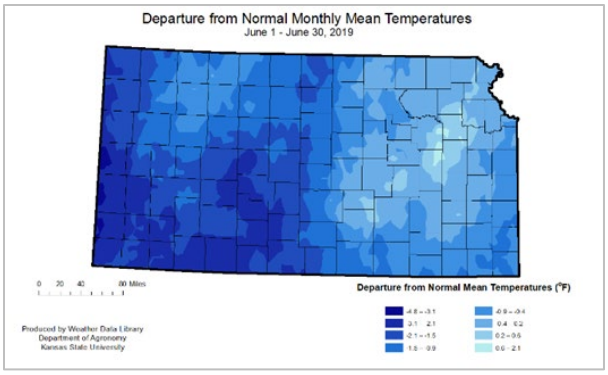
Climate Division	Kansas Climate Division Temperature Summary (ºF)							
	June 2019							
	Maximum	Minimum	Average	Departure*	High	Date	Low	Date
Northwest	84.0	55.1	69.6	-1.3	104	28	39	10
West Central	85.2	56.2	70.7	-1.1	105	28	38	10
Southwest	86.1	57.4	71.8	-1.7	103	28	36	10
North Central	85.0	60.4	72.7	-0.7	101	29	45	13
Central	85.4	61.0	73.2	-1.2	103	30	43	10
South Central	85.8	61.8	73.8	-1.2	100	30	45	10
Northeast	83.7	61.3	72.5	-0.3	97	29	46	13
East Central	83.6	62.9	73.2	0.0	97	30	46	13
Southeast	84.1	63.3	73.7	-0.5	97	30	47	13
STATE	84.8	59.9	72.4	-0.9	105	28th	36	10th

*Departure from normal is departure from the base period of 1981-2010, KSU Weather Data Library.

The maps below summarizing temperature for the month are from the K-State Weather Data Library and / or the High Plans Regional Climate Center. (National Weather Service maps use data from the Applied Climate Information Network. State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)

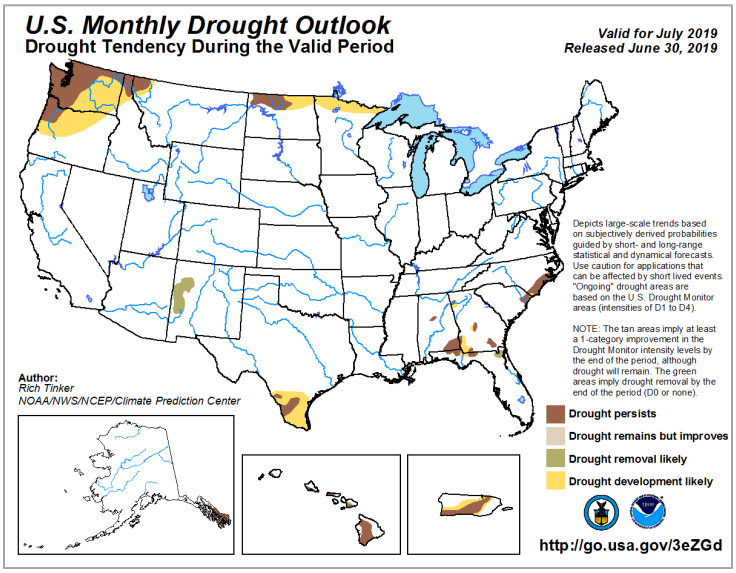


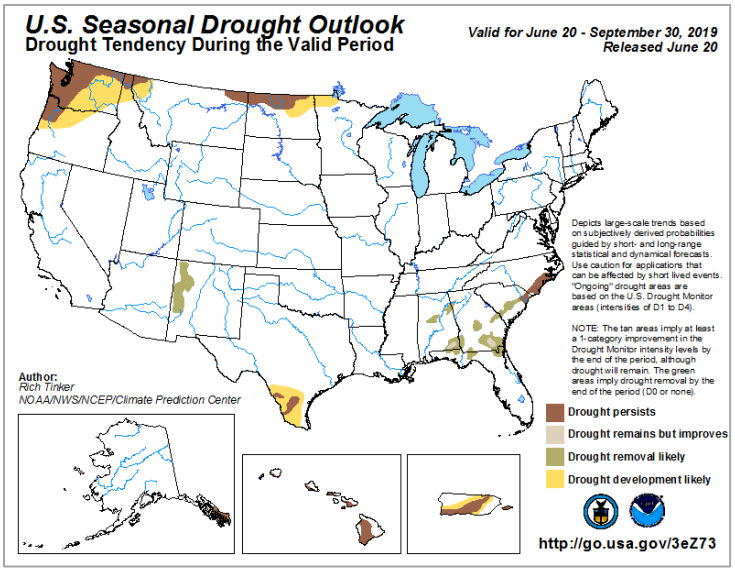




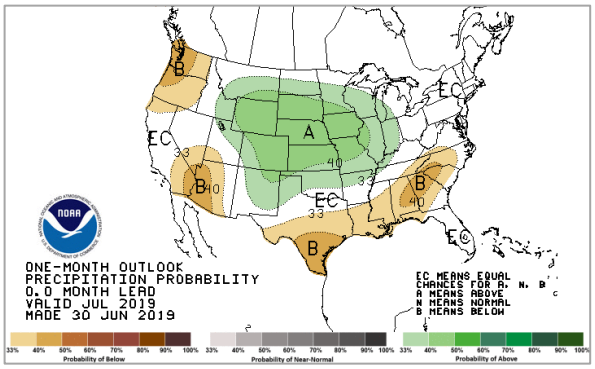
June severe weather wasn't quite as active as May. There were 20 tornadoes reported during the month. Prelimary reports indicate no injuries or fatalities. June 8th was the most active day when 12 tornadoes were reported in Northwest KS. Hail and damaging wind events were also numerous.

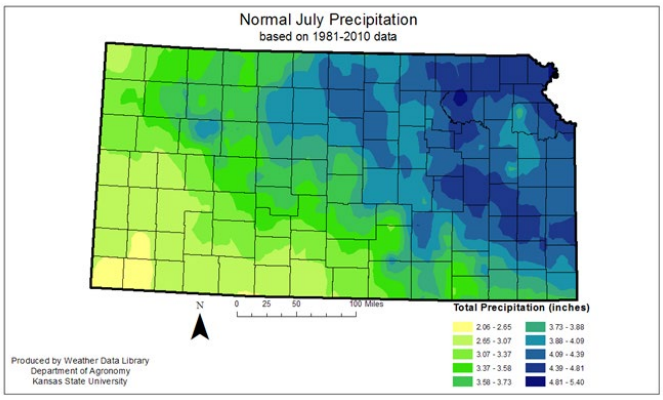
The Monthly Drought Outlook for July 2019 indicates no anticipated drought conditions in Kansas. The Seasonal Outlook (3-month) also favors no drought in Kansas through the summer. The individual temperature and precipitation outlooks that contribute to these outlooks are available below.

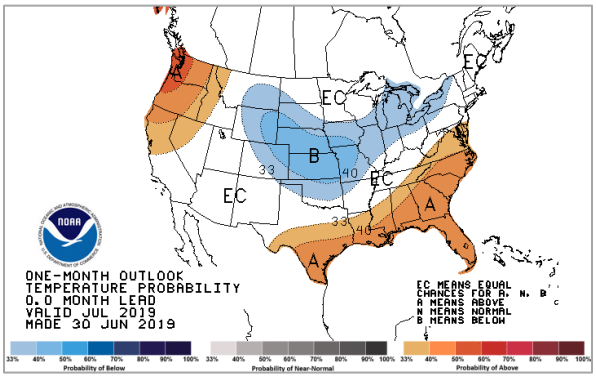


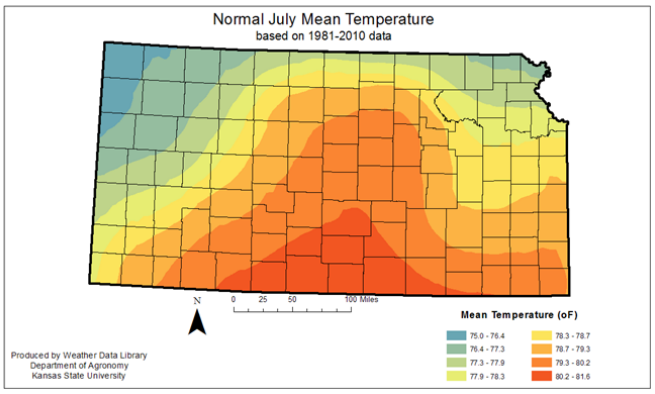


The July precipitation outlook favors a slightly increased chance of above normal precipitation across the state. With the limited dry conditions and the climatologically increased amounts of normal precipitation at this time of the year, drought conditions are unlikely. The temperature outlook is for cooler than normal temperature state-wide. Lingering concerns will be for flooding, particularly in the eastern parts of the state. This will especially be a concern along major rivers which will remain swollen for some time due to continued reservoir water releases.

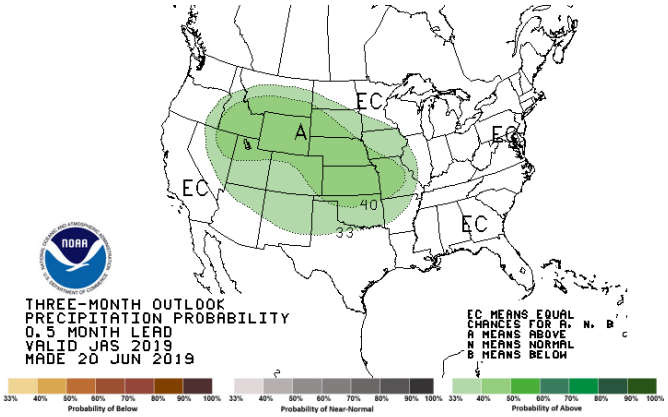


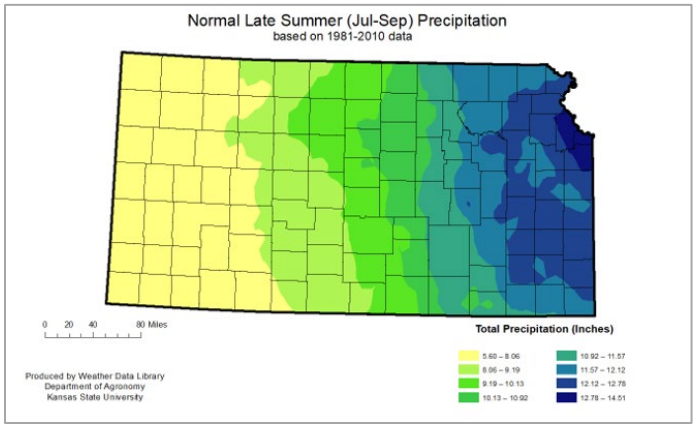


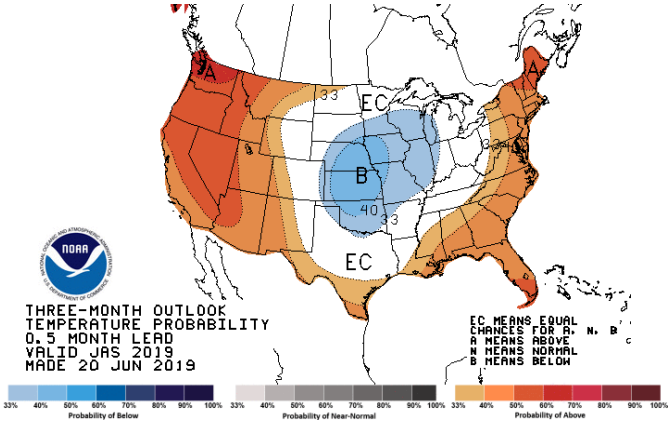


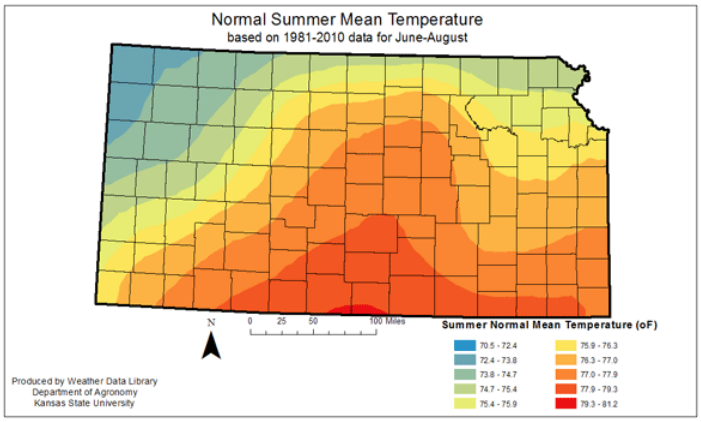


The U.S. three month outlook for July through September slightly favors above-average precipitation (moderate chance) for all of Kansas and below normal temperatures for the entire state.









El Nino conditions are present and expected to continue in the northern hemisphere through spring and summer 2019 according to NOAA's Climate Prediction Center. El Nino favors wetter than normal conditions in the Central Plains.

Additional outlooks for various timeframes are available from the national CPC for up to 13 months. (http://www.cpc.ncep.noaa.gov/products/predictions/90day/)

Water

Public Water Supplies
Storm and flooding created known issues for water and wastewater systems around the state.

The Kansas National Guard (KSNG) continues to conduct water hauling operations in support of Lakeside Village in Jefferson County. The need for water hauling support is expected to last into September due to current water levels at Perry Lake and the anticipated releases identified by the U.S. Corp of Engineers.

Surface Water Supply Conditions
Kansas River basin: Milford, Tuttle Creek, Perry, and Clinton reservoirs experienced higher than normal inflows in June but much more moderate than May. Due to flooding conditions on the Missouri River all basin reservoirs retained a substantial amount of flood storage, about 3 million acre-feet. The U. S. Army Corps of Engineers did make some releases to the Kansas River but primarily only when flood storage was more than 80% full; Clinton Reservoir set a new pool elevation record on June 29th. The flow in the Kansas River was well above normal levels the entire month and reached crests ten times historic median values. Low land flooding was experienced.

Marais des Cygnes basin: Melvern, Pomona, and Hillsdale reservoirs also experienced higher than normal inflows in June but much less inflow than May. However, due to the level of flood storage occupied at the end of May, all three reservoirs reached the highest pool elevations since they were built. Flows in the Marais des Cygnes River remained healthy throughout the month and exceeded historic median values due to rain and intermittent reservoir releases. Some moderate flooding occurred in late June.

Cottonwood/Neosho basin: John Redmond, Council Grove, and Marion reservoirs experienced somewhat moderate inflows for most of the month and about a quarter of the flood pool in each of the reservoirs was evacuated. Some low land flooding occurred along the Cottonwood and Neosho Rivers.

Verdigris basin: Inflows to Toronto, Fall River, Elk City, and Big Hill reservoirs were less than May but still very healthy. Reservoir pool elevations dropped over the month but most of the flood storage capacity remains occupied. Stream flows in the Verdigris and Fall Rivers periodically reached minor flood stage.

Saline basin: The elevation at Wilson Lake crested at its highest level for 2019 on June 11th, about 11 feet above normal. Inflow remained above normal and releases in excess of low flow settings were necessary to manage lake level.

Smoky Hill basin: The middle Smoky Hill River maintained higher than normal flows but declined over the month. Kanopolis Lake experienced consistent healthy inflow and reached its highest level for 2019 on June 2nd. Significant releases were made throughout the month and the pool level was drawn down 11 feet from the crest but ended the month still 22 feet above multipurpose elevation. Cedar Bluff Reservoir also received some inflow and gained elevation over the month due to steady higher than normal inflow. Cedar Bluff reached the highest pool elevation since 2005.

Reservoir Storage

At the end of June all reservoir conservation pools were full except Keith Sebelius and Cedar Bluff, which have filled to 80% and 61% of conservation pools respectively. During June some flood storage was also full at times. Release were, and continue to be made to reduce water in flood pools at many reservoirs.

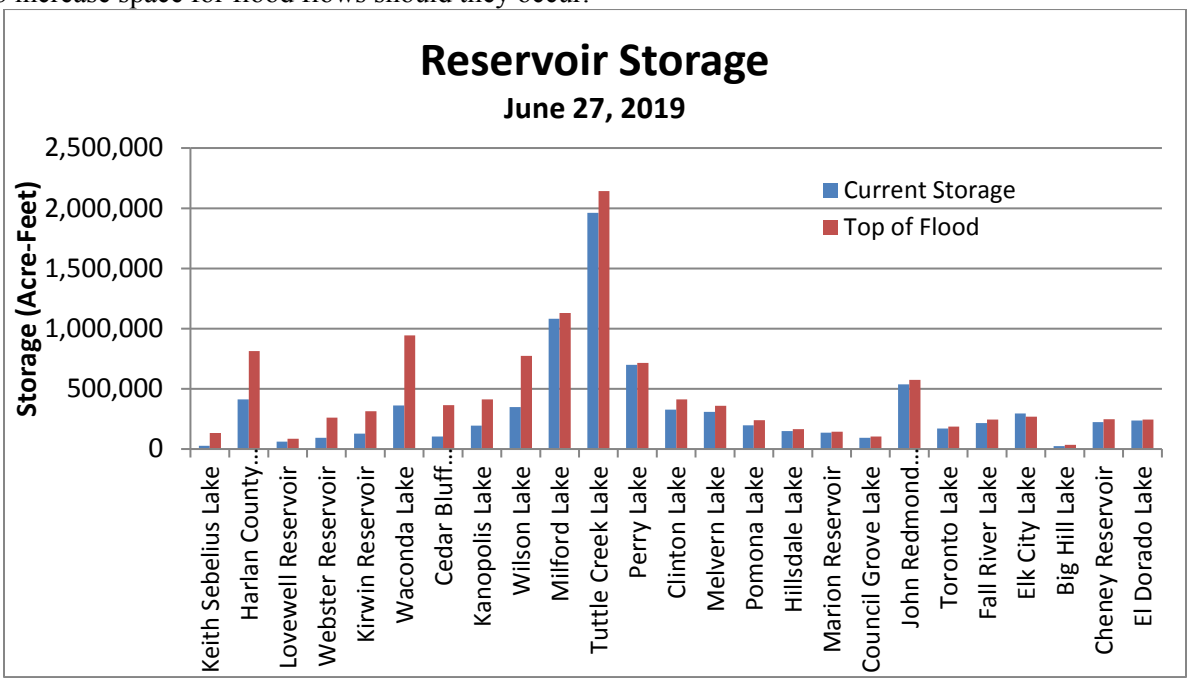
Kansas Federal Reservoir Conservation Pool Levels

Reservoir	Top of Multipurpose / Conservation Pool (Feet MSL)	Multipurpose/Conservation Pool Elevation (Feet MSL)	Change from Top of Pool (Feet)	Percent of Conservation Pool Full
Kansas River Basin		**6/27/19**		
Keith Sebelius Lake[1]	2304.3	2304.3	-3.52	79.3%
Harlan County Lake NE	1945.73	1945.73	6.88	100.0%
Lovewell Reservoir[1]	1582.6	1582.6	7.46	100.0%
Webster Reservoir[1]	1892.45	1892.45	4.07	100.0%
Kirwin Reservoir	1729.25	1729.25	5.30	100.0%
Waconda Lake[1]	1455.6	1455.6	9.61	100.0%
Cedar Bluff Reservoir	2144	2144	-11.66	60.5%
Kanopolis Lake[1]	1463	1463	25.31	100.0%
Wilson Lake[1]	1516	1516	10.36	100.0%
Milford Lake[1]	1144.4	1144.4	30.28	100.0%
Tuttle Creek Lake[1]	1075	1075	57.60	100.0%
Perry Lake[1]	891.5	891.5	28.48	100.0%
Clinton Lake[1]	875.5	875.5	21.42	100.0%
Melvern Lake[1]	1036	1036	17.27	100.0%
Pomona Lake[1]	974	974	23.82	100.0%
Hillsdale Lake[1]	917	917	11.87	100.0%
Arkansas River Basin		**6/27/19**		
Marion Reservoir[1]	1350.5	1350.5	7.12	100.0%
Council Grove Lake[1]	1274	1274	13.27	100.0%
John Redmond Reservoir	1041	1041	25.84	100.0%
Toronto Lake	901.5	901.5	28.03	100.0%
Fall River Lake	948.5	948.5	36.08	100.0%
Elk City Lake	796	796	30.89	100.0%
Big Hill Lake	858	858	0.78	100.0%
Cheney Reservoir	1421.6	1421.6	5.32	100.0%
El Dorado Lake	1339	1339	8.12	100.0%

[1]Lake level management plan in place — Source: U.S. Army Corps of Engineers, U.S. Bureau of Reclamation and U.S. Geological Survey

Note: The conservation pool is the water storage for non-flood purposes of the reservoir, set by the elevation of the top of the pool.

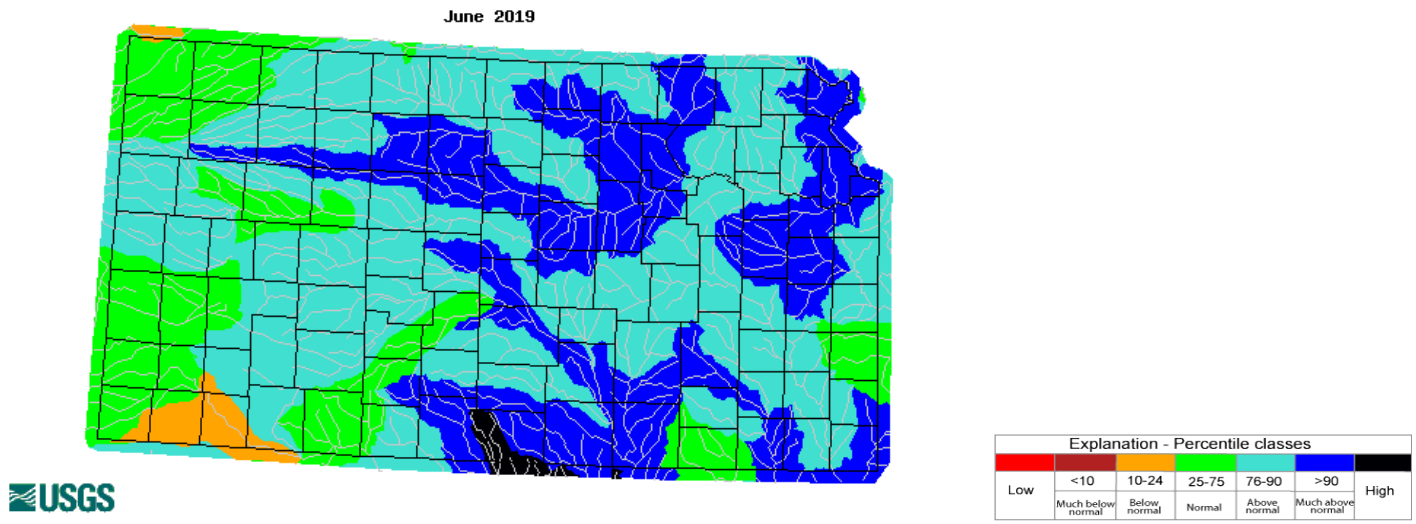
In the graph that follows blue bars indicate water in storage at that reservoir, with red bars indicate top of the flood pool storage. Some reservoirs have storage space remaining for flood flows but the available space varies. Reservoir releases continue to increase space for flood flows should they occur.



Streamflow Conditions

WaterWatch summarizes streamflow conditions in a region (state or hydrologic unit) in terms of the long-term typical condition at stream gages in the region. In general, a streamflow which is greater than the 75 percentile is considered *above normal*, a streamflow which is between 25 and 75 percentiles is considered *normal* and a streamflow which is less than the 25 percentile is considered *below normal*. Color codes are for basins with streamflow averages less than 25 percent of historic values. This comparison aids in evaluating water resources conditions for a time period. A summary of flooding in April is found later in this report.

June streamflow compared to historical streamflow



Flooding

General flooding for the month is shown in the USGS WaterWatch maps in the streamflow section of this report. However this does not provide all the specifics of severity of impacts and duration at specific locations. Additional flooding information can be found for USGS stream gage sites at https://waterwatch.usgs.gov/?m=flood&r=ks&w=flood%2Ctable for current stage. The USGS gage monitoring records indicate 70 gages in Kansas were at flood stage in June. One gage was identified to have major flooding by National Weather Service standards. Twenty stations had moderate and 49 minor flooding in June. The major flooding on the Arkansas River near Hutchinson occurred as to two events June.

State Disaster Declarations have now been issued for 67 counties in response to flooding and storms in May and June. They are: Allen, Anderson, Atchison, Barber, Barton, Bourbon, Brown, Butler, Chase, Chautauqua, Cherokee, Clark, Clay, Cloud, Coffey, Comanche, Cowley, Crawford, Dickinson, Doniphan, Douglas, Edwards, Elk, Ellsworth, Ford, Franklin, Geary, Gray, Greenwood, Harper, Harvey, Hodgeman, Jefferson, Kingman, Leavenworth, Lincoln, Linn, Lyon, Marion, Marshall, McPherson, Meade, Montgomery, Morris, Nemaha, Ness, Neosho, Norton, Osborne, Osage, Ottawa, Pawnee, Phillips, Pottawatomie, Pratt, Reno, Rice, Riley, Rush, Russell, Saline, Stafford, Sumner, Wabaunsee, Washington, Wilson, and Woodson.

A total of 53 Kansas counties were identified in Federal Emergency Declaration issued June 21 due to storms, winds, tornadoes, flooding, landslides and mudslides. The President's action makes federal funding available to state, eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and repair or replacement of facilities in Allen, Anderson, Atchison, Barber, Barton, Butler, Chase, Chautauqua, Cherokee, Clark, Clay, Cloud, Coffey, Cowley, Doniphan, Elk, Ellsworth, Franklin, Geary, Greenwood, Harper, Harvey, Hodgeman, Jefferson, Kingman, Leavenworth, Lincoln, Linn, Lyon, Marion, Marshall, McPherson, Meade, Montgomery, Morris, Nemaha, Neosho, Osage, Ottawa, Pawnee, Phillips, Pottawatomie, Pratt, Reno, Rice, Rush, Russell, Saline, Sumner, Wabaunsee, Washington, Wilson, and Woodson counties.

Federal funding is also available on a cost-sharing basis for hazard mitigation measures statewide. Some additional counties may be eligible for federal declaration and aid in the future once damage assessment is completed by FEMA.

Appendix B provides an overview of Kansas flooding in June 2019 at USGS stream gages in the WaterWatch system.

Lake Safety

Harmful Blue-Green Algal Blooms (lake water safety)

The 2019 HAB monitoring began on April 1, 2019. KDHE samples public use lakes only in response to complaints of human or animal illness or visual sighting of possible blue-green algae by the public or lake officials.

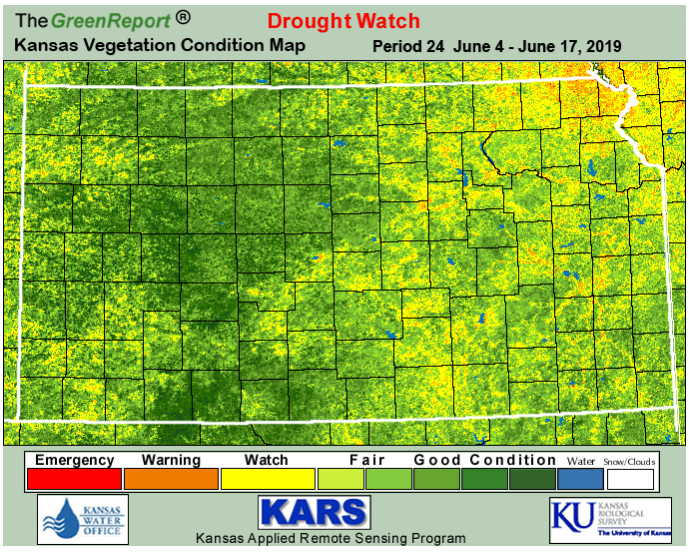
KDHE issues three levels of public health protection notifications for blue-green algae (BGA) Blooms. Public Health Watch–Notifies public that a harmful algae may be present, that the water may be unsafe for humans and animals and contact with the water is discouraged. Public Health Warning–Notifies public that harmful algae is present of expected, that contact with the water should not occur, and all conditions of Public Health Watch remain in effect. Lake Closure –Notifies the public that a portion of the lake or the entire lake be closed to public because harmful algae is present and extreme conditions exist. More information can be found at http://www.kdheks.gov/algae-illness/index.htm.

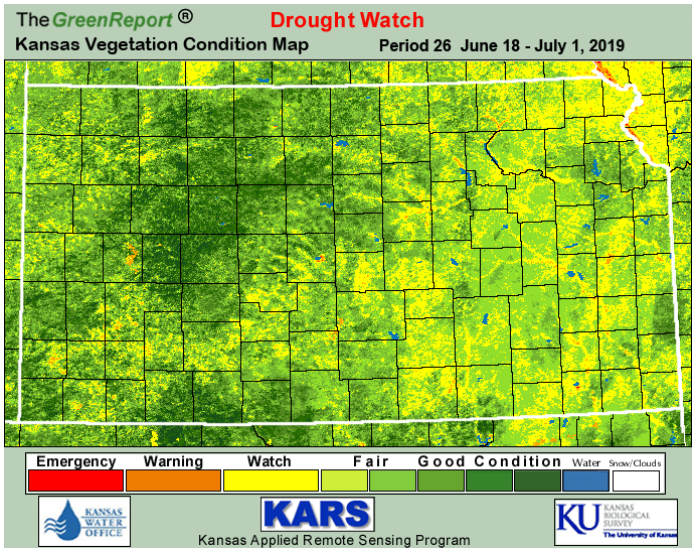
KDHE Lake Health Advisories issued in June 2019						
Lake	County	06/06/2019	06/13/2019	06/20/2019	06/27/2019	07/03/19
Atchison County State Fishing Lake	Atchison	Watch	Watch			
Big Eleven Lake	Wyandotte	Watch	Warning	Warning	Warning	Warning
Carbondale East Lake	Osage			Watch	Watch	Watch
Gathering Pond	Geary				Warning	Warning
Jerry Ivey Pond	Saline		Warning	Warning	Warning	Warning
Keith Sebelius Reservoir	Norton		Watch	Warning	Warning	Warning
Lake Shawnee	Shawnee			Watch	Watch	Watch
Marion County Lake	Marion	Watch	Watch	Watch	Watch	Watch
Marion Reservoir	Marion		Watch	Warning	Warning	Warning
Overbrook City Lake	Osage		Warning	Warning		
Rock Garden Pond	Shawnee					Watch
Webster Lake	Rooks			Watch	Warning	Warning

Vegetation and Soil Moisture

Vegetative Conditions

The Vegetative Condition map provides current conditions related to drought effects on vegetation. It is produced using satellite data. Areas in yellow, orange and red indicate areas of vegetative stress. The green areas are considered to be in good or excellent condition. Change can be seen comparing the two GreenReports below from early and late May.





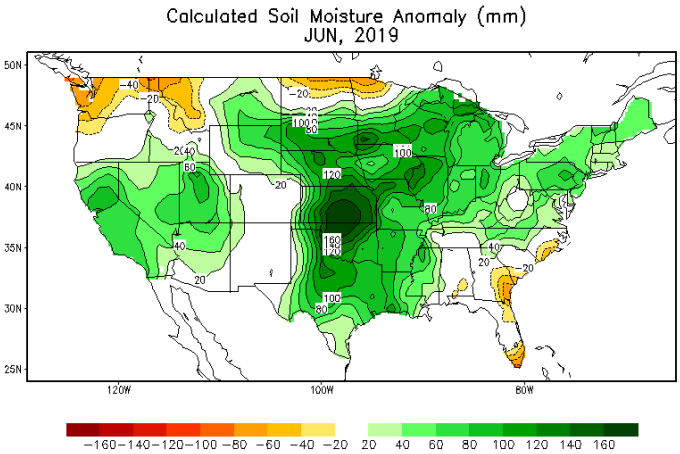
Soil Moisture and Rangeland

The National Agricultural Statistics Service, USDA Crop Progress and Condition provides a summary of the climatic effects on soil and crops. For the week ending June 30, 2019, topsoil moisture supplies rated 0 percent very short, 5 short, 83 adequate, and 12 surplus. Subsoil moisture supplies rated 0 percent very short, 3 short, 84 adequate, and 13 surplus.

Field Crops Report:
Winter wheat condition rated 4 percent very poor, 12 poor, 29 fair, 41 good, and 14 excellent.
Corn condition rated 3 percent very poor, 10 poor, 35 fair, 44 good, and 8 excellent. Soybeans
Soybean condition rated 3 percent very poor, 8 poor, 44 fair, 40 good, and 5 excellent.
Sorghum condition rated 0 percent very poor, 3 poor, 29 fair, 62 good, and 6 excellent.
Cotton condition rated 5 percent very poor, 12 poor, 43 fair, 36 good, and 4 excellent.

Pasture and range conditions rated 1 percent very poor, 3 poor, 21 fair, 59 good, and 16 excellent.

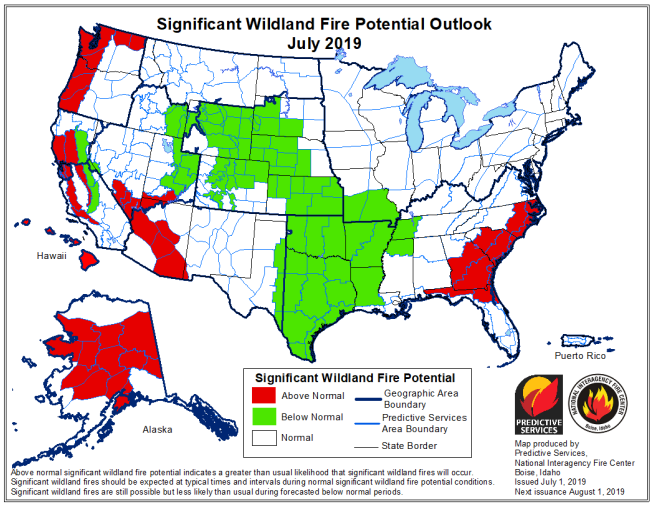
The Climate Prediction Center (CPC), also monitors soil moisture and predicts future soil moisture. Anomalies are defined as deviations from the 1971-2000 monthly climatology. The soil anomaly is provided below.

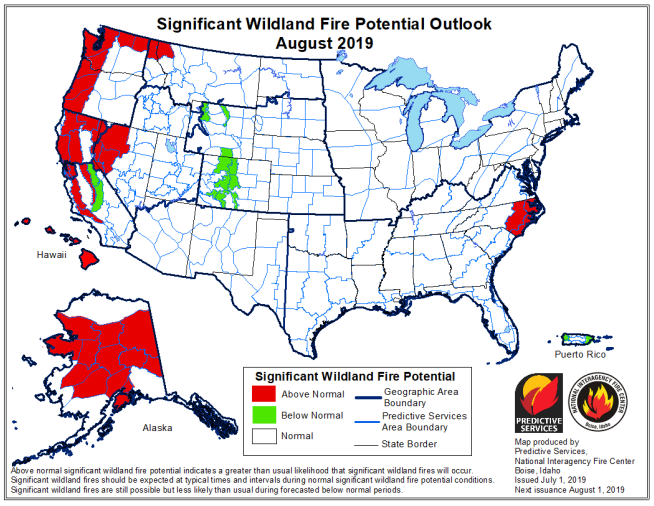


(.http://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml)

Fire

Significant Wildland Fire Potential Outlook is issued monthly for the United States, https://www.predictiveservices.nifc.gov/outlooks/monthly_seasonal_outlook.pdf .





Kansas Climate Summary

The Kansas Weekly Climate Summary and Drought Report are compiled at least monthly, more frequently when conditions warrant, by the KWO. Information from various federal, state, local and academic sources is used. Some of the data is preliminary and subject to change once final data is available. The KWO web site, http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response , contains additional drought information including links to other agencies with drought information and past issues of the Kansas Climate Summary and Drought Report. Kansas State Climatologist, Mary Knapp, is the primary source of the narrative on weather. She works closely with meteorologists throughout the state and region. Details of current conditions at Evapotranspiration (ET) and Mesonet sites across Kansas are available at http://mesonet.k-state.edu/

RESOURCES and REFERENCES

Kansas climate data is provided by Kansas State University, Weather Data Library through the Kansas Mesonet. (http://www.ksre.k-state.edu/wdl/). Soil moisture data was added in 2018 (http://mesonet.k-state.edu/agriculture/soilmoist)

The U.S. Drought Monitor, from the National Drought Mitigation Center at the University of Nebraska-Lincoln, provides a "big picture" perspective of conditions across the nation. In the Kansas county drought stage scheme, a Drought Watch equates roughly to moderate drought in the U.S. Drought Monitor, while a Drought Warning is the equivalent of severe drought. A Drought Emergency is reserved for extreme or exceptional drought. Palmer Drought Severity Index - The Palmer Index (PDSI) is one indicator used in the U.S. Drought Monitor.

The High Plains Regional Climate Center (https://hprcc.unl.edu/) has precipitation and temperature summary maps available at the state, region and nation.

The U.S. Geological Survey (USGS) Drought Watch provides information average streamflow measured at long-term gaging stations and compares them to normal flows.

The Kansas Department of Agriculture-Division of Water Resources monitors stream flow using the USGS gages for determination of administrative needs. Administration may be needed due to Minimum Desirable Streamflow (MDS) requirements, impairments and reservoir release protection. (https://agriculture.ks.gov/divisions-programs/dwr/water-appropriation/minimum-desirable-streamflow.)

The water levels of the federal lakes fluctuate during a year according to the management plan. Lake level Management plans are posted on the Kansas Water Office web site www.kwo.ks.gov .

The Kansas Applied Remote Sensing Program (KARS) at the University of Kansas produces a Kansas Green Report each week during the growing season. For a full set of national and regional ***GreenReport***® maps, go to: http://www.kars.ku.edu/products/greenreport/greenreport.shtml. This Kansas Vegetation Drought Response Index map is developed weekly by the Kansas Biological Survey using state drought triggers as its key. In addition the VegDRI maps may be found at http://vegdri.unl.edu/

The National Weather Service (NWS) provides fire weather products and services for Kansas that include the Rangeland Fire Danger Index, Fire Weather Forecasts, Red Flag Watches/Warnings and Spot Forecasts. The five NWS offices that serve Kansas websites may be accessed from the NWS Offices' page.

The Monthly and Seasonal Drought Outlooks, developed by the NOAA Climate Prediction Center, assess the likelihood for improvement, persistence or deterioration in drought conditions for areas currently experiencing drought as identified by the U.S. Drought Monitor. (http://www.cpc.ncep.noaa.gov/) Also see: http://www.noaa.gov/.

Responding to Drought: A Guide for City, County and Water System Officials provides an overview of Kansas county drought stage declarations, local planning and coordination, disaster declarations and available state and federal assistance. The 2007 Municipal Water Conservation Plan Guidelines and the Drought Vulnerability Assessment Report, both by KWO, provide guidance regarding drought preparedness and response. These are available at http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response.

USDA Drought Programs and Assistance website (https://www.usda.gov/topics/disaster/drought/usda-drought-programs-and-assistance) listing the various USDA programs and agencies to assist with drought issues.

The National Interagency Coordination Center in Boise, Idaho, produces wildfire potential outlook maps monthly. (https://www.predictiveservices.nifc.gov/outlooks/outlooks.htm)

Please contact Diane Knowles at the Kansas Water Office (785) 296-3185 or diane.knowles@kwo.ks.gov should you have any questions or suggestions.

APPENDIX A
Monthly Weather Summary

June Summary

Station[1]	Precipitation (inches)			Temperature °F			
						Extreme (Date)	
	Total	Departure[2]	Percent Normal	Mean	Departure[2]	Highest	Lowest
West							
Burlington, CO	1.56	-1.32	54%	68.6	0.1	101 (29)	38 (10)
Dodge City	3.76	0.52	116%	72.7	-1.2	98 (29)	45 (10)
Garden City	1.68	-1.80	48%	70.9	-1.9	98 (29,27)	38 (10)
Goodland	2.26	-0.99	70%	68.7	-1.0	100 (29)	42 (10)
Guymon, OK	2.16	0.78	157%	72.8	-1.3	100 (29)	49 (24)
Hill City	1.76	-1.00	64%	73.0	0.1	102 (29,27)	45 (10)
Lamar, CO	3.01	0.66	128%	71.1	-0.5	102 (30,29)	36 (10)
McCook, NE	2.89	-0.49	86%	70.1	0.2	104 (29)	41 (10)
Springfield, CO	3.47	0.97	139%	67.2	-4.1	95 (30,14)	37 (10)
Central							
Concordia	4.40	0.43	111%	75.5	2.1	100 (28)	51 (10)
Hebron, NE	5.98	1.20	125%	72.7	0.7	97 (29,28)	46 (13)
Medicine Lodge	3.90	-0.21	95%	75.3	-1.3	99 (29)	48 (10)
Ponca City, OK	1.48	-3.58	29%	76.8	0.2	97 (21)	51 (13)
Salina	5.89	1.78	143%	74.5	-1.1	98 (29,28)	49 (13)
Wichita (ICT)	6.19	0.99	119%	75.9	0.1	98 (21)	51 (13)
East							
Bartlesville, OK	5.55	0.18	103%	75.3	-0.9	94 (29,28)	48 (13)
Chanute	5.48	-1.45	79%	75.9	1.3	94 (29,28)	48 (13)
Falls City, NE	3.17	-1.71	65%	73.6	0.3	95 (29,28)	48 (13)
Johnson Co. Exec. Apt	6.29	0.51	109%	73.6	0.2	92 (29,28)	51 (13)
Joplin, MO	8.49	2.63	145%	74.0	-1.5	92 (29,21)	49 (13)
Kansas City (MCI), MO	7.64	2.41	146%	73.7	0.2	93 (29)	51 (13,11)
St. Joseph, MO	6.07	1.89	145%	74.5	0.9	95 (29)	48 (13)
Topeka (TOP)	5.56	0.16	103%	75.2	1.0	96 (29,28)	50 (13)

1. Airport Automated Observation Stations (NWS/FAA)
2. Departure from 1981-2010 normal value

T - Trace; M - Missing; --- no normal value from which to calculate departure or percent of normal

Source: National Weather Service F-6 Climate Summaries

APPENDIX B-Flooding

Data from WaterWatch-USGS

Summary of June Flooding and High Flows ["--", no data; "<", less than all historical peaks]								
			Highest peak from 2019-06-01 to 2019-06-30				Historical Peaks	
USGS station name	No. Days above flood stage	NWS flood class	Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
TURKEY C NR SENECA, KS	1	Minor	6/23/2019	22.99	9610	27	69	21400 (1973)
MISSOURI R AT ATCHISON, KS	30	Moderate	6/1/2019	28.92	--	--	--	--
MISSOURI R AT LEAVENWORTH, KS	29	Moderate	6/1/2019	28.61	--	--	--	--
REPUBLICAN R NR HARDY, NE	3	Minor	6/16/2019	11.54	5870	54	99	225000 (1935)
REPUBLICAN R AT SCANDIA, KS	1	Minor	6/22/2019	11.22	10100	25	58	215000 (1935)
REPUBLICAN R AT CONCORDIA, KS	1	Minor	6/23/2019	15.1	11800	28	80	207000 (1935)
REPUBLICAN R AT CLAY CENTER, KS	12	Minor	6/23/2019	18.98	9620 (2019-06-01)	67	102	195000 (1935)
SMOKY HILL R AT LINDSBORG, KS	3	Minor	6/24/2019	23.94	6490	11	44	32000 (1903)
SMOKY HILL R NR MENTOR, KS	3	Moderate	6/24/2019	24.65	6420	25	83	32000 (1903)
SMOKY HILL R AT NEW CAMBRIA, KS	4	Minor	6/24/2019	29.94	276 (2019-06-30)	<	45	26400 (1973)
SOLOMON R AT BELOIT, KS	2	Minor	6/23/2019	21.45	2810 (2019-06-19)	57	62	125000 (1951)
SMOKY HILL R AT ENTERPRISE, KS	6	Moderate	6/26/2019	29.2	22400	17	87	233000 (1951)
CHAPMAN C NR CHAPMAN, KS	2	Minor	6/23/2019	21.26	4990	22	65	46700 (1951)
LYON C NR JUNCTION CITY, KS	2	Minor	6/24/2019	23.26	6570	1	7	5957 (2015)
WILDCAT C AT KEATS, KS	3	Minor	6/23/2019	18.94	--	--	--	--
WILDCAT C AT SCENIC DRIVE, MANHATTAN, KS	1	Minor	6/23/2019	16.75	3560	2	6	3920 (2014)
KANSAS R AT MANHATTAN, KS	5	Minor	6/23/2019	19.59	--	--	--	--

Summary of June Flooding and High Flows ["--", no data; "<", less than all historical peaks]								
			Highest peak from 2019-06-01 to 2019-06-30				Historical Peaks	
USGS station name	No. Days above flood stage	NWS flood class	Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
L BLUE R NR BARNES, KS	1	Minor	6/23/2019	16.95	--	--	--	--
BIG BLUE R AT BLUE RAPIDS, KS	30	Moderate	6/1/2019	61.16	--	--	--	--
BLACK VERMILLION R NR FRANKFORT, KS	30	Moderate	6/30/2019	32.72	728 (2019-06-01)	<	65	38300 (1959)
FANCY C AT WINKLER, KS	30	Moderate	6/1/2019	34.34	--	--	--	--
BIG BLUE R NR MANHATTAN, KS	8	Minor	6/1/2019	22.41	31400	6	65	93400 (1951)
ROCK C NR LOUISVILLE, KS	1	Minor	6/23/2019	28.14	14000	6	32	20000 (1968)
MILL C NR PAXICO, KS	1	Minor	6/23/2019	26.34	19000	17	65	77200 (1951)
CROSS C AT ROSSVILLE, KS	2	Minor	6/23/2019	26.75	--	--	--	--
KANSAS R AT TOPEKA, KS	2	Moderate	6/24/2019	27.11	89400	20	121	469000 (1951)
SOLDIER C NR DELIA, KS	2	Moderate	6/23/2019	28.4	10900	8	60	59600 (2005)
KANSAS R AT LECOMPTON, KS	2	Minor	6/24/2019	20.52	107000	17	104	483000 (1951)
KANSAS R AT LAWRENCE, KS	6	Moderate	6/24/2019	20.74	106000	1	5	92600 (2016)
WAKARUSA R AT WAKARUSA, KS	1	Minor	6/23/2019	16.77	--	--	--	--
STRANGER C AT EASTON, KS	4	Moderate	6/24/2019	20.49	6490	3	3	10213
STRANGER C NR TONGANOXIE, KS	3	Minor	6/24/2019	24.78	8850	29	89	40000 (2001)
KANSAS R AT KANSAS CITY, KS	16	Minor	6/2/2019	39.64	--	--	--	--
INDIAN C AT STATE LINE RD, LEAWOOD, KS	1	Minor	6/23/2019	21.17	8180	11	14	23573 (2017)
MARAIS DES CYGNES R NR READING, KS	1	Minor	6/23/2019	19.92	4110	37	49	67400 (1982)
SALT C AT LYNDON, KS	1	Minor	6/23/2019	11.52	5250	6	18	16400 (2007)
DRAGOON C NR BURLINGAME, KS	1	Minor	6/23/2019	19.36	5400	28	58	25000 (2007)
MARAIS DES CYGNES R NR POMONA, KS	4	Minor	6/24/2019	29.14	14900	15	64	69400 (1928)

Summary of June Flooding and High Flows ["--", no data; "<", less than all historical peaks]								
			Highest peak from 2019-06-01 to 2019-06-30				Historical Peaks	
USGS station name	No. Days above flood stage	NWS flood class	Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
MARAIS DES CYGNES R NR OTTAWA, KS	3	Moderate	6/24/2019	34.03	18300	25	110	142000 (1951)
POTTAWATOMIE C NR GARNETT, KS	2	Minor	6/23/2019	29.03	14500	22	63	57000 (1961)
POTTAWATOMIE C AT LANE, KS	1	Minor	6/24/2019	23.71	12100	14	28	75000 (1961)
MARAIS DES CYGNES R AT LA CYGNE, KS	6	Moderate	6/26/2019	30.66	24700	16	33	131000 (2007)
MARAIS DES CYGNES R NR KS-MO ST LINE, KS	7	Moderate	6/28/2019	32.69	30400	20	59	137000 (2007)
ARKANSAS R AT GREAT BEND, KS	1	Minor	6/1/2019	12.05	6640	14	78	27800 (1965)
COW C NR LYONS, KS	2	Minor	6/23/2019	18.61	5400	13	73	28000 (1929)
COW C NR HUTCHINSON, KS	17	Moderate	6/24/2019	11.94	--	--	--	--
ARKANSAS R NR HUTCHINSON, KS	8	Major	6/1/2019	12.18	13400	7	58	24700 (1973)
L ARKANSAS R AT ALTA MILLS, KS	3	Minor	6/24/2019	23.92	6510	17	45	30100 (1973)
L ARKANSAS R AT HWY 50 NR HALSTEAD, KS	4	Minor	6/26/2019	26.28	6560	8	22	11000 (2007)
EMMA C AT SEDGWICK, KS	2	Minor	6/23/2019	19.71	7480	1	3	7308 (2016)
L ARKANSAS R NR SEDGWICK, KS	2	Moderate	6/24/2019	25.16	17400	2	24	17600 (1998)
ARKANSAS R AT DERBY, KS	1	Minor	6/24/2019	12.41	26600	16	49	58300 (1998)
ARKANSAS R AT MULVANE, KS	2	Minor	6/24/2019	17.47	27400	2	3	28238 (2016)
SF NINNESCAH R NR MURDOCK, KS	1	Minor	6/16/2019	8.52	3810	43	67	28700 (1979)
ARKANSAS R ON HWY 160 AT OXFORD, KS	2	Minor	6/25/2019	18.39	28400	2	4	36449 (2016)
SLATE C AT WELLINGTON, KS	3	Minor	6/23/2019	21.39	3880	34	58	28500 (1975)
ARKANSAS R AT ARKANSAS CITY, KS	11	Minor	6/25/2019	15.6	36800	29	100	103000 (1923)
WALNUT R AT WINFIELD, KS	4	Minor	6/24/2019	19.63	20200	48	99	105000 (1944)
CHIKASKIA R NR CORBIN, KS	2	Minor	6/23/2019	13.85	11500	27	59	60000 (1923)

Summary of June Flooding and High Flows ["--", no data; "<", less than all historical peaks]								
			Highest peak from 2019-06-01 to 2019-06-30				Historical Peaks	
USGS station name	No. Days above flood stage	NWS flood class	Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
FALL R AT FREDONIA, KS	1	Minor	6/23/2019	22.71	13600	31	83	77800 (2007)
VERDIGRIS R AT INDEPENDENCE, KS	3	Minor	6/19/2019	32.69	27500	45	103	168823 (2017)
COTTONWOOD R NR FLORENCE, KS	3	Minor	6/23/2019	24.52	12800	17	57	73700 (1998)
COTTONWOOD R NR PLYMOUTH, KS	3	Minor	6/25/2019	32.47	16700	26	55	92900 (1998)
COTTONWOOD R AT EMPORIA, KS	5	Moderate	6/26/2019	24.2	16700	4	4	18672 (2017)
NEOSHO R AT NEOSHO RAPIDS, KS	8	Moderate	6/25/2019	24.93	2250 (2019-06-15)	<	8	26451 (2016)
NEOSHO R NR IOLA, KS	1	Minor	6/1/2019	17.47	22700	63	111	436000 (1951)
NEOSHO R NR ERIE, KS	2	Moderate	6/1/2019	33.43	--	--	--	--
NEOSHO R NR PARSONS, KS	5	Moderate	6/1/2019	27.77	47300	13	96	410000 (1951)
LIGHTNING C NR MCCUNE, KS	5	Minor	6/17/2019	14.74	3850	47	67	67500 (1993)
SPRING R NR BAXTER SPRINGS, KS	3	Minor	6/24/2019	16.7	41400	5	8	145714 (2015)

KANSAS CLIMATE UPDATE
July 2019 Summary

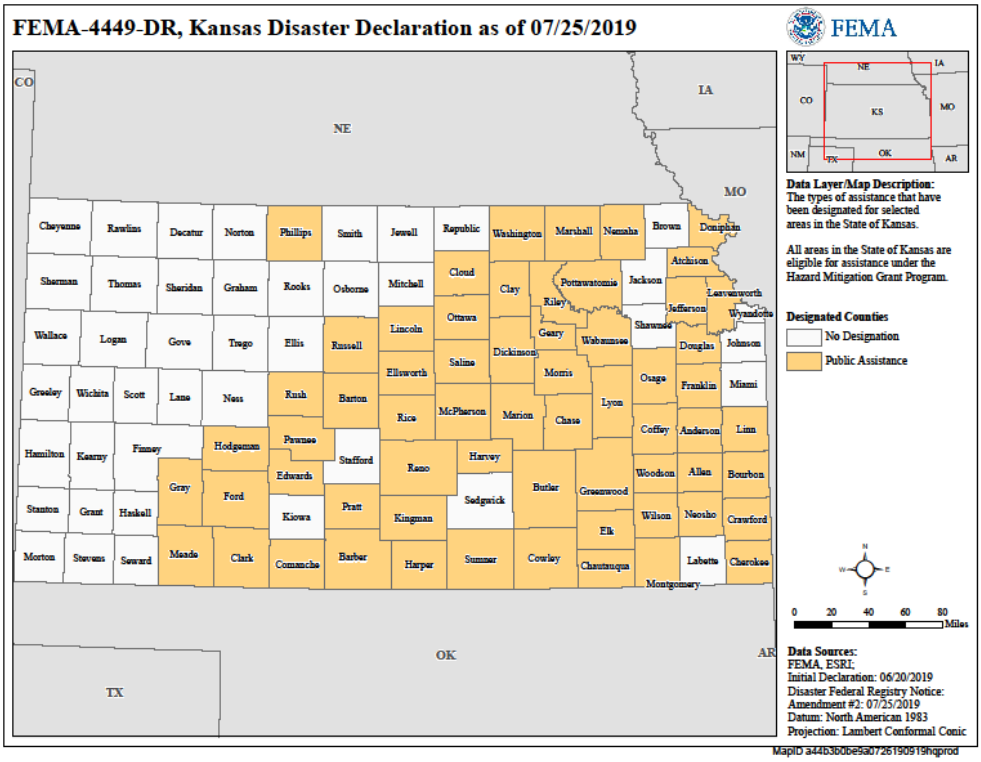
Highlights

- July ended with a return to of abnormally dry conditions, mostly in the central part of the state where the largest precipitation deficits occurred.

- July flooding occurred at 31 USGS stream gages on at least 14 streams for one to as much as 31 days.

- USDA issued agricultural disaster declarations due to flooding since mid-March for three Kansas Counties on July 11. 2019. Producers in Atchison, Leavenworth and Wyandotte counties may be eligible for emergency loans.

- July 25, FEMA added Bourbon, Comanche, Crawford, Dickinson, Douglas, Edwards, Ford, Gray and Riley counties to those eligible for public assistance under DR-4449 on June 20th. The incident period for the Kansas Multi-Hazard Event is April 28-July 12, 2019.



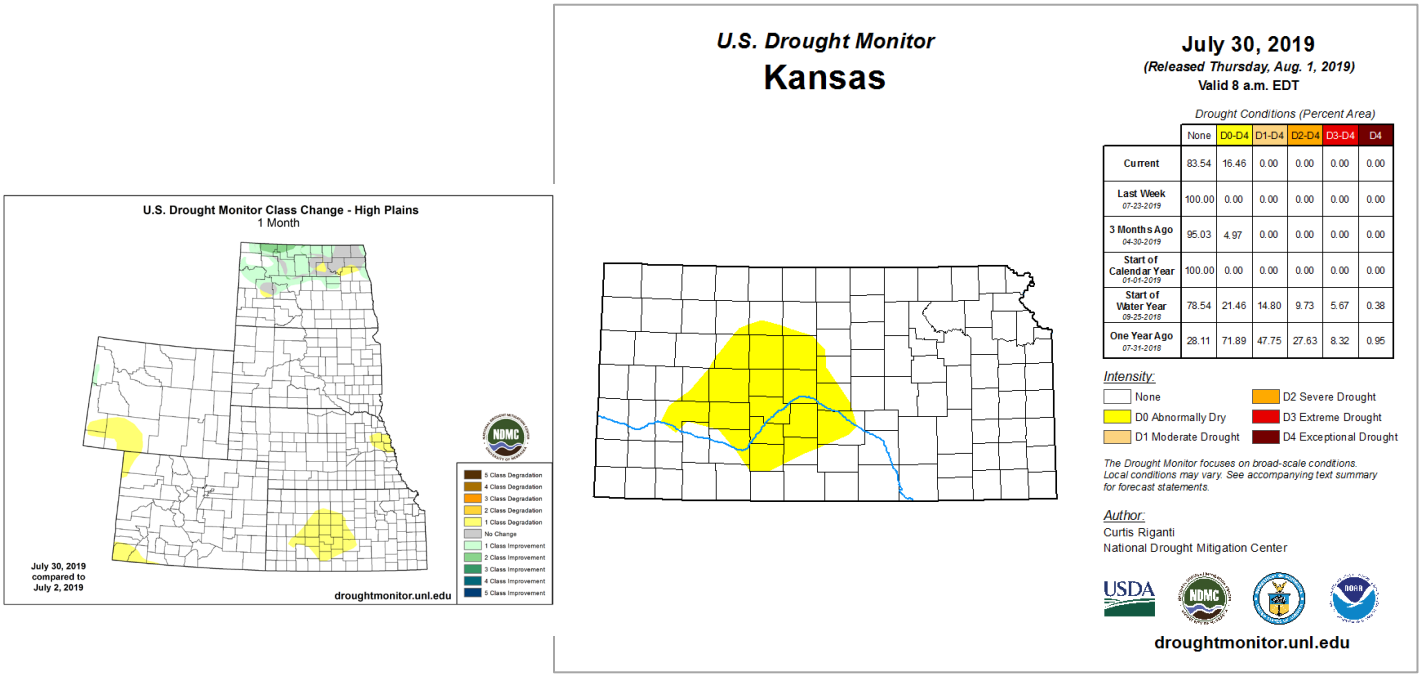
- Federal presidential declarations remain in place for 33 counties. FEMA-3412-EM allows for federal assistance to supplement state and local efforts.

- July 31, 2019 U.S. Small Business Administration made an administrative declaration of disaster due to flooding June 22 –July 6, 2019 making loans available to those affected in Marion County and contiguous counties of Butler, Chase, Dickinson, Harvey, McPherson, Morris and Saline.

General Drought Conditions

Kansas became drought free by the U.S. Drought Monitor in January 2019 but began to see dry conditions the last week in July. Changes in drought classification over the month for the High Plains area is also shown.

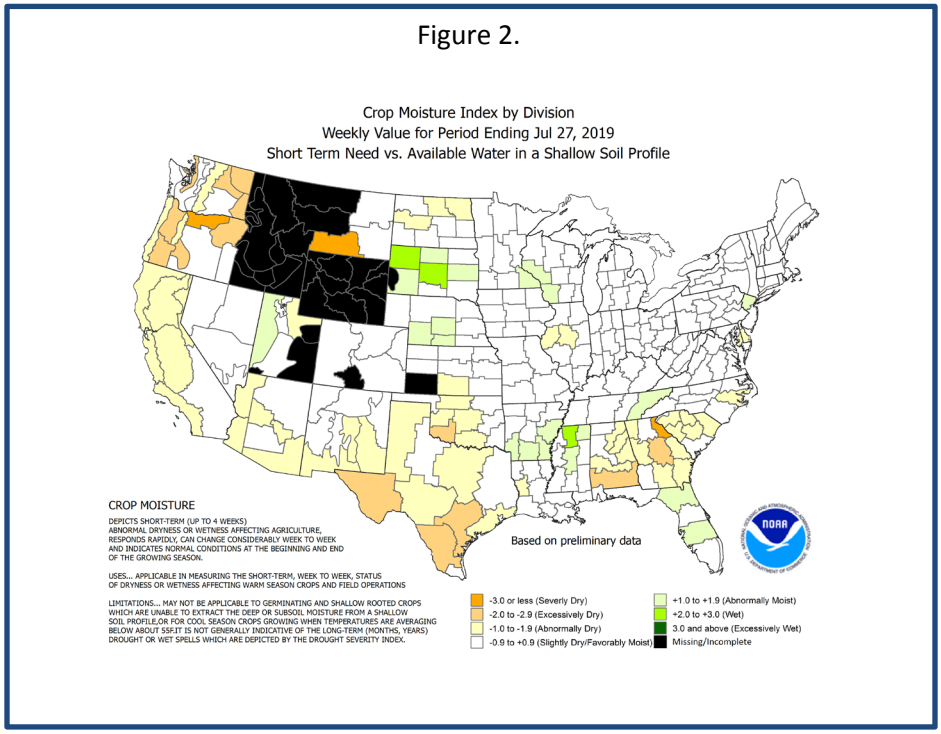
Figure 1. U.S. Drought Monitor Maps of Drought status



More information can be found on the U.S. Drought Monitor web site https://droughtmonitor.unl.edu/ .

Palmer Drought Severity Index (PDSI) - The Palmer Drought Severity Index is an indicator of relative dryness or wetness and is one factor used the U.S. Drought Monitor. The Crop Moisture (Figure 2) component evaluates short term needs and available water. More information on the PDSI and its parts can be found at http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml.

Figure 2.



Climate Summary - Precipitation

Only a few locations saw wetter than normal conditions in July. State-wide average precipitation for the month was 2.50 inches, 67 percent of normal. This ranks as the 36th driest July on record. Only the Southeast Climate Division had above normal precipitation, with a divisional average of 4.67 inches, 115 percent of normal. The remaining divisions were below normal for the month. The Northwest Division was the driest, compared to normal, with an average of 1.38 inches, 40 percent of normal. The isolated nature of the storms can be seen with the highest 24-hour rainfall total for a National Weather Service Cooperative station of 5.47 inches at Clifton, Washington County, on the 4th. The greatest 24-hour rainfall total for a Community Collaborative Rain, Hail and Snow network station was 8.50 inches at Gypsum 4.0 SSE, Saline County, also on the 4th. The greatest monthly precipitation totals for July: 8.85 inches at Clifton, Washington County (NWS) and 7.37 inches at Webber 2.6 ENE, Jewell County (CoCoRaHS).Table 1 summarizes the monthly precipitation (KSU Weather Data Library).

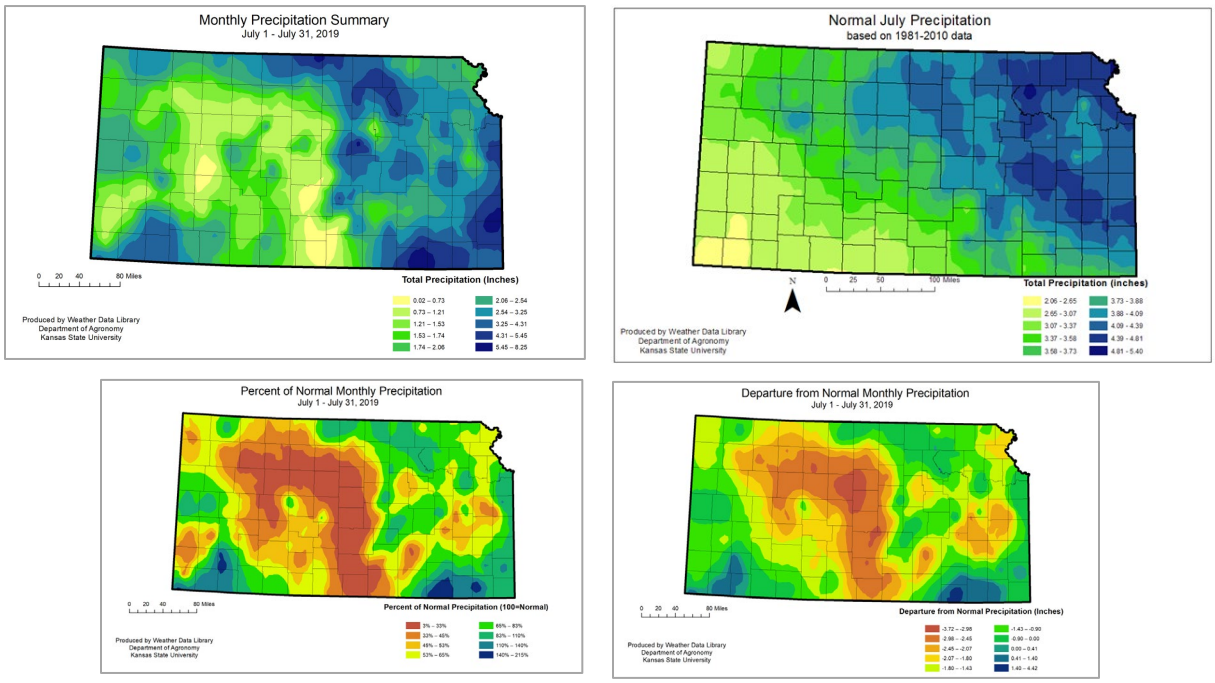
Table 1.

Kansas Climate Division Precipitation Summary (inches)

Climate Division	July 1 - 31, 2019			January 1 – July 31, 2019			April 1, 2019 – July 31, 2019			Sept 1, 2018 – July 31, 2019		
	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal
Northwest	1.38	-2.11	40	13.78	-0.38	97	11.42	-0.44	96	20.83	2.20	112
West Central	1.70	-1.74	49	14.37	0.68	105	11.08	-0.11	99	23.36	5.20	129
Southwest	2.01	-0.76	73	15.09	2.36	119	11.80	1.45	114	23.50	6.31	137
North Central	2.69	-1.42	65	20.31	2.28	113	16.68	2.14	115	34.00	9.24	137
Central	1.75	-2.19	44	22.07	3.16	117	18.29	3.33	122	36.13	10.41	140
South Central	1.45	-2.08	41	26.59	6.56	133	22.58	7.17	147	41.39	13.51	148
Northeast	3.33	-1.05	76	27.79	6.02	128	22.38	4.82	127	42.85	11.75	138
East Central	3.64	-0.66	85	30.26	6.75	129	24.67	6.08	133	43.28	9.45	128
Southeast	4.67	0.60	115	37.84	12.17	147	31.76	12.09	161	52.65	14.89	139
STATE	2.50	-1.23	67	23.25	4.58	125	19.10	4.27	129	35.45	9.39	136

The maps of Figure 3 below summarize precipitation for the month. (State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)

Figure 3. Monthly Precipitation maps



Climate Summary-Temperature

July temperatures fell in the middle of the distribution for the period of record. State-wide average temperature for the month was 78.6 ºF, which is 0.1 degrees cooler than normal. This ranks as the 63rd coolest on record. The West Central Climate Division was the warmest with an average of 78.2 ºF, 0.9 degrees warmer than normal. The Southeast Division was the coolest, with an average of 78.1 ºF, 1.2 degrees cooler than normal. Despite the cooler pattern, only the East Central and the Southeast divisions failed to break the century mark for maximum temperatures. The warmest maximum temperature was 108 ºF at the Hill City Airport, Graham County, on the 17th. The coldest minimum temperature was 51 ºF at Marion Lake, Marion County, on the 12th and at Pratt 4W, Pratt County on the 23rd, There was one record maximum temperature: 107 ºF reported at Colby 1 SW on the 18th. On the other hand, there were 13 new record warm minimum temperatures set. Cold daily records were more numerous with 2 record low maximums and 26 record low minimums. Table 2 summarizes the monthly temperatures (KSU Weather Data Library).

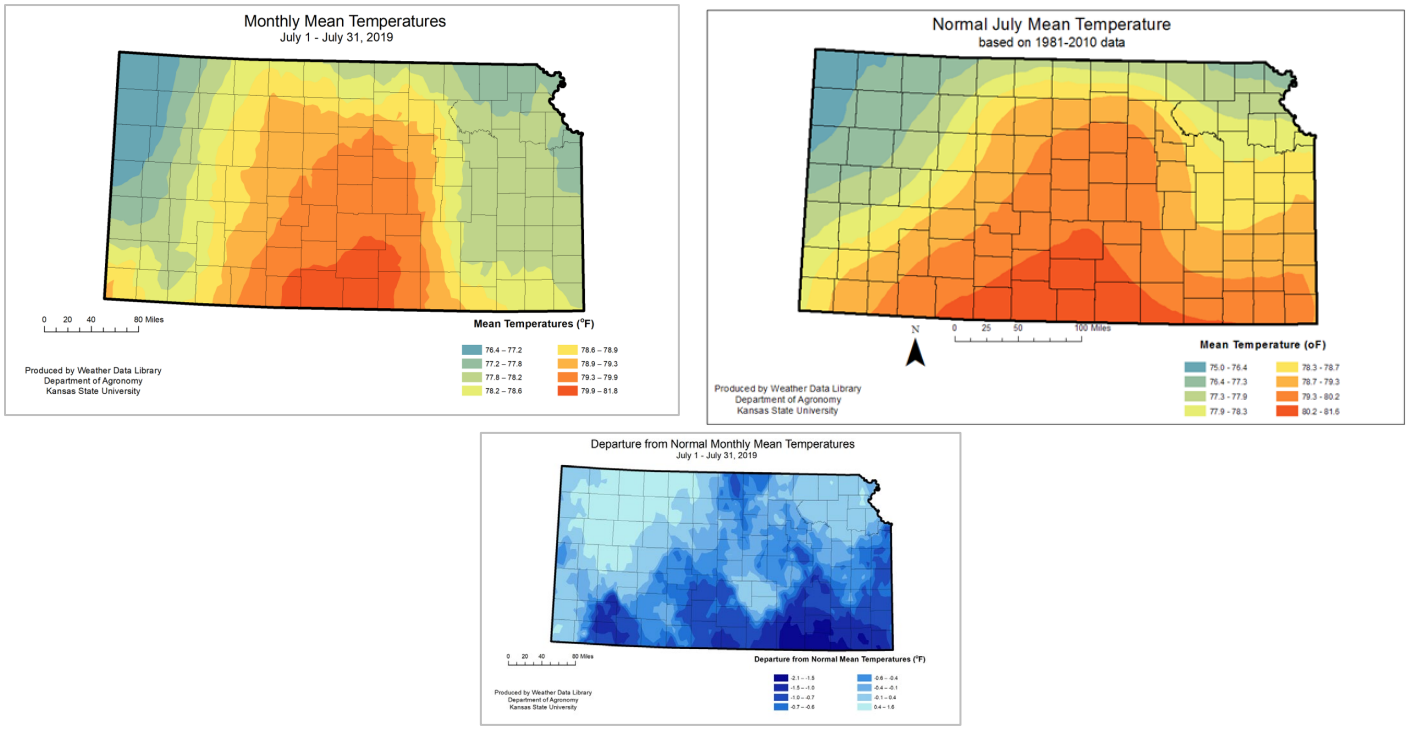
Table 2.

Climate Division	Kansas Climate Division Temperature Summary (ºF) July 2019							
	Maximum	Minimum	Average	Departure*	High	Date	Low	Date
Northwest	92.6	62.7	77.6	0.8	107	18	55	11
West Central	93.4	63.0	78.2	0.9	108	17	52	23
Southwest	93.4	64.7	79.0	0.1	107	21	52	24
North Central	90.8	66.8	78.8	-0.2	105	21	52	23
Central	91.9	66.8	79.4	-0.5	106	17	52	23
South Central	92.6	68.0	80.3	-0.1	104	31	51	23
Northeast	88.2	67.4	77.8	-0.1	100	18	54	23
East Central	87.9	67.8	77.9	-0.5	99	18	55	23
Southeast	88.4	67.9	78.1	-1.2	99	21	53	23
STATE	91.0	66.1	78.6	-0.1	108	21st	51	23rd

*Departure from normal is departure from the base period of 1981-2010, KSU Weather Data Library.

The maps in Figure 4 below summarize temperature for the month. (State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)

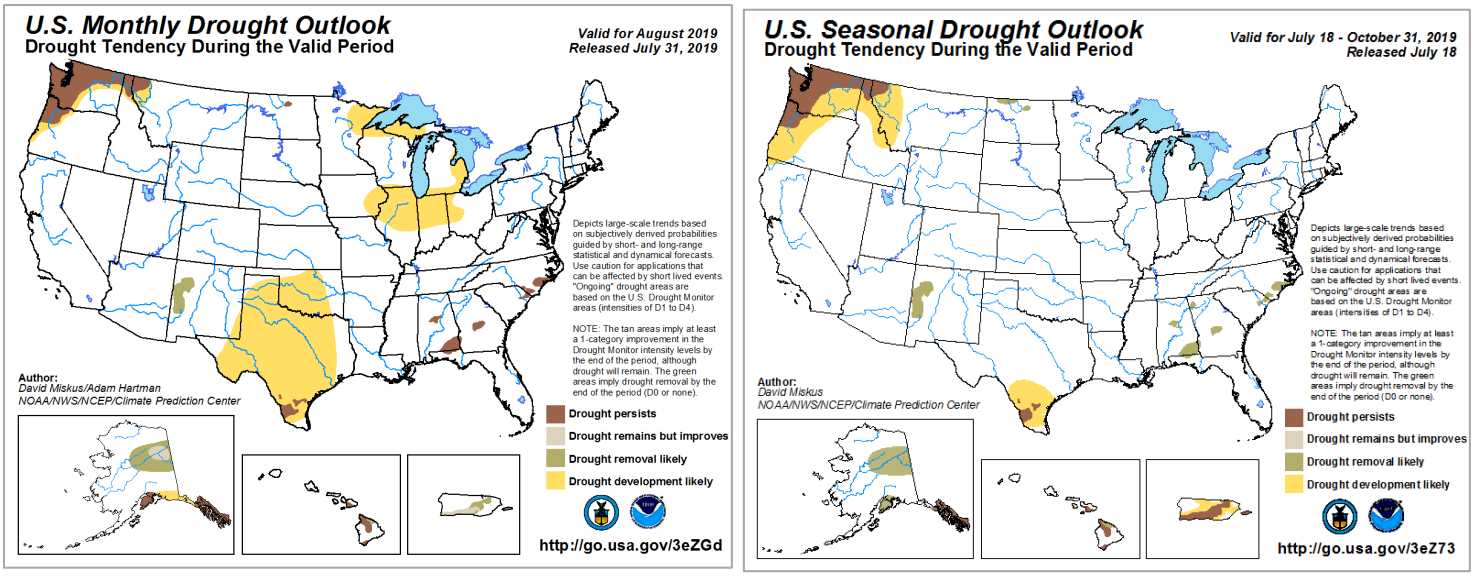
Figure 4. Monthly Temperature Maps



Outlooks

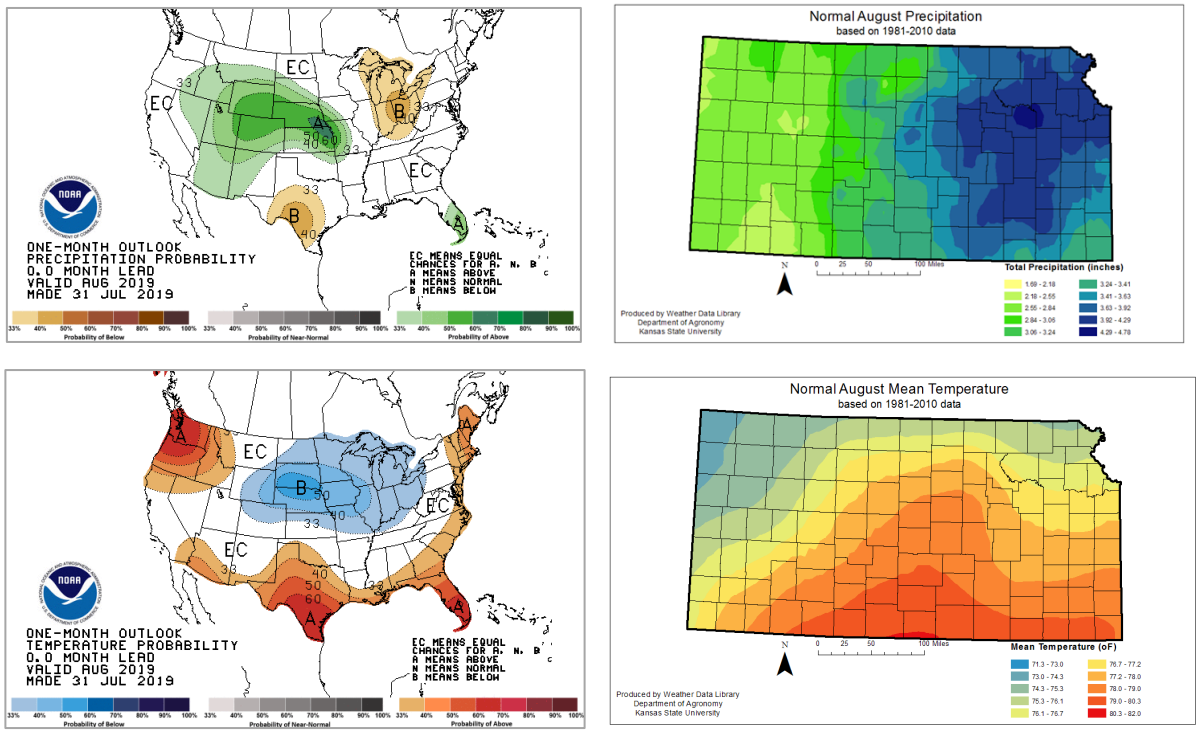
The Monthly Drought Outlook for August 2019 indicates no anticipated drought conditions in Kansas. The Seasonal Outlook (3-month) also favors no drought in Kansas through the summer. The individual temperature and precipitation outlooks that contribute to these outlooks are available below.

Figure 5. Drought Outlooks



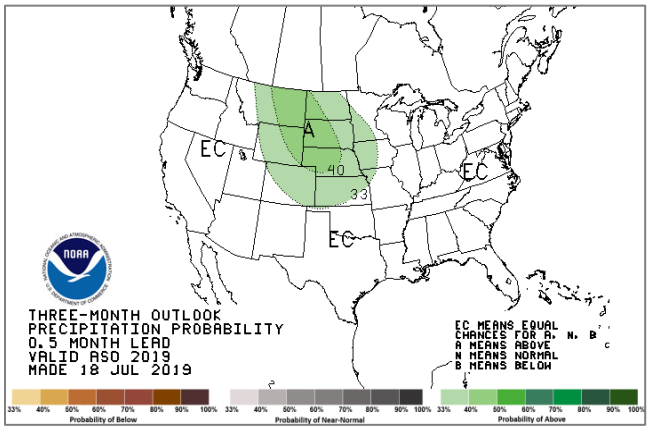
The August precipitation outlook favors a slightly increased chance of above normal precipitation across the state. With the limited dry conditions and the climatologically increased amounts of normal precipitation at this time of the year, a normal to above normal precipitation pattern in August would limit expansion of drought conditions. The temperature outlook is for cooler than normal temperatures across the northern third of the state. One month outlooks are provided in Figure 6.

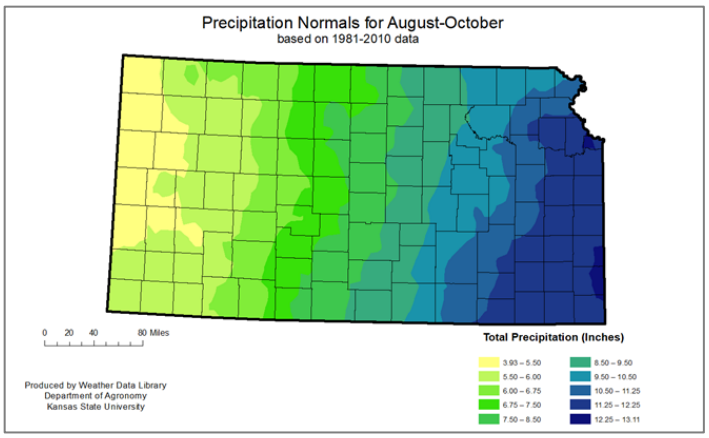
Figure 6. Next Month Precipitation and Temperature Outlooks

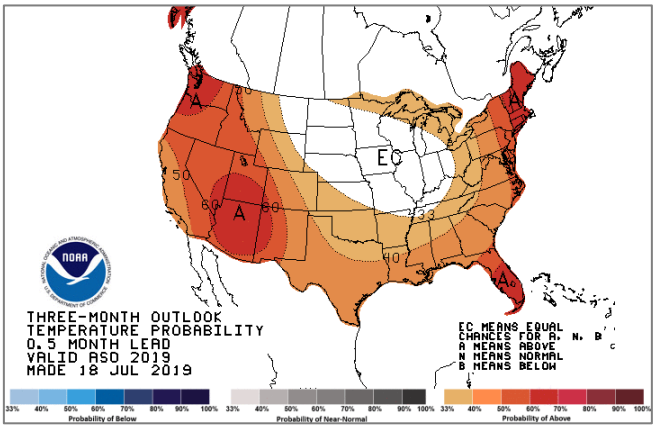


The U.S. three month outlook for August through October slightly favors above-average precipitation (moderate chance) for all of Kansas and above normal temperatures for the entire state.

Figure 7. Three Month Precipitation and Temperature Outlooks







Map of Aug-Oct Normal Temperature not available

Additional outlooks for various timeframes are available from the national CPC for up to 13 months. (http://www.cpc.ncep.noaa.gov/products/predictions/90day/)

Water

Public Water Supplies
Storm and flooding created known issues for water and wastewater systems around the state.

The Kansas National Guard (KSNG) continues to conduct water hauling operations in support of Lakeside Village in Jefferson County. The need for water hauling support is expected to last into September due to current water levels at Perry Lake and the anticipated releases identified by the U.S. Corp of Engineers.

Surface Water Supply Conditions
Kansas River basin: Milford, Tuttle Creek, Perry, and Clinton reservoirs experienced a significant decline in inflows in July. The U. S. Army Corps of Engineers did make some releases to the Kansas River from all basin reservoirs, evacuating about half the flood storage space. With the flood pool releases throughout the month flows in the Kansas River were maintained around 40,000 cfs; normal flow for the Kansas River in July is closer to 4,000 cfs.

Marais des Cygnes basin: Melvern, Pomona, and Hillsdale reservoirs did not experience any significant inflow events, allowing for much needed flood pool releases. Flows in the Marais des Cygnes River remained healthy throughout the month and exceeded historic median values due to some runoff and reservoir releases.

Cottonwood/Neosho basin: John Redmond, Council Grove, and Marion reservoirs experienced somewhat moderate to low inflows for most of the month and most of flood pool storage in each of the reservoirs was evacuated. One precipitation event in early July did cause flooding along the Cottonwood River and over-all basin flows were quite high due to reservoir releases.

Verdigris basin: Inflows to Toronto, Fall River, Elk City, and Big Hill reservoirs were similar to conditions experienced in the Neosho, allowing for evacuation of flood storage. Stream flows in the Verdigris and Fall Rivers were maintained below flood stage but much higher than normal.

Saline basin: The elevation at Wilson Lake declined throughout the month with continuous releases, ending the month still about 6 feet above multipurpose elevation (normal pool).

Smoky Hill basin: The middle Smoky Hill River maintained higher than normal flows but declined over the month. Significant releases were made from Kanopolis Lake throughout the month and the pool level was drawn down about 18 feet, very near the normal summer target elevation. Cedar Bluff Reservoir also received some inflow but experienced a net decline over the month.

Reservoir Storage

At the end of June all reservoir conservation pools were full except Keith Sebelius and Cedar Bluff, which ended July at 77% and 60% of conservation pools respectively. Releases were, and continue to be made to reduce water in flood pools at many reservoirs. Table 3 provides end of month conservation pool status for each federal reservoir.

Table 3. Kansas Federal Reservoir Conservation Pool Levels

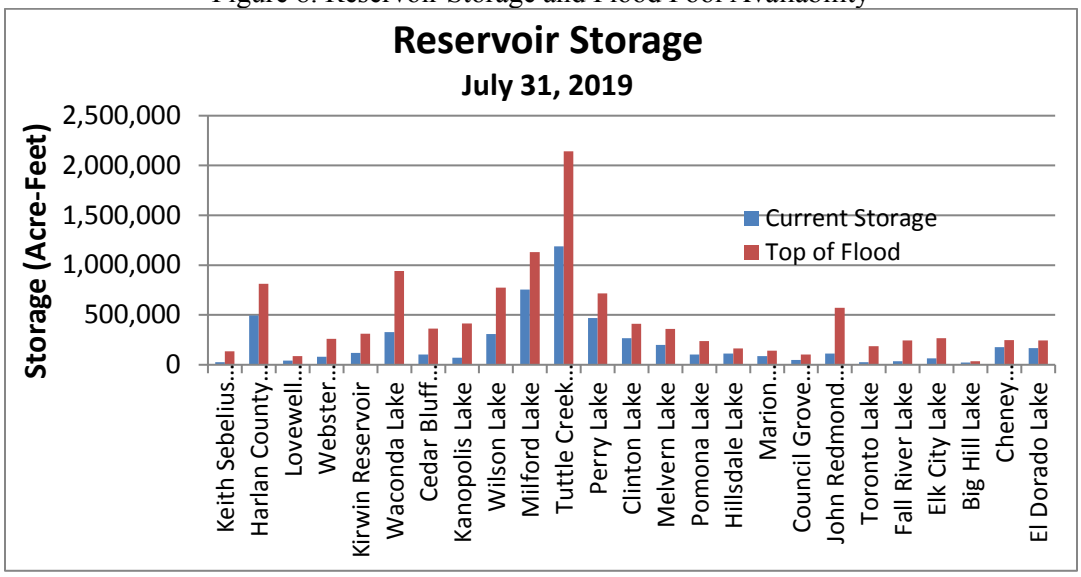
Reservoir	Top of Multipurpose / Conservation Pool (Feet MSL)	Multipurpose/Conservation Pool Elevation (Feet MSL)	Change from Top of Pool (Feet)	Percent of Conservation Pool Full
Kansas River Basin		**7/31/19**		
Keith Sebelius Lake[1]	2304.3	2300.25	-4.05	77%
Harlan County Lake NE	1945.73	1957.69	11.96	100.0%
Lovewell Reservoir[1]	1582.6	1584.75	2.15	100.0%
Webster Reservoir[1]	1892.45	1893.70	1.25	100.0%
Kirwin Reservoir	1729.25	1732.87	3.62	100.0%
Waconda Lake[1]	1455.6	1463.15	7.55	100.0%
Cedar Bluff Reservoir	2144	2132.13	-11.87	60%
Kanopolis Lake[1]	1463	1469.45	6.45	100.0%
Wilson Lake[1]	1516	1522.75	6.75	100.0%
Milford Lake[1]	1144.4	1163.03	18.63	100.0%
Tuttle Creek Lake[1]	1075	1114.84	39.84	100.0%
Perry Lake[1]	891.5	909.53	18.03	100.0%
Clinton Lake[1]	875.5	891.69	16.19	100.0%
Melvern Lake[1]	1036	1042.58	6.58	100.0%
Pomona Lake[1]	974	984.04	10.04	100.0%
Hillsdale Lake[1]	917	923.30	6.30	100.0%
Arkansas River Basin		**7/31/19**		
Marion Reservoir[1]	1350.5	1351.37	0.87	100.0%
Council Grove Lake[1]	1274	1275.60	1.60	100.0%
John Redmond Reservoir	1041	1045.24	4.24	100.0%
Toronto Lake	901.5	904.90	3.40	100.0%
Fall River Lake	948.5	954.49	5.99	100.0%
Elk City Lake	796	801.80	5.80	100.0%
Big Hill Lake	858	857.79	-0.21	99.0%
Cheney Reservoir	1421.6	1422.52	0.92	100.0%
El Dorado Lake	1339	1339.95	0.95	100.0%

[1]Lake level management plan in place — Source: U.S. Army Corps of Engineers, U.S. Bureau of Reclamation and U.S. Geological Survey

Note: The conservation pool is the water storage for non-flood purposes of the reservoir, set by the elevation of the top of the pool.

In Figure 8 the blue bars indicate water in storage at that reservoir, with red bars indicate top of the flood pool storage. Some reservoirs have storage space remaining for flood flows but the available space varies. Reservoir releases in continue to increase space for flood flows should they occur.

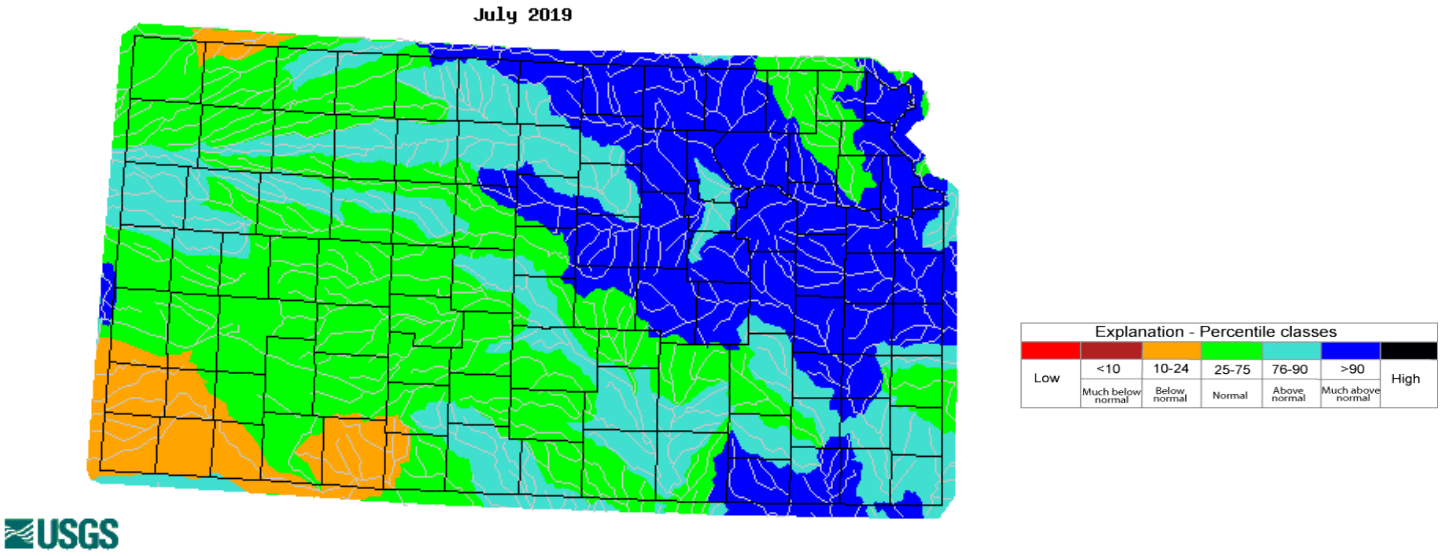
Figure 8. Reservoir Storage and Flood Pool Availability



Streamflow Conditions

WaterWatch summarizes streamflow conditions in a region (state or hydrologic unit) in terms of the long-term typical condition at stream gages in the region. In general, a streamflow which is greater than the 75 percentile is considered *above normal*, a streamflow which is between 25 and 75 percentiles is considered *normal* and a streamflow which is less than the 25 percentile is considered *below normal*. Color codes are for basins with streamflow averages less than 25 percent of historic values. This comparison aids in evaluating water resources conditions for a time period. A summary of flooding in April is found later in this report. Figure 9 summarizes streamflow.

Figure 9. Monthly streamflow compared to historical streamflow



Low flows may be reflected at gage locations when the flow does not reach Minimum Desirable Streamflow (MDS). MDS requirements are in place to ensure base flows in certain streams to protect existing water rights and to meet in-stream water uses related to water quality, fish and wildlife and recreation. The Kansas Department of Agriculture, Division of Water Resources monitors 23 streams and rivers at 33 locations for minimum desirable streamflow. When flows drop below an established threshold, pumping restrictions are imposed on permits or water rights granted after the minimum desirable streamflow provision was made into law in 1984.

Although no water right administration was in effect in July, the table below notes locations of concern including those below MDS. The Rattlesnake Creek gage near Macksville has been below MDS since July 19th.

Table 4.
Streamflows as of July 29, 2019

Gaging Station	July 22 Flow	July 29 Flow	July MDS	Aug MDS	Comment
Rattlesnake Creek near Macksville	3	2	5		No surface water diversions junior to MDS above gage
Rattlesnake Creek near Zenith	13	11	5	3	No surface water diversions junior to MDS above gage

Flooding

General flooding for the month is shown in the USGS WaterWatch maps in the streamflow section of this report. However this does not provide all the specifics of severity of impacts and duration at specific locations. Additional flooding information can be found for USGS stream gage sites at https://waterwatch.usgs.gov/?m=flood&r=ks&w=flood%2Ctable for current stage. The USGS gage monitoring records indicate 31 gages in Kansas were at flood stage sometime in July.

State Disaster Declarations have now been issued for 67 counties in response to flooding and storms in May and June. They are: Allen, Anderson, Atchison, Barber, Barton, Bourbon, Brown, Butler, Chase, Chautauqua, Cherokee, Clark, Clay, Cloud, Coffey, Comanche, Cowley, Crawford, Dickinson, Doniphan, Douglas, Edwards, Elk, Ellsworth, Ford, Franklin, Geary, Gray, Greenwood, Harper, Harvey, Hodgeman, Jefferson, Kingman, Leavenworth, Lincoln, Linn, Lyon, Marion, Marshall, McPherson, Meade, Montgomery, Morris, Nemaha, Ness, Neosho, Norton, Osborne, Osage, Ottawa, Pawnee, Phillips, Pottawatomie, Pratt, Reno, Rice, Riley, Rush, Russell, Saline, Stafford, Sumner, Wabaunsee, Washington, Wilson, and Woodson.

A total of 53 Kansas counties were identified in Federal Emergency Declarations, DR-4449 issued June 21 due to storms, winds, tornadoes, flooding, landslides and mudslides. The President's action makes federal funding available to state, eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and repair or replacement of facilities in Allen, Anderson, Atchison, Barber, Barton, Butler, Chase, Chautauqua, Cherokee, Clark, Clay, Cloud, Coffey, Cowley, Doniphan, Elk, Ellsworth, Franklin, Geary, Greenwood, Harper, Harvey, Hodgeman, Jefferson, Kingman, Leavenworth, Lincoln, Linn, Lyon, Marion, Marshall, McPherson, Meade, Montgomery, Morris, Nemaha, Neosho, Osage, Ottawa, Pawnee, Phillips, Pottawatomie, Pratt, Reno, Rice, Rush, Russell, Saline, Sumner, Wabaunsee, Washington, Wilson, and Woodson counties. An additional nine counties were added July 25th by FEMA. These are Bourbon, Comanche, Crawford, Dickinson, Douglas, Edwards, Ford, Gray and Riley counties.

EM-3412 issued May 27 provides public assistance dollars to state, local and tribal governments for emergency work in Allen, Anderson, Butler, Chautauqua, Cherokee, Cowley, Crawford, Dickinson, Doniphan, Douglas, Elk, Franklin, Geary, Greenwood, Harvey, Jefferson, Leavenworth, Linn, Lyon, Marshall, Montgomery, Morris, Neosho, Osage, Pottawatomie, Reno, Riley, Saline, Sumner, Wabaunsee, Wilson and Woodson counties.

Federal funding is also available on a cost-sharing basis for hazard mitigation measures statewide. Some additional counties may be eligible for federal declaration and aid in the future once damage assessment is completed by FEMA.

USDA has designated Atchison, Leavenworth and Wyandotte counties as primary disaster areas due to flooding, making producers eligible for emergency loans.

Appendix B provides an overview of Kansas flooding in July 2019 at USGS stream gages in the WaterWatch system.

Lake Safety

Harmful Blue-Green Algal Blooms (lake water safety)

The 2019 HAB monitoring began on April 1, 2019. KDHE samples public use lakes only in response to complaints of human or animal illness or visual sighting of possible blue-green algae by the public or lake officials.

KDHE issues three levels of public health protection notifications for blue-green algae (BGA) Blooms. Public Health Watch–Notifies public that a harmful algae may be present, that the water may be unsafe for humans and animals and contact with the water is discouraged. Public Health Warning–Notifies public that harmful algae is present of expected, that contact with the water should not occur, and all conditions of Public Health Watch remain in effect. Lake Closure –Notifies the public that a portion of the lake or the entire lake be closed to public because harmful algae is present and extreme conditions exist. A summary of lakes affected in the month is found in Table 5. More information can be found at http://www.kdheks.gov/algae-illness/index.htm.

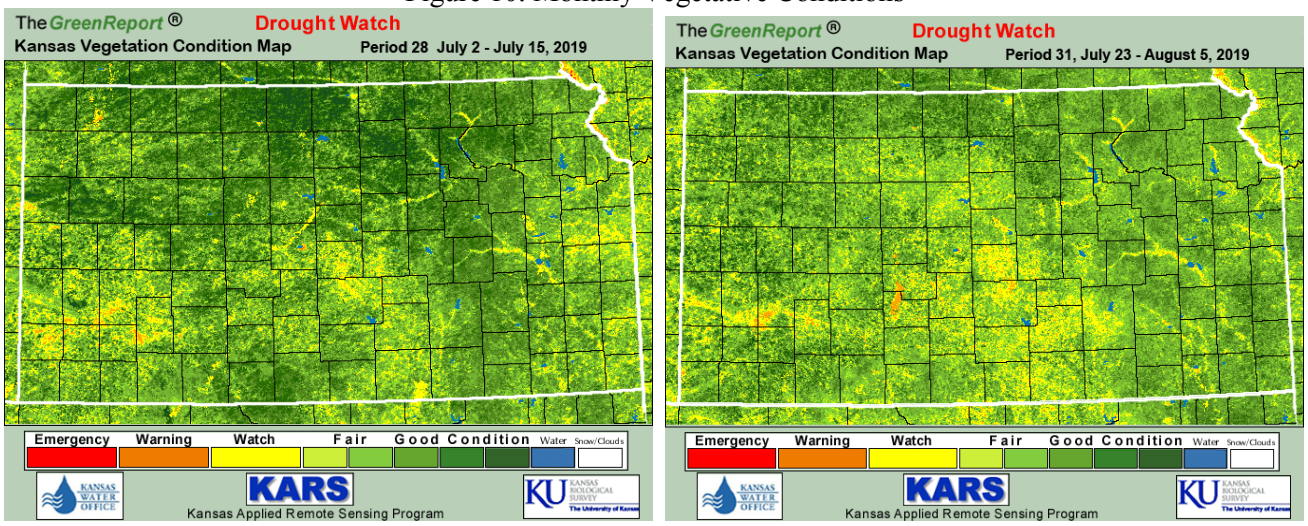
Table 5.						
KDHE Lake Health Advisories issued in July 2019						
Lake	County	07/03/19	7/11/19	7/19/19	7/25/19	8/1/19
Big Eleven Lake	Wyandotte	Warning	Warning	Warning	Warning	Warning
Carbondale East Lake	Osage	Watch				
Camp Hawk Lake	Harvey					Watch
Carousel Lake in Gage Park	Shawnee					Watch
Colby City Pond	Thomas			Warning (visual)		
Gathering Pond	Geary	Warning	Warning	Warning	Warning	Warning
Hiawatha City Lake	Brown		Warning	Warning	Watch	Watch
Hodgeman County State Fishing Lake	Hodgeman				Watch	Watch
Jerry Ivey Pond	Saline	Warning	Warning	Warning	Warning	Warning
Keith Sebelius Reservoir	Norton	Warning	Watch	Watch	Watch	Watch
Lake Afton	Sedgewick				Watch	Watch
Lake Shawnee	Shawnee	Watch	Watch	Watch	Watch	Watch
Lebo Kids' Pond	Coffey				Warning	Warning
Lovewell Reservoir	Jewell		Warning	Warning	Watch	Watch
Marion County Lake	Marion	Watch	Warning	Warning	Warning	Warning
Marion Reservoir	Marion	Warning	Watch	Watch	Watch	Watch
Melvern Outlet Pond	Osage					Warning
Melvern Outlet Swim Pond	Osage					Warning
Rock Garden Pond	Shawnee	Watch	Watch	Watch	Watch	Watch
South Lake	Johnson			Warning	Warning	Warning
Villa High Lake	Thomas				Warning	
Webster Lake	Rooks	Warning				
Westlake in Gage Park	Shawnee					Warning

Vegetation and Soil Moisture

Vegetative Conditions

The Vegetative Condition map provides current conditions related to drought effects on vegetation. It is produced using satellite data. Areas in yellow, orange and red indicate areas of vegetative stress. The green areas are considered to be in good or excellent condition.

Figure 10. Monthly Vegetative Conditions



Soil Moisture and Rangeland

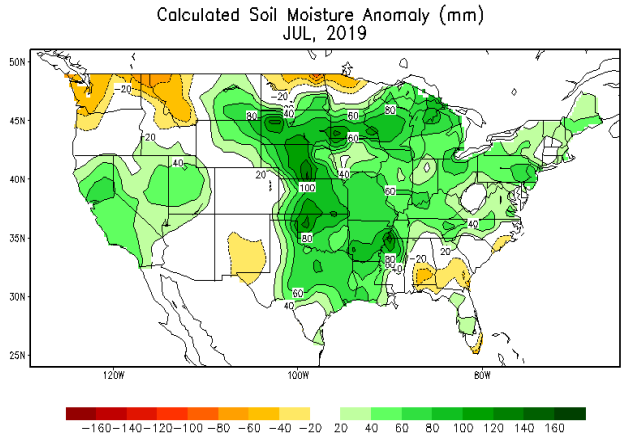
The National Agricultural Statistics Service, USDA Crop Progress and Condition provides a summary of the climatic effects on soil and crops. For the week ending July 28, 2019, topsoil moisture supplies rated 8 percent very short, 32 short, 58 adequate, and 2 surplus. Subsoil moisture supplies rated 3 percent very short, 20 short, 74 adequate, and 3 surplus.

Field Crops Report:
Corn condition rated 3 percent very poor, 9 poor, 31 fair, 46 good, and 11 excellent.
Soybean condition rated 3 percent very poor, 8 poor, 39 fair, 44 good, and 6 excellent.
Sorghum condition rated 1 percent very poor, 5 poor, 25 fair, 62 good, and 7 excellent.
Cotton condition rated 8 percent very poor, 19 poor, 40 fair, 30 good, and 3 excellent.

Pasture and range conditions rated 1 percent very poor, 4 poor, 26 fair, 57 good, and 12 excellent.

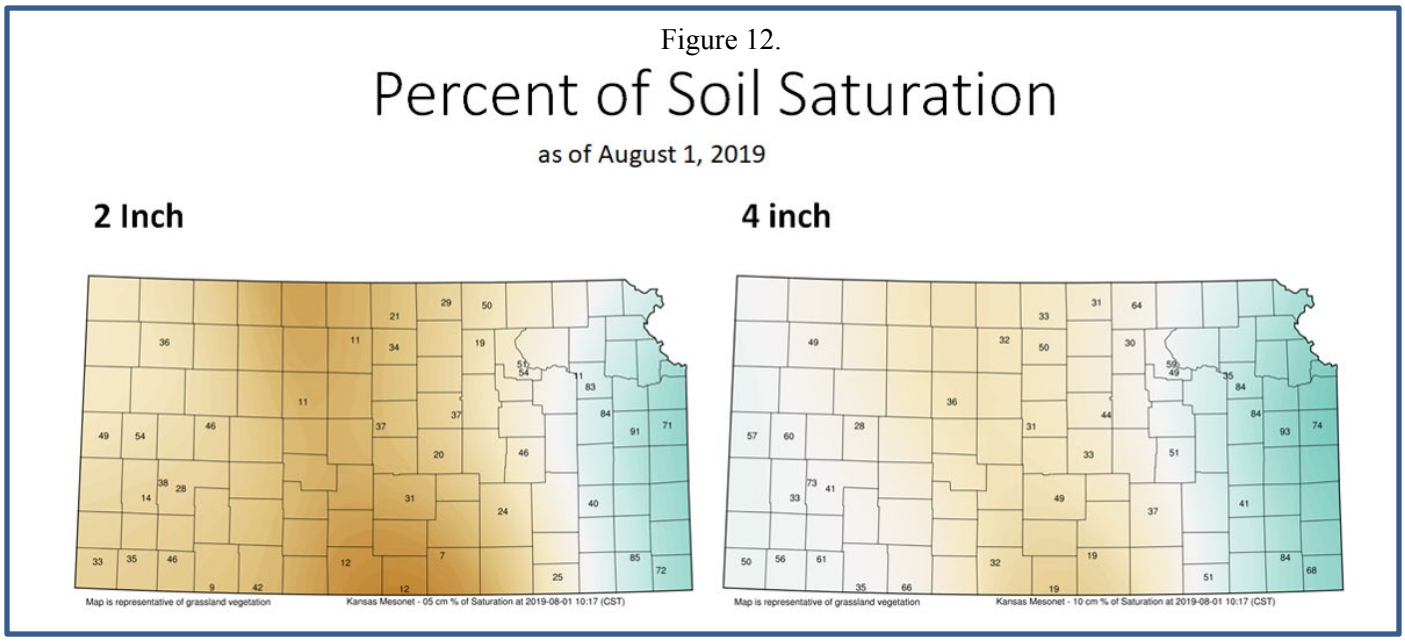
The Climate Prediction Center (CPC), monitors soil moisture and predicts future soil moisture. Anomalies are defined as deviations from the 1971-2000 monthly climatology. The monthly soil anomaly is shown in Figure 11. (.http://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml).

Figure 11.



Within Kansas soil moisture is now being measured through the Kansas Mesonet and Kansas State University the percent of soil saturation as of August 1, 2019 is shown in Figure 12.

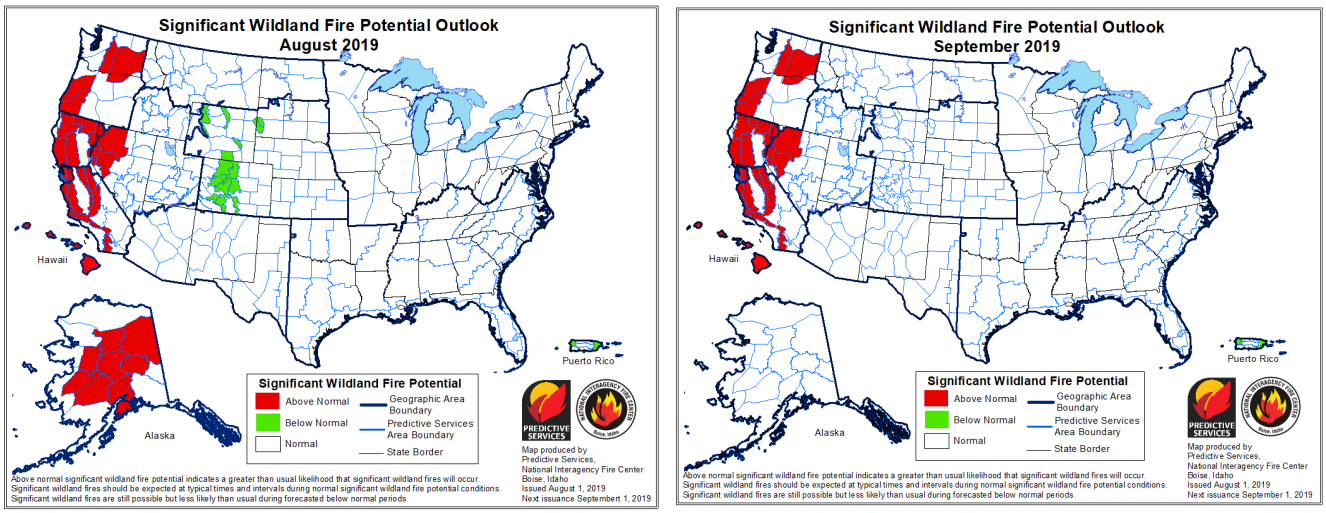
Figure 12.



Fire

Significant Wildland Fire Potential Outlook is issued monthly for the United States, https://www.predictiveservices.nifc.gov/outlooks/monthly_seasonal_outlook.pdf .

Figure 13. Wildfire Outlook



Kansas Climate Summary

The Kansas Weekly Climate Summary and Drought Report are compiled at least monthly, more frequently when conditions warrant, by the KWO. Information from various federal, state, local and academic sources is used. Some of the data is preliminary and subject to change once final data is available. The KWO web site, http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response , contains additional drought information including links to other agencies with drought information and past issues of the Kansas Climate Summary and Drought Report. Mary Knapp, at the Kansas Climate Office, Weather Data Library is the primary source of the narrative on weather. She works closely with meteorologists throughout the state and region. Details of current conditions at Evapotranspiration (ET) and Mesonet sites across Kansas are available at http://mesonet.k-state.edu/

RESOURCES and REFERENCES

Kansas climate data is provided by Kansas State University, Weather Data Library through the Kansas Mesonet. (http://www.ksre.k-state.edu/wdl/). Soil moisture data was added in 2018 (http://mesonet.k-state.edu/agriculture/soilmoist)

The U.S. Drought Monitor, from the National Drought Mitigation Center at the University of Nebraska-Lincoln, provides a "big picture" perspective of conditions across the nation. In the Kansas county drought stage scheme, a Drought Watch equates roughly to moderate drought in the U.S. Drought Monitor, while a Drought Warning is the equivalent of severe drought. A Drought Emergency is reserved for extreme or exceptional drought. Palmer Drought Severity Index - The Palmer Index (PDSI) is one indicator used in the U.S. Drought Monitor.

The High Plains Regional Climate Center (https://hprcc.unl.edu/) has precipitation and temperature summary maps available at the state, region and nation.

The U.S. Geological Survey (USGS) Drought Watch provides information average streamflow measured at long-term gaging stations and compares them to normal flows.

The Kansas Department of Agriculture-Division of Water Resources monitors stream flow using the USGS gages for determination of administrative needs. Administration may be needed due to Minimum Desirable Streamflow (MDS) requirements, impairments and reservoir release protection. (https://agriculture.ks.gov/divisions-programs/dwr/water-appropriation/minimum-desirable-streamflow.)

The water levels of the federal lakes fluctuate during a year according to the management plan. Lake level Management plans are posted on the Kansas Water Office web site www.kwo.ks.gov .

The Kansas Applied Remote Sensing Program (KARS) at the University of Kansas produces a Kansas Green Report each week during the growing season. For a full set of national and regional ***GreenReport***® maps, go to: http://www.kars.ku.edu/products/greenreport/greenreport.shtml. This Kansas Vegetation Drought Response Index map is developed weekly by the Kansas Biological Survey using state drought triggers as its key. In addition the VegDRI maps may be found at http://vegdri.unl.edu/

The National Weather Service (NWS) provides fire weather products and services for Kansas that include the Rangeland Fire Danger Index, Fire Weather Forecasts, Red Flag Watches/Warnings and Spot Forecasts. The five NWS offices that serve Kansas websites may be accessed from the NWS Offices' page.

The Monthly and Seasonal Drought Outlooks, developed by the NOAA Climate Prediction Center, assess the likelihood for improvement, persistence or deterioration in drought conditions for areas currently experiencing drought as identified by the U.S. Drought Monitor. (http://www.cpc.ncep.noaa.gov/) Also see: http://www.noaa.gov/.

Responding to Drought: A Guide for City, County and Water System Officials provides an overview of Kansas county drought stage declarations, local planning and coordination, disaster declarations and available state and federal assistance. The 2007 Municipal Water Conservation Plan Guidelines and the Drought Vulnerability Assessment Report, both by KWO, provide guidance regarding drought preparedness and response. These are available at http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response.

USDA Drought Programs and Assistance website (https://www.usda.gov/topics/disaster/drought/usda-drought-programs-and-assistance) listing the various USDA programs and agencies to assist with drought issues.

The National Interagency Coordination Center in Boise, Idaho, produces wildfire potential outlook maps monthly. (https://www.predictiveservices.nifc.gov/outlooks/outlooks.htm)

Please contact Diane Knowles at the Kansas Water Office (785) 296-3185 or diane.knowles@kwo.ks.gov should you have any questions or suggestions.

APPENDIX A
Monthly Weather Summary

July Summary

Station[1]	Precipitation (inches)			Temperature °F			
						Extreme (Date)	
	Total	Departure[2]	Percent Normal	Mean	Departure[2]	Highest	Lowest
West							
Burlington, CO	2.40	-0.73	77%	76.9	2.4	104 (19)	57 (29,23)
Dodge City	1.34	-1.74	44%	80.2	0.6	105 (31, 20)	55 (23)
Garden City	0.95	-1.83	34%	78.3	0.1	103 (31,20)	56 (23)
Goodland	1.71	-1.76	49%	77.1	1.4	105 (19)	57 (23,11)
Guymon, OK	1.58	-1.08	59%	80.9	1.3	107 (20)	58 (24)
Hill City	1.28	-2.43	35%	80.3	1.2	108 (17)	53 (23)
Lamar, CO	0.40	-2.49	14%	79.7	2.4	111 (19)	56 (14,9)
McCook, NE	3.81	0.56	117%	77.5	1.6	101 (19)	57 (24,23)
Springfield, CO	0.43	-2.40	15%	76.2	0.2	103 (19)	52 (14)
Central							
Concordia	3.16	-0.76	81%	80.4	1.3	102 (17)	56 (23)
Hebron, NE	5.84	1.71	141%	77.6	0.5	98 (17)	56 (24,23)
Medicine Lodge	1.26	-2.12	37%	81.0	-1.1	104 (31)	55 (24,23)
Ponca City, OK	2.13	-1.20	64%	89.6	-0.1	99 (31,20)	59 (23)
Salina	1.46	-2.83	34%	80.6	-0.5	105 (17)	55 (24)
Wichita (ICT)	1.38	-1.94	42%	81.5	0.4	102 (20)	58 (23)
East							
Bartlesville, OK	5.50	2.09	161%	79.3	-1.8	98 (21)	57 (24)
Chanute	3.63	-0.74	83%	80.0	0.5	98 (20,19)	57 (24)
Falls City, NE	2.59	-2.45	51%	77.6	0.1	97 (19,18)	57 (23)
Johnson Co. Exec. Apt	3.82	0.10	103%	77.3	-1.0	95 (20)	60 (24)
Joplin, MO	6.27	2.46	165%	78.4	-1.8	95 (20)	57 (24)
Kansas City (MCI), MO	2.49	-1.96	56%	77.8	-0.5	97 (20,19)	57 (23)
St. Joseph, MO	0.81	-4.38	16%	78.5	1.4	96 (20,19)	56 (23)
Topeka (TOP)	4.14	0.32	108%	79.3	0.3	98 (20,19)	58 (23)

1. Airport Automated Observation Stations (NWS/FAA)
2. Departure from 1981-2010 normal value

T - Trace; M - Missing; --- no normal value from which to calculate departure or percent of normal

Source: National Weather Service F-6 Climate Summaries

APPENDIX B-Flooding

Data from WaterWatch-USGS

Summary of July Flooding and High Flows

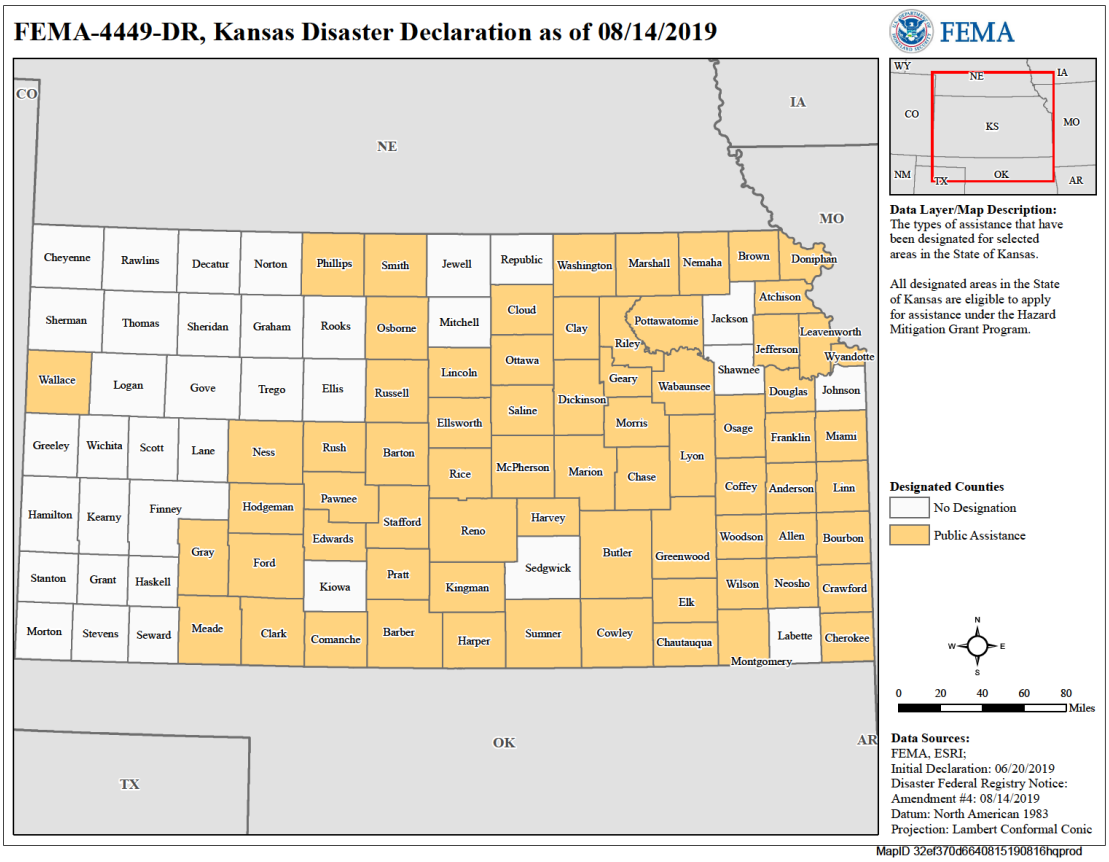
["--", no data; "<", less than all historical peaks]

USGS station name	No. Days above flood stage	NWS flood class	Highest peak from 2019-06-01 to 2019-06-30				Historical Peaks	
			Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
MISSOURI R AT ATCHISON, KS	7	Minor	7/1/2019	22.88	--	--	--	--
REPUBLICAN R NR HARDY, NE	5	Minor	7/11/2019	13.77	11000	23	99	225000 (1935)
WHITE ROCK C NR BURR OAK, KS	1	Minor	7/9/2019	16.46	1950	19	61	15800 (1973)
REPUBLICAN R AT SCANDIA, KS	7	Minor	7/10/2019	12.09	11700	22	58	215000 (1935)
REPUBLICAN R AT CONCORDIA, KS	2	Minor	7/11/2019	15.05	11700	28	80	207000 (1935)
REPUBLICAN R AT CLAY CENTER, KS	13	Minor	7/5/2019	19.48	9370 (07/16/2019)	67	102	195000 (1935)
SMOKY HILL R NR MENTOR, KS	1	Moderate	7/4/2019	24.05	6210	27	83	32000 (1903)
SMOKY HILL R AT NEW CAMBRIA, KS	2	Minor	7/4/2019	27.6	--	--	--	--
NF SOLOMON R AT PORTIS, KS	2	Minor	7/10/2019	18.32	3760	34	72	35700 (1951)
SOLOMON R AT NILES, KS	2	Minor	7/5/2019	25.75	6880	45	107	178000 (1951)
SMOKY HILL R AT ENTERPRISE, KS	4	Moderate	7/6/2019	30.98	31000	8	87	233000 (1951)
CHAPMAN C NR CHAPMAN, KS	1	Minor	7/5/2019	19.46	3050	42	65	46700 (1951)
KANSAS R AT MANHATTAN, KS	3	Minor	7/7/2019	19.76	--	--	--	--
BIG BLUE R AT BLUE RAPIDS, KS	31	Moderate	7/1/2019	56.9	--	--	--	--
BLACK VERMILLION R NR FRANKFORT, KS	18	Minor	7/1/2019	24.79	--	--	--	--
FANCY C AT WINKLER, KS	26	Moderate	7/1/2019	30.16	--	--	--	--
BIG BLUE R NR MANHATTAN, KS	9	Minor	7/19/2019	19.76	24800	15	65	93400 (1951)
EMMA C AT SEDGWICK, KS	2	Minor	7/5/2019	19.23	7210	2	3	7310 (2016)
COTTONWOOD R NR FLORENCE, KS	2	Moderate	7/5/2019	27.21	29700	7	57	73700 (1998)
COTTONWOOD R NR PLYMOUTH, KS	1	Minor	7/7/2019	32.24	16200	27	55	92900 (1998)
COTTONWOOD R AT EMPORIA, KS	3	Minor	7/8/2019	23.53	15300	4	4	18700 (2017)
NEOSHO R AT NEOSHO RAPIDS, KS	2	Minor	7/9/2019	22.51	11400 (07/05/2019)	6	7	26500 (2016)

KANSAS CLIMATE UPDATE
August 2019 Summary

Highlights

- August saw abnormally dry conditions develop and worsen in the central and western parts of the state.
- For Kansas, 2019 had the wettest August since 1895. State-wide average precipitation for the month was 6.9 inches, 208 % of normal.
- State-wide average temperature for August was roughly 66 degrees F, 0.4 degrees F cooler than normal. This ranks as the 53rd coolest on record.
- August flooding occurred at 33 USGS stream gages on at least 25 streams for one to as much as 31 days.
- During August DR-4449 was amended a third and fourth time, adding counties to those eligible for public assistance for Multi- Hazard Event of April 28-July 12, 2019. August 5, 2019, DR-4449 was amended a third time to add Brown, Ness, Osbourne, Smith, Stafford, Wallace and Wyandotte counties. August 14th Miami County was added.

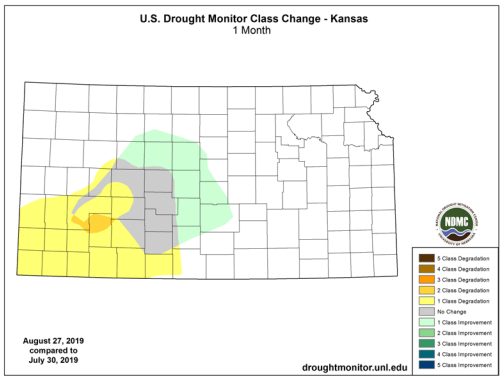


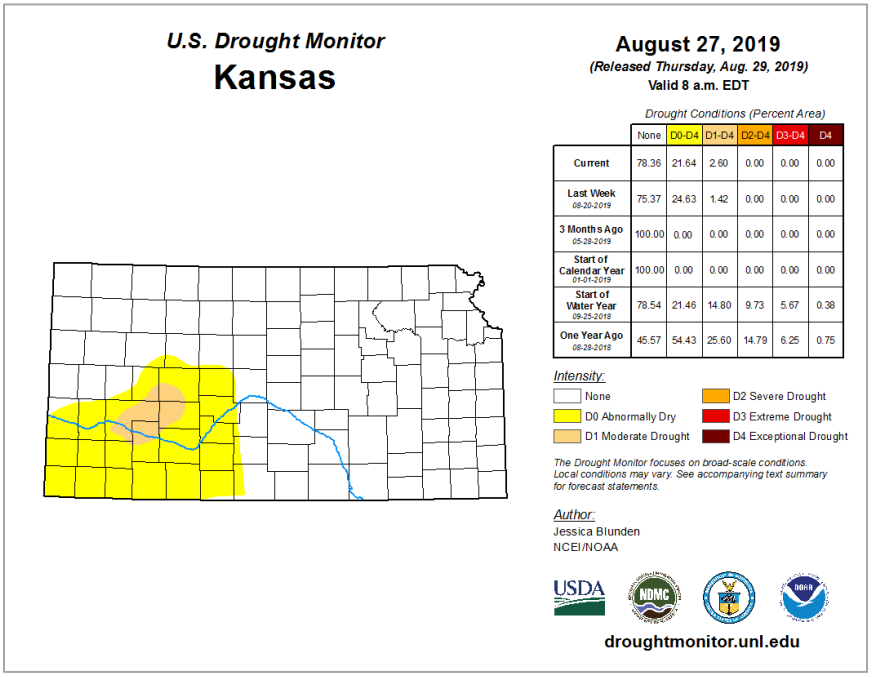
- There were 8 tornadoes reported during the month. Most were brief touchdowns with minimal damage. There were no reports of deaths or injuries. Hail and damaging wind events were also more numerous, with 90 hail reports and 241 wind reports. (Kansas Weather Data Library)

General Drought Conditions

Despite the wetter than normal pattern overall, abnormal dry conditions and moderate drought remains. This was largely confined to the Southwest part of the state where the largest precipitation deficits occurred. The U.S. Drought Monitor indicated dry and drought conditions in parts of western and central Kansas in August, ending the month with conditions shown below in Figure 1. Changes in drought classification over the month for the High Plains area is also shown.

Figure 1. U.S. Drought Monitor Maps of Drought status



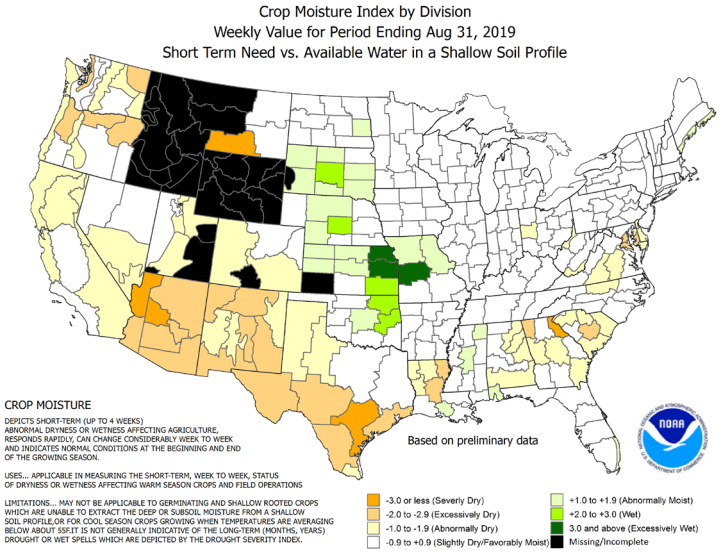


	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	78.36	21.64	2.60	0.00	0.00	0.00
Last Week 08-20-2019	75.37	24.63	1.42	0.00	0.00	0.00
3 Months Ago 05-28-2019	100.00	0.00	0.00	0.00	0.00	0.00
Start of Calendar Year 01-01-2019	100.00	0.00	0.00	0.00	0.00	0.00
Start of Water Year 09-25-2018	78.54	21.46	14.80	9.73	5.67	0.38
One Year Ago 08-28-2018	45.57	54.43	25.60	14.79	6.25	0.75

More information can be found on the U.S. Drought Monitor web site https://droughtmonitor.unl.edu/ .

Palmer Drought Severity Index (PDSI) - The Palmer Drought Severity Index is an indicator of relative dryness or wetness and is one factor used the U.S. Drought Monitor. The Crop Moisture (Figure 2) component evaluates short term needs and available water. More information on the PDSI and its parts can be found at http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml.

Figure 2.



Climate Summary - Precipitation

August 2019 was the wettest August on record. State-wide average precipitation for the month was 6.93 inches, 208 percent of normal. Only the Southwest Division had below normal precipitation, with a divisional average of 2.20 inches, 81 percent of normal. The remaining divisions were above normal for the month. The East Central Division was the wettest, compared to normal, with an average of 10.37 inches, 254 percent of normal. The highest 24-hour rainfall total for a National Weather Service Cooperative station was 8.46 inches at Ottawa, Franklin County, on the 1st. The greatest 24-hour rainfall total for a Community Collaborative Rain, Hail and Snow network station was 11.00 inches at Baldwin City 7.5 WSW, Douglas County, also on the 1st. Three National Weather Service COOP stations set all-time daily rainfall records, all on the 1st: Ottawa, 8.45"; Clinton Lake, 8.24"; and Lecompton, 7.22". The greatest monthly precipitation totals for August: 20.51 inches at Clinton Lake, Douglas County (NWS) and 22.51 inches at Lawrence 2.2 W, Douglas County (CoCoRaHS). Table 1 summarizes the monthly precipitation (KSU Weather Data Library).

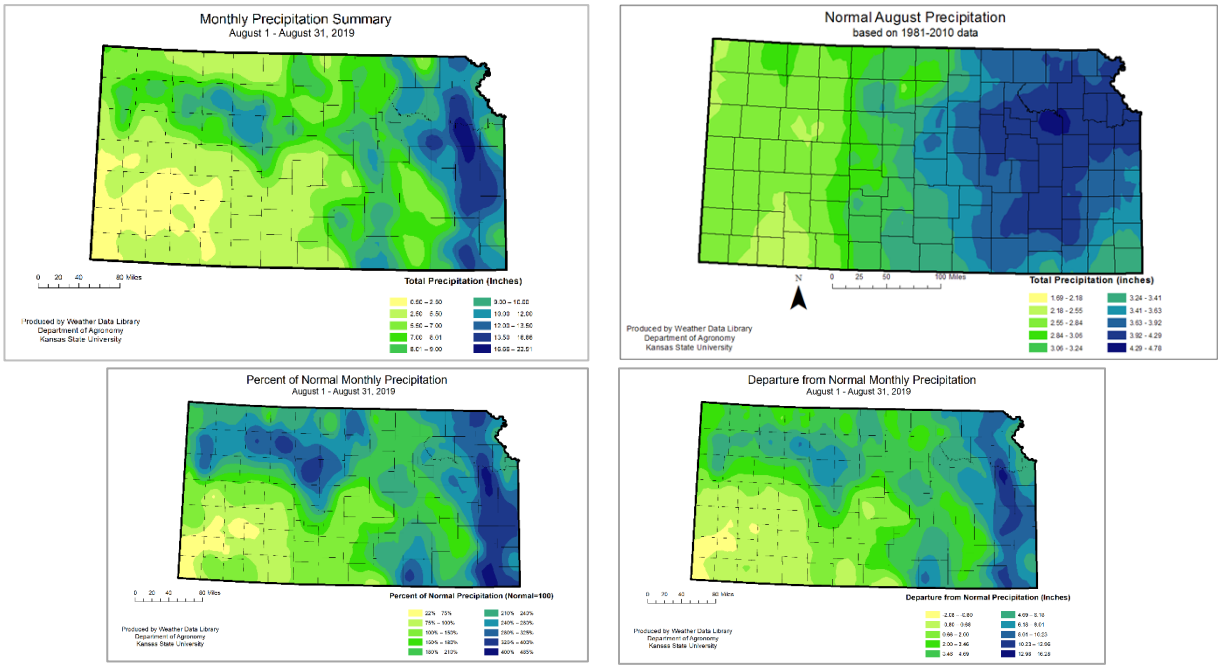
Table 1.

Kansas Climate Division Precipitation Summary (inches)

Climate Division	August 1 - 31, 2019			January 1 – August 31, 2019			April 1, 2019 – August 31, 2019			Sept 1, 2018 – August 31, 2019		
	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal
Northwest	6.57	3.84	241	20.60	3.71	122	18.24	3.65	124	27.65	6.29	129
West Central	4.76	2.15	182	19.12	2.83	117	15.82	2.03	114	28.11	7.34	135
Southwest	2.20	-0.51	81	17.25	1.81	112	13.96	0.90	106	25.65	5.75	129
North Central	7.74	4.45	235	27.99	6.68	131	24.35	6.52	135	41.67	13.63	149
Central	7.57	4.00	212	29.57	7.09	132	25.80	7.27	139	43.63	14.34	149
South Central	6.14	2.70	178	32.63	9.16	139	28.62	9.77	150	47.42	16.10	151
Northeast	8.75	4.85	224	35.82	10.16	140	30.41	8.95	140	50.88	15.88	145
East Central	10.37	6.28	254	39.11	11.50	142	33.53	10.85	146	52.14	14.22	138
Southeast	9.86	6.12	264	46.58	17.17	158	40.50	17.09	173	61.39	19.90	148
STATE	6.93	3.60	208	29.80	7.80	135	25.66	7.51	136	42.01	12.62	143

The maps of Figure 3 below summarize precipitation for the month. (State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)

Figure 3. Monthly Precipitation maps



Climate Summary-Temperature

Temperatures for August fell on the cool side of the middle of the distribution for the period of record. State-wide average temperature for the month was 76.7 ºF, which is 0.4 degrees cooler than normal. This ranks as the 53rd coolest on record. The Southwest Division was the warmest with an average of 79.5 ºF, 2.2 degrees warmer than normal. The Southeast Division was the coolest, with an average of 77.0 ºF, 1.5 degrees cooler than normal. Despite the cooler pattern, only the eastern divisions failed to break the century mark for maximum temperatures. The warmest maximum temperature was 108 oF at Kearny County, on the 1st. The coldest minimum temperature was 51 ºF Brewster 4W, Thomas County, on the 28th. There was one record maximum temperature: 104 ºF reported at Great Bend 3W on the 22nd. On the other hand, there were 19 new record warm minimum temperatures set. Cold daily records were also numerous with 18 record low maximums. There were no new record low minimums. Table 2 summarizes the monthly temperatures (KSU Weather Data Library).

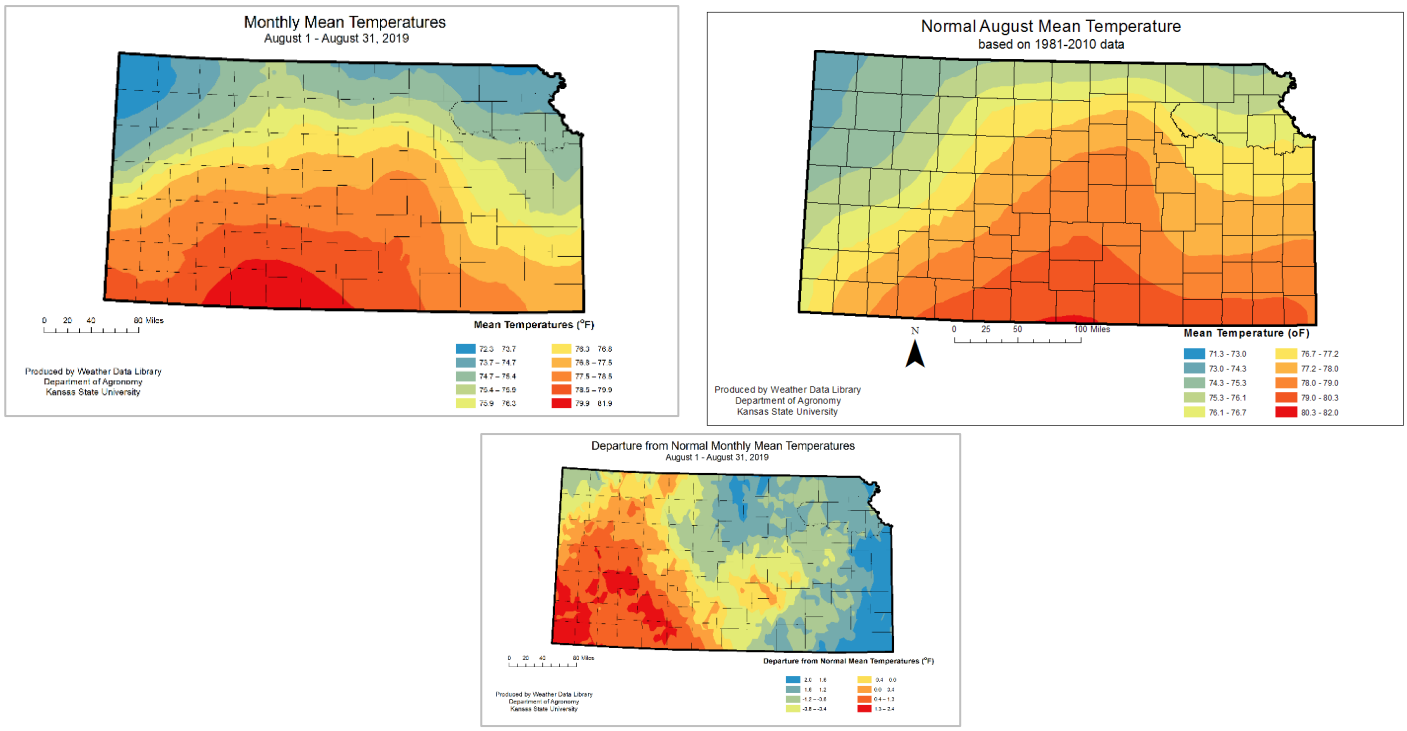
Table 2.

Climate Division	Kansas Climate Division Temperature Summary (ºF) August 2019							
	Maximum	Minimum	Average	Departure*	High	Date	Low	Date
Northwest	86.8	61.9	74.3	-0.4	103	1	51	28
West Central	90.1	62.7	76.4	0.8	106	1	52	28
Southwest	93.9	65.1	79.5	2.2	108	1	55	28
North Central	86.1	65.8	76.0	-1.1	105	1	53	28
Central	88.2	66.3	77.2	-0.9	107	1	53	28
South Central	90.6	68.3	79.5	0.3	106	20	54	28
Northeast	84.2	65.6	74.9	-1.4	95	21	52	28
East Central	84.8	66.7	75.7	-1.4	98	21	53	28
Southeast	86.1	68.0	77.0	-1.5	99	21	54	25
STATE	87.9	65.6	76.7	-0.4	108	1st	51	28th

*Departure from normal is departure from the base period of 1981-2010, KSU Weather Data Library.

The maps in Figure 4 below summarize temperature for the month. (State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)

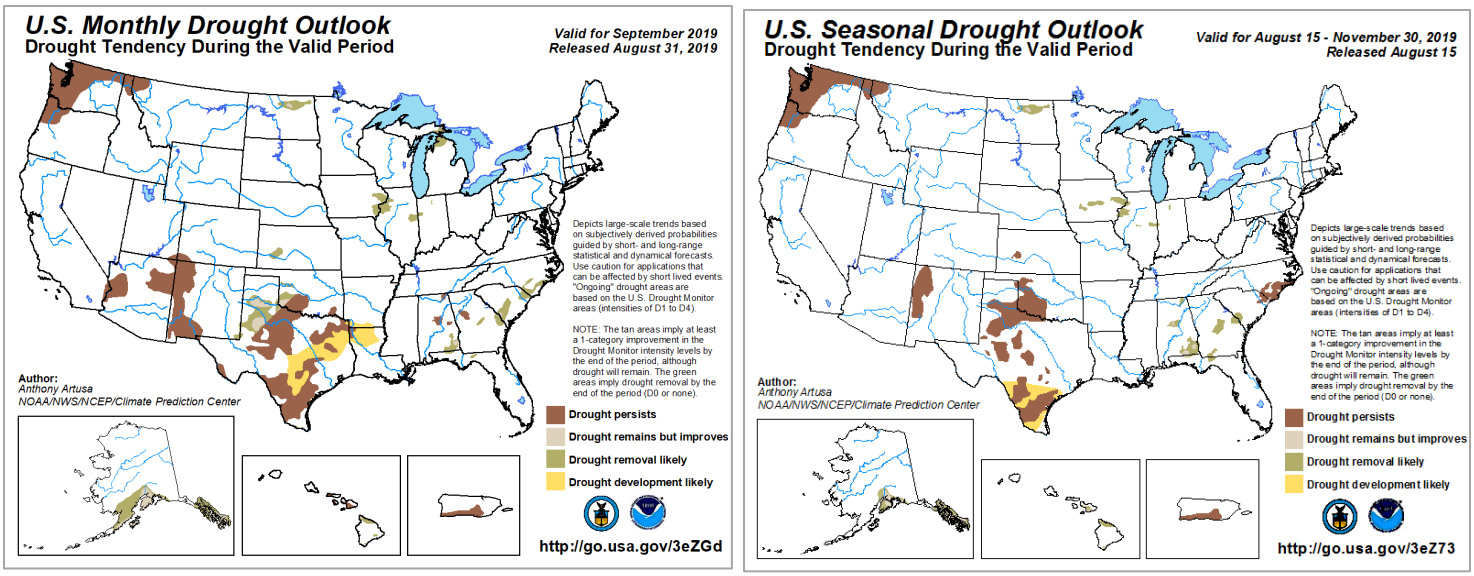
Figure 4. Monthly Temperature Maps



Outlooks

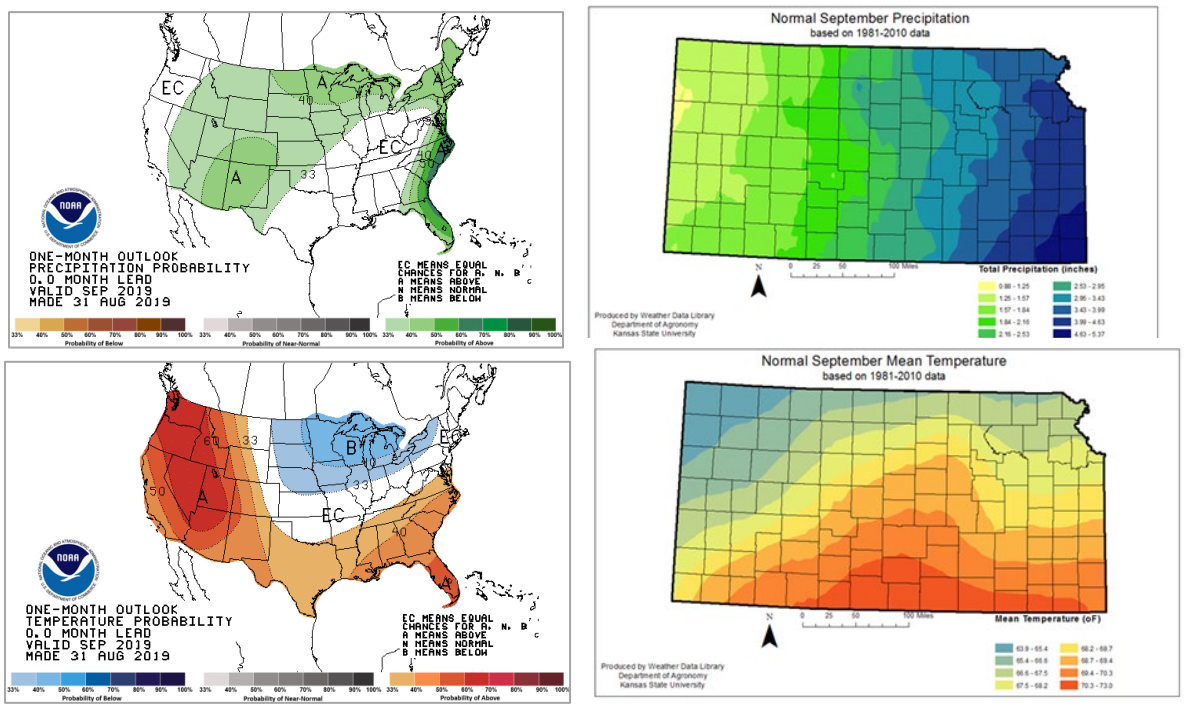
The Monthly Drought Outlook for September 2019 indicates removal of the drought conditions that developed in August. The Seasonal Outlook (3-month) favors a small area of drought in Kansas persisting in the mid-August to mid-November period. The individual temperature and precipitation outlooks that contribute to these outlooks are available below.

Figure 5. Drought Outlooks



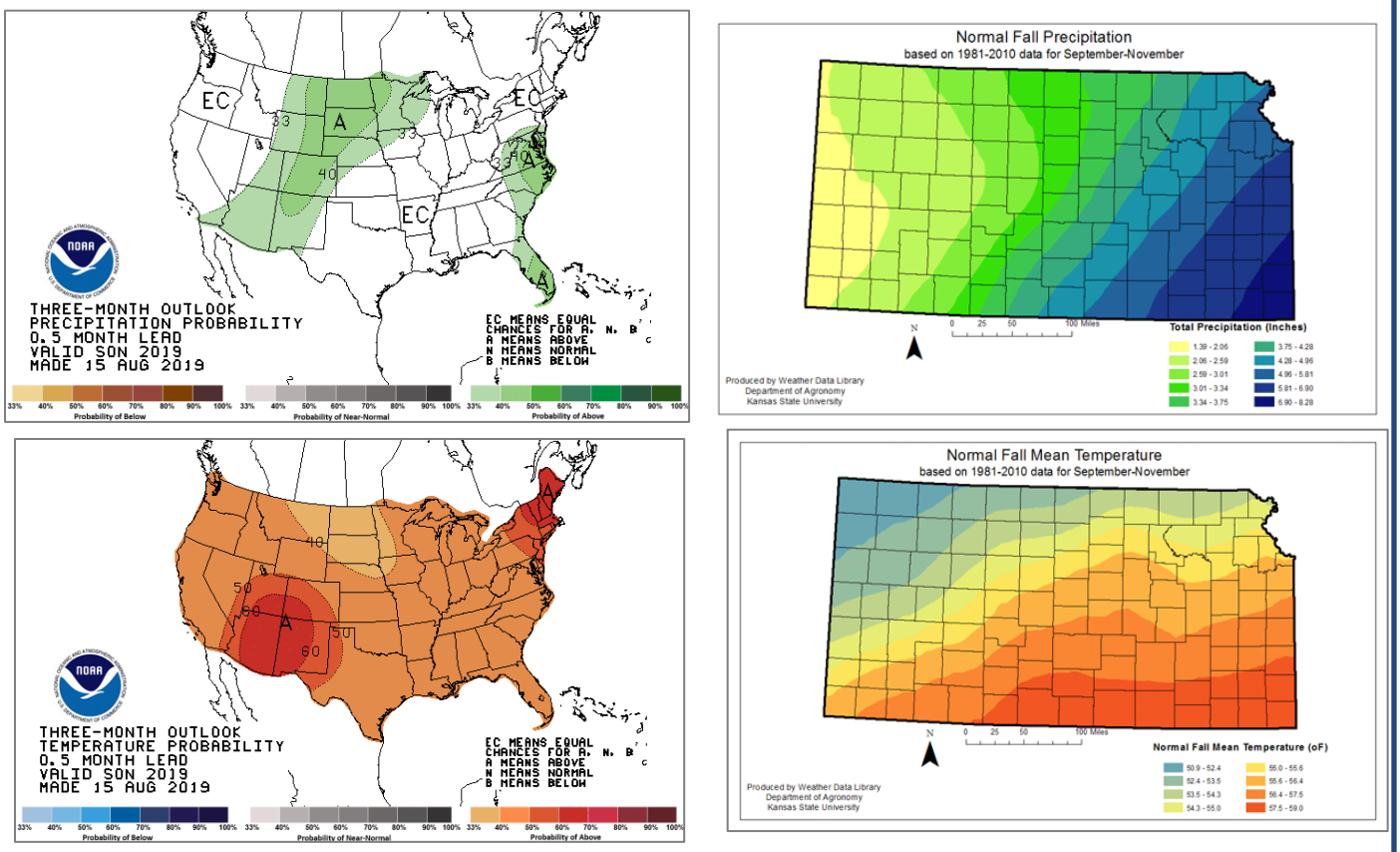
The September precipitation outlook favors a slightly increased chance of above normal precipitation across the state. With the limited dry conditions and the climatologically increased amounts of normal precipitation at this time of the year, a normal to above normal precipitation pattern in September could limit expansion of drought conditions. The temperature outlook is for equal chances of above or below normal temperatures across the state, with best chances of above normal temperatures to the northwest. Lingering concerns will be for flooding, particularly in the eastern parts of the state. One month outlooks are provided in Figure 6.

Figure 6. Next Month Precipitation and Temperature Outlooks



The U.S. three month outlook for August through October slightly favors above-average precipitation (moderate chance) for all of Kansas and above normal temperatures for the entire state.

Figure 7. Three Month Precipitation and Temperature Outlooks



Additional outlooks for various timeframes are available from the national CPC for up to 13 months. (http://www.cpc.ncep.noaa.gov/products/predictions/90day/)

Water

Public Water Supplies

Storm and flooding created known issues for water and wastewater systems around the state.

The Kansas National Guard (KSNG) continues to conduct water hauling operations in support of Lakeside Village in Jefferson County. The need for water hauling support is expected to last into September due to current water levels at Perry Lake and the anticipated releases identified by the U.S. Corp of Engineers.

Reservoir Storage

At the end of the month all reservoir conservation pools were full except Keith Sebelius and Cedar Bluff, which ended at 75% and 63% of conservation pools respectively. Releases were, and continue to be made to reduce water in flood pools at many reservoirs. Table 3 provides end of month conservation pool status for each federal reservoir.

Table 3. Kansas Federal Reservoir Conservation Pool Levels

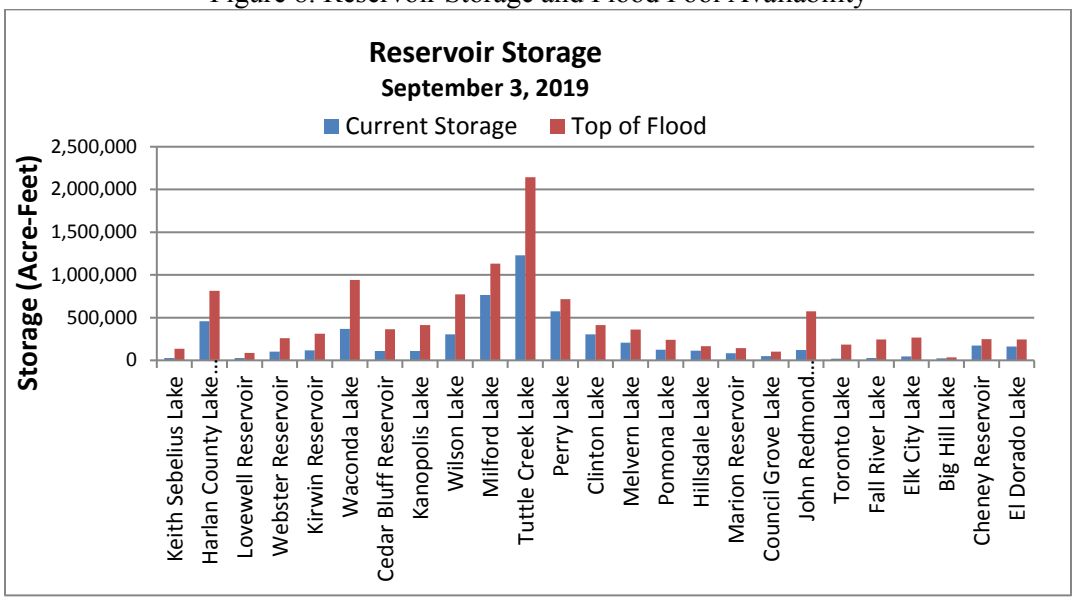
Reservoir	Top of Multipurpose / Conservation Pool (Feet MSL)	Multipurpose/Conservation Pool Elevation (Feet MSL)	Change from Top of Pool (Feet)	Percent of Conservation Pool Full
Kansas River Basin		**9/03/2019**		
Keith Sebelius Lake[1]	2304.3	2299.88	-4.42	74.5%
Harlan County Lake NE	1945.73	1955.45	9.72	100.0%
Lovewell Reservoir[1]	1582.6	1578.80	-3.80	71.2%
Webster Reservoir[1]	1892.45	1898.82	6.37	100.0%
Kirwin Reservoir	1729.25	1732.89	3.64	100.0%
Waconda Lake[1]	1455.6	1465.63	10.03	100.0%
Cedar Bluff Reservoir	2144	2133.38	-10.62	63.4%
Kanopolis Lake[1]	1463	1476.42	13.42	100.0%
Wilson Lake[1]	1516	1522.18	6.18	100.0%
Milford Lake[1]	1144.4	1163.50	19.10	100.0%
Tuttle Creek Lake[1]	1075	1115.99	40.99	100.0%
Perry Lake[1]	891.5	914.68	23.18	100.0%
Clinton Lake[1]	875.5	894.98	19.48	100.0%
Melvern Lake[1]	1036	1043.50	7.50	100.0%
Pomona Lake[1]	974	988.01	14.01	100.0%
Hillsdale Lake[1]	917	923.37	6.37	100.0%
Arkansas River Basin		**9/03/2019**		
Marion Reservoir[1]	1350.5	1350.79	0.29	100.0%
Council Grove Lake[1]	1274	1276.32	2.32	100.0%
John Redmond Reservoir	1041	1046.11	5.11	100.0%
Toronto Lake	901.5	903.45	1.95	100.0%
Fall River Lake	948.5	950.54	2.04	100.0%
Elk City Lake	796	798.08	2.08	100.0%
Big Hill Lake	858	858.22	0.22	100.0%
Cheney Reservoir	1421.6	1422.06	0.46	100.0%
El Dorado Lake	1339	1339.18	0.18	100.0%

[1]Lake level management plan in place — Source: U.S. Army Corps of Engineers, U.S. Bureau of Reclamation and U.S. Geological Survey

Note: The conservation pool is the water storage for non-flood purposes of the reservoir, set by the elevation of the top of the pool.

In Figure 8 the blue bars indicate water in storage at that reservoir, with red bars indicate top of the flood pool storage. Some reservoirs have storage space remaining for flood flows but the available space varies. Reservoir releases in continue to increase space for flood flows should they occur.

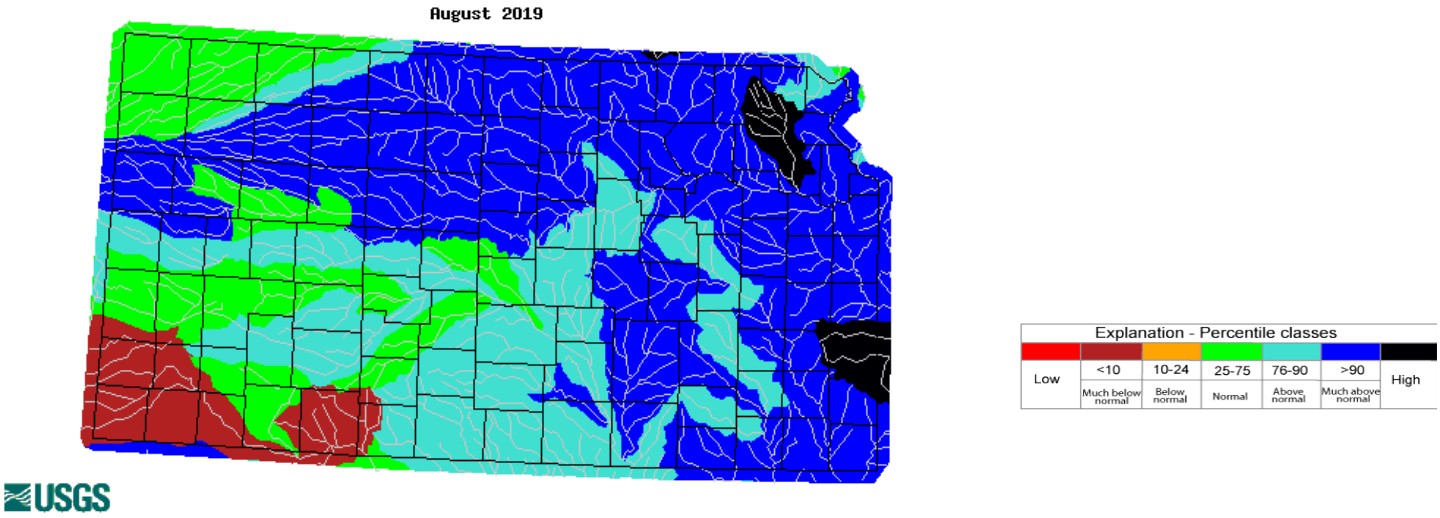
Figure 8. Reservoir Storage and Flood Pool Availability



Streamflow Conditions

WaterWatch summarizes streamflow conditions in a region (state or hydrologic unit) in terms of the long-term typical condition at stream gages in the region. In general, a streamflow which is greater than the 75 percentile is considered *above normal*, a streamflow which is between 25 and 75 percentiles is considered *normal* and a streamflow which is less than the 25 percentile is considered *below normal*. Color codes are for basins with streamflow averages less than 25 percent of historic values. This comparison aids in evaluating water resources conditions for a time period. A summary of flooding in is found later in this report. Figure 9 summarizes streamflow.

Figure 9. Monthly streamflow compared to historical streamflow



Minimum Desirable Streamflow: Low flows may be reflected at gage locations when the flow does not reach Minimum Desirable Streamflow (MDS). MDS requirements are in place to ensure base flows in certain streams to protect existing water rights and to meet in-stream water uses related to water quality, fish and wildlife and recreation. The Kansas Department of Agriculture, Division of Water Resources monitors 23 streams and rivers at 33 locations for minimum desirable streamflow. When flows drop below an established threshold, pumping restrictions are imposed on permits or water rights granted after the minimum desirable streamflow provision was made into law in 1984.

Although no water right administration was in effect in July, the table below notes locations of concern including those below MDS.

Table 4.
Streamflows of Note

Gaging Station	Aug 5 Flow	Aug 12 Flow	Aug 19 Flow	Aug 26 Flow	Aug MDS	Comment
Rattlesnake Creek near Macksville	1	2	0.63	4	1	No surface water diversions junior to MDS above gage
Rattlesnake Creek near Zenith	9	9	8	22	3	No surface water diversions junior to MDS above gage

Flooding

General flooding for the month is shown in the USGS WaterWatch maps in the streamflow section of this report. However this does not provide all the specifics of severity of impacts and duration at specific locations. Additional flooding information can be found for USGS stream gage sites at https://waterwatch.usgs.gov/?m=flood&r=ks&w=flood%2Ctable for current stage. The USGS gage monitoring records indicate 33 gages in Kansas were at flood stage sometime during the month.

State Disaster Declarations have now been issued for 67 counties in response to flooding and storms in May and June. They are: Allen, Anderson, Atchison, Barber, Barton, Bourbon, Brown, Butler, Chase, Chautauqua, Cherokee, Clark, Clay, Cloud, Coffey, Comanche, Cowley, Crawford, Dickinson, Doniphan, Douglas, Edwards, Elk, Ellsworth, Ford, Franklin, Geary, Gray, Greenwood, Harper, Harvey, Hodgeman, Jefferson, Kingman, Leavenworth, Lincoln, Linn, Lyon, Marion, Marshall, McPherson, Meade, Montgomery, Morris, Nemaha, Ness, Neosho, Norton, Osborne, Osage, Ottawa, Pawnee, Phillips, Pottawatomie, Pratt, Reno, Rice, Riley, Rush, Russell, Saline, Stafford, Sumner, Wabaunsee, Washington, Wilson, and Woodson.

A total of 70 Kansas counties are now identified in Federal Emergency Declarations, DR-4449 due to storms, winds, tornadoes, flooding, landslides and mudslides. The President's action makes federal funding available to state, eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and repair or replacement of facilities in Allen, Anderson, Atchison, Barber, Barton, Bourbon, Brown, Butler, Chase, Chautauqua, Cherokee, Clark, Clay, Cloud, Coffey, Comanche, Cowley, Crawford, Dickinson, Doniphan, Douglas, Edwards, Elk, Ellsworth, Ford, Franklin, Geary, Gray, Greenwood, Harper, Harvey, Hodgeman, Jefferson, Kingman, Leavenworth, Lincoln, Linn, Lyon, Marion, Marshall, McPherson, Meade, Miami, Montgomery, Morris, Nemaha, Neosho, Ness, Osage, Osbourne, Ottawa, Pawnee, Phillips, Pottawatomie, Pratt, Reno, Rice, Riley, Rush, Russell, Saline, Smith, Sumner, Wabaunsee, Wallace, Washington, Wilson, Woodson and Wyandotte counties.

Federal funding is also available on a cost-sharing basis for hazard mitigation measures statewide. Some additional counties may be eligible for federal declaration and aid in the future once damage assessment is completed by FEMA.

USDA has designated Atchison, Leavenworth and Wyandotte counties as primary disaster areas due to flooding, making producers eligible for emergency loans.

Appendix B provides an overview of Kansas flooding in July 2019 at USGS stream gages in the WaterWatch system.

Harmful Blue-Green Algal Blooms (lake water safety)

The 2019 HAB monitoring began on April 1, 2019. KDHE samples public use lakes only in response to complaints of human or animal illness or visual sighting of possible blue-green algae by the public or lake officials.

KDHE issues three levels of public health protection notifications for blue-green algae (BGA) Blooms. Public Health Watch–Notifies public that a harmful algae may be present, that the water may be unsafe for humans and animals and contact with the water is discouraged. Public Health Warning–Notifies public that harmful algae is present of expected, that contact with the water should not occur, and all conditions of Public Health Watch remain in effect. Lake Closure –Notifies the public that a portion of the lake or the entire lake be closed to public because harmful algae is present and extreme conditions exist. A summary of lakes affected in the month is found in Table 5. More information can be found at http://www.kdheks.gov/algae-illness/index.htm.

Table 5.
KDHE Lake Health Advisories issued in July 2019

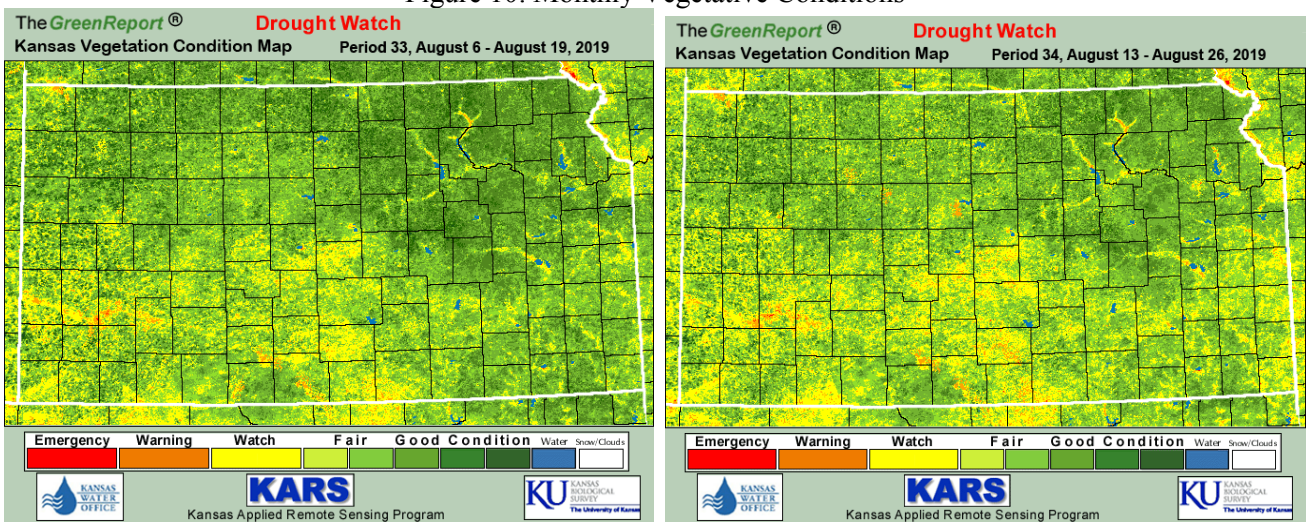
Lake	County	8/1/19	8/9/19	8/15/19	8/22/19	8/29/19
Big Eleven Lake	Wyandotte	Warning	Warning	Warning		Warning
Camp Hawk Lake	Harvey	Watch	Warning	Warning		Warning
Carousel Lake in Gage Park	Shawnee	Watch	Watch	Watch		Watch
Elk Horn Lake	Jackson					Watch
Gathering Pond	Geary	Warning	Warning	Warning	Warning	Warning
Hiawatha City Lake	Brown	Watch	Watch	Watch	Warning	Warning
Hodgeman County State Fishing Lake	Hodgeman	Watch	Watch	Watch	Warning	Warning
Jerry Ivey Pond	Saline	Warning	Warning	Warning	Warning	Warning
Keith Sebelius Reservoir	Norton	Watch	Watch			
Lake Afton	Sedgewick	Watch	Warning	Warning	Warning	Warning
Lake Shawnee	Shawnee	Watch	Watch	Watch	Watch	Watch
Lakewood Park Lake	Saline		Warning	Warning	Warning	Warning
Lebo Kids' Pond	Coffey	Warning	Warning	Warning	Warning	Warning
Lovewell Reservoir	Jewell	Watch	Watch	Watch	Watch	
Marais des Cygnes Wildlife Area	Linn		Warning	Warning	Warning	Warning
Marion County Lake	Marion	Warning	Warning	Warning	Warning	Warning
Marion Reservoir	Marion	Watch	Watch			
Meadowbrook Park lake	Johnson			Watch	Watch	Watch
Melvern Outlet Pond	Osage	Warning	Warning	Warning	Warning	Warning
Melvern Outlet Swim Pond	Osage	Warning	Warning	Warning	Warning	Warning
Mission Lake	Brown				Watch	Watch
Neosho County State Fishing Lake	Neosho		Warning	Warning	Warning	Warning
Riggs park	Sedgwick				Watch	Watch
Rock Garden Pond	Shawnee	Watch	Watch	Watch	Watch	Watch
South Lake	Johnson	Warning	Warning	Warning	Warning	Watch
Westlake in Gage Park	Shawnee	Warning	Warning	Warning	Warning	Warning
Yates Center Kids" Fishing Pond	Woodson					Warning

Vegetation and Soil Moisture

Vegetative Conditions

The Vegetative Condition map provides current conditions related to drought effects on vegetation. It is produced using satellite data. Areas in yellow, orange and red indicate areas of vegetative stress. The green areas are considered to be in good or excellent condition.

Figure 10. Monthly Vegetative Conditions



Soil Moisture and Rangeland

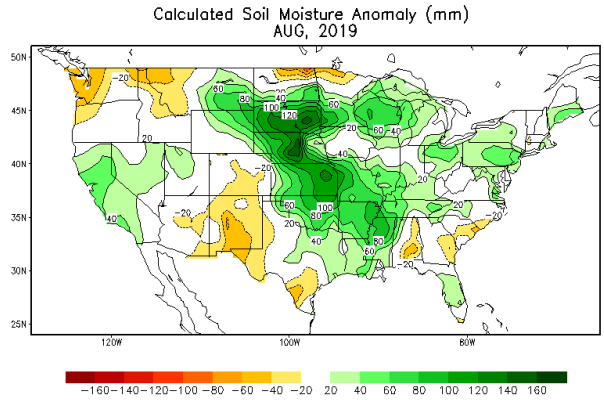
The National Agricultural Statistics Service, USDA Crop Progress and Condition provides a summary of the climatic effects on soil and crops. For the week ending August 26, 2019, topsoil moisture supplies rated 4 percent very short, 13 short, 70 adequate, and 13 surplus. Subsoil moisture supplies rated 3 percent very short, 15 short, 73 adequate, and 9 surplus.

Field Crops Report:
Corn condition rated 5 percent very poor, 11 poor, 33 fair, 41 good, and 10 excellent.
Soybean condition rated 4 percent very poor, 8 poor, 35 fair, 46 good, and 7 excellent.
Sorghum condition rated 2 percent very poor, 9 poor, 27 fair, 54 good, and 9 excellent.
Cotton condition rated 2 percent very poor, 9 poor, 42 fair, 42 good, and 5 excellent.

Pasture and range conditions rated 1 percent very poor, 5 poor, 24 fair, 59 good, and 11 excellent.

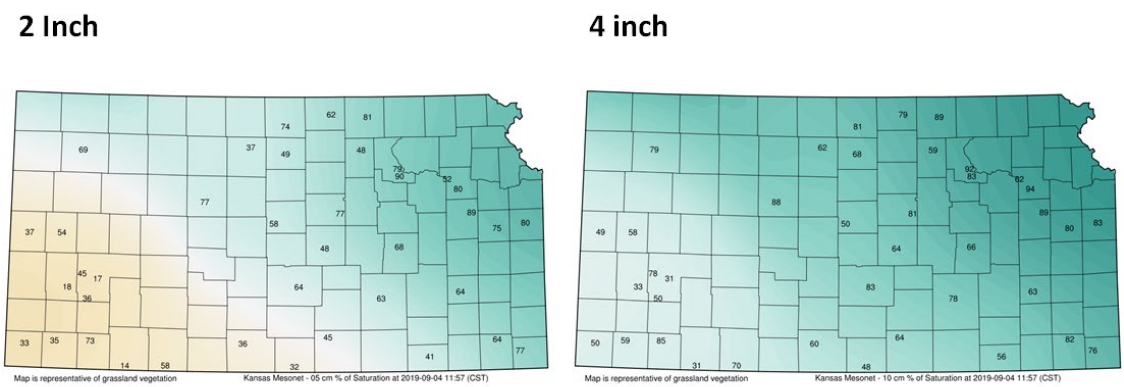
The Climate Prediction Center (CPC), monitors soil moisture and predicts future soil moisture. Anomalies are defined as deviations from the 1971-2000 monthly climatology. The monthly soil anomaly is shown in Figure 11. (.http://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml).

Figure 11.



Within Kansas soil moisture is now being measured through the Kansas Mesonet and Kansas State University the percent of soil saturation is shown in Figure 12.

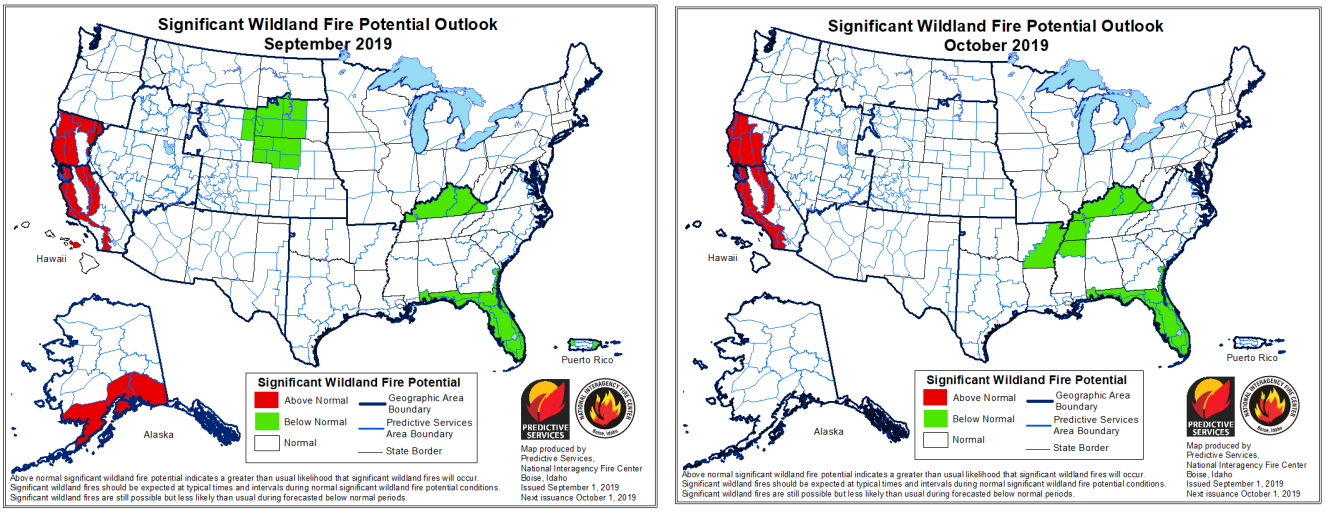
Figure 12.



Fire

Significant Wildland Fire Potential Outlook is issued monthly for the United States, https://www.predictiveservices.nifc.gov/outlooks/monthly_seasonal_outlook.pdf .

Figure 13. Wildfire Outlook



Kansas Climate Summary

The Kansas Weekly Climate Summary and Drought Report are compiled at least monthly, more frequently when conditions warrant, by the KWO. Information from various federal, state, local and academic sources is used. Some of the data is preliminary and subject to change once final data is available. The KWO web site, http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response , contains additional drought information including links to other agencies with drought information and past issues of the Kansas Climate Summary and Drought Report. Mary Knapp, at the Kansas Climate Office, Weather Data Library is the primary source of the narrative on weather. She works closely with meteorologists throughout the state and region. Details of current conditions at Evapotranspiration (ET) and Mesonet sites across Kansas are available at http://mesonet.k-state.edu/

RESOURCES and REFERENCES

Kansas climate data is provided by Kansas State University, Weather Data Library through the Kansas Mesonet. (http://www.ksre.k-state.edu/wdl/). Soil moisture data was added in 2018 (http://mesonet.k-state.edu/agriculture/soilmoist)

The U.S. Drought Monitor, from the National Drought Mitigation Center at the University of Nebraska-Lincoln, provides a "big picture" perspective of conditions across the nation. In the Kansas county drought stage scheme, a Drought Watch equates roughly to moderate drought in the U.S. Drought Monitor, while a Drought Warning is the equivalent of severe drought. A Drought Emergency is reserved for extreme or exceptional drought. Palmer Drought Severity Index - The Palmer Index (PDSI) is one indicator used in the U.S. Drought Monitor.

The High Plains Regional Climate Center (https://hprcc.unl.edu/) has precipitation and temperature summary maps available at the state, region and nation.

The U.S. Geological Survey (USGS) Drought Watch provides information average streamflow measured at long-term gaging stations and compares them to normal flows.

The Kansas Department of Agriculture-Division of Water Resources monitors stream flow using the USGS gages for determination of administrative needs. Administration may be needed due to Minimum Desirable Streamflow (MDS) requirements, impairments and reservoir release protection. (https://agriculture.ks.gov/divisions-programs/dwr/water-appropriation/minimum-desirable-streamflow.)

The water levels of the federal lakes fluctuate during a year according to the management plan. Lake level Management plans are posted on the Kansas Water Office web site www.kwo.ks.gov .

The Kansas Applied Remote Sensing Program (KARS) at the University of Kansas produces a Kansas Green Report each week during the growing season. For a full set of national and regional ***GreenReport***® maps, go to: http://www.kars.ku.edu/products/greenreport/greenreport.shtml. This Kansas Vegetation Drought Response Index map is developed weekly by the Kansas Biological Survey using state drought triggers as its key. In addition the VegDRI maps may be found at http://vegdri.unl.edu/

The National Weather Service (NWS) provides fire weather products and services for Kansas that include the Rangeland Fire Danger Index, Fire Weather Forecasts, Red Flag Watches/Warnings and Spot Forecasts. The five NWS offices that serve Kansas websites may be accessed from the NWS Offices' page.

The Monthly and Seasonal Drought Outlooks, developed by the NOAA Climate Prediction Center, assess the likelihood for improvement, persistence or deterioration in drought conditions for areas currently experiencing drought as identified by the U.S. Drought Monitor. (http://www.cpc.ncep.noaa.gov/) Also see: http://www.noaa.gov/.

Responding to Drought: A Guide for City, County and Water System Officials provides an overview of Kansas county drought stage declarations, local planning and coordination, disaster declarations and available state and federal assistance. The 2007 Municipal Water Conservation Plan Guidelines and the Drought Vulnerability Assessment Report, both by KWO, provide guidance regarding drought preparedness and response. These are available at http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response.

USDA Drought Programs and Assistance website (https://www.usda.gov/topics/disaster/drought/usda-drought-programs-and-assistance) listing the various USDA programs and agencies to assist with drought issues.

The National Interagency Coordination Center in Boise, Idaho, produces wildfire potential outlook maps monthly. (https://www.predictiveservices.nifc.gov/outlooks/outlooks.htm)

Please contact Diane Knowles at the Kansas Water Office (785) 296-3185 or diane.knowles@kwo.ks.gov should you have any questions or suggestions.

APPENDIX A
Monthly Weather Summary

August Summary

Station[1]	Precipitation (inches)			Temperature °F			
						Extreme (Date)	
	Total	Departure[2]	Percent Normal	Mean	Departure[2]	Highest	Lowest
West							
Burlington, CO	4.33	1.92		74.6	2.5	96 (29,20)	55 (28,27)
Dodge City	2.83	0.08		80.3	2.2	104 (20)	57 (28)
Garden City	1.46	-0.99		78.4	1.7	103 (20)	55 (28)
Goodland	9.47	6.77		73.9	0.2	99 (20)	53 (30,28)
Guymon, OK	3.56	0.64		81.1	3.0	107 (19)	62 (27,23)
Hill City	11.95	9.04		76.7	0.1	101 (20)	54 (28)
Lamar, CO	0.73	-1.55		78.6	3.2	105 (29,20)	53 (29)
McCook, NE	3.30	0.16		74.4	0.6	97 (10)	53 (30)
Springfield, CO	1.07	-0.97		75.9	1.7	102 (19)	53 (27,24)
Central							
Concordia	6.61	3.47		76.8	-0.3	96 (20)	56 (28)
Hebron, NE	6.45	2.72		74.6	-0.7	91 (20,19)	53 (28)
Medicine Lodge	3.40	0.28		80.9	0.2	105 (20)	57 (28)
Ponca City, OK	7.72	4.47		80.8	-0.2	101 (12)	61 (28)
Salina	8.87	4.92		77.5	-2.1	99 (20)	56 (28)
Wichita (ICT)	8.32	4.61		79.8	-0.2	104 (20)	61 (28)
East							
Bartlesville, OK	7.26	4.19		79.2	-1.0	98 (20,12)	62 (31,30)
Chanute	7.28	3.59		78.7	-0.2	97 (20)	58 (28)
Falls City, NE	8.21	4.17		74.5	-0.9	91 (29,20)	52 (28)
Johnson Co. Exec. Apt	9.55	5.83		75.3	-2.3	91 (20,19)	58 (28)
Joplin, MO	5.98	2.63		77.7	-2.0	93 (20,19)	62 (31,30)
Kansas City (MCI), MO	7.65	3.76		76.0	-1.1	94 (12)	56 (28)
St. Joseph, MO	7.19	3.21		75.2	-0.1	92 (29,20)	56 (28)
Topeka (TOP)	12.03	7.79		76.6	-0.8	96 (12)	55 (28)

1. Airport Automated Observation Stations (NWS/FAA)
2. Departure from 1981-2010 normal value

T - Trace; M - Missing; --- no normal value from which to calculate departure or percent of normal

Source: National Weather Service F-6 Climate Summaries

APPENDIX B-Flooding

Data from WaterWatch-USGS

Summary of August Flooding and High Flows

["--", no data; "<", less than all historical peaks]

USGS station name	No. Days above flood stage	NWS flood class	Highest peak from 2019-08-01 to 2019-08-31				Historical Peaks	
			Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
MISSOURI R AT ATCHISON, KS	1	minor	8/18/2019	22.04	--	--	--	--
REPUBLICAN R AT CLAY CENTER, KS	3	minor	8/17/2019	17.47	9340	68	102	195000 (1935)
SMOKY HILL R NR RUSSELL, KS	1	minor	8/26/2019	18.61	8560	18	43	70000 (1938)
NF SOLOMON R AT PORTIS, KS	2	minor	8/25/2019	17.42	3390	36	72	35700 (1951)
SF SOLOMON R AB WEBSTER RE, KS	1	minor	8/30/2019	8.95	3390	29	75	55200 (1951)
SF SOLOMON R AT WOODSTON, KS	2	minor	8/26/2019	14.24	2120	7	39	8710 (1993)
SF SOLOMON R AT OSBORNE, KS	3	moderate	8/25/2019	21.37	9600	7	72	81200 (1951)
SOLOMON R NR GLEN ELDER, KS	1	minor	8/25/2019	22.13	4050	7	53	9410 (1993)
SOLOMON R AT NILES, KS	3	minor	8/3/2019	26.92	7580	39	107	178000 (1951)
WILDCAT C AT SCENIC DRIVE, MANHATTAN, KS	1	minor	8/30/2019	16.57	3520	2	6	3920 (2014)
KANSAS R AT MANHATTAN, KS	1	minor	8/30/2019	18.13	--	--	--	--
BIG BLUE R AT BLUE RAPIDS, KS	31	minor	8/31/2019	41.97	--	--	--	--
BLACK VERMILLION R NR FRANKFORT, KS	3	minor	8/30/2019	24.27	--	--	--	--
FANCY C AT WINKLER, KS	1	minor	8/17/2019	18.12	103 (2019-08-01	<	35	24000 (1972)
MILL C NR PAXICO, KS	2	minor	8/16/2019	24.67	13500	31	65	77200 (1951)
SHUNGANUNGA C AT GAGE BLVD, TOPEKA, KS	1	minor	8/17/2019	15.47	--	--	--	--
DELAWARE R NR MUSCOTAH, KS	1	minor	8/30/2019	27.06	16900	16	49	35600 (2013)
KANSAS R AT LAWRENCE, KS	1	minor	8/31/2019	18.17	48500	4	5	92600 (2016)
WAKARUSA R AT WAKARUSA, KS	1	moderate	8/30/2019	22.14	--	--	--	--
WAKARUSA R NR LAWRENCE, KS	3	moderate	8/1/2019	28.94	8790	21	82	24200 (1951)
STRANGER C AT EASTON, KS	7	moderate	8/27/2019	20.17	6010	3	3	10200 (2016)
MARAIS DES CYGNES R NR READING, KS	1	moderate	8/30/2019	21.18	4420	36	49	67400 (1982)
DRAGOON C NR BURLINGAME, KS	1	minor	8/30/2019	21.47	10200	12	58	25000 (2007)
MARAIS DES CYGNES R NR OTTAWA, KS	4	moderate	8/1/2019	33.79	19800	19	110	142000 (1951)
POTTAWATOMIE C NR GARNETT, KS	2	minor	8/1/2019	27.66	11200	36	63	57000 (1961)

Summary of August Flooding and High Flows ["--", no data; "<", less than all historical peaks]								
			Highest peak from 2019-08-01 to 2019-08-31				Historical Peaks	
USGS station name	No. Days above flood stage	NWS flood class	Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
MARAIS DES CYGNES R AT LA CYGNE, KS	10	minor	8/31/2019	29.71	20700	16	33	131000 (2007)
MARAIS DES CYGNES R NR KS-MO ST LINE, KS	2	moderate	8/31/2019	31.38	27700	22	59	137000 (2007)
L OSAGE R AT FULTON, KS	2	moderate	8/17/2019	26.6	9840	29	69	62800 (1986)
SLATE C AT WELLINGTON, KS	2	minor	8/26/2019	20.04	3060	38	58	28500 (1975)
VERDIGRIS R AT INDEPENDENCE, KS	2	minor	8/8/2019	34.09	29000	40	103	169000 (2017)
NEOSHO R NR IOLA, KS	1	minor	8/8/2019	15.07	18300	77	111	436000 (1951)
NEOSHO R NR ERIE, KS	4	minor	8/9/2019	31.51	--	--	--	--
LIGHTNING C NR MCCUNE, KS	2	minor	8/9/2019	14.46	3660	47	67	67500 (1993)

KANSAS CLIMATE UPDATE
September 2019 Summary

Highlights

- U.S. Drought Monitor - September saw abnormally dry conditions in the central and western parts of the state. By the end of the month moderate drought centered in a portion of western Kansas. Moderate drought affected nearly 5% of the state with abnormally dry conditions affecting 19% at the end of September.

- September 2019 was the second warmest September on record (since 1931) for Kansas with statewide average temperature of 75.2 degrees Fahrenheit.

- Highest temperature recorded this September was 103°F at multiple locations on multiple dates.

- Precipitation in September ranged to over 11 inches in Crawford County.

- The greatest 24 hour precipitation event was recorded at Pratt at 7.38 inches on September 25th.

- Drought Outlooks favor drought removal for the current area of moderate drought, with above normal temperatures and precipitation likely.

- Of the 24 federal reservoirs in Kansas all conservation pools are full except Cedar Bluff (63%), Lovewell (32%) and Keith Sebelius (73%).

- September flooding did occur, although frequency, duration and severity were less than previous months. Eleven (13) USGS stream gages on at least 11 streams were at flood levers sometime during the month.

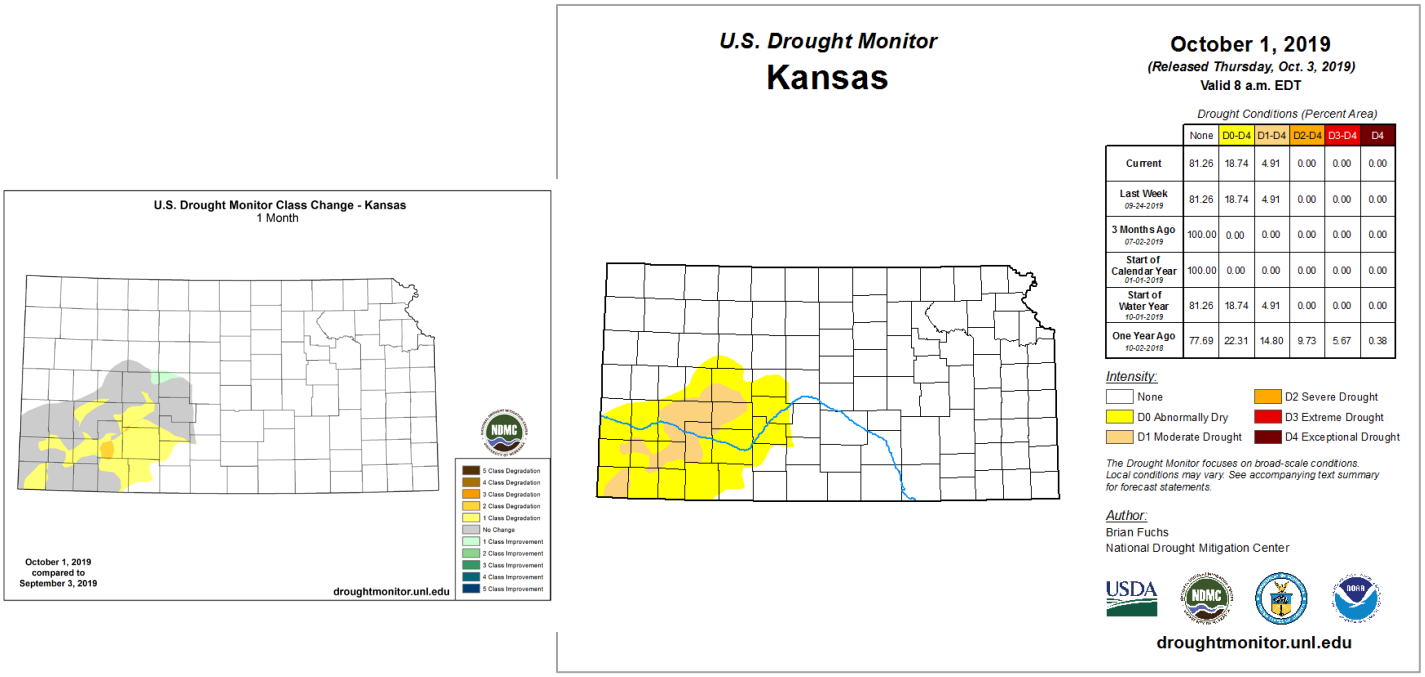
- Harmful Algal Blooms (HABs) are known to have affected 28 lakes at various times during the month with health watches or warnings issued by Kansas Department of Health and Environment.

- The Vegetation Drought Response Index (VegDRI) indicated 31.4% of Kansas was near normal with 51.3% considered unusually, very or extremely moist at the end of the month.

General Drought Conditions

The U.S. Drought Monitor indicated dry and drought conditions in parts of western and central Kansas increased in area and severity through September to affect about 19% of the state. The condition at the end of the month is shown below in Figure 1. Changes in drought classification over the month is also shown.

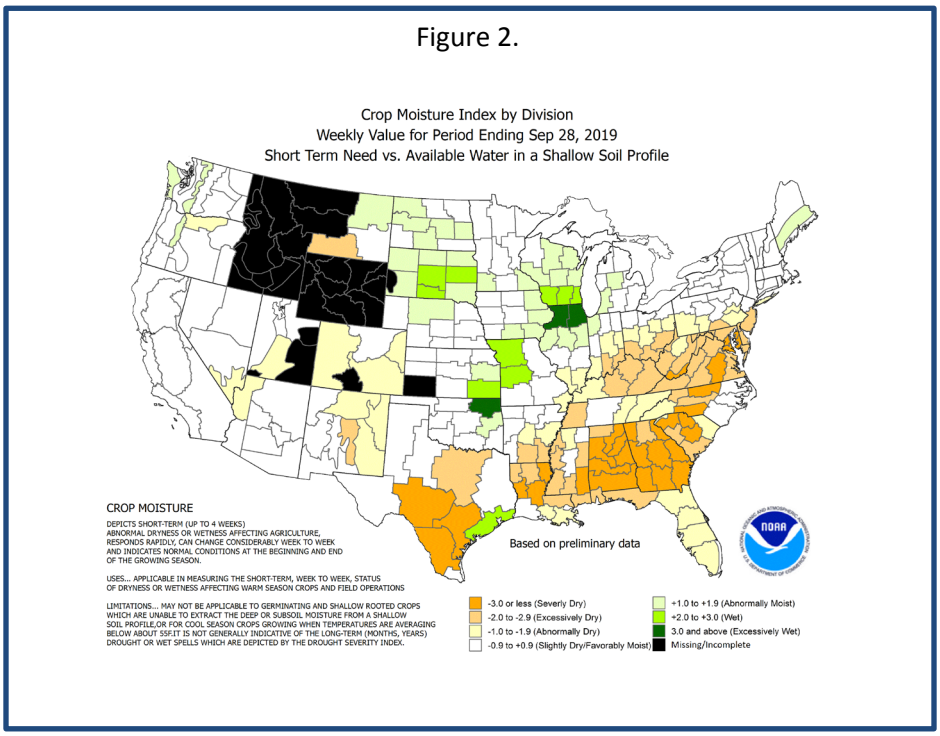
Figure 1. U.S. Drought Monitor Maps of Drought status



More information can be found on the U.S. Drought Monitor web site https://droughtmonitor.unl.edu/ .

Palmer Drought Severity Index (PDSI) - The Palmer Drought Severity Index is an indicator of relative dryness or wetness and is one factor used the U.S. Drought Monitor. The Crop Moisture Index (Figure 2) component evaluates short term needs and available water. More information on the PDSI and its parts can be found at http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml.

Figure 2.



Climate Summary - Precipitation

September 2019 was drier than normal, ranking as the 30th driest September. State-wide average precipitation for the month was 2.08 inches, 79 percent of normal. Only the Southeast and South Central climate divisions had above normal precipitation. The Southeast Division was the wettest, with a divisional average of 4.46 inches, 111 percent of normal. The remaining divisions were below normal for the month. The Southwest Division was the driest, with an average of 0.49 inches, 30 percent of normal. The highest 24-hour rainfall total for a National Weather Service Cooperative station was 4.82 inches at Galesburg 1NNE, Neosho County on the 22nd. The greatest 24-hour rainfall total for a Community Collaborative Rain, Hail and Snow network station was 7.38 inches at Pratt 1.6 SSE, Pratt County on the 25th. The greatest monthly precipitation totals for September: 11.21 inches at Girard, Crawford County (NWS) and 11.82 inches at Farlington 0.8 NNE, Crawford County (CoCoRaHS). Table 1 summarizes the monthly precipitation (KSU Weather Data Library).

Table 1.

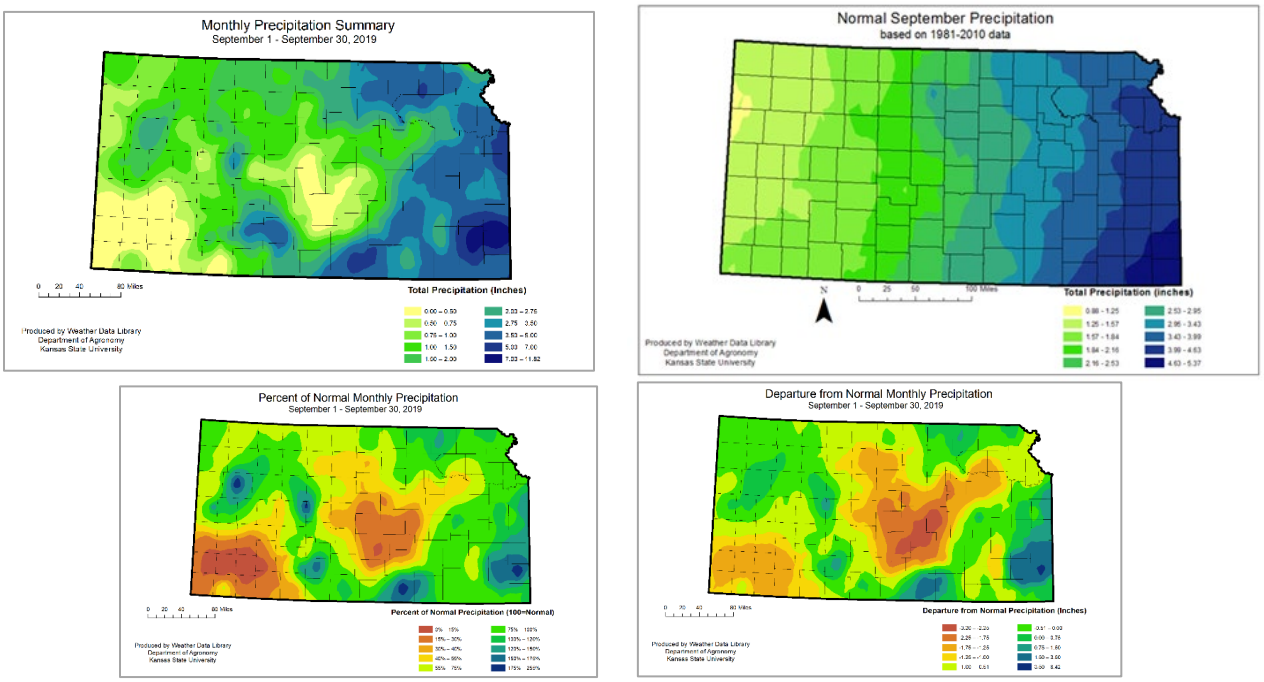
Kansas Climate Division Precipitation Summary (inches)

Climate Division	September 1 - 30, 2019			January 1 – September 30, 2019			April 1, 2019 – September 30, 2019			Sept 1, 2018 – September 30, 2019		
	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal
Northwest	0.98	-0.54	64	22.31	3.90	121	19.95	3.84	124	0.98	-0.54	64
West Central	1.21	-0.39	76	20.64	2.75	115	17.34	1.94	113	1.21	-0.39	76
Southwest	0.49	-1.13	30	17.90	0.84	105	14.61	-0.07	100	0.49	-1.13	30
North Central	1.96	-0.67	75	30.14	6.20	126	26.50	6.04	130	1.96	-0.67	75
Central	1.37	-1.14	55	30.88	5.89	124	27.11	6.07	129	1.37	-1.14	55
South Central	2.93	0.33	113	35.54	9.47	136	31.54	10.10	147	2.93	0.33	113
Northeast	2.89	-0.72	80	39.54	10.27	135	34.29	9.22	137	2.89	-0.72	80
East Central	2.40	-1.26	66	41.05	9.79	131	35.67	9.33	135	2.40	-1.26	66
Southeast	4.46	0.45	111	50.72	17.30	152	44.79	17.37	163	4.46	0.45	111
STATE	2.08	-0.54	79	32.00	7.38	130	27.90	7.13	134	2.08	-0.54	79

*Departure from normal is departure from the base period 1981-2010, KSU Weather Data Library.

The maps of Figure 3 below summarize precipitation for the month. (State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)

Figure 3. Monthly Precipitation maps



Climate Summary-Temperature

Temperatures for September were much warmer than normal. State-wide average temperature for the month was 74.9 ºF, which is 6.8 degrees warmer than normal. This ranks as the 2nd warmest on record, slightly lower than the 1931 record of 76.7 ºF. The Southwest Climate Division was the warmest with an average of 76.0 ºF, 7.4 degrees warmer than normal. The Northwest Division was the coolest, with an average of 71.5 ºF, 6.2 degrees warmer than normal. Even with the warmer pattern, the eastern divisions failed to break the century mark for maximum temperatures. The warmest maximum temperature was 103 ºF at multiple locations on the 3rd and 4th. The coldest minimum temperature was 40 ºF at Marysville, Marshall County, on the 14th. There was three record maximum temperatures. On the other hand, there were 67 new record warm minimum temperatures set. Cold daily records were also numerous with 18 record low maximums. There were no new record low minimums Table 2 summarizes the monthly temperatures (KSU Weather Data Library).

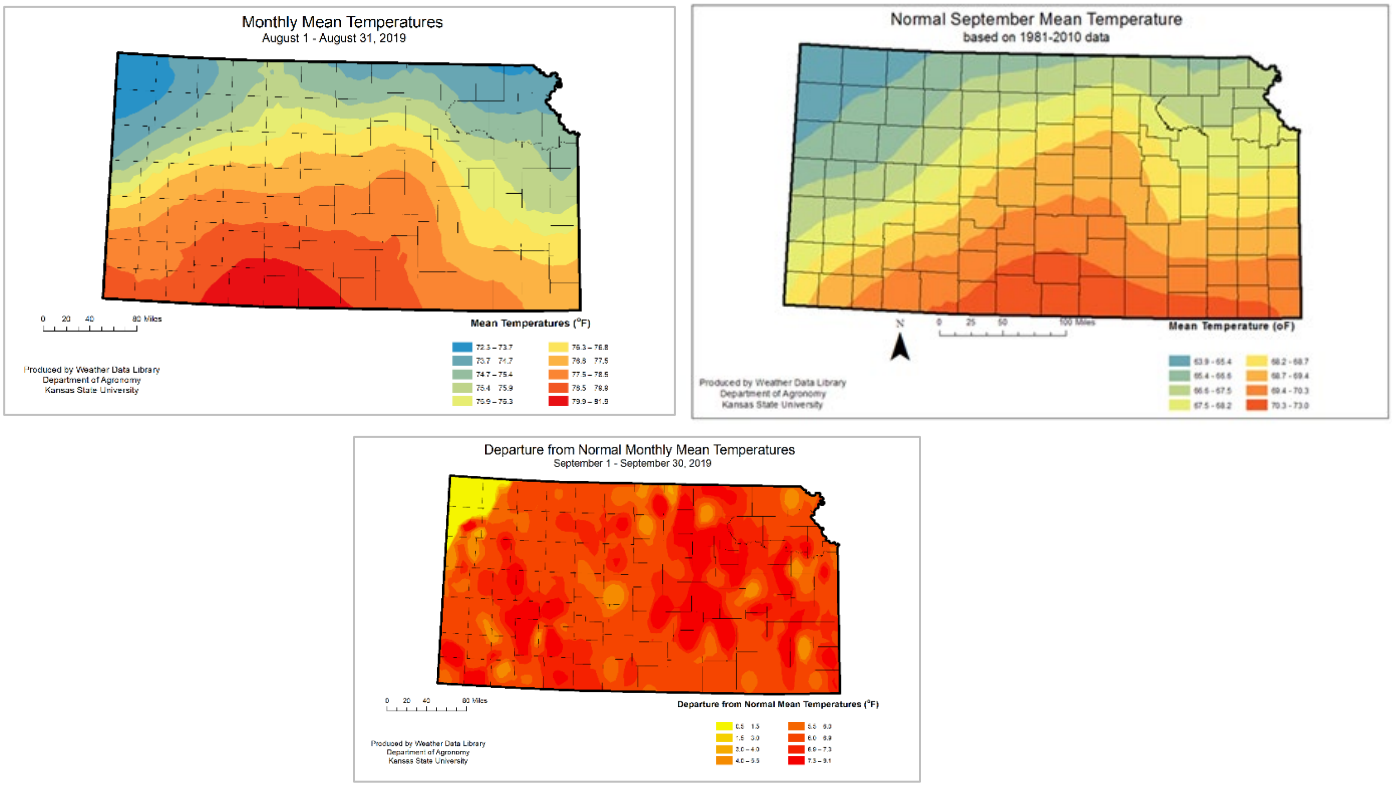
Table 2.

Climate Division	Kansas Climate Division Temperature Summary (ºF) September 2019							
	Maximum	Minimum	Average	Departure*	High	Date	Low	Date
Northwest	85.7	57.2	71.5	6.2	103	6	43	14
West Central	87.9	59.1	73.5	7.1	103	3	47	13
Southwest	91.0	61.1	76.0	7.4	103	4	46	13
North Central	86.3	63.1	74.7	6.8	98	15	40	14
Central	87.5	64.1	75.8	6.8	100	6	49	23
South Central	88.9	65.8	77.3	7.0	98	3	46	23
Northeast	84.7	62.9	73.8	6.4	95	16	51	26
East Central	84.8	64.9	74.8	6.6	95	16	51	23
Southeast	86.3	66.8	76.5	6.9	96	9	53	30
STATE	87.0	62.8	74.9	6.8	103	6th	40	14th

*Departure from normal is departure from the base period 1981-2010, KSU Weather Data Library.

The maps in Figure 4 below summarize temperature for the month. (State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/ and NOAA and High Plains Regional Climate Center)

Figure 4. Monthly Temperature Maps

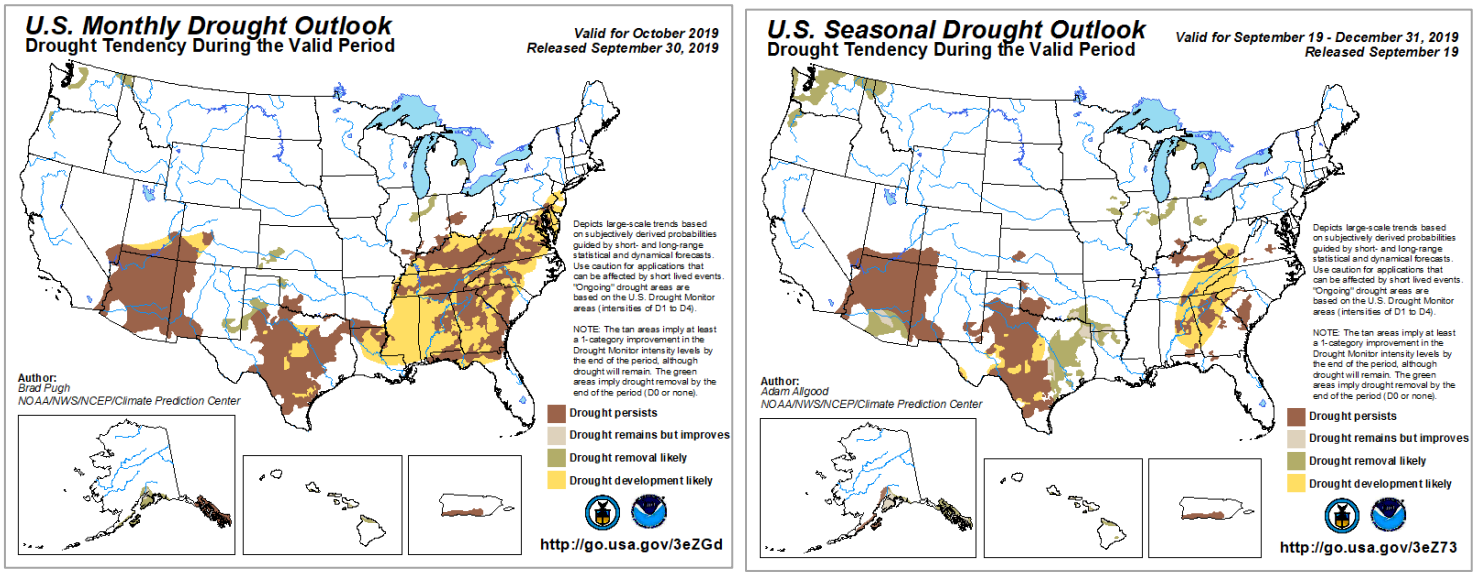


Severe weather was more limited this month with only 3 tornadoes reported. Most were brief touchdowns with minimal damage. There were no reports of deaths or injuries. Hail and damaging wind events were also less numerous, with just 33 hail reports and 18 wind reports.

Outlooks

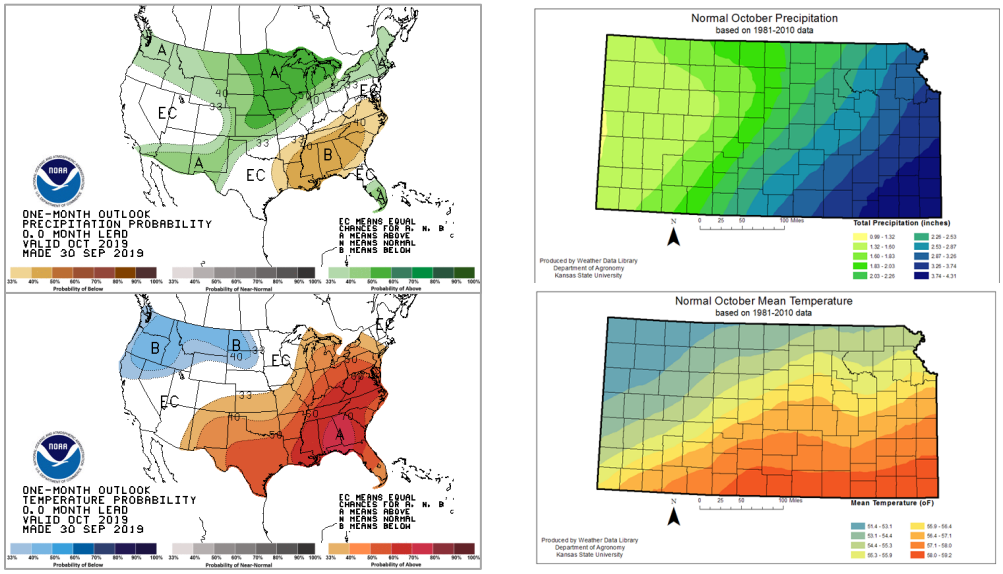
The Monthly Drought Outlook for October 2019 indicates removal of the drought conditions southwest Kansas is likely. The Seasonal Outlook (3-month) favors a small area of drought in Kansas persisting in the mid-September through December period. The individual temperature and precipitation outlooks that contribute to these outlooks are available below.

Figure 5. Drought Outlooks



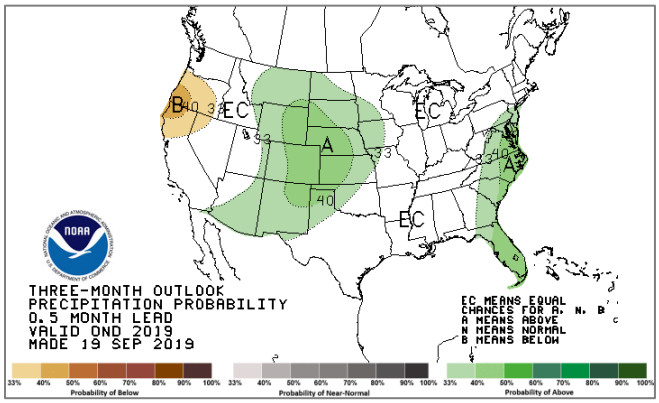
The October precipitation outlook favors a slightly increased chance of above normal precipitation across the state. With the limited dry conditions and the climatologically lower amounts of normal precipitation at this time of the year, a normal to above normal precipitation pattern in October could limit reduction of drought conditions. The temperature outlook favors above normal temperatures across the state, with best chances of above normal temperatures to the northwest. One month outlooks are provided in Figure 6.

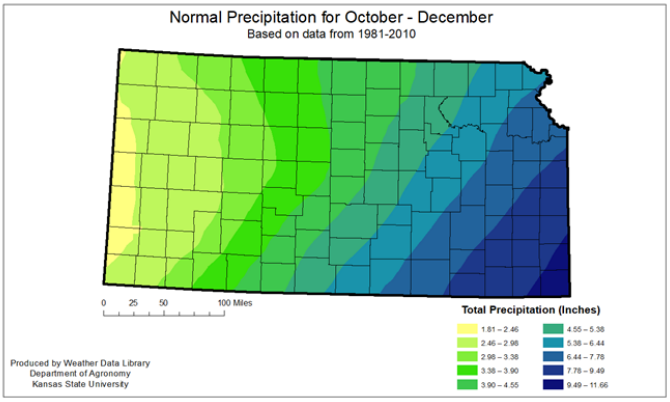
Figure 6. Next Month Precipitation and Temperature Outlooks

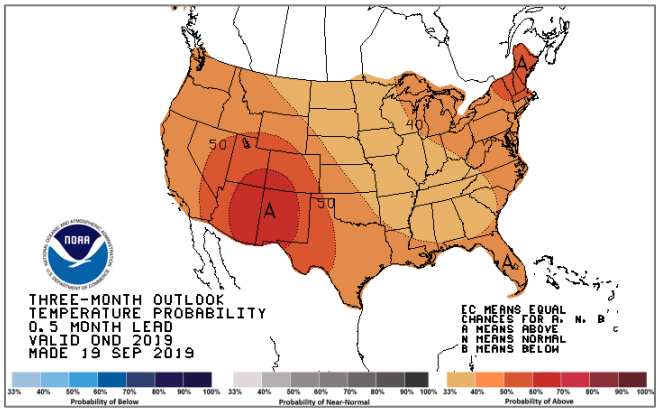


The U.S. three month outlook for October through December slightly favors above-average precipitation (moderate chance) for all of Kansas and above normal temperatures for the entire state.

Figure 7. Three Month Precipitation and Temperature Outlooks







Additional outlooks for various timeframes are available from the national CPC for up to 13 months. (http://www.cpc.ncep.noaa.gov/products/predictions/90day/)

Reservoir Storage

At the end of the month all reservoir conservation pools were full except Keith Sebelius, Cedar Bluff and Lovewell, which ended at 73%, 63% and 32% of conservation pools respectively. Releases were, and continue to be made to reduce water in flood pools at many reservoirs in the Kansas River basin. Releases consider the entire Missouri basin system which has been receiving above normal precipitation and runoff throughout spring and summer. Table 3 provides conservation pool status for each federal reservoir.

Table 3. Kansas Federal Reservoir Conservation Pool Levels

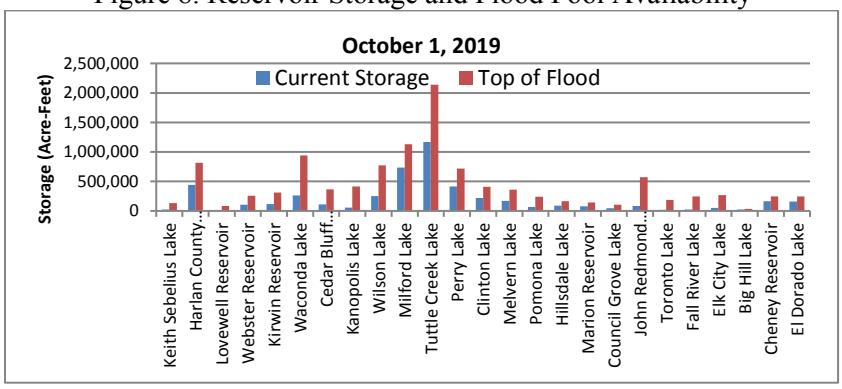
Reservoir	Top of Multipurpose / Conservation Pool (Feet MSL)	Multipurpose/Conservation Pool Elevation (Feet MSL)	Change from Top of Pool (Feet)	Percent of Conservation Pool Full
Kansas River Basin		**10/01/2019**		
Keith Sebelius Lake[1]	2304.3	2299.59	-4.71	73%
Harlan County Lake NE	1945.73	1954.53	8.80	100%
Lovewell Reservoir[1]	1582.6	1571.54	-11.06	32%
Webster Reservoir[1]	1892.45	1899.17	6.72	100%
Kirwin Reservoir	1729.25	1732.80	3.55	100%
Waconda Lake[1]	1455.6	1458.69	3.09	100%
Cedar Bluff Reservoir	2144	2133.32	-10.68	63%
Kanopolis Lake[1]	1463	1466.14	3.14	100%
Wilson Lake[1]	1516	1517.03	1.03	100%
Milford Lake[1]	1144.4	1162.23	17.83	100%
Tuttle Creek Lake[1]	1075	1114.26	39.26	100%
Perry Lake[1]	891.5	906.44	14.94	100%
Clinton Lake[1]	875.5	887.16	11.66	100%
Melvern Lake[1]	1036	1038.54	2.54	100%
Pomona Lake[1]	974	977.13	3.13	100%
Hillsdale Lake[1]	917	918.93	1.93	100%
Arkansas River Basin		**10/01/2019**		
Marion Reservoir[1]	1350.5	1350.38	-0.12	99%
Council Grove Lake[1]	1274	1274.06	0.06	100%
John Redmond Reservoir	1041	1042.88	1.88	100%
Toronto Lake	901.5	902.78	1.28	100%
Fall River Lake	948.5	950.71	2.21	100%
Elk City Lake	796	799.42	3.42	100%
Big Hill Lake	858	858.86	0.86	100%
Cheney Reservoir	1421.6	1421.36	-0.24	99%
El Dorado Lake	1339	1338.96	-0.04	100%

[1]Lake level management plan in place — Source: U.S. Army Corps of Engineers, U.S. Bureau of Reclamation and U.S. Geological Survey

Note: The conservation pool is the water storage for non-flood purposes of the reservoir, set by the elevation of the top of the pool.

In Figure 8 the blue bars indicate water in storage at that reservoir, with red bars indicate top of the flood pool storage. Some reservoirs have storage space remaining for flood flows but the available space varies.

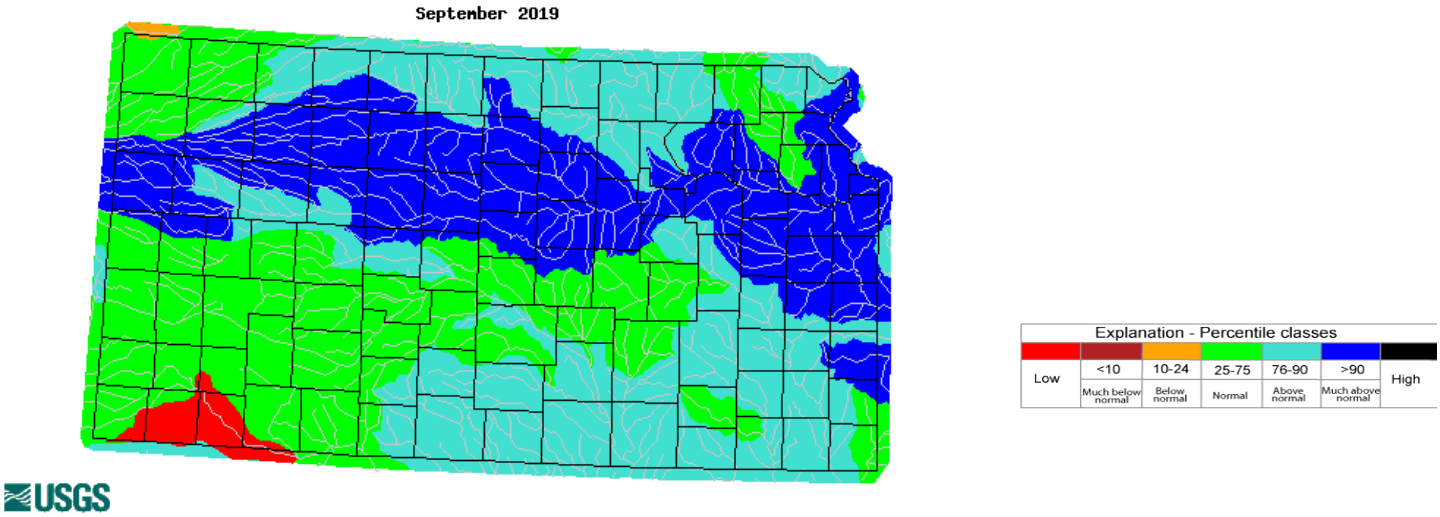
Figure 8. Reservoir Storage and Flood Pool Availability



Streamflow Conditions

WaterWatch summarizes streamflow conditions in a region (state or hydrologic unit) in terms of the long-term typical condition at stream gages in the region. In general, a streamflow which is greater than the 75 percentile is considered *above normal*, a streamflow which is between 25 and 75 percentiles is considered *normal* and a streamflow which is less than the 25 percentile is considered *below normal*. Color codes are for basins with streamflow averages less than 25 percent of historic values. This comparison aids in evaluating water resources conditions for a time period. A summary of flooding in is found later in this report. Figure 9 summarizes streamflow.

Figure 9. Monthly streamflow compared to historical streamflow



Minimum Desirable Streamflow: Low flows may be reflected at gage locations when the flow does not reach Minimum Desirable Streamflow (MDS). MDS requirements are in place to ensure base flows in certain streams to protect existing water rights and to meet in-stream water uses related to water quality, fish and wildlife and recreation. The Kansas Department of Agriculture, Division of Water Resources monitors 23 streams and rivers at 33 locations for minimum desirable streamflow. When flows drop below an established threshold, pumping restrictions are imposed on permits or water rights granted after the minimum desirable streamflow provision was made into law in 1984.

Although no water right administration was in effect in July, the table below notes locations of concern including those below MDS.

Table 4.
Streamflows of Note

Gaging Station	Sept 3 Flow	Sept 9 Flow	Sept 16 Flow	Sept 23 Flow	Sept 30 Flow	Sept MDS	Comment
Rattlesnake Creek near Macksville	2	0.95	0.55	0.5	24	1	No surface water diversions junior to MDS above gage
Rattlesnake Creek near Zenith	7.78	6	6.8	5	9	3	No surface water diversions junior to MDS above gage
Little Arkansas at Alta Mills	Na	Na	Na	Na	11	8	

General flooding for the month is shown in the USGS WaterWatch maps in the streamflow section of this report. However this does not provide all the specifics of severity of impacts and duration at specific locations. Additional flooding information can be found for USGS stream gage sites at https://waterwatch.usgs.gov/?m=flood&r=ks&w=flood%2Ctable for current stage. The USGS gage monitoring records indicate 13 gages in Kansas were at flood stage sometime during the month. The Big Blue River at Blue Rapids was above flood stage the entire month.

Appendix B provides an overview of Kansas flooding in at USGS stream gages in the WaterWatch system.

Harmful Blue-Green Algal Blooms (lake water safety)
KDHE samples public use lakes only in response to complaints of human or animal illness or visual sighting of possible blue-green algae by the public or lake officials. The season for harmful algal blooms (HABs) is April 1-October 31.

KDHE issues three levels of public health protection notifications for blue-green algae (BGA) Blooms. Public Health Watch–Notifies public that a harmful algae may be present, that the water may be unsafe for humans and animals and contact with the water is discouraged. Public Health Warning–Notifies public that harmful algae is present of expected, that contact with the water should not occur, and all conditions of Public Health Watch remain in effect. Lake Closure –Notifies the public that a portion of the lake or the entire lake be closed to public because harmful algae is present and extreme conditions exist. Actual lake closure is issued by the lake management officials based on the KDHE public health recommendations and advisories. A summary of lakes affected in the month is found in Table 5. More information can be found at http://www.kdheks.gov/algae-illness/index.htm.

Table 5.
KDHE Lake Health Advisories issued in September 2019

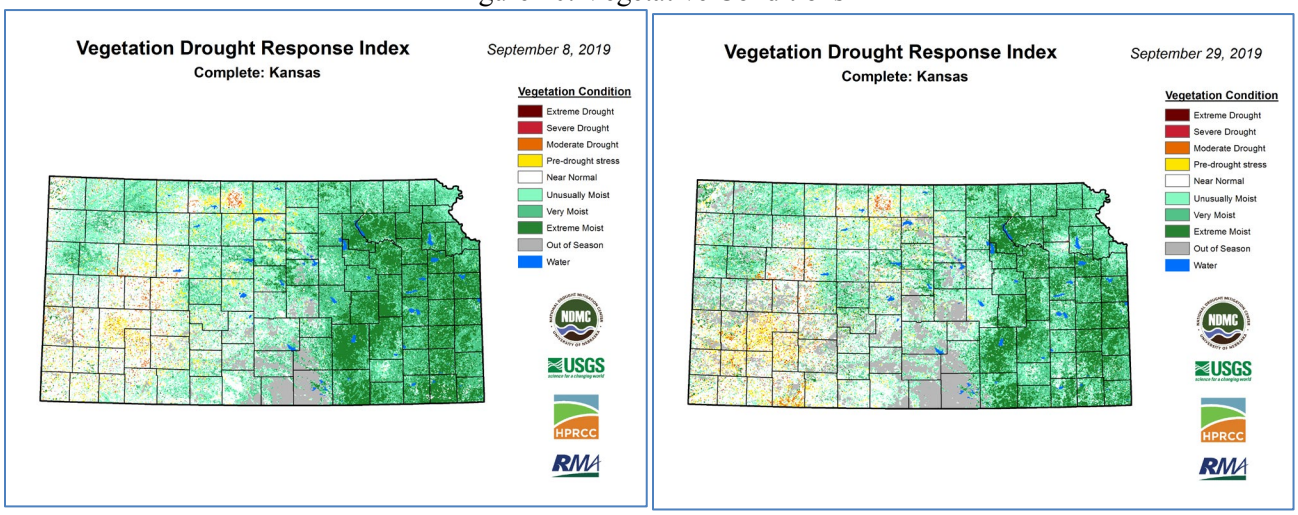
Lake	County	9/5/19	9/12/19	9/19/19	9/26/19	10/3/2019
Atchison County Park lake	Atchison			Watch	Warning	Warning
Big Eleven Lake	Wyandotte	Warning	Watch	Watch	Watch	Watch
Camp Hawk Lake	Harvey	Warning	Watch	Watch	Watch	Watch
Carousel Lake in Gage Park	Shawnee	Watch	Watch	Watch	Watch	Watch
Central Park Lake	Shawnee					Warning
Elk Horn Lake	Jackson	Watch	Watch	Warning	Warning	Warning
Gathering Pond	Geary	Warning	Warning	Warning	Warning	Warning
Hiawatha City Lake	Brown	Warning	Warning	Warning	Warning	Warning
Hodgeman County State Fishing Lake	Hodgeman	Warning	Warning	Watch	Watch	Watch
Jerry Ivey Pond	Saline	Warning	Warning	Warning	Warning	Warning
La Cygne Lake	Linn/Miami	Warning				
Lake Afton	Sedgewick	Warning	Warning	Watch	Watch	Watch
Lake Jeanette	Leavenworth		Warning	Warning	Warning	Warning
Lake Shawnee	Shawnee	Watch	Watch	Watch		
Lakewood Park Lake	Saline	Warning	Warning	Warning	Warning	Warning
Lebo Kids' Pond	Coffey	Warning	Warning	Watch	Watch	Watch
Marais des Cygnes Wildlife Area	Linn	Warning				
Marion County Lake	Marion	Warning	Warning	Warning	Warning	Warning
Meadowbrook Park lake	Johnson	Watch	Watch	Warning	Warning	Warning
Melvern Outlet Pond	Osage	Warning	Warning	Warning	Warning	
Melvern Outlet Swim Pond	Osage	Warning	Warning	Warning	Warning	
Mission Lake	Brown	Watch				
Neosho County State Fishing Lake	Neosho	Warning	Watch	Watch	Watch	Watch
Riggs Park	Sedgwick	Watch				
Rock Garden Pond	Shawnee	Watch	Watch	Watch	Watch	Watch
South Lake	Johnson	Watch	Watch	Watch	Watch	Watch
Webster Reservoir	Rooks				Warning	Warning
Westlake in Gage Park	Shawnee	Warning	Warning	Warning	Warning	
Yates Center Kids" Fishing Pond	Woodson	Warning	Warning	Warning	Warning	Warning
Yorkshire Channel E. of N. Crestline Dr (Lawrence)	Douglas					Watch

Vegetation and Soil Moisture

Vegetative Conditions

The Vegetative Condition map depicts vegetation stress. It is produced using satellite data by the National Drought Mitigation Center https://vegdri.unl.edu/Home.aspx and often customized for Kansas by the Kansas Biological Survey in the GreenReport. Areas in yellow, orange and red indicate areas of vegetative stress. The green areas are considered to be in good or excellent condition (moist).

Figure 10. Vegetative Conditions



Soil Moisture and Rangeland

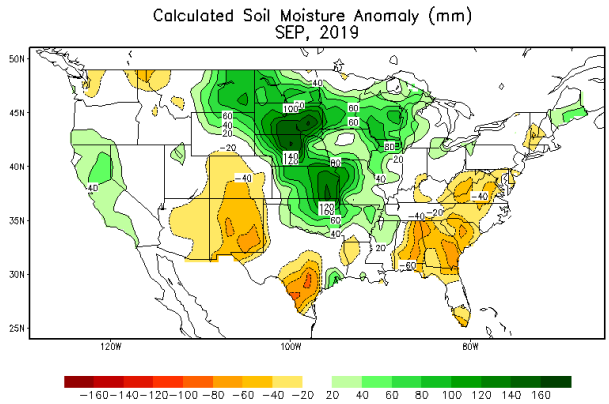
The National Agricultural Statistics Service, USDA Crop Progress and Condition provides a summary of the climatic effects on soil and crops. For the week ending September 29, 2019, topsoil moisture supplies rated 6 percent very short, 23 short, 65 adequate, and 6 surplus. Subsoil moisture supplies rated 5 percent very short, 18 short, 73 adequate, and 4 surplus.

Field Crops Report:
Corn condition rated 4 percent very poor, 10 poor, 34 fair, 42 good, and 10 excellent.
Soybean condition rated 3 percent very poor, 7 poor, 34 fair, 48 good, and 8 excellent.
Sorghum condition rated 3 percent very poor, 8 poor, 27 fair, 51 good, and 11 excellent.
Cotton condition rated 3 percent very poor, 12 poor, 37 fair, 40 good, and 8 excellent.

Pasture and range conditions rated 2 percent very poor, 6 poor, 26 fair, 56 good, and 10 excellent.

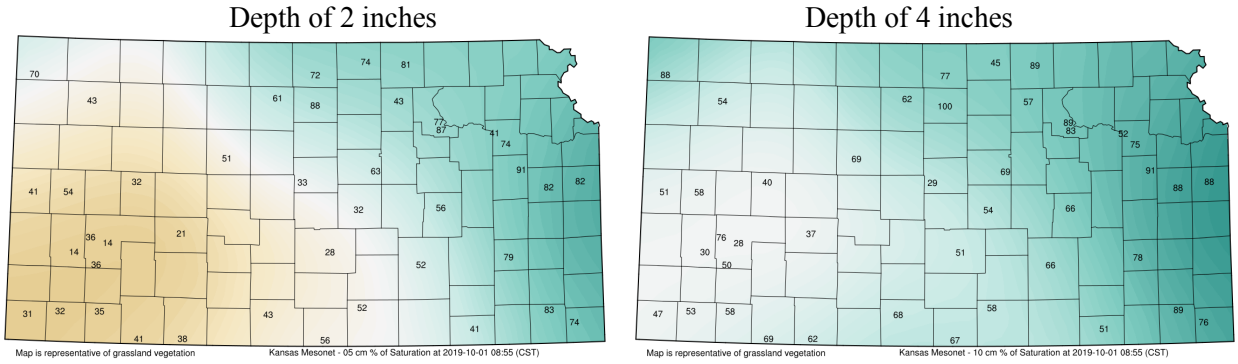
The Climate Prediction Center (CPC), monitors soil moisture and predicts future soil moisture. Anomalies are defined as deviations from the 1971-2000 monthly climatology. The monthly soil anomaly is shown in Figure 11. (.http://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml).

Figure 11.



Within Kansas soil moisture is now being measured through the Kansas Mesonet and Kansas State University the percent of soil saturation is shown in Figure 12.

Figure 12. Percent of Soil Saturation
October 1, 2019

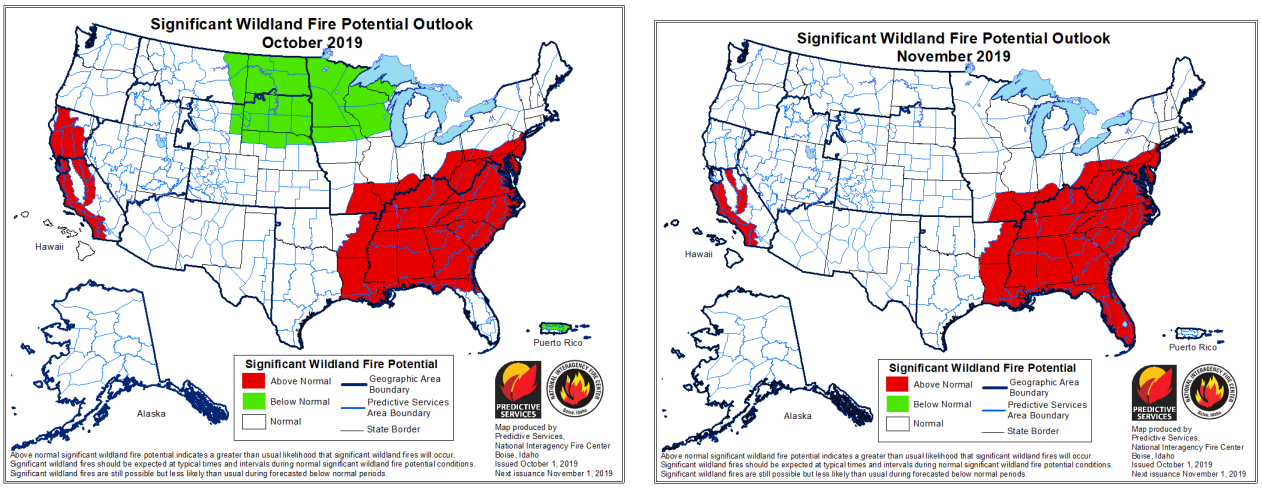


Saturation at 2 inches ranged from 14% at Garden City (Finney County) and Lakin (Kearny County) to 91% at the station at Overbrook (Osage County.

Fire

Significant Wildland Fire Potential Outlook is issued monthly for the United States, https://www.predictiveservices.nifc.gov/outlooks/monthly_seasonal_outlook.pdf .

Figure 13. Wildfire Outlook

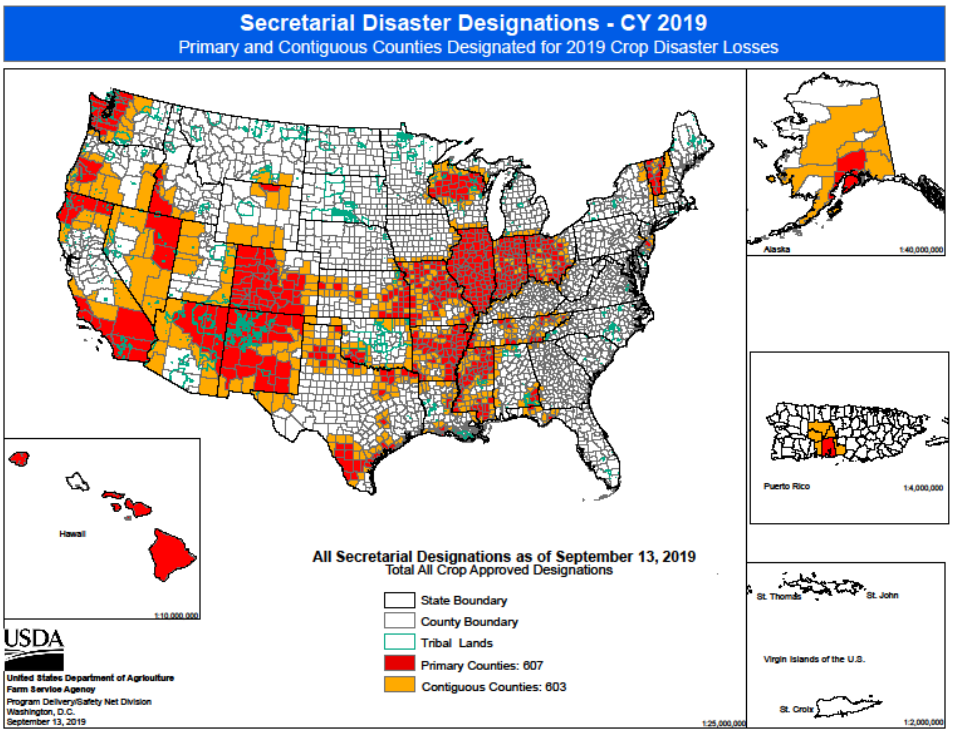


Disaster Designations

A total of 70 Kansas counties are now identified in Federal Emergency Declarations, DR-4449 due to storms, winds, tornadoes, flooding, landslides and mudslides. The President's action makes federal funding available to state, eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and repair or replacement of facilities in Allen, Anderson, Atchison, Barber, Barton, Bourbon, Brown, Butler, Chase, Chautauqua, Cherokee, Clark, Clay, Cloud, Coffey, Comanche, Cowley, Crawford, Dickinson, Doniphan, Douglas, Edwards, Elk, Ellsworth, Ford, Franklin, Geary, Gray, Greenwood, Harper, Harvey, Hodgeman, Jefferson, Kingman, Leavenworth, Lincoln, Linn, Lyon, Marion, Marshall, McPherson, Meade, Miami, Montgomery, Morris, Nemaha, Neosho, Ness, Osage, Osbourne, Ottawa, Pawnee, Phillips, Pottawatomie, Pratt, Reno, Rice, Riley, Rush, Russell, Saline, Smith, Sumner, Wabaunsee, Wallace, Washington, Wilson, Woodson and Wyandotte counties.

Federal funding is also available on a cost-sharing basis for hazard mitigation measures statewide. Some additional counties may be eligible for federal declaration and aid in the future once damage assessment is completed by FEMA.

Producers in 57 counties may be eligible for agricultural emergency loans as USDA has designated 25 counties as primary agricultural disaster areas for crop year 2019 due to flooding or excessive rain. Primary counties are Allen, Anderson, Atchison, Barton, Bourbon, Chase, Chautauqua, Cherokee, Cowley, Doniphan, Franklin, Gove, Johnson, Labette, Leavenworth, Linn, Lyon, Miami, Montgomery, Neosho, Osage, Wallace, Wilson, Woodson, Wyandotte. Additional, contiguous counties are: Brown, Butler, Coffey, Crawford, Douglas, Elk, Ellsworth, Graham, Greeley, Greenwood, Jackson, Jefferson, Johnson, Lane, Linn, Logan, Marion, Miami, Morris, Ness, Pawnee, Rice, Rush, Russell, Scott, Sedgwick, Shawnee, Sheridan, Sherman, Stafford, Sumner, Thomas, Trego, Wabaunsee, and Wichita.



The Additional Supplemental Appropriations for Disaster Relief Act of 2019 was signed into law by President Trump on June 6, 2019. Congress appropriated $3.005 billion in assistance for a wide array of losses resulting from disasters throughout 2018 and 2019, including loses related to prevented planting of insured crops in calendar year 2019. In Kansas, WHIP+ is available only for crops affected by flooding, snowstorm, tornado and wildfires. Eligible crops are those in a Secretary or President-declared disaster county, or those with COC-accepted documentation of the qualifying disaster event that caused the crop loss. WHIP+ applications must be filed with the local FSA office, with a deadline to be announced later. Payments will be disbursed by FSA.

Kansas Climate Summary

The Kansas Weekly Climate Summary and Drought Report are compiled at least monthly, more frequently when conditions warrant, by the KWO. Information from various federal, state, local and academic sources is used. Some of the data is preliminary and subject to change once final data is available. The KWO web site, http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response , contains additional drought information including links to other agencies with drought information and past issues of the Kansas Climate Summary and Drought Report. Mary Knapp, at the Kansas Climate Office, Weather Data Library is the primary source of the narrative on weather. She works closely with meteorologists throughout the state and region. Details of current conditions at Evapotranspiration (ET) and Mesonet sites across Kansas are available at http://mesonet.k-state.edu/

RESOURCES and REFERENCES

Kansas climate data is provided by Kansas State University, Weather Data Library through the Kansas Mesonet. (http://www.ksre.k-state.edu/wdl/). Soil moisture data was added in 2018 (http://mesonet.k-state.edu/agriculture/soilmoist)

The U.S. Drought Monitor, from the National Drought Mitigation Center at the University of Nebraska-Lincoln, provides a "big picture" perspective of conditions across the nation. In the Kansas county drought stage scheme, a Drought Watch equates roughly to moderate drought in the U.S. Drought Monitor, while a Drought Warning is the equivalent of severe drought. A Drought Emergency is reserved for extreme or exceptional drought. Palmer Drought Severity Index - The Palmer Index (PDSI) is one indicator used in the U.S. Drought Monitor.

The High Plains Regional Climate Center (https://hprcc.unl.edu/) has precipitation and temperature summary maps available at the state, region and nation.

The U.S. Geological Survey (USGS) Drought Watch provides information average streamflow measured at long-term gaging stations and compares them to normal flows.

The Kansas Department of Agriculture-Division of Water Resources monitors stream flow using the USGS gages for determination of administrative needs. Administration may be needed due to Minimum Desirable Streamflow (MDS) requirements, impairments and reservoir release protection. (https://agriculture.ks.gov/divisions-programs/dwr/water-appropriation/minimum-desirable-streamflow.)

The water levels of the federal lakes fluctuate during a year according to the management plan. Lake level Management plans are posted on the Kansas Water Office web site www.kwo.ks.gov .

The Kansas Applied Remote Sensing Program (KARS) at the University of Kansas produces a Kansas Green Report each week during the growing season. For a full set of national and regional ***GreenReport***® maps, go to: http://www.kars.ku.edu/products/greenreport/greenreport.shtml. This Kansas Vegetation Drought Response Index map is developed weekly by the Kansas Biological Survey using state drought triggers as its key. In addition, the National Drought Mitigation Center also produces VegDRI maps which may be found at http://vegdri.unl.edu/.

The National Weather Service (NWS) provides fire weather products and services for Kansas that include the Rangeland Fire Danger Index, Fire Weather Forecasts, Red Flag Watches/Warnings and Spot Forecasts. The five NWS offices that serve Kansas websites may be accessed from the NWS Offices' page.

The Monthly and Seasonal Drought Outlooks, developed by the NOAA Climate Prediction Center, assess the likelihood for improvement, persistence or deterioration in drought conditions for areas currently experiencing drought as identified by the U.S. Drought Monitor. (http://www.cpc.ncep.noaa.gov/) Also see: http://www.noaa.gov/.

Responding to Drought: A Guide for City, County and Water System Officials provides an overview of Kansas county drought stage declarations, local planning and coordination, disaster declarations and available state and federal assistance. The 2007 Municipal Water Conservation Plan Guidelines and the Drought Vulnerability Assessment Report, both by KWO, provide guidance regarding drought preparedness and response. These are available at http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response.

USDA Drought Programs and Assistance website (https://www.usda.gov/topics/disaster/drought/usda-drought-programs-and-assistance) listing the various USDA programs and agencies to assist with drought issues.

The National Interagency Coordination Center in Boise, Idaho, produces wildfire potential outlook maps monthly. (https://www.predictiveservices.nifc.gov/outlooks/outlooks.htm)

Please contact Diane Knowles at the Kansas Water Office (785) 296-3185 or diane.knowles@kwo.ks.gov should you have any questions or suggestions.

APPENDIX A
Monthly Weather Summary

September Summary	Precipitation (inches)			Temperature °F			
						Extreme (Date)	
Station[1]	Total	Departure[2]	Percent Normal	Mean	Departure[2]	Highest	Lowest
West							
Burlington, CO	0.32	-0.82	28%	71.6	8.3	100 (5)	42 (22)
Dodge City	0.21	-1.46	13%	78.0	8.8	99 (7.5.3)	50 (13)
Garden City	0.24	-1.23	16%	76.0	7.8	100 (7)	48 (23)
Goodland	0.65	-0.57	53%	70.8	6.2	96 (5,2)	46 (22,13)
Guymon, OK	0.55	-1.24	31%	77.0	6.6	98 (6,3)	50 (23)
Hill City	1.32	-0.56	70%	75.0	7.6	99 (5)	50 (13)
Lamar, CO	0.52	-0.73	42%	74.6	8.1	105 (2)	45 (25,22)
McCook, NE	0.64	-0.80	44%	72.7	8.3	101 (5)	44 (26)
Springfield, CO	0.14	-1.19	11%	72.6	6.5	98 (2)	44 (23)
Central							
Concordia	2.18	-0.73	75%	76.9	8.9	98 (15)	52 (13)
Hebron, NE	4.11	1.19	141%	74.4	8.5	95 (5)	48 (26)
Medicine Lodge	2.11	0.01	100%	78.6	7.4	99 (7)	50 (23)
Ponca City, OK	3.90	0.61	119%	79.9	7.8	98 (6)	60 (26)
Salina	1.05	-1.65	39%	76.8	6.6	97 (15)	50 (23)
Wichita (ICT)	0.98	-2.16	31%	78.7	7.7	95 (7)	55 (23)
East							
Bartlesville, OK	4.69	0.85	122%	78.5	7.1	96 (6)	63 (26,14)
Chanute	6.64	2.97	181%	78.9	9.0	96 (9)	57 (23)
Falls City, NE	4.33	0.78	122%	73.9	7.2	94 (18)	50 (26)
Johnson Co. Exec. Apt	6.15	1.64	136%	74.9	6.3	94 (19,18)	54 (29)
Joplin, MO	4.45	-0.50	90%	78.4	7.6	93 (18,17)	58 (26)
Kansas City (MCI), MO	6.83	2.21	148%	74.8	6.6	91 (18,3)	54 (23)
St. Joseph, MO	4.33	0.91	127%	74.8	8.2	92 (18,15)	52 (26)
Topeka (TOP)	0.04	-0.93	4%	77.0	4.0	94 (3)	60 (7)

1. Airport Automated Observation Stations (NWS/FAA)
2. Departure from 1981-2010 normal value

T - Trace; M - Missing; --- no normal value from which to calculate departure or percent of normal

Source: National Weather Service F-6 Climate Summaries

APPENDIX B-Flooding

Data from WaterWatch-USGS

Summary of Flooding and High Flows

["--", no data; "<", less than all historical peaks]

USGS station name	No. Days above flood stage	NWS flood class	Highest peak from 2019-09-01 to 2019-09-30				Historical Peaks	
			Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
MISSOURI R AT ATCHISON, KS	9	Minor	9/30/2019	25.34	--	--	--	--
MISSOURI R AT LEAVENWORTH, KS	3	Minor	9/30/2019	21.53	--	--	--	--
SMOKY HILL R AT ELKADER, KS	1	Minor	9/10/2019	9.03	4690	17	79	71000 (1938)
SOLOMON R NR GLEN ELDER, KS	1	Minor	9/22/2019	21.46	3830	8	53	9410 (1993)
BIG BLUE R AT BLUE RAPIDS, KS	30	Minor	9/1/2019	41.9	--	--	--	--
BLACK VERMILLION R NR FRANKFORT, KS	2	Minor	9/22/2019	20.55	--	--	--	--
INDIAN C AT STATE LINE RD, LEAWOOD, KS	1	Minor	9/22/2019	22.11	9670	10	14	23600 (2017)
MARAIS DES CYGNES R AT LA CYGNE, KS	5	Minor	9/1/2019	29.71	20500	16	33	131000 (2007)
MARAIS DES CYGNES R NR KS-MO ST LINE, KS	3	Moderate	9/1/2019	32.62	30300	20	59	137000 (2007)
SF NINNESCAH R NR PRATT, KS	2	Minor	9/25/2019	9.45	1460	13	37	26200 (1991)
COTTONWOOD R AT COTTONWOOD FALLS, KS	2	Minor	9/29/2019	10.42	--	--	--	--
NEOSHO R NR PARSONS, KS	3	Moderate	9/23/2019	23.88	25700	59	96	410000 (1951)
LIGHTNING C NR MCCUNE, KS	3	Minor	9/24/2019	14.97	4000	47	67	67500 (1993)

KANSAS CLIMATE UPDATE
October 2019 Summary

Highlights

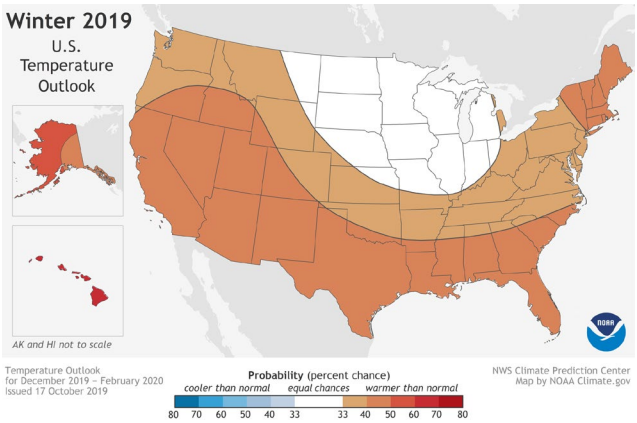
- U.S. Drought Monitor indicated expanding areas in western and south central Kansas conditions of abnormally dry (D0), moderate drought (D1) and severe drought (D2) during October.

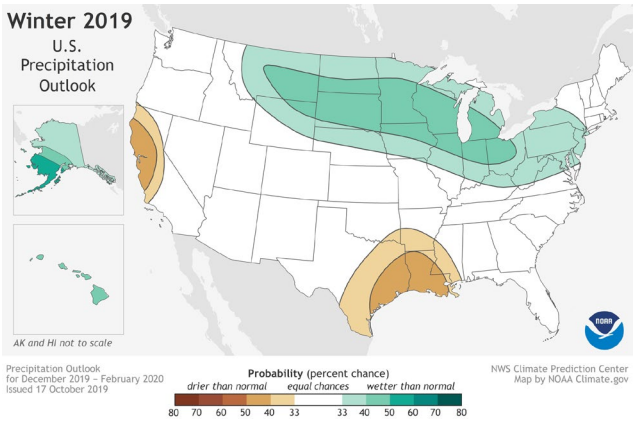
- Precipitation in October ranged to over 4 inches in the southeast climate division, averaging 1.92 inches statewide. This resulted in only 83% of the normal precipitation statewide.

- Temperatures averaged upper 40s to the lower 50s degrees Fahrenheit across the state, averaging below normal for the month almost everywhere. Statewide temperature was 4.8 degrees below normal.

- Drought Outlook favors drought continuing for the current area of moderate drought, with equal chances of below, near or above normal temperatures and precipitation likely in November.

- Winter 2019 (Dec. 2019-Feb. 2020) outlooks were released by the National Weather Service Climate Prediction Center in mid-October. The majority of Kansas is likely to be warmer than average with the north east to have below, near or above average temperatures. Precipitation is shown as having equal chances of below, near or above average precipitation for the entire state.





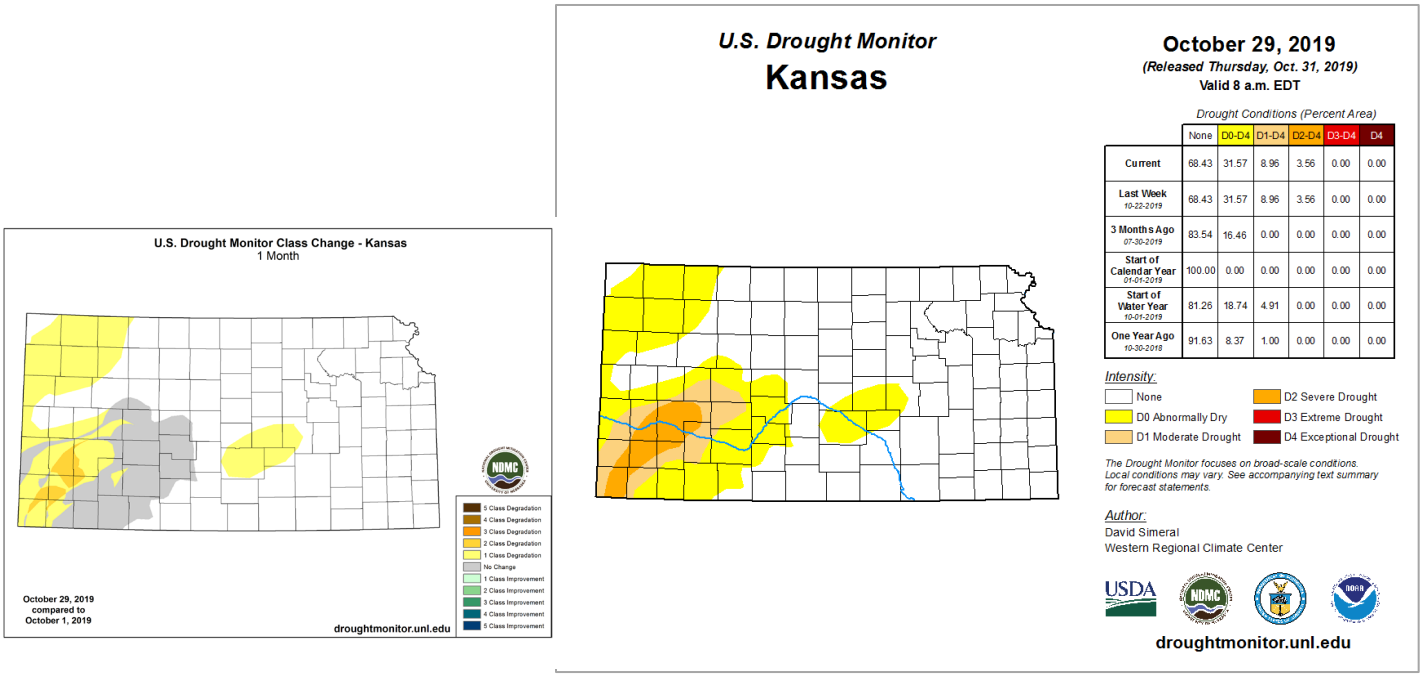
- Although still nearly 11 feet below full, Cedar Bluff Reservoir water level has recovered to a level not seen since 2005. The conservation pool is now 63% full.

- Harmful Algal Blooms (HABs) are known to have 22 affected lakes at various times during the month with health watches or warnings issued by Kansas Department of Health and Environment. The month ended with warnings at five lakes. October is the end of HAB monitoring for 2019.

General Drought Conditions

The U.S. Drought Monitor indicated dry and drought conditions in parts of western and central Kansas. The condition at the end of the month is shown below in Figure 1. Changes in drought classification over the month is also shown.

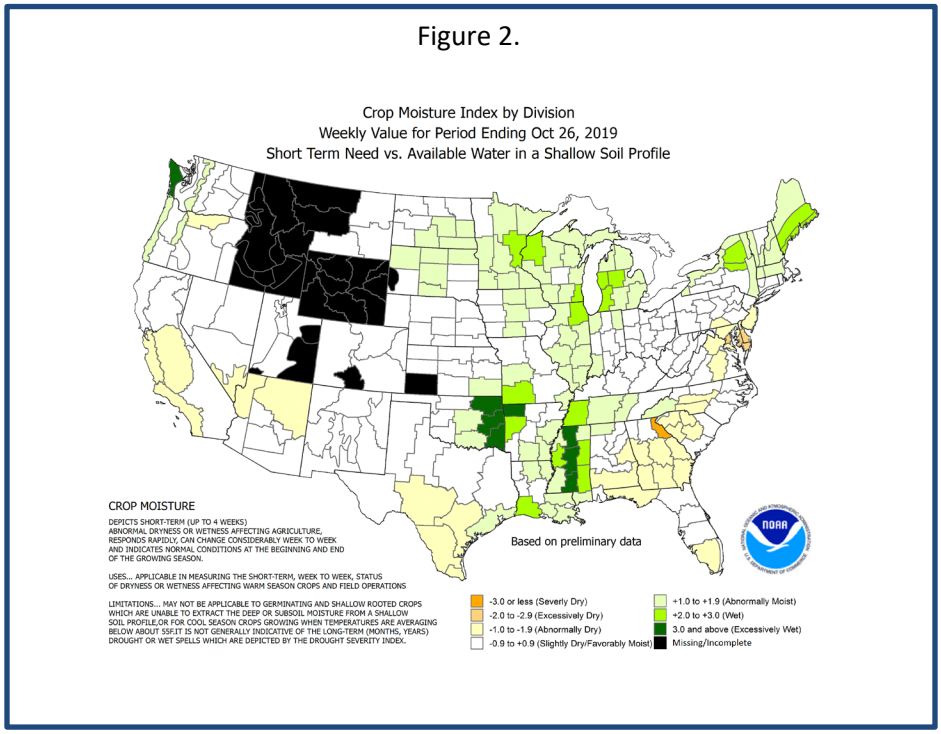
Figure 1. U.S. Drought Monitor Maps of Drought status



More information can be found on the U.S. Drought Monitor web site https://droughtmonitor.unl.edu/ .

Palmer Drought Severity Index (PDSI) - The Palmer Drought Severity Index is an indicator of relative dryness or wetness and is one factor used the U.S. Drought Monitor. The Crop Moisture (Figure 2) component evaluates short term needs and available water. More information on the PDSI and its parts can be found at http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml.

Figure 2.



Climate Summary - Precipitation

October continued the drier-than-normal pattern. Statewide average precipitation for the month was 1.92 inches, 83 percent of normal. Only the Southeast and South Central climate divisions had above normal precipitation. The Southeast Division was the wettest, with a divisional average of 4.10 inches, 112 percent of normal. The Northwest Division was the driest, with an average of 0.34 inches, 22 percent of normal. The highest 24-hour rainfall total for a National Weather Service Cooperative station was 3.79 inches at Anthony, Harper County, on the third. The greatest 24-hour rainfall total for a Community Collaborative Rain, Hail and Snow network station was 4.00 inches at Anthony 0.4 NNW, Harper County also on the 3rd. The greatest monthly precipitation totals for October: 6.71 inches at Centralia Lake, Nemaha County (NWS); 6.62 inches at Pittsburg 1.0 ESE, Crawford County (CoCoRaHS). Table 1 summarizes the monthly precipitation (KSU Weather Data Library).

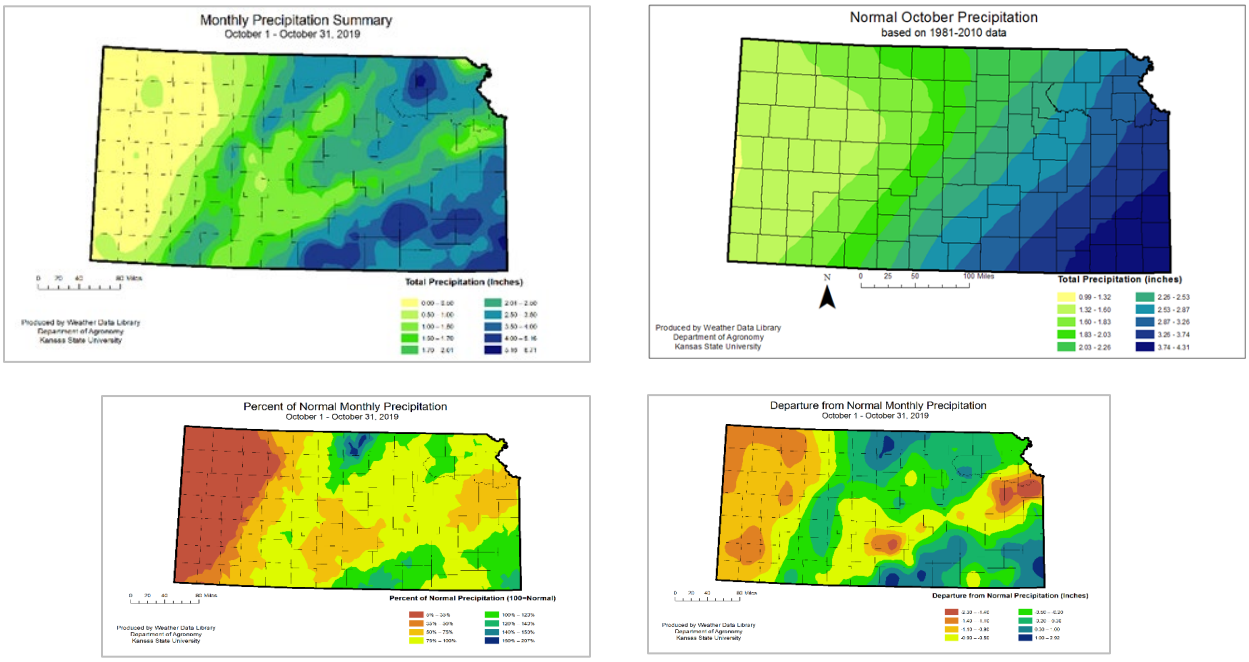
Table 1.

Kansas Climate Division Precipitation Summary (inches)

Climate Division	October 1 - 31, 2019			January 1 – October 31, 2019			April 1, 2019 – October 31, 2019			Sept 1, 2018 – October 31, 2019		
	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal
Northwest	0.34	-1.22	22	22.77	2.81	114	20.42	2.76	116	1.45	-1.63	47
West Central	0.46	-1.00	32	20.92	1.57	108	17.63	0.78	105	1.49	-1.57	49
Southwest	0.90	-0.62	59	18.65	0.07	100	15.37	-0.83	95	1.24	-1.9	39
North Central	1.75	-0.23	88	32.19	6.26	124	28.56	6.12	127	3.93	-0.68	85
Central	1.85	-0.28	87	32.54	5.41	120	28.76	5.59	124	3.03	-1.62	65
South Central	2.75	0.11	104	38.09	9.38	133	34.09	10.01	142	5.48	0.24	105
Northeast	2.39	-0.34	88	42.14	10.14	132	36.9	9.11	133	5.47	-0.87	86
East Central	2.35	-0.74	76	43.60	9.25	127	38.22	8.79	130	4.98	-1.77	74
Southeast	4.10	0.43	112	54.90	17.81	148	48.97	17.88	158	8.64	0.96	113
STATE	1.92	-0.4	83	33.92	6.98	126	29.83	6.74	129	4.00	-0.94	81

The maps of Figure 3 below summarize precipitation for the month. (State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)

Figure 3. Monthly Precipitation maps



Climate Summary-Temperature

Temperatures for October were much cooler than normal. Statewide average temperature for the month was 50.9 ºF, which is 4.8 degrees cooler than normal. This ranks as the 6th coolest October on record. The Southeast Division was the warmest with an average of 54.4 ºF, 3.4 degrees cooler than normal. The Southwest Division was the coolest, with an average of 50.1 ºF, 5.9 degrees cooler than normal. Even with the cooler pattern, all divisions saw highs in the 90s to start the month. The warmest maximum temperature was 98 ºF at Atwood, Rawlins County, on the 1st. The coldest minimum temperature was 2 ºF at multiple locations in west central KS on the 31st. There was five daily record maximum temperatures. On the other hand, there were 138 new record low minimum temperatures set and 114 record low maximum temperatures set. There were 29 new monthly record low minimums. Table 2 summarizes the monthly temperatures (KSU Weather Data Library).

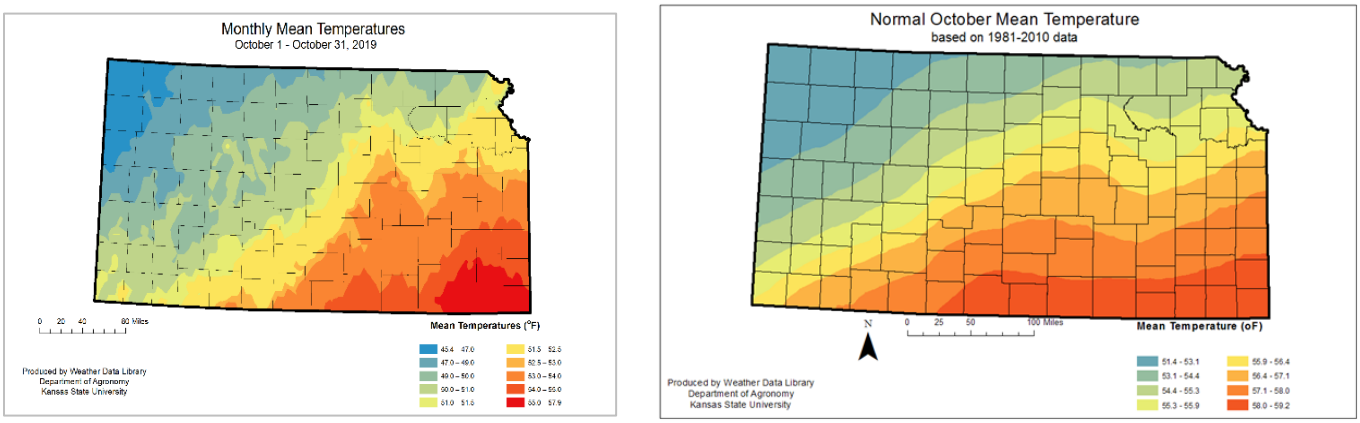
Table 2.

Climate Division	Kansas Climate Division Temperature Summary (ºF) October 2019							
	Maximum	Minimum	Average	Departure*	High	Date	Low	Date
Northwest	63.1	31.4	47.2	-5.0	98	1	6	31
West Central	64.6	32.1	48.4	-5.2	96	1	2	31
Southwest	65.7	34.4	50.1	-5.9	96	1	4	31
North Central	62.9	37.0	49.9	-5.2	94	1	11	31
Central	64.0	37.9	51.0	-5.3	92	1	10	29
South Central	65.8	40.0	52.9	-4.8	91	1	10	31
Northeast	63.1	39.7	51.4	-4.0	92	1	18	31
East Central	63.5	41.3	52.4	-4.0	91	2	15	31
Southeast	65.8	43.1	54.4	-3.4	91	2	13	31
STATE	64.3	37.4	50.9	-4.8	98	1st	2	31st

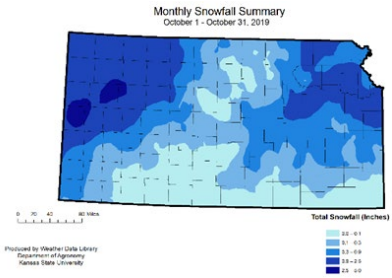
*Departure from normal is departure from the base period of 1981-2010, KSU Weather Data Library.

The maps in Figure 4 below summarize temperature for the month. (State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)

Figure 4. Monthly Temperature Maps



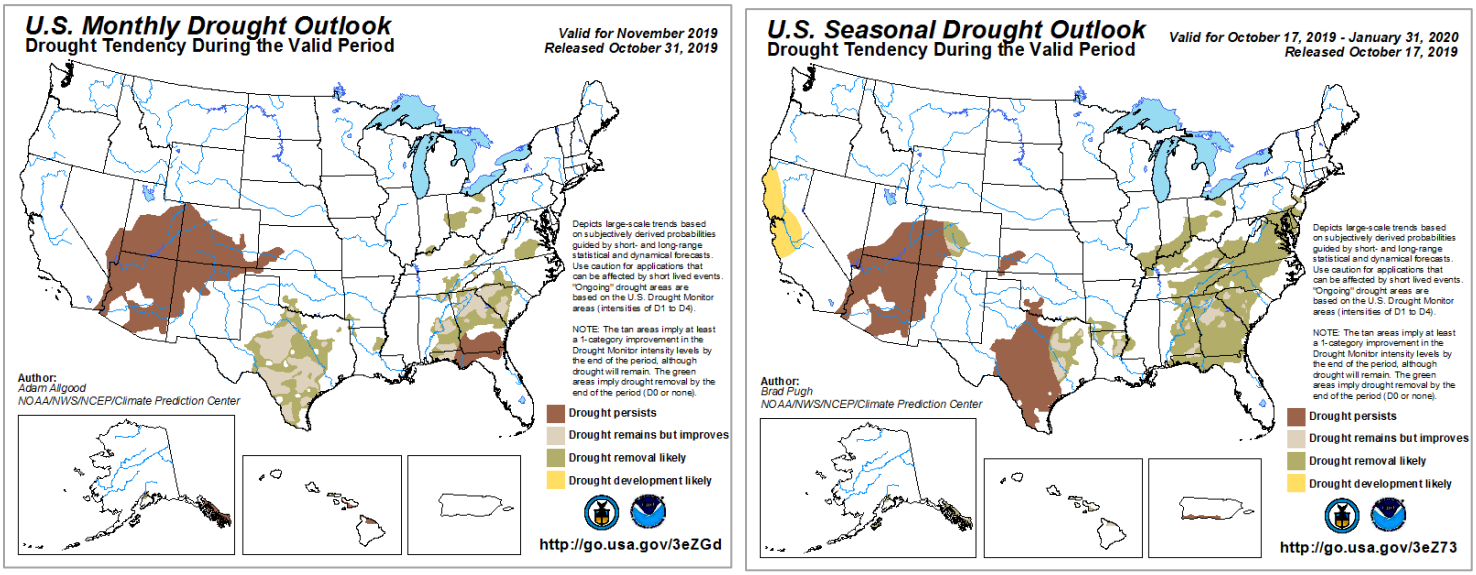
Severe weather was limited in October. There were no tornadoes reported during the month, and just two hail events. There were nine reports of damaging wind. The first widespread winter weather advisories were issued at the end of the month as snow and cold temperatures arrived for Halloween. Five daily record snowfalls were recorded. Rivers and reservoirs continue to be elevated, particularly in the eastern third of the state.



Outlooks

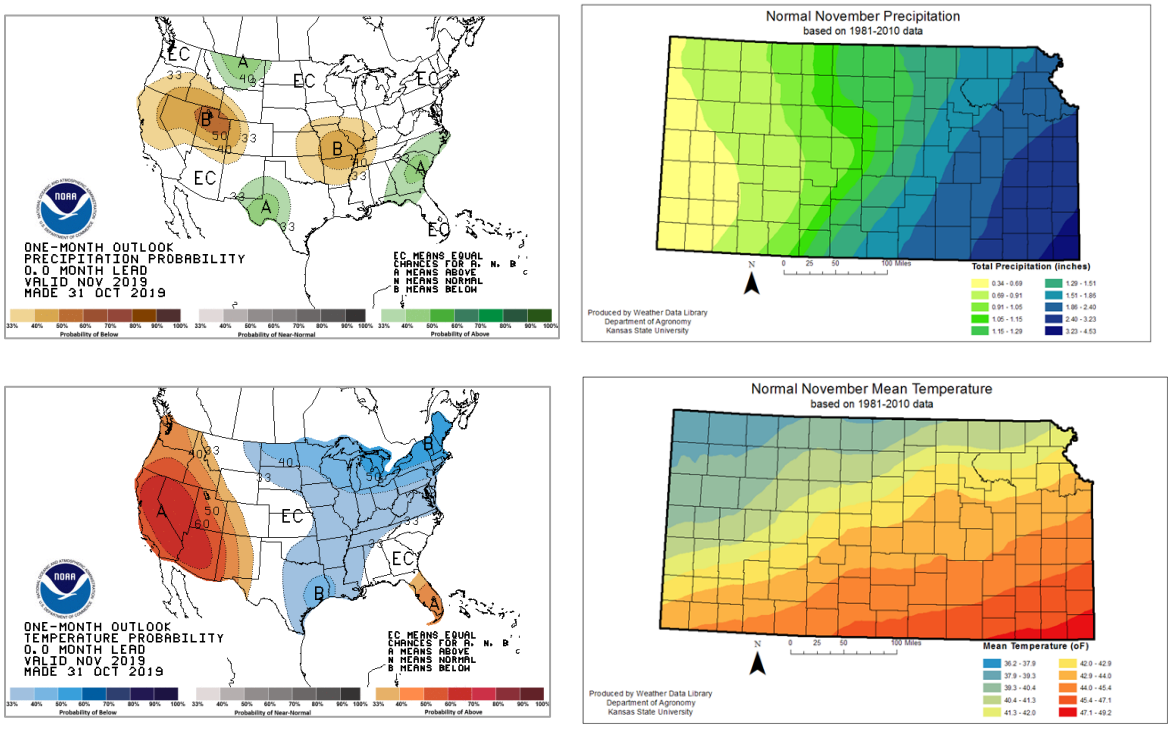
The Monthly Drought Outlook for November 2019 indicates drought conditions in southwest Kansas to persist. The Seasonal Outlook (3-month) favors a small area of drought in Kansas persisting in the mid-September through December period. The individual temperature and precipitation outlooks that contribute to these outlooks are available below.

Figure 5. Drought Outlooks



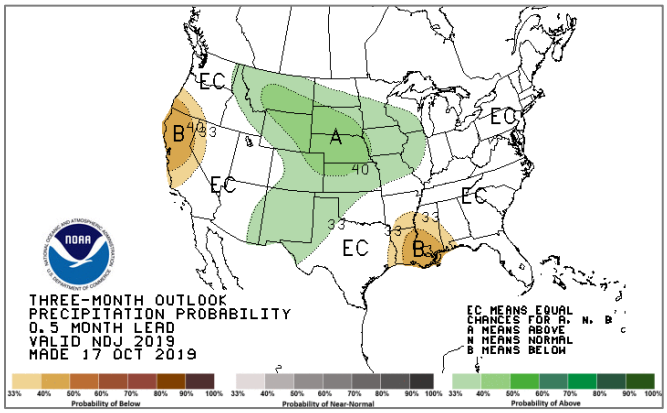
The monthly precipitation outlook favors below, near and above normal precipitation across western Kansas with below normal precipitation favored in the east. The temperature outlook indicates equal chances of below, near and above normal temperatures across the state. One month outlooks are provided in Figure 6.

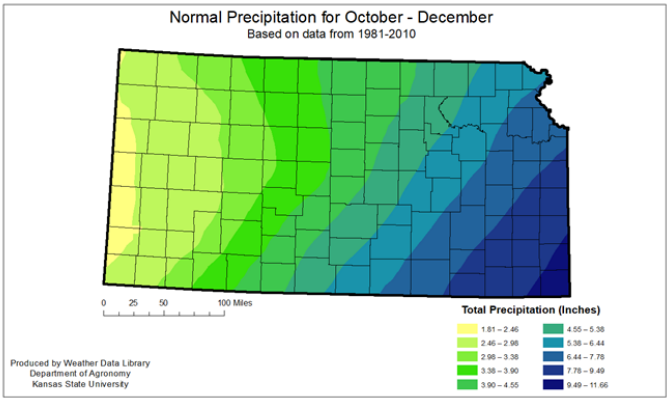
Figure 6. Next Month Precipitation and Temperature Outlooks

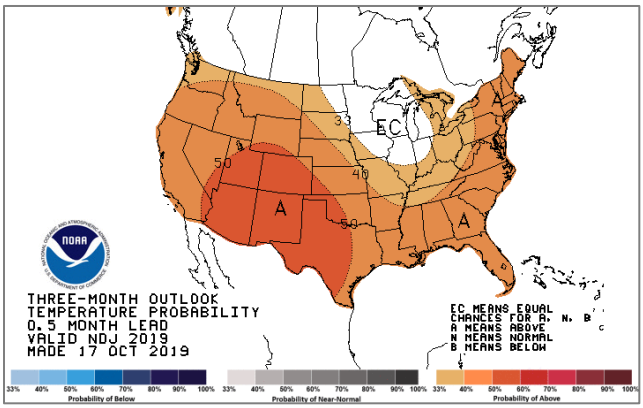


The U.S. three month outlook for November through January favors above-average precipitation (moderate chance) for all of Kansas and above normal temperatures for the entire state.

Figure 7. Three Month Precipitation and Temperature Outlooks







Additional outlooks for various timeframes are available from the national CPC for up to 13 months. (http://www.cpc.ncep.noaa.gov/products/predictions/90day/)

Reservoir Storage

At the end of the month most reservoir conservation pools were full or almost full except Keith Sebelius, Cedar Bluff and Lovewell, which are 72%, 63% and 44% full respectively. Reservoir releases consider the entire Missouri basin system so have been making releases to reduce flood pool storage accumulated from the above normal precipitation and runoff throughout spring and summer. Table 3 provides conservation pool status for each federal reservoir.

Table 3. Kansas Federal Reservoir Conservation Pool Levels

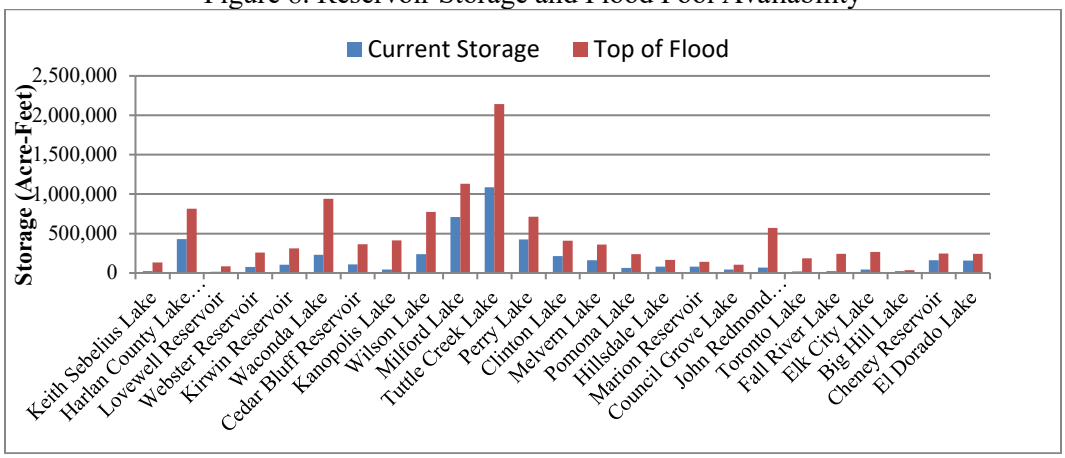
Reservoir	Top of Multipurpose / Conservation Pool (Feet MSL)	Multipurpose/Conservation Pool Elevation (Feet MSL)	Change from Top of Pool (Feet)	Percent of Conservation Pool Full
Kansas River Basin		**10/31/2019**		
Keith Sebelius Lake[1]	2304.3	2299.35	-4.95	71.9%
Harlan County Lake NE	1945.73	1953.65	7.92	100.0%
Lovewell Reservoir[1]	1582.6	1574.90	-7.70	47.7%
Webster Reservoir[1]	1892.45	1892.53	0.08	100.0%
Kirwin Reservoir	1729.25	1730.30	1.05	100.0%
Waconda Lake[1]	1455.6	1456.61	1.01	100.0%
Cedar Bluff Reservoir	2144	2133.08	-10.92	62.5%
Kanopolis Lake[1]	1463	1461.83	-1.17	92.9%
Wilson Lake[1]	1516	1515.37	-0.63	97.7%
Milford Lake[1]	1144.4	1161.20	16.80	100.0%
Tuttle Creek Lake[1]	1075	1112.01	37.01	100.0%
Perry Lake[1]	891.5	907.13	15.63	100.0%
Clinton Lake[1]	875.5	886.45	10.95	100.0%
Melvern Lake[1]	1036	1037.42	1.42	100.0%
Pomona Lake[1]	974	976.28	2.28	100.0%
Hillsdale Lake[1]	917	917.88	0.88	100.0%
Arkansas River Basin		**10/31/2019**		
Marion Reservoir[1]	1350.5	1350.18	-0.32	97.5%
Council Grove Lake[1]	1274	1274.05	0.05	100.0%
John Redmond Reservoir	1041	1041.29	0.29	100.0%
Toronto Lake	901.5	902.04	0.54	100.0%
Fall River Lake	948.5	949.44	0.94	100.0%
Elk City Lake	796	797.28	1.28	100.0%
Big Hill Lake	858	858.38	0.38	100.0%
Cheney Reservoir	1421.6	1421.09	-0.51	97.1%
El Dorado Lake	1339	1338.90	-0.10	99.5%

[1]Lake level management plan in place — Source: U.S. Army Corps of Engineers, U.S. Bureau of Reclamation and U.S. Geological Survey

Note: The conservation pool is the water storage for non-flood purposes of the reservoir, set by the elevation of the top of the pool.

In Figure 8 the blue bars indicate water in storage at that reservoir, with red bars indicate top of the flood pool storage. Some reservoirs have storage space remaining for flood flows but the available space varies.

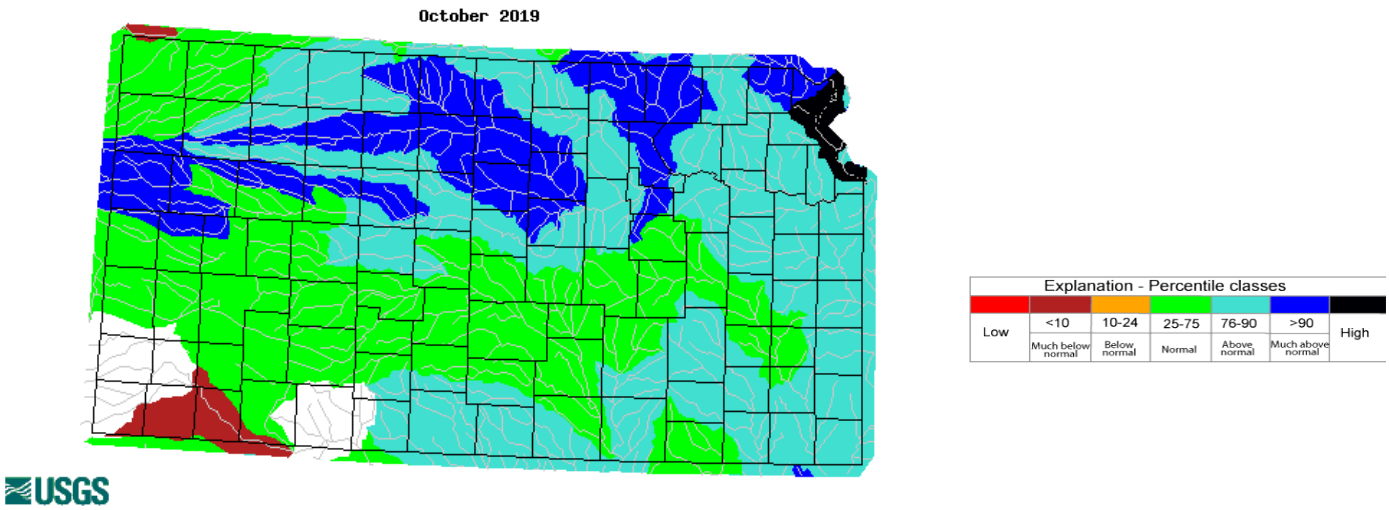
Figure 8. Reservoir Storage and Flood Pool Availability



Streamflow Conditions

WaterWatch summarizes streamflow conditions in a region (state or hydrologic unit) in terms of the long-term typical condition at stream gages in the region. In general, a streamflow which is greater than the 75 percentile is considered *above normal*, a streamflow which is between 25 and 75 percentiles is considered *normal* and a streamflow which is less than the 25 percentile is considered *below normal*. Color codes are for basins with streamflow averages less than 25 percent of historic values. This comparison aids in evaluating water resources conditions for a time period. A summary of flooding in is found later in this report. Figure 9 summarizes streamflow.

Figure 9. Monthly streamflow compared to historical streamflow



Minimum Desirable Streamflow: Low flows may be reflected at gage locations when the flow does not reach Minimum Desirable Streamflow (MDS). MDS requirements are in place to ensure base flows in certain streams to protect existing water rights and to meet in-stream water uses related to water quality, fish and wildlife and recreation. The Kansas Department of Agriculture, Division of Water Resources monitors 23 streams and rivers at 33 locations for minimum desirable streamflow. When flows drop below an established threshold, pumping restrictions are imposed on permits or water rights granted after the minimum desirable streamflow provision was made into law in 1984.

Although no water right administration was in effect in July, the table below notes locations of concern including those below MDS.

Table 4.
Streamflows of Note

Gaging Station	Oct 7 Flow	Oct 15 Flow	Oct 21 Flow	Oct 28 Flow	Oct MDS	Comment
Rattlesnake Creek near Macksville	6	5	5	4	1	No surface water diversions junior to MDS above gage
Rattlesnake Creek near Zenith	17	12	12	12	3	No surface water diversions junior to MDS above gage
Little Arkansas at Alta Mills	153	17	12	11	8	

General flooding for the month is shown in the USGS WaterWatch maps in the streamflow section of this report. However this does not provide all the specifics of severity of impacts and duration at specific locations. Additional flooding information can be found for USGS stream gage sites at https://waterwatch.usgs.gov/?m=flood&r=ks&w=flood%2Ctable for current stage.

Harmful Blue-Green Algal Blooms (lake water safety)
KDHE samples public use lakes only in response to complaints of human or animal illness or visual sighting of possible blue-green algae by the public or lake officials. The season for harmful algal blooms (HABs) monitoring is April 1-October 31.

KDHE issues three levels of public health protection notifications for blue-green algae (BGA) Blooms. Public Health Watch–Notifies public that a harmful algae may be present, that the water may be unsafe for humans and animals and contact with the water is discouraged. Public Health Warning–Notifies public that harmful algae is present of expected, that contact with the water should not occur, and all conditions of Public Health Watch remain in effect. Lake Closure –Notifies the public that a portion of the lake or the entire lake be closed to public because harmful algae is present and extreme conditions exist. Actual lake closure is issued by the lake management officials based on the KDHE public health recommendations and advisories. A summary of lakes affected in the month is found in Table 5. More information can be found at http://www.kdheks.gov/algae-illness/index.htm.

Table 5.
KDHE Lake Health Advisories issued in October 2019

Lake	County	10/3/2019	10/10/19	10/17/19	10/24/19	10/31/19
Atchison County Park lake	Atchison	Warning	Warning			
Big Eleven Lake	Wyandotte	Watch				
Camp Hawk Lake	Harvey	Watch				
Carousel Lake in Gage Park	Shawnee	Watch	Watch	Watch		
Central Park Lake	Shawnee	Warning	Warning	Warning		
Elk Horn Lake	Jackson	Warning	Warning			
Gathering Pond	Geary	Warning	Warning	Watch	Watch	Warning
Hiawatha City Lake	Brown	Warning	Warning			
Hodgeman County State Fishing Lake	Hodgeman	Watch				
Jerry Ivey Pond	Saline	Warning	Warning	Warning	Warning	Warning
Lake Afton	Sedgewick	Watch	Watch	Watch		
Lake Jeanette	Leavenworth	Warning	Warning	Warning	Warning	Warning
Lakewood Park Lake	Saline	Warning	Warning	Warning	Warning	Warning
Lebo Kids' Pond	Coffey	Watch				
Marion County Lake	Marion	Warning	Warning			
Meadowbrook Park lake	Johnson	Warning	Warning			
Neosho County State Fishing Lake	Neosho	Watch				
Rock Garden Pond	Shawnee	Watch	Watch	Watch		
South Lake	Johnson	Watch	Watch	Watch	Watch	Watch
Webster Reservoir	Rooks	Warning		Watch		
Yates Center Kids" Fishing Pond	Woodson	Warning	Warning	Warning		
Yorkshire Channel E. of N. Crestline Dr (Lawrence)	Douglas	Watch				

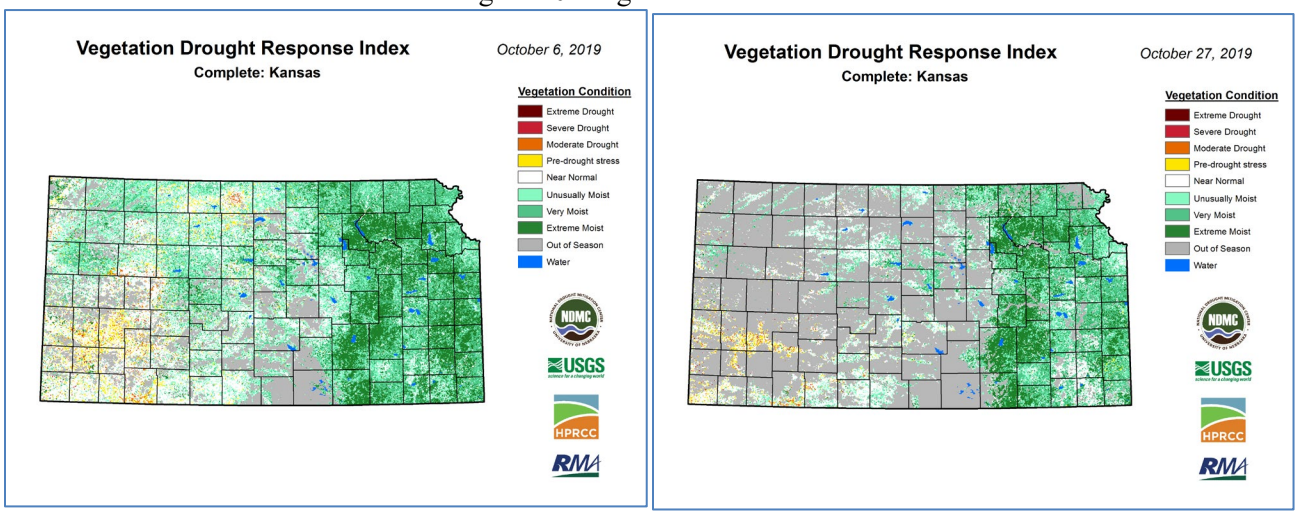
KDHE will not be issuing public health advisories for algal blooms again until April 2020. The public is encouraged to be aware of algal blooms and report any health impacts to humans or animals from algal blooms to 877-427-7317 or KDHE.EpiHotline@ks.gov. For those advisories that were still active at the end of the season, KDHE relies on lake managers to continue monitoring those lakes.

Vegetation and Soil Moisture

Vegetative Conditions

The Vegetative Condition map depicts vegetation stress. It is produced using satellite data by the National Drought Mitigation Center https://vegdri.unl.edu/Home.aspx and often customized for Kansas by the Kansas Biological Survey in the GreenReport. Areas in yellow, orange and red indicate areas of vegetative stress. The green areas are considered to be in good or excellent condition (moist).

Figure 10. Vegetative Conditions

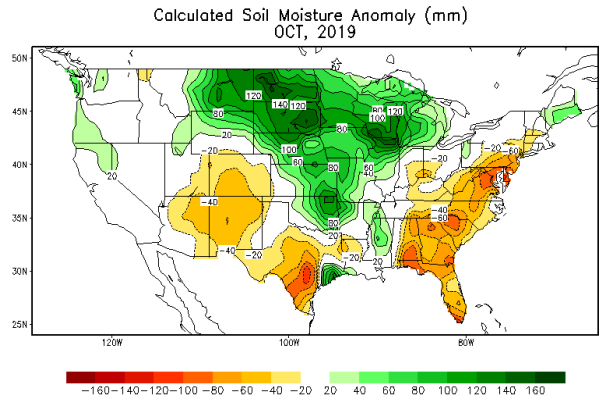


The Vegetation Drought Response Index (VegDRI) classified less than 1% of the land area as dry or in drought and 14% of Kansas was near normal with 31% considered unusually, very or extremely moist at the end of the month. The majority of Kansas is now considered out of season by the standards of this tool.

Soil Moisture and Rangeland

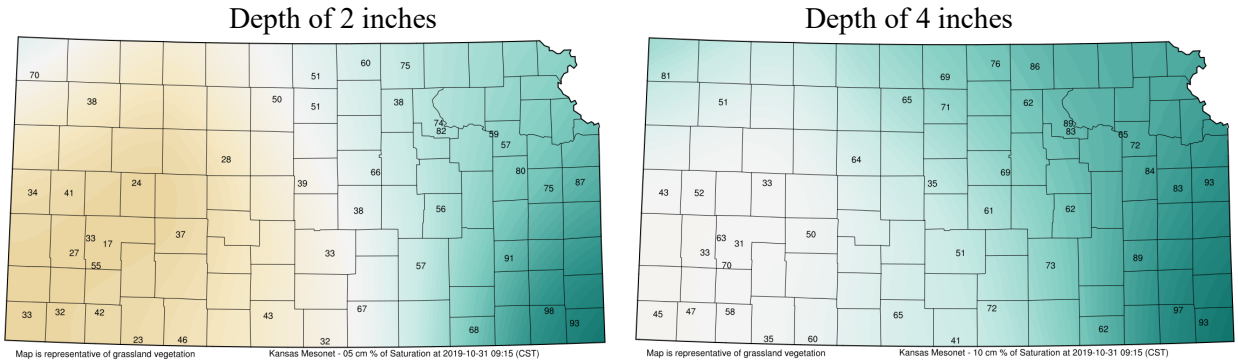
The Climate Prediction Center (CPC), monitors soil moisture and predicts future soil moisture. Anomalies are defined as deviations from the 1971-2000 monthly climatology. The monthly soil anomaly is shown in Figure 11. (.http://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml).

Figure 11.



Within Kansas soil moisture is now being measured through the Kansas Mesonet and Kansas State University the percent of soil saturation is shown in Figure 12.

Figure 12. Percent of Soil Saturation
October 31, 2019



Saturation at 2 inches ranged from 17% at Garden City (Finney County)
to 98% at the station at Parsons (Labette County).

The National Agricultural Statistics Service, USDA Crop Progress and Condition provides a summary of the climatic effects on soil and crops. For the week ending October 27, 2019, topsoil moisture supplies rated 6 percent very short, 22 short, 68 adequate, and 4 surplus. Subsoil moisture supplies rated 6 percent very short, 19 short, 71 adequate, and 4 surplus.

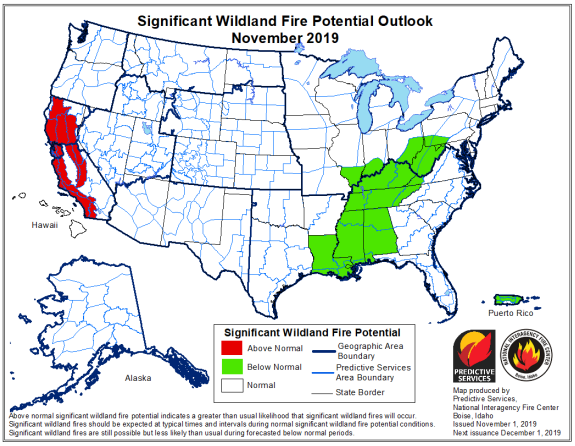
Field Crops Report: Corn harvested was 74 percent, near 75 last year, and behind 82 average.
Soybean condition rated 4 percent very poor, 8 poor, 31 fair, 47 good, and 10 excellent.
Sorghum condition rated 3 percent very poor, 9 poor, 30 fair, 51 good, and 7 excellent.
Cotton condition rated 2 percent very poor, 13 poor, 41 fair, 38 good, and 6 excellent.
Winter wheat condition rated 3 percent very poor, 10 poor, 32 fair, 43 good, and 12 excellent.

Pasture and range conditions rated 2 percent very poor, 8 poor, 30 fair, 54 good, and 6 excellent.

Fire

Significant Wildland Fire Potential Outlook is issued monthly for the United States. Figure 13 is the most recent. Additional forecasts can be found at https://www.predictiveservices.nifc.gov/outlooks/monthly_seasonal_outlook.pdf .

Figure 13. Wildfire Outlook

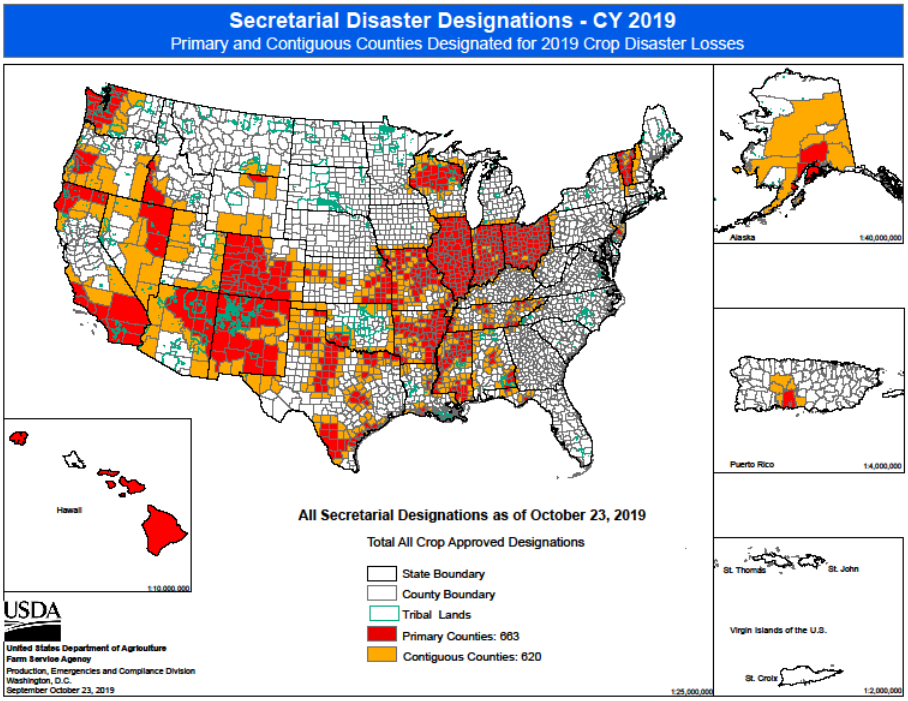


Disaster Designations

A total of 70 Kansas counties are now identified in Federal Emergency Declarations, DR-4449 due to storms, winds, tornadoes, flooding, landslides and mudslides. The President's action makes federal funding available to state, eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and repair or replacement of facilities in Allen, Anderson, Atchison, Barber, Barton, Bourbon, Brown, Butler, Chase, Chautauqua, Cherokee, Clark, Clay, Cloud, Coffey, Comanche, Cowley, Crawford, Dickinson, Doniphan, Douglas, Edwards, Elk, Ellsworth, Ford, Franklin, Geary, Gray, Greenwood, Harper, Harvey, Hodgeman, Jefferson, Kingman, Leavenworth, Lincoln, Linn, Lyon, Marion, Marshall, McPherson, Meade, Miami, Montgomery, Morris, Nemaha, Neosho, Ness, Osage, Osbourne, Ottawa, Pawnee, Phillips, Pottawatomie, Pratt, Reno, Rice, Riley, Rush, Russell, Saline, Smith, Sumner, Wabaunsee, Wallace, Washington, Wilson, Woodson and Wyandotte counties.

Federal funding is also available on a cost-sharing basis for hazard mitigation measures statewide. Some additional counties may be eligible for federal declaration and aid in the future once damage assessment is completed by FEMA.

Producers in 57 counties may be eligible for agricultural emergency loans as USDA has designated 25 counties as primary agricultural disaster areas for crop year 2019 due to flooding or excessive rain. Primary counties are Allen, Anderson, Atchison, Barton, Bourbon, Chase, Chautauqua, Cherokee, Cowley, Doniphan, Franklin, Gove, Johnson, Labette, Leavenworth, Linn, Lyon, Miami, Montgomery, Neosho, Osage, Wallace, Wilson, Woodson, Wyandotte. Additional, contiguous counties are: Brown, Butler, Coffey, Crawford, Douglas, Elk, Ellsworth, Graham, Greeley, Greenwood, Jackson, Jefferson, Johnson, Lane, Linn, Logan, Marion, Miami, Morris, Ness, Pawnee, Rice, Rush, Russell, Scott, Sedgwick, Shawnee, Sheridan, Sherman, Stafford, Sumner, Thomas, Trego, Wabaunsee, and Wichita.



The Additional Supplemental Appropriations for Disaster Relief Act of 2019 was signed into law by President Trump on June 6, 2019. Congress appropriated $3.005 billion in assistance for a wide array of losses resulting from disasters throughout 2018 and 2019, including loses related to prevented planting of insured crops in calendar year 2019. In Kansas, WHIP+ is available only for crops affected by flooding, snowstorm, tornado and wildfires. Eligible crops are those in a Secretary or President-declared disaster county, or those with COC-accepted documentation of the qualifying disaster event that caused the crop loss. WHIP+ applications must be filed with the local FSA office, with a deadline to be announced later. Payments will be disbursed by FSA.

Kansas Climate Summary

The Kansas Weekly Climate Summary and Drought Report are compiled at least monthly, more frequently when conditions warrant, by the KWO. Information from various federal, state, local and academic sources is used. Some of the data is preliminary and subject to change once final data is available. The KWO web site, http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response , contains additional drought information including links to other agencies with drought information and past issues of the Kansas Climate Summary and Drought Report. Mary Knapp, at the Kansas Climate Office, Weather Data Library is the primary source of the narrative on weather. She works closely with meteorologists throughout the state and region. Details of current conditions at Evapotranspiration (ET) and Mesonet sites across Kansas are available at http://mesonet.k-state.edu/

RESOURCES and REFERENCES

Kansas climate data is provided by Kansas State University, Weather Data Library through the Kansas Mesonet. (http://www.ksre.k-state.edu/wdl/). Soil moisture data was added in 2018 (http://mesonet.k-state.edu/agriculture/soilmoist)

The U.S. Drought Monitor, from the National Drought Mitigation Center at the University of Nebraska-Lincoln, provides a "big picture" perspective of conditions across the nation. In the Kansas county drought stage scheme, a Drought Watch equates roughly to moderate drought in the U.S. Drought Monitor, while a Drought Warning is the equivalent of severe drought. A Drought Emergency is reserved for extreme or exceptional drought. Palmer Drought Severity Index - The Palmer Index (PDSI) is one indicator used in the U.S. Drought Monitor.

The High Plains Regional Climate Center (https://hprcc.unl.edu/) has precipitation and temperature summary maps available at the state, region and nation.

The U.S. Geological Survey (USGS) Drought Watch provides information average streamflow measured at long-term gaging stations and compares them to normal flows.

The Kansas Department of Agriculture-Division of Water Resources monitors stream flow using the USGS gages for determination of administrative needs. Administration may be needed due to Minimum Desirable Streamflow (MDS) requirements, impairments and reservoir release protection. (https://agriculture.ks.gov/divisions-programs/dwr/water-appropriation/minimum-desirable-streamflow.)

The water levels of the federal lakes fluctuate during a year according to the management plan. Lake level Management plans are posted on the Kansas Water Office web site www.kwo.ks.gov .

The Kansas Applied Remote Sensing Program (KARS) at the University of Kansas produces a Kansas Green Report each week during the growing season. For a full set of national and regional ***GreenReport***® maps, go to: http://www.kars.ku.edu/products/greenreport/greenreport.shtml. This Kansas Vegetation Drought Response Index map is developed weekly by the Kansas Biological Survey using state drought triggers as its key. In addition, the National Drought Mitigation Center also produces VegDRI maps which may be found at http://vegdri.unl.edu/.

The National Weather Service (NWS) provides fire weather products and services for Kansas that include the Rangeland Fire Danger Index, Fire Weather Forecasts, Red Flag Watches/Warnings and Spot Forecasts. The five NWS offices that serve Kansas websites may be accessed from the NWS Offices' page.

The Monthly and Seasonal Drought Outlooks, developed by the NOAA Climate Prediction Center, assess the likelihood for improvement, persistence or deterioration in drought conditions for areas currently experiencing drought as identified by the U.S. Drought Monitor. (http://www.cpc.ncep.noaa.gov/) Also see: http://www.noaa.gov/.

Responding to Drought: A Guide for City, County and Water System Officials provides an overview of Kansas county drought stage declarations, local planning and coordination, disaster declarations and available state and federal assistance. The 2007 Municipal Water Conservation Plan Guidelines and the Drought Vulnerability Assessment Report, both by KWO, provide guidance regarding drought preparedness and response. These are available at http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response.

USDA Drought Programs and Assistance website (https://www.usda.gov/topics/disaster/drought/usda-drought-programs-and-assistance) listing the various USDA programs and agencies to assist with drought issues.

The National Interagency Coordination Center in Boise, Idaho, produces wildfire potential outlook maps monthly. (https://www.predictiveservices.nifc.gov/outlooks/outlooks.htm)

Please contact Diane Knowles at the Kansas Water Office (785) 296-3185 or diane.knowles@kwo.ks.gov should you have any questions or suggestions.

APPENDIX A
Monthly Weather Summary

October Summary	Precipitation (inches)			Temperature °F			
						Extreme (Date)	
Station[1]	Total	Departure[2]	Percent Normal	Mean	Departure[2]	Highest	Lowest
West							
Burlington, CO	0.01	-1.14	1%	45.8	-5.1	87 (17,8)	4 (31,30)
Dodge City	1.43	-0.31	82%	50.9	-5.7	87 (18,9)	10 (31)
Garden City	0.65	-0.63	51%	48.2	-7.3	89 (18)	5 (31)
Goodland	0.26	-1.11	19%	46.0	-5.9	87 (17)	8 (31,30)
Guymon, OK	0.71	-0.86	45%	52.2	-5.1	90 (9)	11 (31)
Hill City	0.58	-0.94	38%	49.1	-4.9	87 (18(	11 (31)
Lamar, CO	0.20	-0.60	25%	46.6	-6.3	91 (17)	-1 (31)
McCook, NE	0.59	-1.20	33%	46.1	-5.2	87 (17)	6 (31)
Springfield, CO	0.57	-0.82	41%	45.8	-8.1	86 (17)	4 (31)
Central							
Concordia	1.24	-0.68	65%	51.5	-3.9	85 (1)	16 (31)
Hebron, NE	-	-	-	48.6	-4.7	79 (18)	15 (31)
Medicine Lodge	1.79	-1.05	63%	52.9	-5.7	89 (1)	15 (31)
Ponca City, OK	2.22	-1.16	66%	56.2	-3.9	92 (2)	21 (31)
Salina	1.82	-0.45	80%	51.2	-6.4	91 (1)	13 (31)
Wichita (ICT)	3.22	0.44	116%	54.4	-3.9	91 (1)	19 (31)
East							
Bartlesville, OK	3.11	-0.36	90%	55.7	-3.8	93 (2)	24 (31)
Chanute	4.17	0.51	114%	56.0	-2.3	91 (2)	24 (31)
Falls City, NE	3.92	1.28	148%	49.7	-5.0	91 (1)	19 (31)
Johnson Co. Exec. Apt	1.40	-2.04	41%	51.5	-5.5	87 (1)	23 (31)
Joplin, MO	5.19	1.16	129%	55.5	-4.3	89 (2,1)	27 (31)
Kansas City (MCI), MO	1.69	-1.47	53%	51.4	-5.0	88 (1)	21 (31)
St. Joseph, MO	3.29	0.48	117%	51.0	-3.7	91 (1)	20 (31)
Topeka (TOP)	1.91	-1.12	63%	52.1	-4.5	90 (1)	22 (31)

1. Airport Automated Observation Stations (NWS/FAA)
2. Departure from 1981-2010 normal value

T - Trace; M - Missing; --- no normal value from which to calculate departure or percent of normal

Source: National Weather Service F-6 Climate Summaries

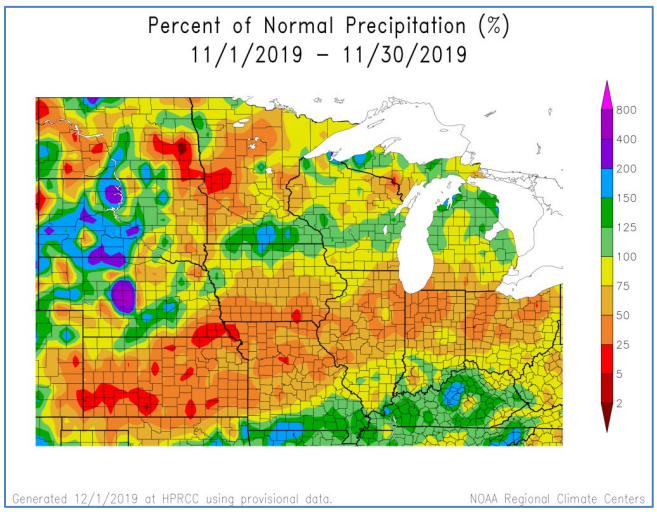
KANSAS CLIMATE UPDATE
November 2019 Summary

Highlights

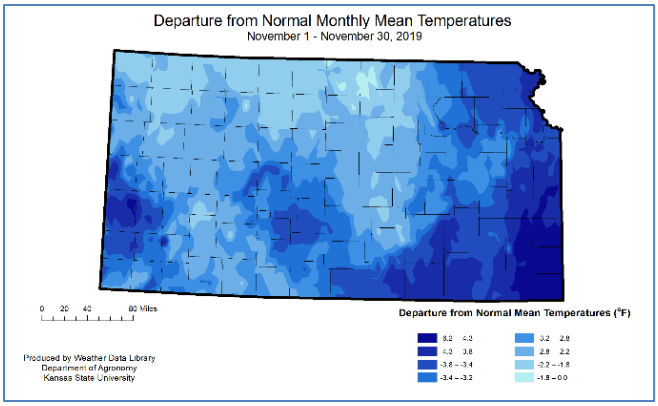
- U.S. Drought Monitor indicated continuing and expanding areas of abnormally dry (D0), moderate drought (D1) and severe drought (D2) in western and south central Kansas conditions. November 19 a small area was declared as extreme drought (D3) including parts of Finney, Grant, Kearny, Morton and Stanton counties.

- Wildfires break out in began in very late October continuing in November with the drying out of fuels. One fire near St Francis, Cheyenne County November 8th was declared a disaster by the Governor affecting an estimated 10,000 acres.

- In November, all of Kansas was below normal for precipitation. Less than 50% of average precipitation occurred in a band from Kansas to Ohio across the Midwest.



- Temperatures ranged from below zero into the 80's in November across the state. The average temperature was 39.7°F, which is 2.9 degrees cooler than normal for the month.

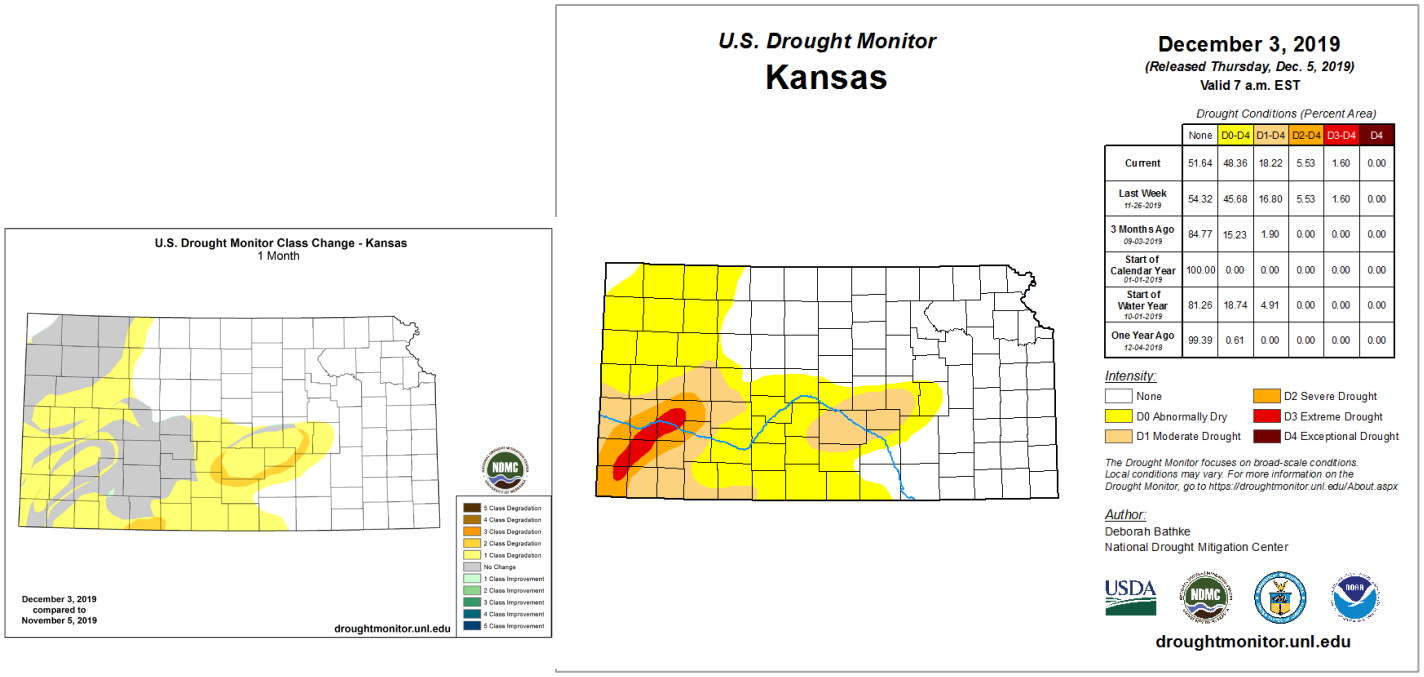


- Drought Outlook favors drought continuing for the current area of drought, with equal chances of below, near or above normal temperatures and precipitation likely in December for most of Kansas.

General Drought Conditions

The U.S. Drought Monitor indicated dry and drought conditions in parts of western and central Kansas throughout the month. These drought conditions expanded and intensified in parts of South Central and Southwest Kansas. The condition at the end of the month is shown below in Figure 1. Changes in drought classification over the month is also shown.

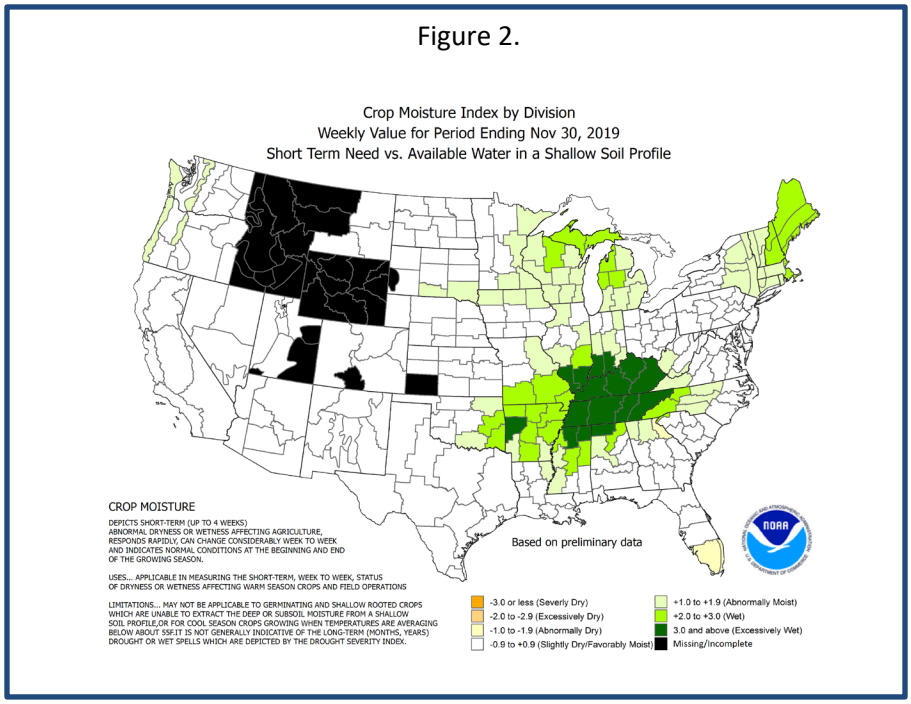
Figure 1. U.S. Drought Monitor Maps of Drought status



More information can be found on the U.S. Drought Monitor web site https://droughtmonitor.unl.edu/ .

Palmer Drought Severity Index (PDSI) - The Palmer Drought Severity Index is an indicator of relative dryness or wetness and is one factor used the U.S. Drought Monitor. The Crop Moisture (Figure 2) component evaluates short term needs and available water. More information on the PDSI and its parts can be found at http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml.

Figure 2.



Climate Summary - Precipitation

November was drier than normal. Statewide average precipitation for the month was 0.57 inches, 40 percent of normal, ranking as the 37th driest November in the 125-year record. The Northwest Climate Division had the greatest percent of normal, with a divisional average of 0.62 inches, 76 percent of normal. The Southeast Division had the highest average amount, with an average of 1.13 inches, 44 percent of normal. The highest 24-hour rainfall total for a National Weather Service Cooperative station was 0.94 inches at Iola 1W, Allen County on the 22nd. The greatest 24-hour rainfall total for a Community Collaborative Rain, Hail and Snow network station was 1.25 inches at Frontenac 0.4 SW, Crawford County on the 30th. The greatest monthly precipitation totals for November: 2.32 inches at Bartlett, Labette County (NWS); 2.63 inches at Baldwin City 0.6 W, Douglas County (CoCoRaHS). Table 1 summarizes the monthly precipitation (KSU Weather Data Library).

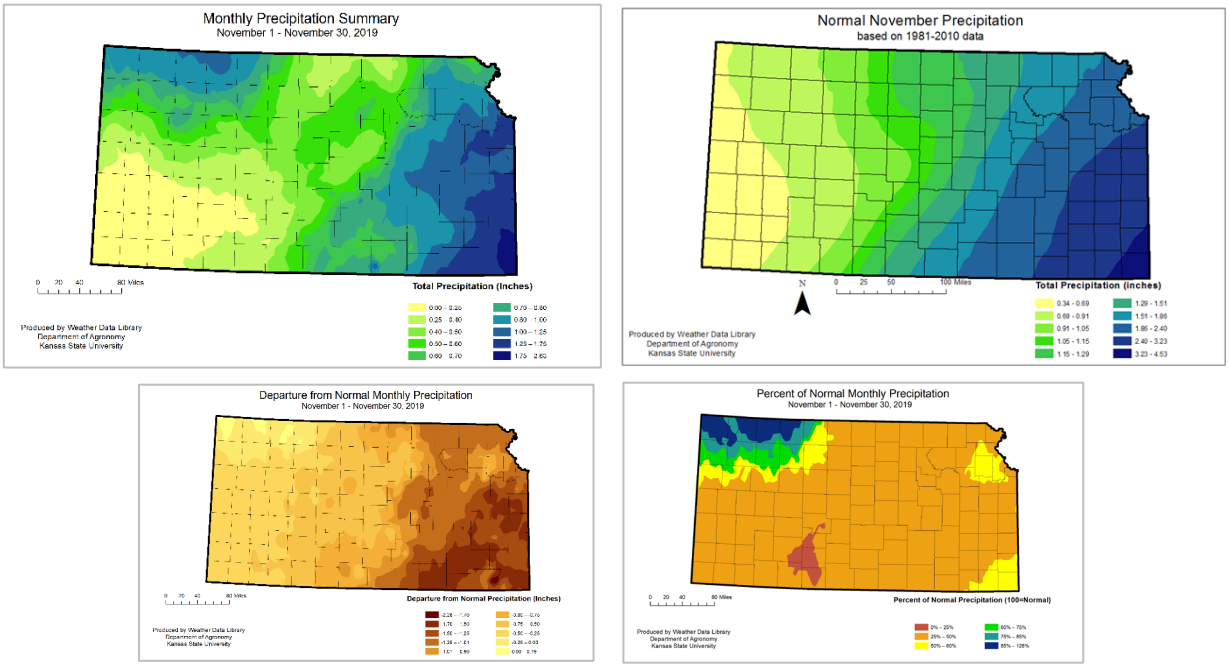
Table 1.

Kansas Climate Division Precipitation Summary (inches)

Climate Division	November 1 - 30, 2019			January 1 – November 30, 2019			April 1, 2019 – November 30, 2019			Sept 1, 2018 – November 30, 2019		
	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal
Northwest	0.62	-0.20	76	23.54	2.75	113	21.18	2.69	115	2.21	-1.69	57
West Central	0.24	-0.55	30	21.20	1.06	105	17.91	0.27	102	1.77	-2.07	46
Southwest	0.17	-0.49	26	18.72	-0.51	97	15.43	-1.42	92	1.31	-2.48	35
North Central	0.51	-0.72	41	32.75	5.59	121	29.11	5.44	123	4.48	-1.36	77
Central	0.38	-0.86	31	32.96	4.60	116	29.19	4.78	120	3.45	-2.44	59
South Central	0.53	-0.96	36	38.63	8.43	128	34.62	9.04	135	6.02	-0.71	89
Northeast	0.61	-1.16	34	43.04	9.26	127	37.79	8.22	128	6.37	-1.74	79
East Central	0.97	-1.20	45	44.59	8.07	122	39.21	7.61	124	5.97	-2.94	67
Southeast	1.13	-1.46	44	55.90	16.22	141	49.97	16.29	148	9.64	-0.63	94
STATE	0.57	-0.85	40	34.51	6.16	122	30.42	5.91	124	4.59	-1.76	72

The maps of Figure 3 below summarize precipitation for the month. (State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)

Figure 3. Monthly Precipitation maps



Climate Summary-Temperature

Temperatures for November were cooler than normal. Statewide average temperature for the month was 39.7 oF, which is 2.9 degrees cooler than normal. This ranks as the 33rd coolest November on record. The Northwest Division was the warmest with an average of 37.3 oF, 1.8 degrees cooler than normal. The Southeast Division was the coolest, with an average of 41.5 oF, 4.4 degrees cooler than normal. Even with the cooler pattern, all central/west divisions saw highs in the 80s. The warmest maximum temperature was 86 oF at Healy, Lane County, on the 10th. The coldest minimum temperature was -5 oF at Oakley 19SW, Logan County, on the 12th. There was three daily record maximum temperatures. On the other hand, there were 113 new record low maximum temperatures set and 123 record low minimum temperatures set. There were no new record warm minimum temperatures. Table 2 summarizes the monthly temperatures (KSU Weather Data Library).

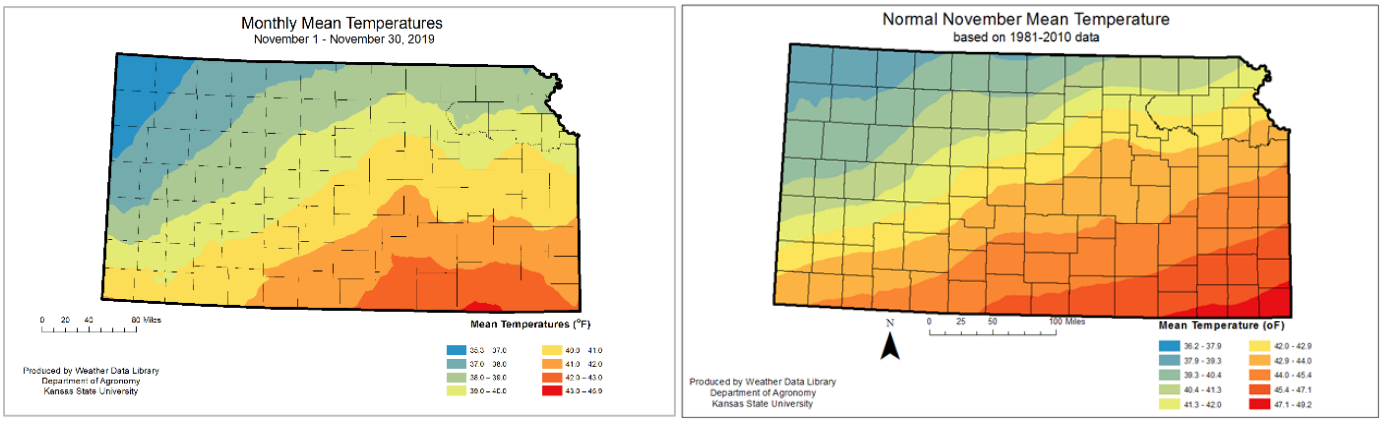
Table 2.

Climate Division	Kansas Climate Division Temperature Summary (ºF) November 2019							
	Maximum	Minimum	Average	Departure*	High	Date	Low	Date
Northwest	52.5	22.0	37.3	-1.8	82	10	-2	12
West Central	54.2	22.8	38.5	-2.0	86	10	-5	12
Southwest	57.4	24.6	41.0	-1.8	82	10	-3	12
North Central	51.8	25.8	38.8	-2.4	80	10	1	12
Central	53.8	26.5	40.1	-2.7	80	10	1	12
South Central	56.0	27.5	41.7	-2.8	80	10	2	12
Northeast	50.2	26.2	38.2	-4.0	74	10	5	12
East Central	51.5	28.0	39.8	-3.8	77	10	4	12
Southeast	53.8	29.2	41.5	-4.4	76	11	3	12
STATE	53.5	25.8	39.7	-2.9	86	10th	-5	12th

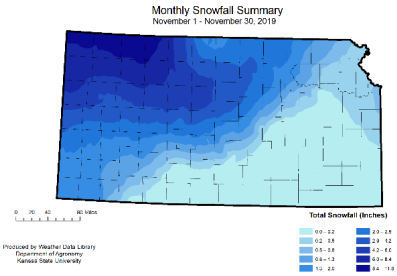
*Departure from normal is departure from the base period of 1981-2010, KSU Weather Data Library.

The maps in Figure 4 below summarize temperature for the month. (State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)

Figure 4. Monthly Temperature Maps



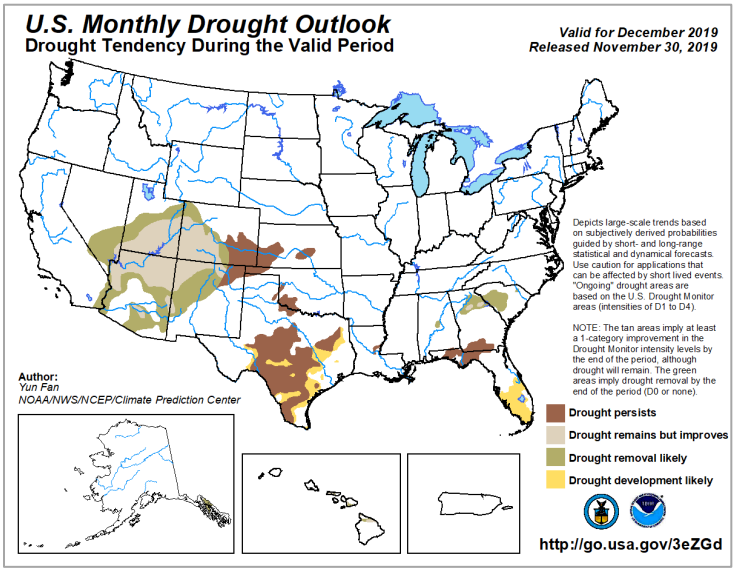
Severe weather was limited to winter weather conditions in November. Heavy snow and high winds complicated travel during the Thanksgiving week The only precipitation records set during the month were for daily snowfall amounts, and these were set at just seven locations . There were no reports of tornadoes, hail or damaging wind.

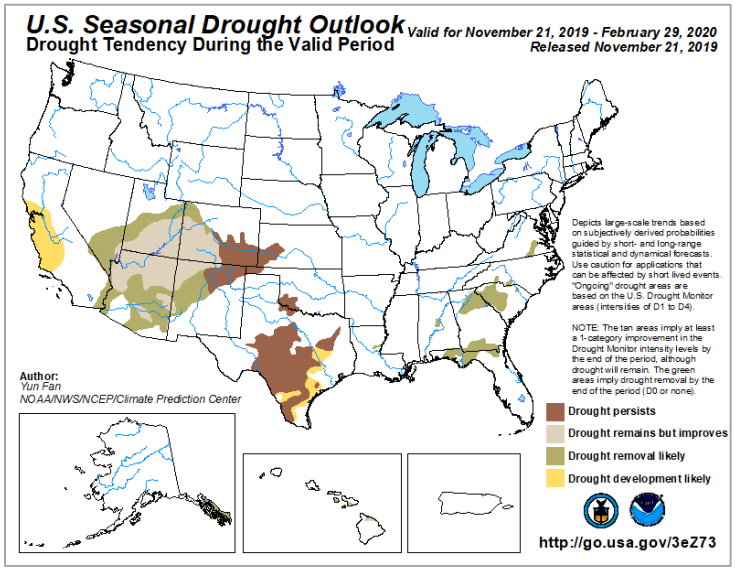


Outlooks

The Monthly Drought Outlook issued November 30, 2019 indicates drought conditions in southwest Kansas to persist. The Seasonal Outlook (3-month) favors a small area of drought in Kansas persisting in the mid-November through February period. The individual temperature and precipitation outlooks that contribute to these outlooks are available below.

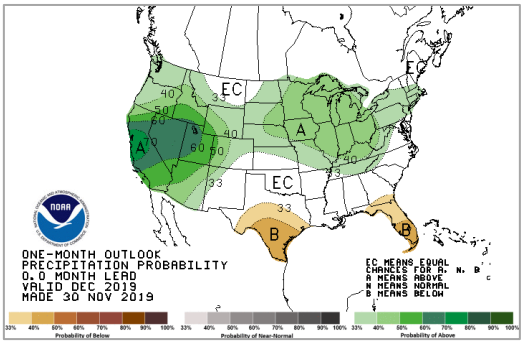
Figure 5. Drought Outlooks

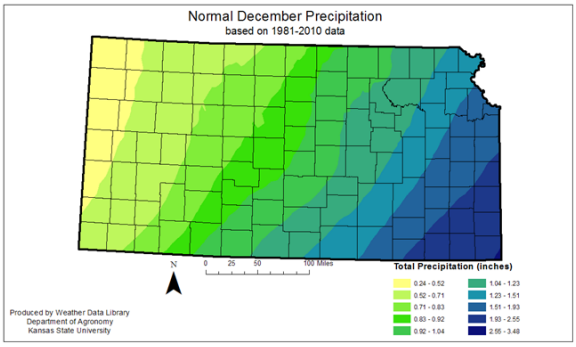


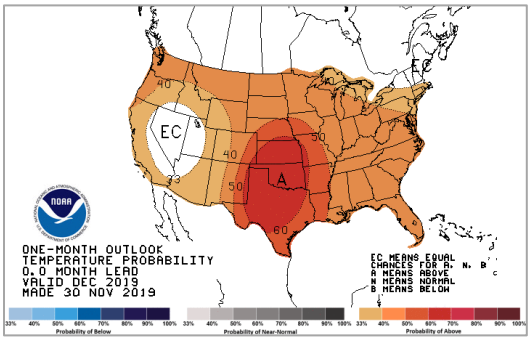


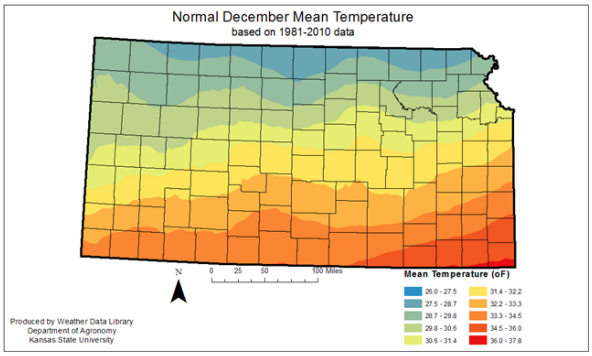
The monthly precipitation outlook has equal chances of below, near or above normal precipitation across most of western and southern Kansas with slightly increased chance of above normal precipitation favored across the northern parts of the state. The temperature outlook indicates equal chances of below, near and above normal temperatures across the state, with best chances of below normal temperatures to the east. One month outlooks are provided in Figure 6.

Figure 6. Next Month Precipitation and Temperature Outlooks



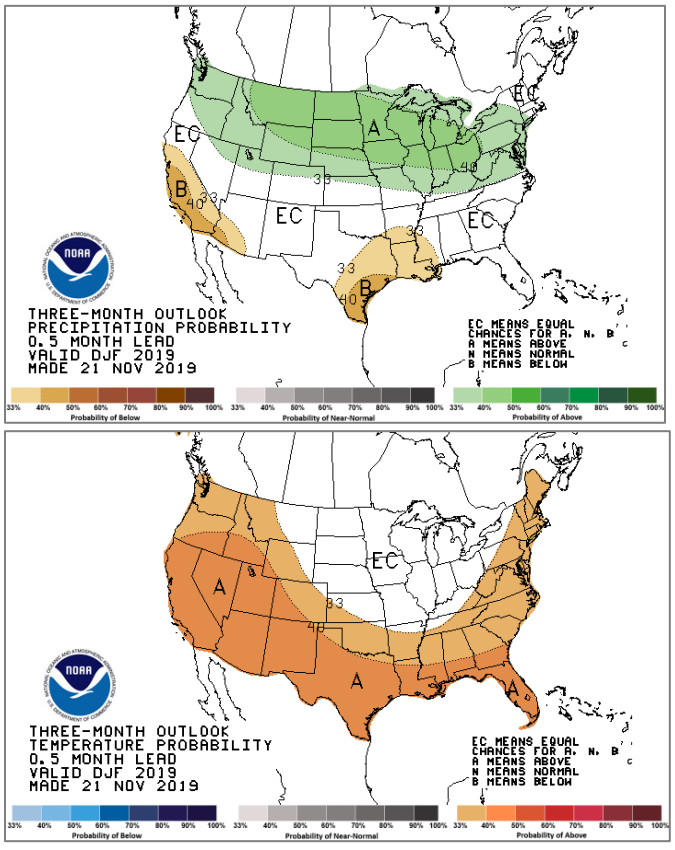


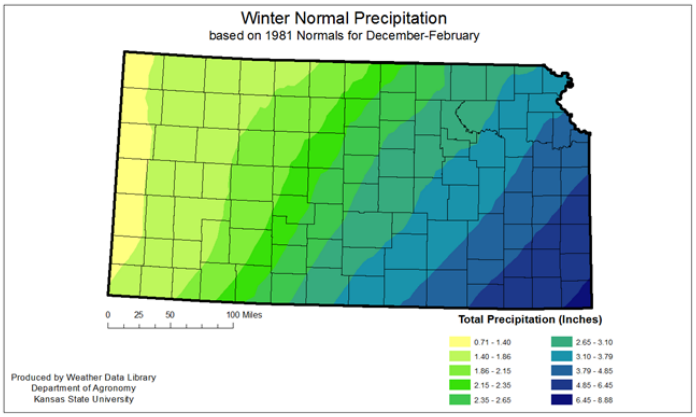




The U.S. three month outlook for December through February favors above-average precipitation (moderate chance) for only the northern edge of Kansas with equal chances of below, normal or above average precipitation for the majority of the state. Above normal temperatures are favored for southwest Kansas with equal chances of below, normal or above normal for the rest of the state.

Figure 7. Three Month Precipitation and Temperature Outlooks





Additional outlooks for various timeframes are available from the national CPC for up to 13 months. (http://www.cpc.ncep.noaa.gov/products/predictions/90day/)

Reservoir Storage

At the end of the month most reservoir conservation pools were full or almost full except Keith Sebelius, Cedar Bluff and Lovewell. Reservoir releases consider the entire Missouri basin system so releases continue in many locations to reduce flood pool storage accumulated from the above normal precipitation and runoff earlier in the year. Table 3 provides conservation pool status for each federal reservoir.

Table 3. Kansas Federal Reservoir Conservation Pool Levels

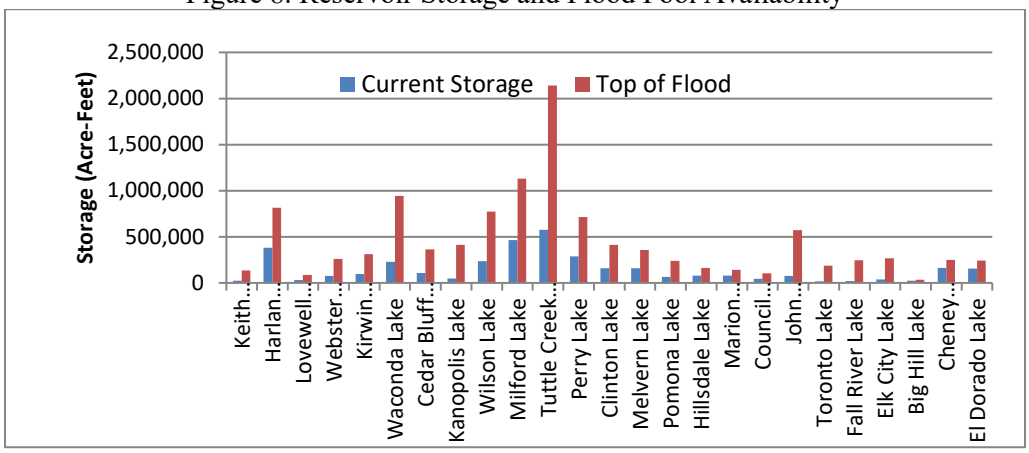
Reservoir	Top of Multipurpose / Conservation Pool (Feet MSL)	Multipurpose/Conservation Pool Elevation (Feet MSL)	Change from Top of Pool (Feet)	Percent of Conservation Pool Full
Kansas River Basin		**11/25/2019**		
Keith Sebelius Lake[1]	2304.3	2299.49	-4.81	72.6%
Harlan County Lake NE	1945.73	1950.44	4.71	100.0%
Lovewell Reservoir[1]	1582.6	1581.24	-1.36	89.0%
Webster Reservoir[1]	1892.45	1892.64	0.19	100.0%
Kirwin Reservoir	1729.25	1729.13	-0.12	99.4%
Waconda Lake[1]	1455.6	1456.33	0.73	100.0%
Cedar Bluff Reservoir	2144	2133.06	-10.94	62.5%
Kanopolis Lake[1]	1463	1462.45	-0.55	96.6%
Wilson Lake[1]	1516	1515.38	-0.62	97.7%
Milford Lake[1]	1144.4	1149.60	5.20	100.0%
Tuttle Creek Lake[1]	1075	1093.99	18.99	100.0%
Perry Lake[1]	891.5	898.58	7.08	100.0%
Clinton Lake[1]	875.5	880.65	5.15	100.0%
Melvern Lake[1]	1036	1037.24	1.24	100.0%
Pomona Lake[1]	974	976.19	2.19	100.0%
Hillsdale Lake[1]	917	917.74	0.74	100.0%
Arkansas River Basin		**11/25/2019**		
Marion Reservoir[1]	1350.5	78,301	-0.37	97.1%
Council Grove Lake[1]	1274	44,471	0.17	100.0%
John Redmond Reservoir	1041	75,054	0.82	100.0%
Toronto Lake	901.5	17,826	0.58	100.0%
Fall River Lake	948.5	20,967	0.13	100.0%
Elk City Lake	796	37,975	0.15	100.0%
Big Hill Lake	858	23,474	0.10	100.0%
Cheney Reservoir	1421.6	162,608	-0.47	97.3%
El Dorado Lake	1339	156,725	-0.25	98.8%

[1]Lake level management plan in place — Source: U.S. Army Corps of Engineers, U.S. Bureau of Reclamation and U.S. Geological Survey

Note: The conservation pool is the water storage for non-flood purposes of the reservoir, set by the elevation of the top of the pool.

In Figure 8 the blue bars indicate water in storage at that reservoir, with red bars indicate top of the flood pool storage. Some reservoirs have storage space remaining for flood flows but the available space varies.

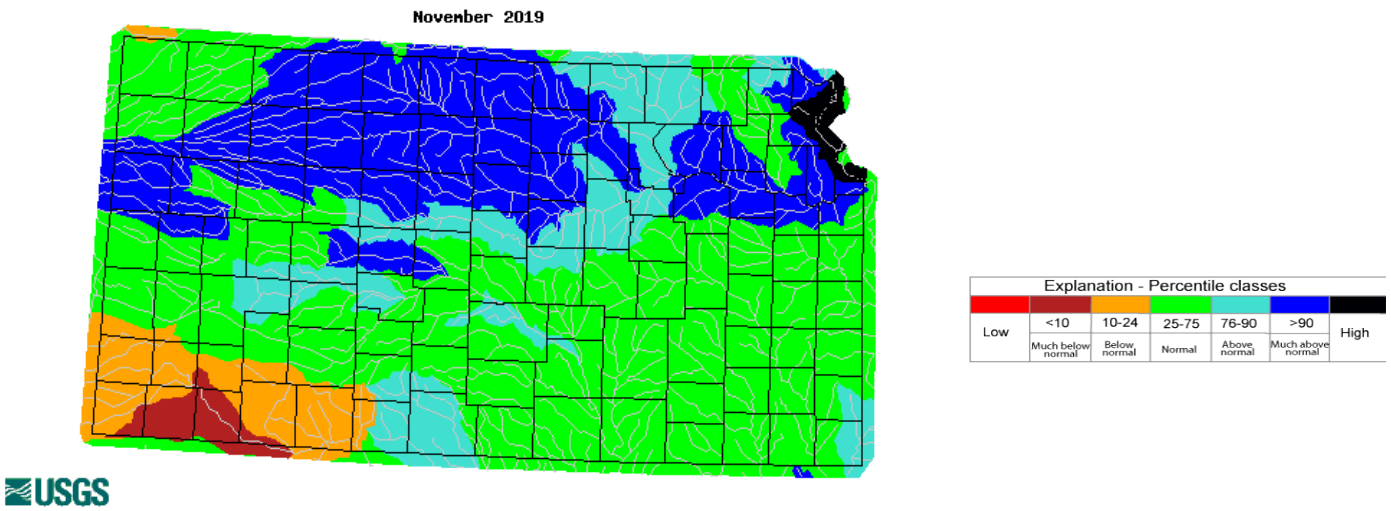
Figure 8. Reservoir Storage and Flood Pool Availability



Streamflow Conditions

WaterWatch summarizes streamflow conditions in a region (state or hydrologic unit) in terms of the long-term typical condition at stream gages in the region. In general, a streamflow which is greater than the 75 percentile is considered *above normal*, a streamflow which is between 25 and 75 percentiles is considered *normal* and a streamflow which is less than the 25 percentile is considered *below normal*. Color codes are for basins with streamflow averages less than 25 percent of historic values. This comparison aids in evaluating water resources conditions for a time period. A summary of flooding in is found later in this report. Figure 9 summarizes streamflow.

Figure 9. Monthly streamflow compared to historical streamflow



Minimum Desirable Streamflow: Low flows may be reflected at gage locations when the flow does not reach Minimum Desirable Streamflow (MDS). MDS requirements are in place to ensure base flows in certain streams to protect existing water rights and to meet in-stream water uses related to water quality, fish and wildlife and recreation. The Kansas Department of Agriculture, Division of Water Resources monitors 23 streams and rivers at 33 locations for minimum desirable streamflow. When flows drop below an established threshold, pumping restrictions are imposed on permits or water rights granted after the minimum desirable streamflow provision was made into law in 1984.

Although no water right administration was in effect in this month, the table below notes locations of concern including those below MDS.

Table 4.
Streamflows of Note

Gaging Station	Nov 4 Flow	Nov 12 Flow	Nov 18 Flow	Nov 25 Flow	Nov MDS	Comment
Rattlesnake Creek near Macksville	4.89	4	4.59	4.59	5	No surface water diversions junior to MDS above gage
South Fork Ninnescah River near Pratt	11	11	11	11	10	No surface water diversions junior to MDS above gage

General flooding for the month is shown in the USGS WaterWatch maps in the streamflow section of this report. However this does not provide all the specifics of severity of impacts and duration at specific locations. Additional flooding information can be found for USGS stream gage sites at https://waterwatch.usgs.gov/?m=flood&r=ks&w=flood%2Ctable for current stage.

Lake Safety

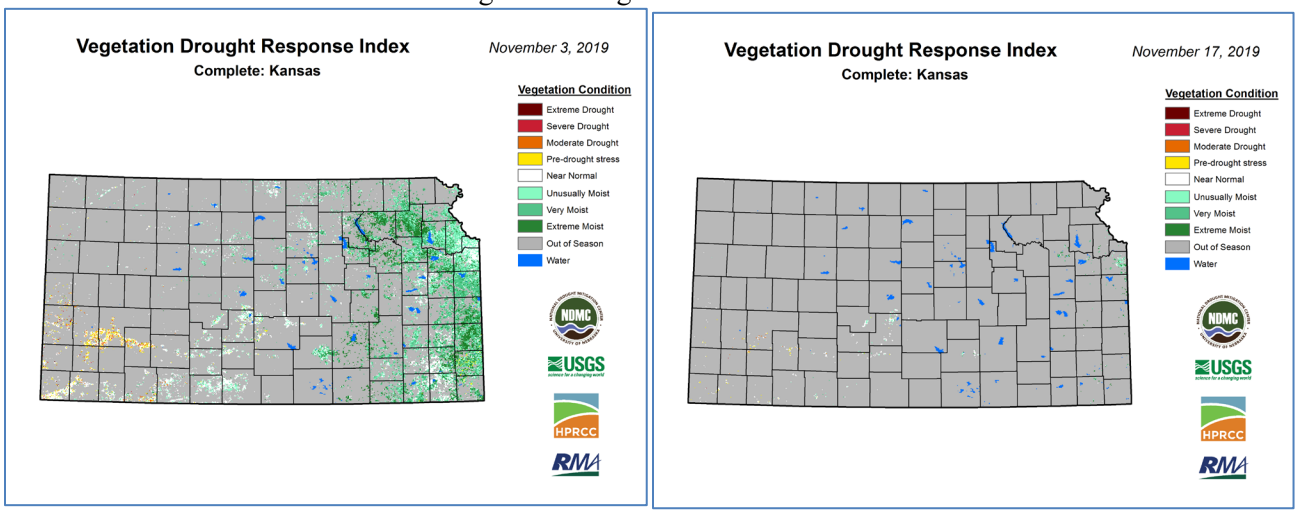
Harmful Blue-Green Algal Blooms (lake water safety)
KDHE samples public use lakes only in response to complaints of human or animal illness or visual sighting of possible blue-green algae by the public or lake officials. The season for harmful algal blooms (HABs) monitoring is April 1-October 31.

Lakes affected in the end of the season were Warnings for Elkhorn Lake, Jackson County; Jerry Ivey Pond, Saline County; Lake Jeanette, Leavenworth County; Lakewood Park Lake, Saline County and Watch for South Lake, Johnson County. More information can be found at http://www.kdheks.gov/algae-illness/index.htm.

Vegetation and Soil Moisture

Vegetative Conditions
The Vegetative Condition map depicts vegetation stress. It is produced using satellite data by the National Drought Mitigation Center https://vegdri.unl.edu/Home.aspx and often customized for Kansas by the Kansas Biological Survey in the GreenReport. Areas in yellow, orange and red indicate areas of vegetative stress. The green areas are considered to be in good or excellent condition (moist).

Figure 10. Vegetative Conditions

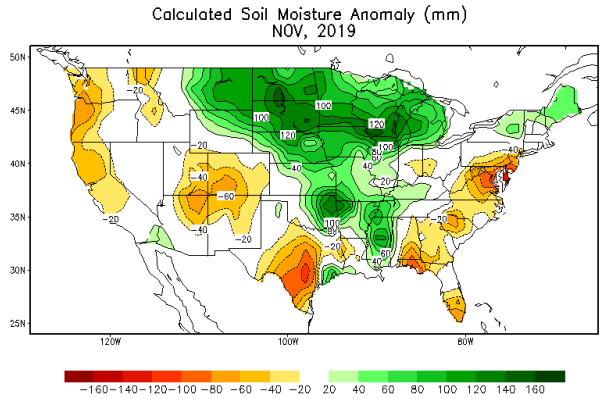


The Vegetation Drought Response Index (VegDRI) classified less than 1% of the land area as dry or in drought at the beginning of November, with 4% of Kansas near normal and 11% considered unusually, very or extremely moist. By mid-November the state was considered out of season for vegetation by the standards of this tool.

Soil Moisture and Rangeland

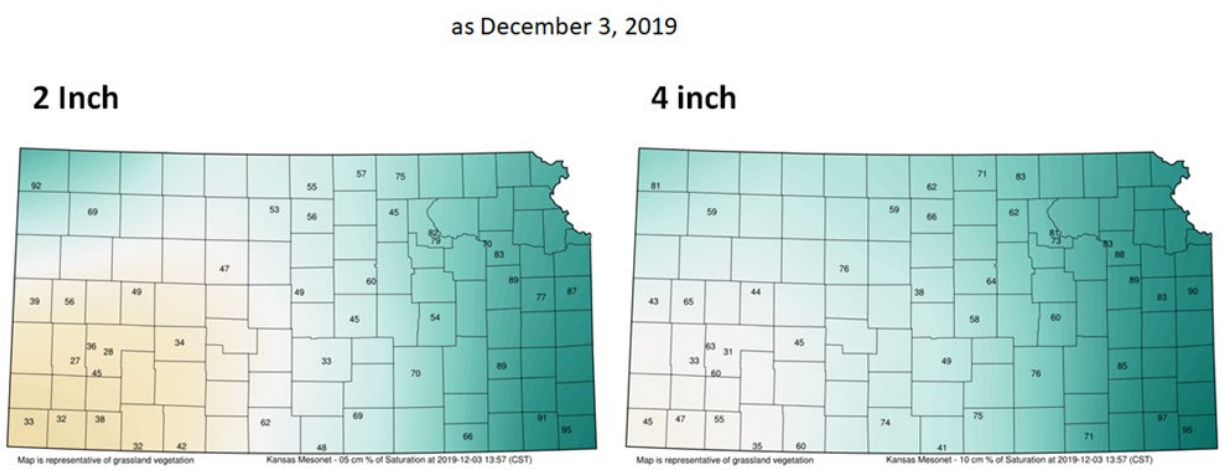
The Climate Prediction Center (CPC), monitors soil moisture and predicts future soil moisture. Anomalies are defined as deviations from the 1971-2000 monthly climatology. The monthly soil anomaly is shown in Figure 11. (.http://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml).

Figure 11.



Within Kansas soil moisture is now being measured through the Kansas Mesonet and Kansas State University the percent of soil saturation (representative of grassland vegetation) is shown in Figure 12. (http://mesonet.k-state.edu/agriculture/soilmoist/)

Figure 12. Percent of Soil Saturation



The National Agricultural Statistics Service, USDA Crop Progress and Condition provides a summary of the climatic effects on soil and crops. For the week ending December 1, 2019, topsoil moisture supplies 9 percent very short, 31 short, 57 adequate, and 3 surplus. Subsoil moisture supplies rated 8 percent very short, 28 short, 60 adequate, and 4 surplus.

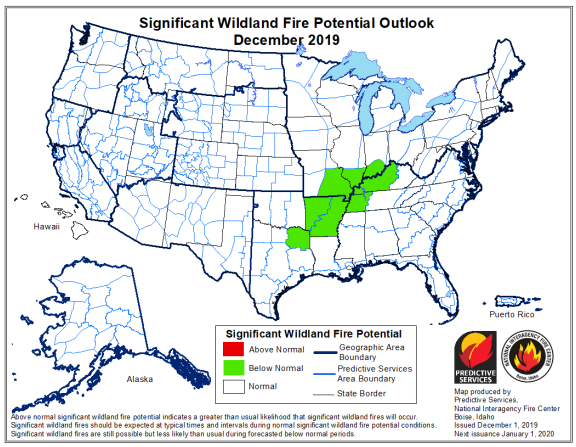
Field Crops Report:
Winter wheat condition rated 4 percent very poor, 12 poor, 38 fair, 39 good, and 7 excellent.
Pasture and range conditions rated 4 percent very poor, 10 poor, 29 fair, 51 good, and 6 excellent.

Fire

Fire activity increased in early November with grass fires in Cheyenne, Harvey, and Riley counties Nov. 3-13. The Cherry Creek Fire near St Francis. (Cheyenne Co) affected an estimated 10,000 acres.

The National Weather Service issues Red Flag Warnings when conditions favoring wildfire are at an increased risk. These are issued daily when needed. A Significant Wildland Fire Potential Outlook is issued monthly for the United States. Figure 13 is the most recent outlook for possible wildfires tor the next month. Additional forecasts can be found at https://www.predictiveservices.nifc.gov/outlooks/monthly_seasonal_outlook.pdf .

Figure 13. Wildfire Outlook



Disaster Designations

A total of 70 Kansas counties are now identified in Federal Emergency Declarations, DR-4449 due to storms, winds, tornadoes, flooding, landslides and mudslides. The President's action makes federal funding available to state, eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and repair or replacement of facilities in Allen, Anderson, Atchison, Barber, Barton, Bourbon, Brown, Butler, Chase, Chautauqua, Cherokee, Clark, Clay, Cloud, Coffey, Comanche, Cowley, Crawford, Dickinson, Doniphan, Douglas, Edwards, Elk, Ellsworth, Ford, Franklin, Geary, Gray, Greenwood, Harper, Harvey, Hodgeman, Jefferson, Kingman, Leavenworth, Lincoln, Linn, Lyon, Marion, Marshall, McPherson, Meade, Miami, Montgomery, Morris, Nemaha, Neosho, Ness, Osage, Osbourne, Ottawa, Pawnee, Phillips, Pottawatomie, Pratt, Reno, Rice, Riley, Rush, Russell, Saline, Smith, Sumner, Wabaunsee, Wallace, Washington, Wilson, Woodson and Wyandotte counties.

Federal funding is also available on a cost-sharing basis for hazard mitigation measures statewide. Some additional counties may be eligible for federal declaration and aid in the future once damage assessment is completed by FEMA.

Producers in 57 counties may be eligible for agricultural emergency loans as USDA has designated 25 counties as primary agricultural disaster areas for crop year 2019 due to flooding or excessive rain. Primary counties are Allen, Anderson, Atchison, Barton, Bourbon, Chase, Chautauqua, Cherokee, Cowley, Doniphan, Franklin, Gove, Johnson, Labette, Leavenworth, Linn, Lyon, Miami, Montgomery, Neosho, Osage, Wallace, Wilson, Woodson, Wyandotte. Additional, contiguous counties are: Brown, Butler, Coffey, Crawford, Douglas, Elk, Ellsworth, Graham, Greeley, Greenwood, Jackson, Jefferson, Johnson, Lane, Linn, Logan, Marion, Miami, Morris, Ness, Pawnee, Rice, Rush, Russell, Scott, Sedgwick, Shawnee, Sheridan, Sherman, Stafford, Sumner, Thomas, Trego, Wabaunsee, and Wichita.

The Additional Supplemental Appropriations for Disaster Relief Act of 2019 was signed into law by President Trump on June 6, 2019. Congress appropriated $3.005 billion in assistance for a wide array of losses resulting from disasters throughout 2018 and 2019, including loses related to prevented planting of insured crops in calendar year 2019. In Kansas, WHIP+ is available only for crops affected by flooding, snowstorm, tornado and wildfires. Eligible crops are those in a Secretary or President-declared disaster county, or those with COC-accepted documentation of the qualifying disaster event.

Kansas Climate Summary

The Kansas Weekly Climate Summary and Drought Report are compiled at least monthly, more frequently when conditions warrant, by the KWO. Information from various federal, state, local and academic sources is used. Some of the data is preliminary and subject to change once final data is available. The KWO web site, http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response , contains additional drought information including links to other agencies with drought information and past issues of the Kansas Climate Summary and Drought Report. Mary Knapp, at the Kansas Climate Office, Weather Data Library is the primary source of the narrative on weather. She works closely with meteorologists throughout the state and region. Details of current conditions at such as precipitation, temperature, evapotranspiration (ET), soil moisture and more are available at http://mesonet.k-state.edu/

RESOURCES and REFERENCES

Kansas climate data is provided by Kansas State University, Weather Data Library through the Kansas Mesonet. (http://www.ksre.k-state.edu/wdl/). Soil moisture data was added in 2018 (http://mesonet.k-state.edu/agriculture/soilmoist)

The U.S. Drought Monitor, from the National Drought Mitigation Center at the University of Nebraska-Lincoln, provides a "big picture" perspective of conditions across the nation. In the Kansas county drought stage scheme, a Drought Watch equates roughly to moderate drought in the U.S. Drought Monitor, while a Drought Warning is the equivalent of severe drought. A Drought Emergency is reserved for extreme or exceptional drought. Palmer Drought Severity Index - The Palmer Index (PDSI) is one indicator used in the U.S. Drought Monitor.

The High Plains Regional Climate Center (https://hprcc.unl.edu/) has precipitation and temperature summary maps available for the state, region and nation.

The U.S. Geological Survey (USGS) Drought Watch provides information average streamflow measured at long-term gaging stations and compares them to normal flows.

The Kansas Department of Agriculture-Division of Water Resources monitors stream flow using the USGS gages for determination of administrative needs. Administration may be needed due to Minimum Desirable Streamflow (MDS) requirements, impairments and reservoir release protection. (https://agriculture.ks.gov/divisions-programs/dwr/water-appropriation/minimum-desirable-streamflow.)

The water levels of the federal lakes fluctuate during a year according to the management plan. Lake level Management plans are posted on the Kansas Water Office web site www.kwo.ks.gov .

The Kansas Applied Remote Sensing Program (KARS) at the University of Kansas produces a Kansas Green Report each week during the growing season. For a full set of national and regional ***GreenReport***® maps, go to: http://www.kars.ku.edu/products/greenreport/greenreport.shtml. This Kansas Vegetation Drought Response Index map is developed weekly by the Kansas Biological Survey using state drought triggers as its key. In addition, the National Drought Mitigation Center also produces VegDRI maps which may be found at http://vegdri.unl.edu/.

The National Weather Service (NWS) provides fire weather products and services for Kansas that include the Rangeland Fire Danger Index, Fire Weather Forecasts, Red Flag Watches/Warnings and Spot Forecasts. The five NWS offices that serve Kansas websites may be accessed from the NWS Offices' page.

The Monthly and Seasonal Drought Outlooks, developed by the NOAA Climate Prediction Center, assess the likelihood for improvement, persistence or deterioration in drought conditions for areas currently experiencing drought as identified by the U.S. Drought Monitor. (http://www.cpc.ncep.noaa.gov/) Also see: http://www.noaa.gov/.

Responding to Drought: A Guide for City, County and Water System Officials provides an overview of Kansas county drought stage declarations, local planning and coordination, disaster declarations and available state and federal assistance. The 2007 Municipal Water Conservation Plan Guidelines and the Drought Vulnerability Assessment Report, both by KWO, provide guidance regarding drought preparedness and response. These are available at http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response.

USDA Drought Programs and Assistance website (https://www.usda.gov/topics/disaster/drought/usda-drought-programs-and-assistance) listing the various USDA programs and agencies to assist with drought issues.

The National Interagency Coordination Center in Boise, Idaho, produces wildfire potential outlook maps monthly. (https://www.predictiveservices.nifc.gov/outlooks/outlooks.htm)

Please contact Diane Knowles at the Kansas Water Office (785) 296-3185 or diane.knowles@kwo.ks.gov should you have any questions or suggestions.

APPENDIX A
Monthly Weather Summary

November Summary

Station[1]	Precipitation (inches)			Temperature °F			
						Extreme (Date)	
	Total	Departure[2]	Percent Normal	Mean	Departure[2]	Highest	Lowest
West							
Burlington, CO	0.03	-0.56	5%	38.7	0.5	77 (9)	2 (12)
Dodge City	0.20	-0.56	26%	42.5	-0.6	79 (9)	4 (12)
Garden City	0.21	-0.34	38%	39.8	-1.9	78 (9)	-1 (12)
Goodland	0.75	0.04	106%	38.0	-1.0	77 (9)	3 (11)
Guymon, OK	0.41	-0.12	77%	43.8	-1.8	81 (9)	2 (12)
Hill City	0.62	-0.33	65%	39.7	-1.0	81 (9)	1 (12)
Lamar, CO	0.18	-0.20	47%	38.5	-1.5	77 (9)	2 (12)
McCook, NE	0.48	-0.47	51%	38.0	-0.2	82 (9)	0 (12)
Springfield, CO	0.34	-0.24	59%	39.6	-2.1	76 (9)	1 (12,11)
Central							
Concordia	0.56	-0.55	50%	42.2	0.6	78 (9)	6 (12)
Hebron, NE				39.4	0.0	76 (9)	2 (12)
Medicine Lodge	0.56	-0.37	60%	43.0	-2.4	76 (18)	4 (12)
Ponca City, OK	0.59	-1.22	33%	45.8	-1.9	75 (18)	12 (12)
Salina	0.61	-0.64	49%	41.3	-2.6	78 (9)	3 (12)
Wichita (ICT)	0.64	-0.79	45%	43.7	-1.7	74 (18)	8 (12)
East							
Bartlesville, OK	2.24	-0.44	84%	44.8	-3.2	76 (10)	13 (12)
Chanute	0.87	-1.63	35%	44.2	-2.1	71 (10)	11 (12)
Falls City, NE	0.55	-1.41	28%	39.2	-1.8	79 (9)	3 (12)
Johnson Co. Exec. Apt	1.17	-1.32	47%	40.6	-3.4	68 (20)	7 (12)
Joplin, MO	2.54	-1.24	67%	44.5	-3.9	73 (10)	11 (12)
Kansas City (MCI), MO	0.93	-1.22	43%	40.8	-2.8	68 (20)	8 (12)
St. Joseph, MO	0.35	-1.20	23%	39.1	-2.8	66 (20,9)	5 (12)
Topeka (TOP)	1.22	-0.63	66%	41.6	-2.2	73 (9)	8 (12)

1. Airport Automated Observation Stations (NWS/FAA)
2. Departure from 1981-2010 normal value

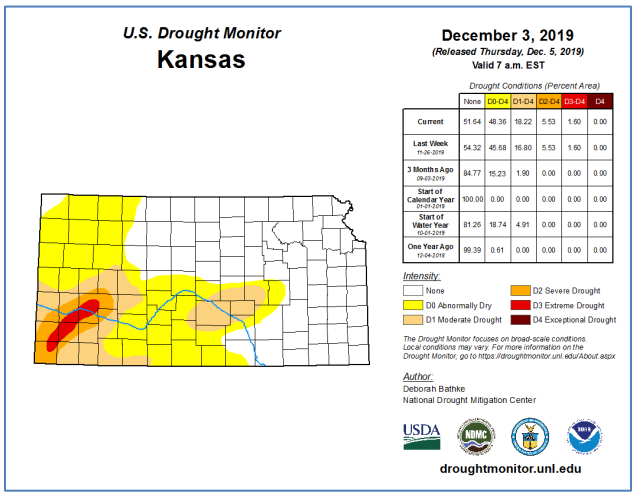
T - Trace; M - Missing; --- no normal value from which to calculate departure or percent of normal

Source: National Weather Service F-6 Climate Summaries

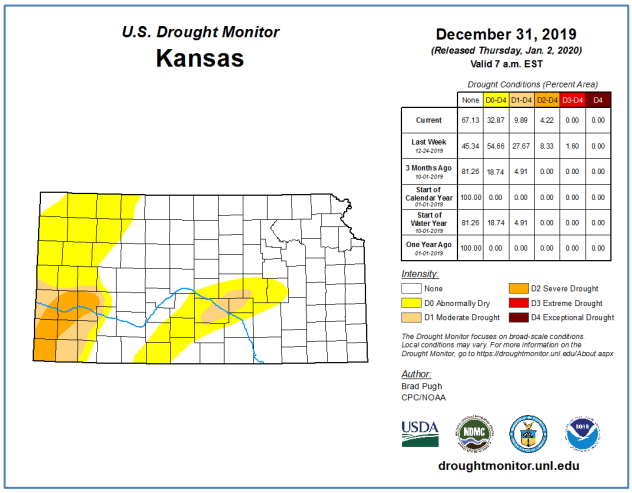
KANSAS CLIMATE UPDATE
December 2019 Summary

Highlights

- U.S. Drought Monitor indicated continuing and expanding areas of abnormally dry (D0), moderate drought (D1), severe drought (D2) and moderate drought (D3) in western and south central Kansas conditions though December however, the wet end to the month allowed for improvement in the drought conditions.



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	51.64	48.36	18.22	5.53	1.60	0.00
Last Week 11-26-2019	54.32	45.68	16.80	5.53	1.60	0.00
3 Months Ago 09-03-2019	84.77	15.23	1.90	0.00	0.00	0.00
Start of Calendar Year 01-01-2019	100.00	0.00	0.00	0.00	0.00	0.00
Start of Water Year 10-01-2019	81.26	18.74	4.91	0.00	0.00	0.00
One Year Ago 12-04-2018	99.39	0.61	0.00	0.00	0.00	0.00



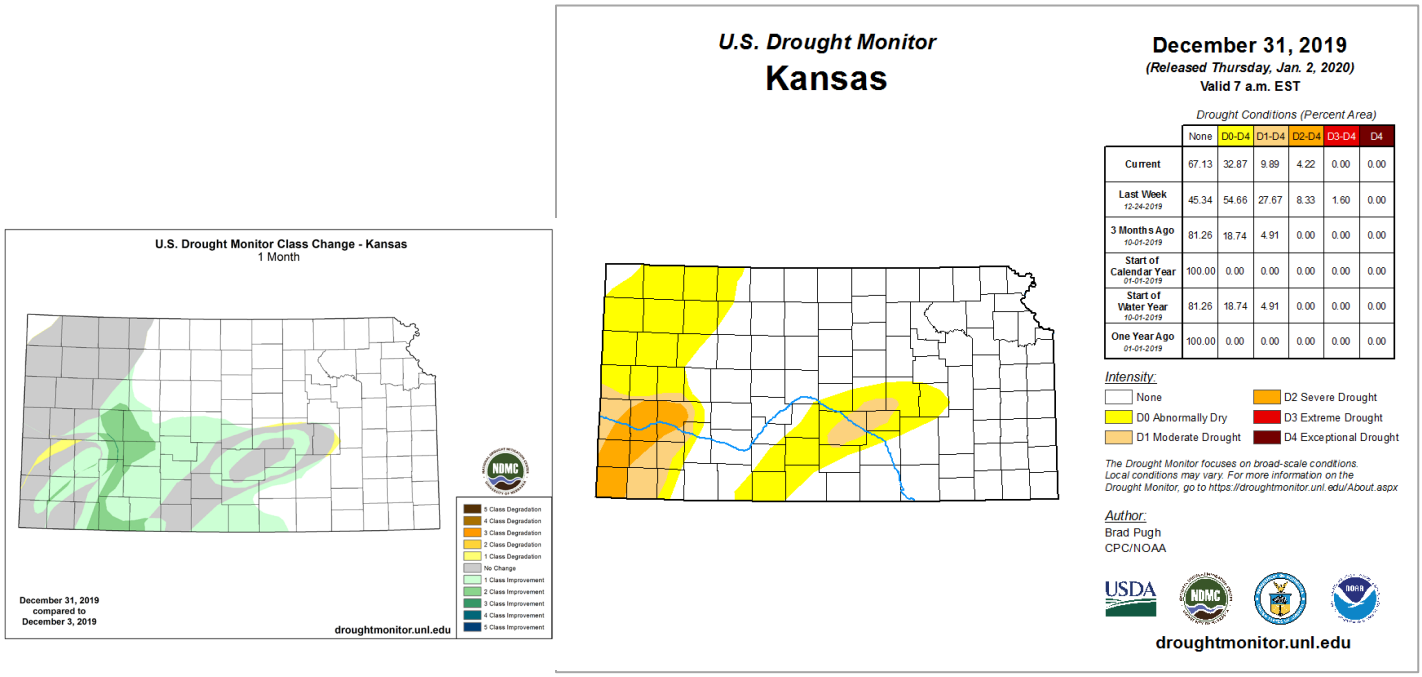
	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	67.13	32.87	9.89	4.22	0.00	0.00
Last Week 12-24-2019	45.34	54.66	27.67	8.33	1.60	0.00
3 Months Ago 10-01-2019	81.26	18.74	4.91	0.00	0.00	0.00
Start of Calendar Year 01-01-2019	100.00	0.00	0.00	0.00	0.00	0.00
Start of Water Year 10-01-2019	81.26	18.74	4.91	0.00	0.00	0.00
One Year Ago 01-01-2019	100.00	0.00	0.00	0.00	0.00	0.00

- KSU ranks December 2019 as the 28th wettest, and 15th warmest December in Kansas.
- Statewide average precipitation for December was 1.27 inches, 123% or normal
- December set 40 records for daily snowfall, with as much as 9 inches
- Kansas average temperature in 2019 was ranked overall as the 72nd warmest year (54th coolest) by NOAA. (NOAA National Centers for Environmental information, Climate at a Glance: Statewide Time Series, published January 2020, retrieved on January 14, 2020 from https://www.ncdc.noaa.gov/cag/)
- Kansas average precipitation in 2019 was ranked overall as the 5th wettest year (121st driest) by NOAA. (NOAA National Centers for Environmental information, Climate at a Glance: Statewide Time Series, published January 2020, retrieved on January 14, 2020 from https://www.ncdc.noaa.gov/cag/)
- Drought Outlook favors drought continuing for the current area of drought in extreme western Kansas, with equal chances of below, near or above normal temperatures and precipitation likely in January for all of the state.

General Drought Conditions

The U.S. Drought Monitor indicated dry and drought conditions in parts of western and central Kansas throughout the month. These drought conditions expanded and intensified in parts of South Central and Southwest Kansas before improving some at the end of the month. The condition at the end of the month is shown below in Figure 1. Change in drought classification over the month is also shown.

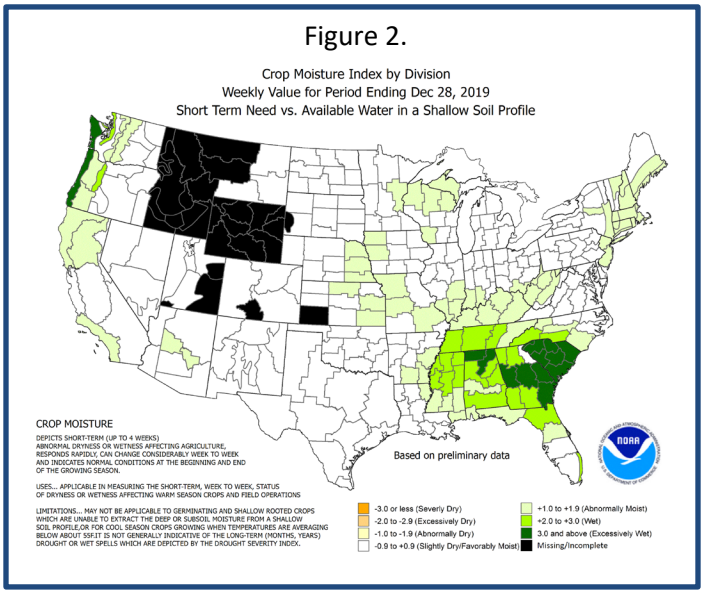
Figure 1. U.S. Drought Monitor Maps of Drought status



More information can be found on the U.S. Drought Monitor web site https://droughtmonitor.unl.edu/ .

Palmer Drought Severity Index (PDSI) - The Palmer Drought Severity Index is an indicator of relative dryness or wetness and is one factor used the U.S. Drought Monitor. The Crop Moisture (Figure 2) component evaluates short term needs and available water. More information on the PDSI and its parts can be found at http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml.

Figure 2.



Climate Summary - Precipitation

December was wetter than normal. Statewide average precipitation for the month was 1.27 inches, 123 percent of normal. This ranks as the 28th wettest December in the 125-year record by KSU-Weather Data Library. The North Central Climate Division had the greatest percent of normal, with a divisional average of 1.54 inches, 176 percent of normal. The Central Division had the highest average amount, with an average of 1.55 inches, 167 percent of normal. The highest 24-hour rainfall total for a National Weather Service Cooperative station was 2.21 inches at Girard, Crawford County, on the 29th. The greatest 24-hour rainfall total for a Community Collaborative Rain, Hail and Snow network station was 2.66 inches at Hays 5.6 N. Ellis County on the 28th. The greatest monthly precipitation totals for December: 2.73 inches at Sylvan Grove, Lincoln County (NWS); 2.66 inches at Hays 5.6 N. Ellis County (CoCoRaHS). Table 1 summarizes the monthly precipitation (KSU Weather Data Library).

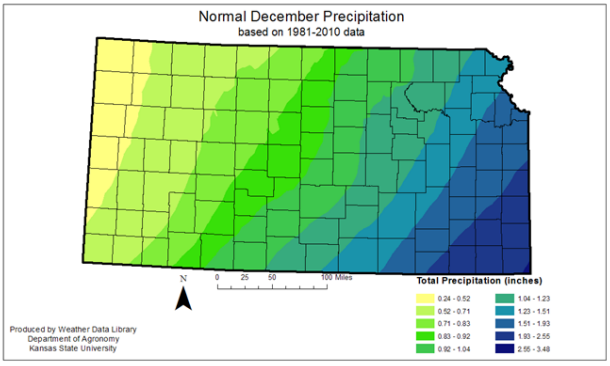
Table 1.

Kansas Climate Division Precipitation Summary (inches)

Climate Division	December 1 - 31, 2019			January 1 – December 31, 2019			April 1, 2019 – December 31, 2019			Sept 1, 2018 – December 31, 2019		
	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal
Northwest	0.44	-0.13	77	24.08	2.72	113	21.72	2.66	114	2.75	-1.72	62
West Central	0.91	0.28	144	22.23	1.46	107	18.94	0.67	104	2.8	-1.67	63
Southwest	1.13	0.46	169	19.89	-0.01	100	16.6	-0.92	95	2.48	-1.98	56
North Central	1.54	0.65	173	34.28	6.24	122	30.64	6.08	125	6.01	-0.72	89
Central	1.55	0.62	167	34.54	5.25	118	30.77	5.43	121	5.03	-1.78	74
South Central	1.38	0.26	123	40.04	8.72	128	36.03	9.33	135	7.43	-0.42	95
Northeast	1.26	0.04	103	44.36	9.36	127	39.12	8.33	127	7.69	-1.65	82
East Central	1.53	0.13	109	46.08	8.16	122	40.7	7.7	123	7.46	-2.85	72
Southeast	1.49	-0.33	82	57.40	15.91	138	51.47	15.97	145	11.14	-0.95	92
STATE	1.27	0.24	123	35.81	6.42	122	31.72	6.18	124	5.89	-1.50	80

The maps of Figure 3 below summarize precipitation for the month. (State maps by KSU are based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)

Figure 3. Monthly Precipitation maps



Climate Summary-Temperature

Temperatures for December were warmer than normal. Statewide average temperature for the month was 36.0 ºF, which is 4.7 degrees warmer than normal. This ranks as the 15th warmest December on record by KSU-Weather Data Library. The East Central Climate Division had the greatest departure with an average of 36.7 ºF, 5.2 degrees warmer than normal. The Northwest Division was the warmest, with an average of 32.7 ºF, 4.2 degrees warmer than normal. Even with the warmer pattern, all divisions saw lows in the 10-degree and cooler range. The warmest maximum temperature was 75 ºF at 75 oF at Elkhart, Morton County, on the 24th. The coldest minimum temperature was 1 ºF at Hill City 1E, Graham County, on the 7th. There were 27 daily record high maximum temperatures and 28 daily record high minimum temperatures. There were no new record low maximum or minimum temperature. Table 2 summarizes the monthly temperatures (KSU Weather Data Library).

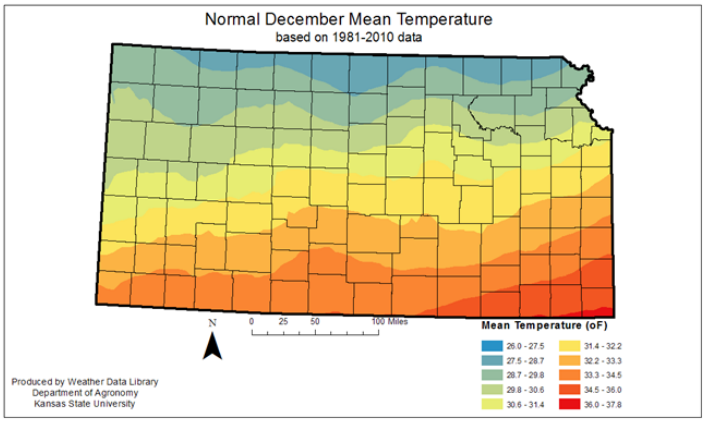
Table 2.

Climate Division	Kansas Climate Division Temperature Summary (ºF) December 2019							
	Maximum	Minimum	Average	Departure*	High	Date	Low	Date
Northwest	46.4	20.1	33.2	4.2	74	23	1	7
West Central	48.9	21.2	35.0	4.5	71	24	8	17
Southwest	51.8	22.2	37.0	4.3	75	24	8	17
North Central	45.6	23.1	34.3	4.9	64	23	7	17
Central	48.2	23.9	36.0	4.6	68	7	4	17
South Central	50.2	25.7	37.9	4.6	70	26	10	17
Northeast	45.3	24.0	34.7	4.8	66	26	9	18
East Central	47.2	26.3	36.7	5.2	67	26	7	18
Southeast	49.8	28.3	39.1	5.0	71	26	6	17
STATE	48.2	23.9	36.0	4.7	75	24th	1	7th

*Departure from normal is departure from the base period of 1981-2010, KSU Weather Data Library.

The maps in Figure 4 below summarize temperature for the month. (State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.) Some maps obtained from the High Plains Regional Climate Center, ACIS system.

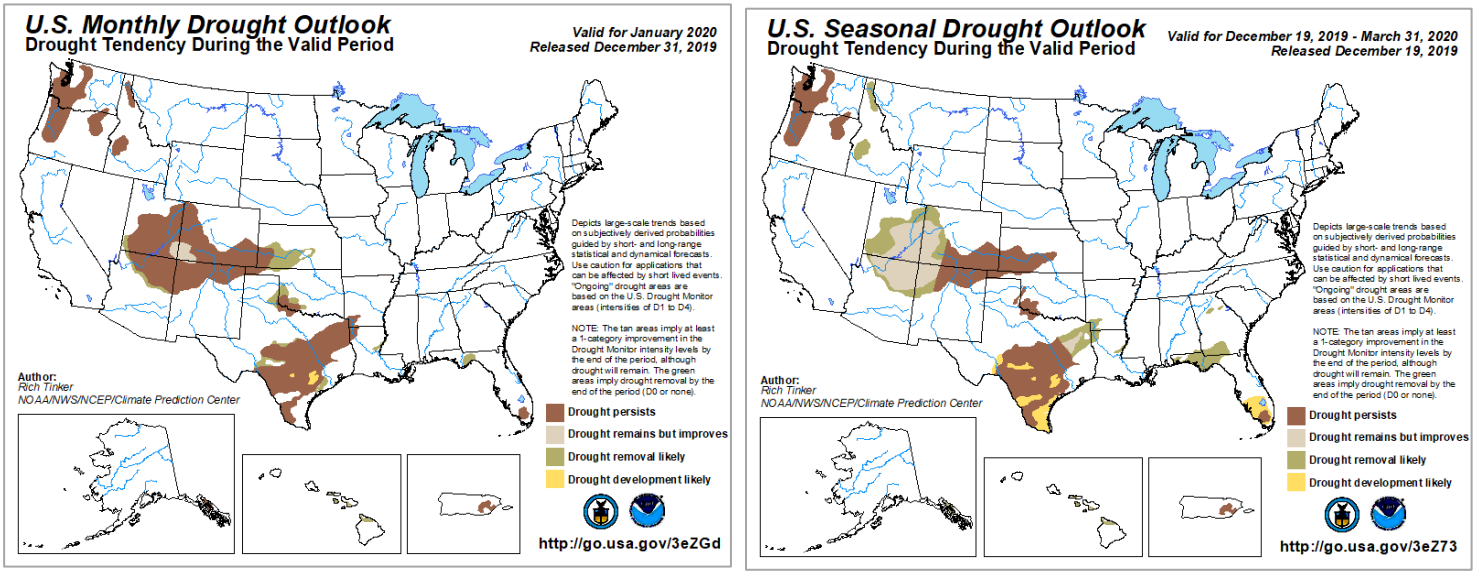
Figure 4. Monthly Temperature Maps



Outlooks

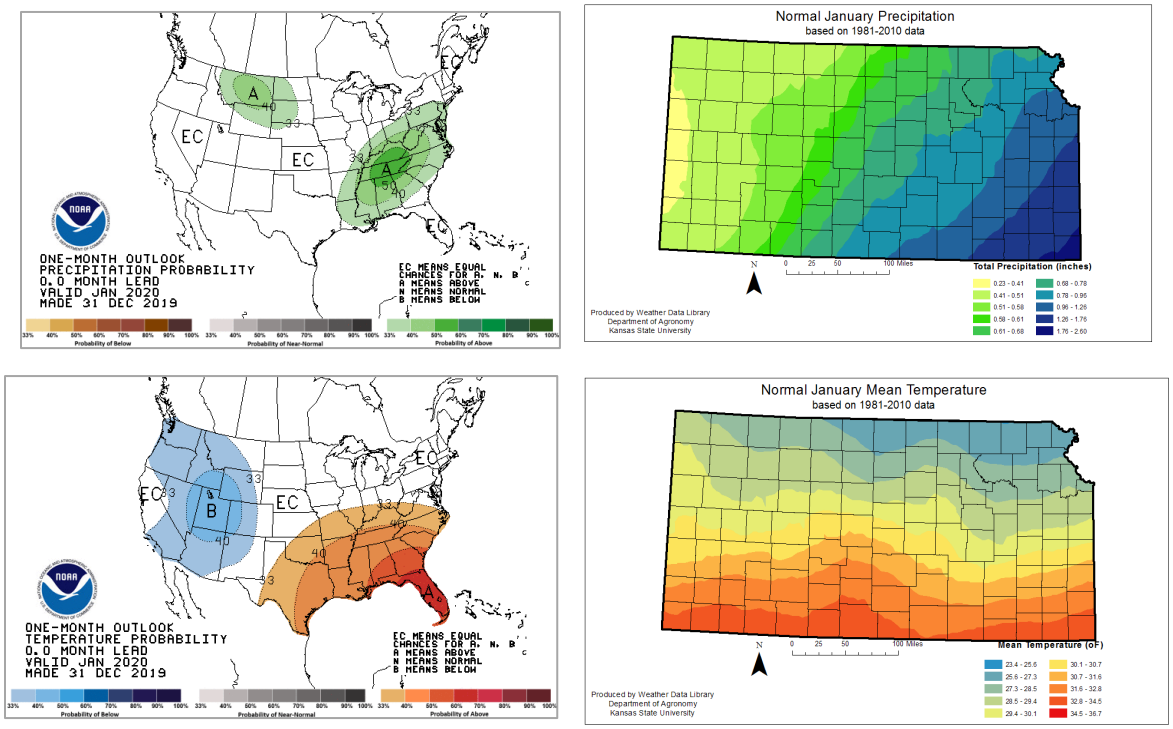
The Monthly Drought Outlook issued December 31, 2019 indicates drought conditions in southwest Kansas to persist, with removal likely moving slightly eats into south central Kansas. The Seasonal Outlook (3-month) favors the area of drought in Kansas persisting in the late-December through March period. The individual temperature and precipitation outlooks that contribute to these outlooks are available below.

Figure 5. Drought Outlooks



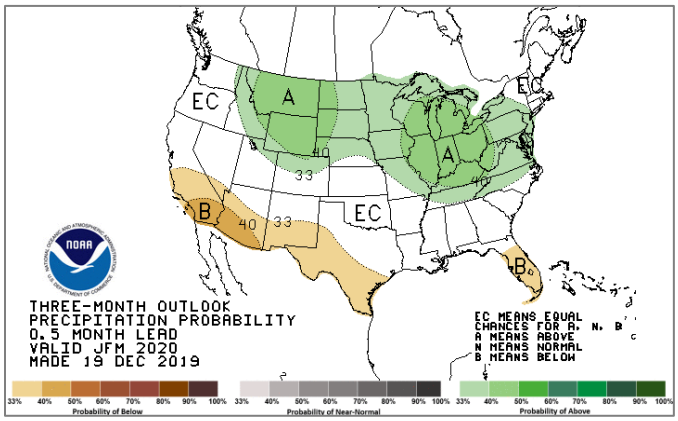
The monthly precipitation outlook has equal chances of below, near or above normal precipitation across all of Kansas. The temperature outlook indicates equal chances of below, near and above normal temperatures across the state, except for the south east where above normal is favored. One month outlooks are provided in Figure 6.

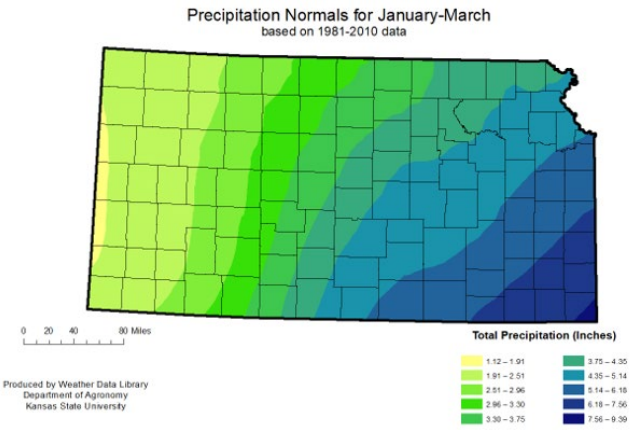
Figure 6. Next Month Precipitation and Temperature Outlooks

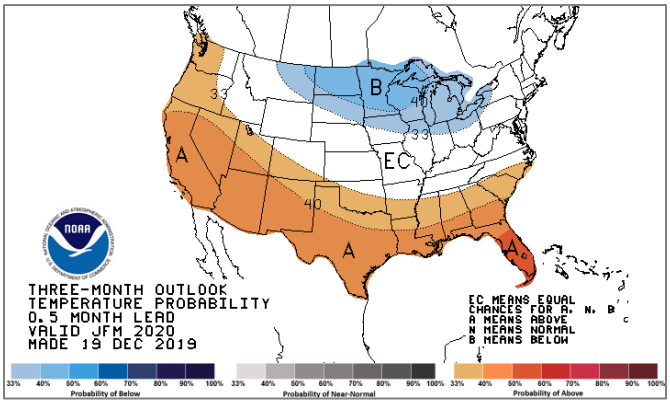


The U.S. three month outlook for January through March suggests equal chances of above, normal or below -average precipitation and temperatures for the state.

Figure 7. Three Month Precipitation and Temperature Outlooks







Additional outlooks for various timeframes are available from the national CPC for up to 13 months. (http://www.cpc.ncep.noaa.gov/products/predictions/90day/)

Reservoir Storage

At the end of the month most reservoir conservation pools were full or almost full except Keith Sebelius, Cedar Bluff and Lovewell. Reservoir releases consider the entire Missouri basin system so releases continue in many locations to reduce flood pool storage accumulated from the above normal precipitation and runoff earlier in the year. Table 3 provides conservation pool status for each federal reservoir.

Table 3. Kansas Federal Reservoir Conservation Pool Levels

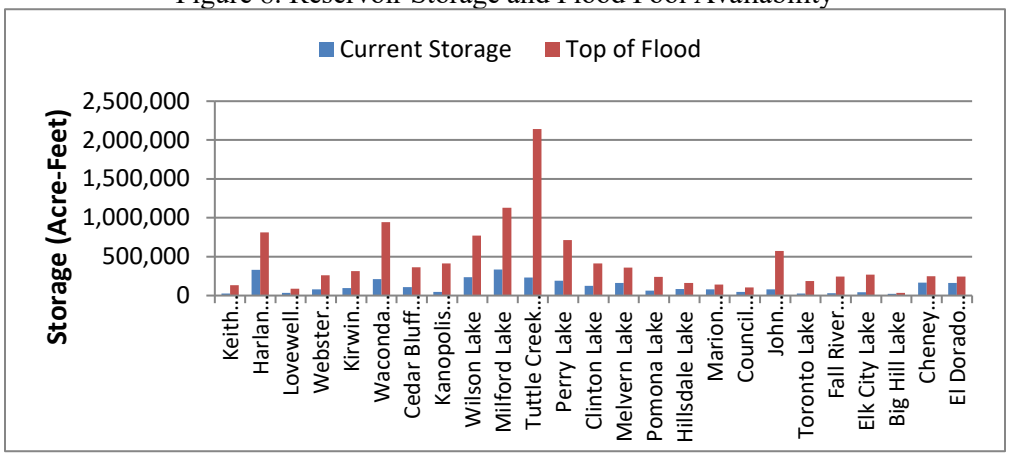
Reservoir	Top of Multipurpose / Conservation Pool (Feet MSL)	Multipurpose/Conservation Pool Elevation (Feet MSL)	Change from Top of Pool (Feet)	Percent of Conservation Pool Full
Kansas River Basin		**12/30/2019**		
Keith Sebelius Lake[1]	2304.3	2299.93	-4.37	74.8%
Harlan County Lake NE	1945.73	1946.95	1.22	100.0%
Lovewell Reservoir[1]	1582.6	1582.65	0.05	100.0%
Webster Reservoir[1]	1892.45	1892.99	0.54	100.0%
Kirwin Reservoir	1729.25	1729.27	0.02	100.0%
Waconda Lake[1]	1455.6	1455.06	-0.54	96.9%
Cedar Bluff Reservoir	2144	2133.49	-10.51	63.7%
Kanopolis Lake[1]	1463	1462.59	-0.41	97.5%
Wilson Lake[1]	1516	1515.45	-0.55	98.0%
Milford Lake[1]	1144.4	1141.78	-2.62	89.6%
Tuttle Creek Lake[1]	1075	1072.76	-2.24	90.9%
Perry Lake[1]	891.5	890.55	-0.95	95.2%
Clinton Lake[1]	875.5	876.59	1.09	100.0%
Melvern Lake[1]	1036	1037.52	1.52	100.0%
Pomona Lake[1]	974	976.14	2.14	100.0%
Hillsdale Lake[1]	917	918.61	1.61	100.0%
Arkansas River Basin		**12/30/2019**		
Marion Reservoir[1]	1350.5	1350.32	-0.18	98.6%
Council Grove Lake[1]	1274	1274.92	0.92	100.0%
John Redmond Reservoir	1041	1042.36	1.36	100.0%
Toronto Lake	901.5	905.51	4.01	100.0%
Fall River Lake	948.5	951.87	3.37	100.0%
Elk City Lake	796	797.13	1.13	100.0%
Big Hill Lake	858	858.48	0.48	100.0%
Cheney Reservoir	1421.6	1421.51	-0.09	99.5%
El Dorado Lake	1339	1339.18	0.18	100.0%

[1]Lake level management plan in place — Source: U.S. Army Corps of Engineers, U.S. Bureau of Reclamation and U.S. Geological Survey

Note: The conservation pool is the water storage for non-flood purposes of the reservoir, set by the elevation of the top of the pool.

In Figure 8 the blue bars indicate water in storage at that reservoir, with red bars indicate top of the flood pool storage. Some reservoirs have storage space remaining for flood flows but the available space varies.

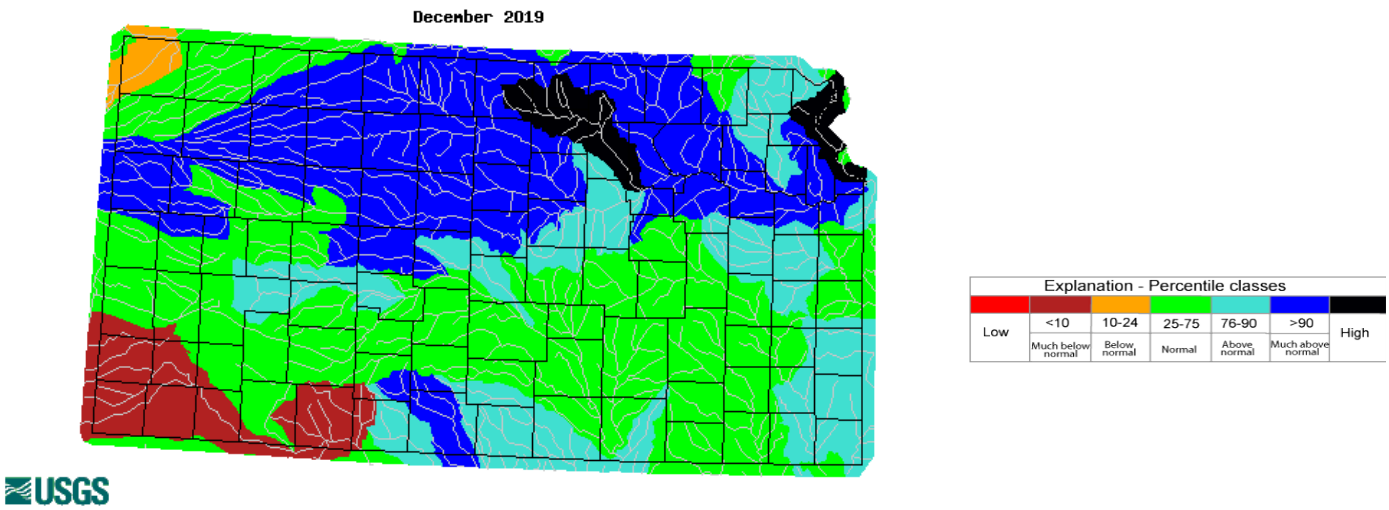
Figure 8. Reservoir Storage and Flood Pool Availability



Streamflow Conditions

WaterWatch summarizes streamflow conditions in a region (state or hydrologic unit) in terms of the long-term typical condition at stream gages in the region. In general, a streamflow which is greater than the 75 percentile is considered *above normal*, a streamflow which is between 25 and 75 percentiles is considered *normal* and a streamflow which is less than the 25 percentile is considered *below normal*. Color codes are for basins with streamflow averages less than 25 percent of historic values. This comparison aids in evaluating water resources conditions for a time period. A summary of flooding in is found later in this report. Figure 9 summarizes streamflow.

Figure 9. Monthly streamflow compared to historical streamflow



Minimum Desirable Streamflow: Low flows may be reflected at gage locations when the flow does not reach Minimum Desirable Streamflow (MDS). MDS requirements are in place to ensure base flows in certain streams to protect existing water rights and to meet in-stream water uses related to water quality, fish and wildlife and recreation. The Kansas Department of Agriculture, Division of Water Resources monitors 23 streams and rivers at 33 locations for minimum desirable streamflow. When flows drop below an established threshold, pumping restrictions are imposed on permits or water rights granted after the minimum desirable streamflow provision was made into law in 1984.

Although no water right administration was in effect in this month, the table below notes locations of concern including those below MDS.

Table 4.
Streamflows of Note

Gaging Station	Dec 2 Flow	Dec 9 Flow	Dec 16 Flow	Dec 23 Flow	Dec 30 Flow	Dec MDS	Comment
Rattlesnake Creek near Macksville	6.27	5.97	5.8	6	6.5	5	No surface water diversions junior to MDS above gage
Rattlesnake Creek near Zenith	19	18	19	18	29.3	15	
South Fork Ninnescah River near Pratt	12.2	12.4	12.4	12	13.3	10	No surface water diversions junior to MDS above gage

Lake Safety

Harmful Blue-Green Algal Blooms (lake water safety)
KDHE samples public use lakes only in response to complaints of human or animal illness or visual sighting of possible blue-green algae by the public or lake officials. The season for harmful algal blooms (HABs) monitoring is April 1-October 31.

Lakes affected in the end of the season were Warnings for Elkhorn Lake, Jackson County; Jerry Ivey Pond, Saline County; Lake Jeanette, Leavenworth County; Lakewood Park Lake, Saline County and Watch for South Lake, Johnson County. More information can be found at http://www.kdheks.gov/algae-illness/index.htm.

Vegetation, Soil Moisture and Crops

Vegetative Conditions
The Vegetative Condition map depicts vegetation stress. It is produced using satellite data by the National Drought Mitigation Center https://vegdri.unl.edu/Home.aspx and often customized for Kansas by the Kansas Biological Survey in the GreenReport. December is out of season for the vegetative conditions, so is not part of this report.

Soil Moisture and Rangeland
The Climate Prediction Center (CPC), monitors soil moisture and predicts future soil moisture. Anomalies are defined as deviations from the 1971-2000 monthly climatology. The monthly soil anomaly is shown in Figure 10. (.http://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml).

Within Kansas soil moisture is now being measured through the Kansas Mesonet and Kansas State University the percent of soil saturation (representative of grassland vegetation) is shown in Figure 10. (http://mesonet.k-state.edu/agriculture/soilmoist/)

Figure 10.

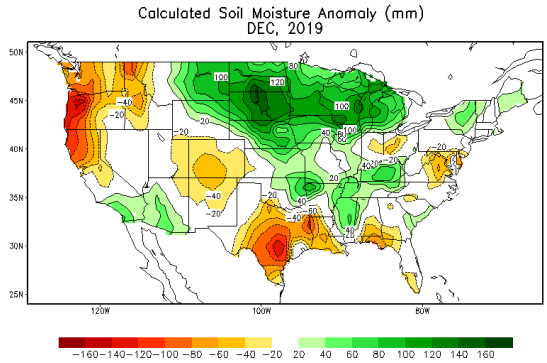
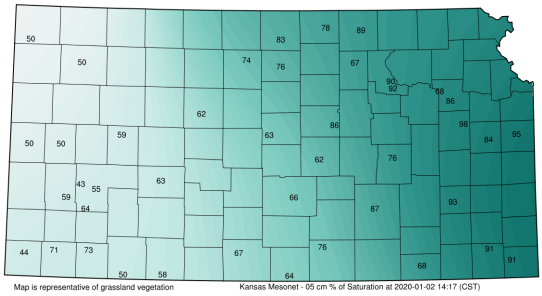
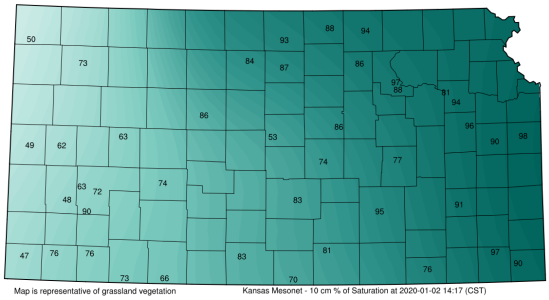


Figure 11. Percent of Soil Saturation as of January 1, 2020

5 cm (2 inch)



10 cm (4 inch)



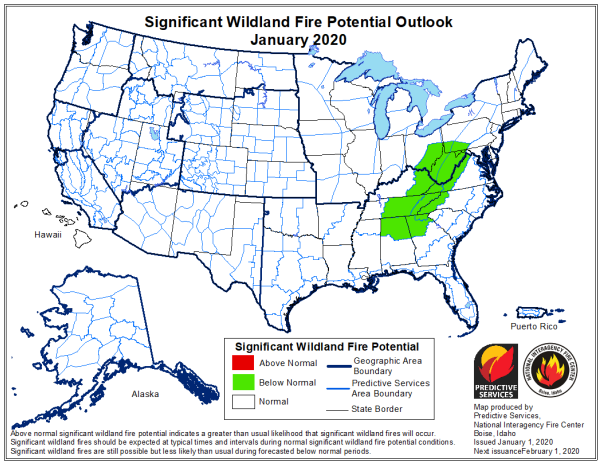
The National Agricultural Statistics Service, USDA Crop Progress and Condition provides a summary of the climatic effects on soil and crops. For the month of December 2019, topsoil moisture supplies rated 9 percent very short, 31 short, 56 adequate, and 4 surplus, according to the USDA's National Agricultural Statistics Service. Subsoil moisture supplies rated 10 percent very short, 28 short, 60 adequate, and 2 surplus.

Field Crops Report:
Winter wheat condition rated 5 percent very poor, 16 poor, 39 fair, 36 good, and 4 excellent.

Fire

The National Weather Service issues Red Flag Warnings when conditions favoring wildfire are at an increased risk. These are issued daily when needed. A Significant Wildland Fire Potential Outlook is issued monthly for the United States. Figure 12 is the most recent outlook for possible wildfires tor the next month. Additional forecasts can be found at https://www.predictiveservices.nifc.gov/outlooks/monthly_seasonal_outlook.pdf .

Figure 12. Wildfire Outlook



Disaster Designations

A total of 70 Kansas counties are now identified in Federal Emergency Declarations, DR-4449 due to storms, winds, tornadoes, flooding, landslides and mudslides. The President's action makes federal funding available to state, eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and repair or replacement of facilities in Allen, Anderson, Atchison, Barber, Barton, Bourbon, Brown, Butler, Chase, Chautauqua, Cherokee, Clark, Clay, Cloud, Coffey, Comanche, Cowley, Crawford, Dickinson, Doniphan, Douglas, Edwards, Elk, Ellsworth, Ford, Franklin, Geary, Gray, Greenwood, Harper, Harvey, Hodgeman, Jefferson, Kingman, Leavenworth, Lincoln, Linn, Lyon, Marion, Marshall, McPherson, Meade, Miami, Montgomery, Morris, Nemaha, Neosho, Ness, Osage, Osbourne, Ottawa, Pawnee, Phillips, Pottawatomie, Pratt, Reno, Rice, Riley, Rush, Russell, Saline, Smith, Sumner, Wabaunsee, Wallace, Washington, Wilson, Woodson and Wyandotte counties.

Federal funding is also available on a cost-sharing basis for hazard mitigation measures statewide. Some additional counties may be eligible for federal declaration and aid in the future once damage assessment is completed by FEMA.

Producers in 57 counties may be eligible for agricultural emergency loans as USDA has designated 25 counties as primary agricultural disaster areas for crop year 2019 due to flooding or excessive rain. Primary counties are Allen, Anderson, Atchison, Barton, Bourbon, Chase, Chautauqua, Cherokee, Cowley, Doniphan, Franklin, Gove, Johnson, Labette, Leavenworth, Linn, Lyon, Miami, Montgomery, Neosho, Osage, Wallace, Wilson, Woodson, Wyandotte. Additional, contiguous counties are: Brown, Butler, Coffey, Crawford, Douglas, Elk, Ellsworth, Graham, Greeley, Greenwood, Jackson, Jefferson, Johnson, Lane, Linn, Logan, Marion, Miami, Morris, Ness, Pawnee, Rice, Rush, Russell, Scott, Sedgwick, Shawnee, Sheridan, Sherman, Stafford, Sumner, Thomas, Trego, Wabaunsee, and Wichita. No Kansas county was designated as a drought disaster in 2019.

The Additional Supplemental Appropriations for Disaster Relief Act of 2019 was signed into law by President Trump on June 6, 2019. Congress appropriated $3.005 billion in assistance for a wide array of losses resulting from disasters throughout 2018 and 2019, including loses related to prevented planting of insured crops in calendar year 2019. In Kansas, WHIP+ is available only for crops affected by flooding, snowstorm, tornado and wildfires. Eligible crops are those in a Secretary or President-declared disaster county, or those with COC-accepted documentation of the qualifying disaster event.

Kansas Climate Summary

The Kansas Weekly Climate Summary and Drought Report are compiled at least monthly, more frequently when conditions warrant, by the KWO. Information from various federal, state, local and academic sources is used. Some of the data is preliminary and subject to change once final data is available. The KWO web site, http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response , contains additional drought information including links to other agencies with drought information and past issues of the Kansas Climate Summary and Drought Report. Mary Knapp, at the Kansas Climate Office, Weather Data Library is the primary source of the narrative on weather. She works closely with meteorologists throughout the state and region. Details of current conditions at such as precipitation, temperature, evapotranspiration (ET), soil moisture and more are available at http://mesonet.k-state.edu/

RESOURCES and REFERENCES

Kansas climate data is provided by Kansas State University, Weather Data Library through the Kansas Mesonet. (http://www.ksre.k-state.edu/wdl/). Soil moisture data was added in 2018 (http://mesonet.k-state.edu/agriculture/soilmoist)

The U.S. Drought Monitor, from the National Drought Mitigation Center at the University of Nebraska-Lincoln, provides a "big picture" perspective of conditions across the nation. In the Kansas county drought stage scheme, a Drought Watch equates roughly to moderate drought in the U.S. Drought Monitor, while a Drought Warning is the equivalent of severe drought. A Drought Emergency is reserved for extreme or exceptional drought. Palmer Drought Severity Index - The Palmer Index (PDSI) is one indicator used in the U.S. Drought Monitor.

The High Plains Regional Climate Center (https://hprcc.unl.edu/) has precipitation and temperature summary maps available for the state, region and nation.

The U.S. Geological Survey (USGS) Drought Watch provides information average streamflow measured at long-term gaging stations and compares them to normal flows.

The Kansas Department of Agriculture-Division of Water Resources monitors stream flow using the USGS gages for determination of administrative needs. Administration may be needed due to Minimum Desirable Streamflow (MDS) requirements, impairments and reservoir release protection. (https://agriculture.ks.gov/divisions-programs/dwr/water-appropriation/minimum-desirable-streamflow.)

The water levels of the federal lakes fluctuate during a year according to the management plan. Lake level Management plans are posted on the Kansas Water Office web site www.kwo.ks.gov .

The Kansas Applied Remote Sensing Program (KARS) at the University of Kansas produces a Kansas Green Report each week during the growing season. For a full set of national and regional ***GreenReport***® maps, go to: http://www.kars.ku.edu/products/greenreport/greenreport.shtml. This Kansas Vegetation Drought Response Index map is developed weekly by the Kansas Biological Survey using state drought triggers as its key. In addition, the National Drought Mitigation Center also produces VegDRI maps which may be found at http://vegdri.unl.edu/.

The National Weather Service (NWS) provides fire weather products and services for Kansas that include the Rangeland Fire Danger Index, Fire Weather Forecasts, Red Flag Watches/Warnings and Spot Forecasts. The five NWS offices that serve Kansas websites may be accessed from the NWS Offices' page.

The Monthly and Seasonal Drought Outlooks, developed by the NOAA Climate Prediction Center, assess the likelihood for improvement, persistence or deterioration in drought conditions for areas currently experiencing drought as identified by the U.S. Drought Monitor. (http://www.cpc.ncep.noaa.gov/) Also see: http://www.noaa.gov/.

Responding to Drought: A Guide for City, County and Water System Officials provides an overview of Kansas county drought stage declarations, local planning and coordination, disaster declarations and available state and federal assistance. The 2007 Municipal Water Conservation Plan Guidelines and the Drought Vulnerability Assessment Report, both by KWO, provide guidance regarding drought preparedness and response. These are available at http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response.

USDA Drought Programs and Assistance website (https://www.usda.gov/topics/disaster/drought/usda-drought-programs-and-assistance) listing the various USDA programs and agencies to assist with drought issues.

The National Interagency Coordination Center in Boise, Idaho, produces wildfire potential outlook maps monthly. (https://www.predictiveservices.nifc.gov/outlooks/outlooks.htm)

Please contact Diane Knowles at the Kansas Water Office (785) 296-3185 or diane.knowles@kwo.ks.gov should you have any questions or suggestions.

APPENDIX A
Monthly Weather Summary

December Summary	Precipitation (inches)			Temperature °F			
						Extreme (Date)	
Station[1]	Total	Departure[2]	Percent Normal	Mean	Departure[2]	Highest	Lowest
West							
Burlington, CO	0.38	-0.05	88%	35.4	6.5	71 (22)	8 (17)
Dodge City	1.32	0.48	157%	37.7	4.9	67 (25)	18 (18,17)
Garden City	0.95	0.43	183%	35.5	3.8	65 (25,23)	10 (17)
Goodland	0.30	-0.16	65%	35.2	5.3	71 (22)	11 (17)
Guymon, OK	0.84	0.20	131%	39.8	4.7	75 (23)	15 (18)
Hill City	1.15	0.46	167%	35.3	5.0	69 (22)	15 (19)
Lamar, CO	0.30	-0.10	75%	34.1	4.5	65 (25,3)	5 (19,17)
McCook, NE	0.37	-0.27	58%	33.6	5.6	65 (22)	13 (19)
Springfield, CO	0.59	0.08	116%	36.4	4.1	74 (23)	8 (17)
Central							
Concordia	1.98	1.13	233%	36.7	6.7	62 (25,24)	18 (17)
Hebron, NE				33.9	6.0	59 (5,3)	14 (18,17)
Medicine Lodge	1.54	0.62	167%	37.9	3.2	69 (25)	14 (17)
Ponca City, OK	0.61	-0.81	43%	42.1	5.5	72 (25)	16 (18)
Salina	1.45	0.51	154%	35.5	3.2	65 (25)	4 (17)
Wichita (ICT)	1.77	0.57	148%	38.9	5.1	68 (25)	10 (17)
East							
Bartlesville, OK	0.93	-1.28	42%	41.2	4.7	72 (25)	17 (18)
Chanute	1.13	-0.62	65%	41.2	6.4	69 (25)	17 (18)
Falls City, NE	0.65	-0.33	66%	34.9	5.9	64 (25)	12 (18)
Johnson Co. Exec. Apt	1.22	-0.42	74%	37.2	4.8	66 (25)	11 (18)
Joplin, MO	1.37	-1.45	49%	42.0	4.8	70 (25)	17 (18)
Kansas City (MCI), MO	1.73	0.20	113%	37.9	6.4	66 (25)	14 (10)
St. Joseph, MO	1.40	-0.12	92%	35.7	6.3	65 (25)	9 (18)
Topeka (TOP)	2.23	0.88	165%	37.7	5.7	67 (25)	10 (18)

1. Airport Automated Observation Stations (NWS/FAA)
2. Departure from 1981-2010 normal value

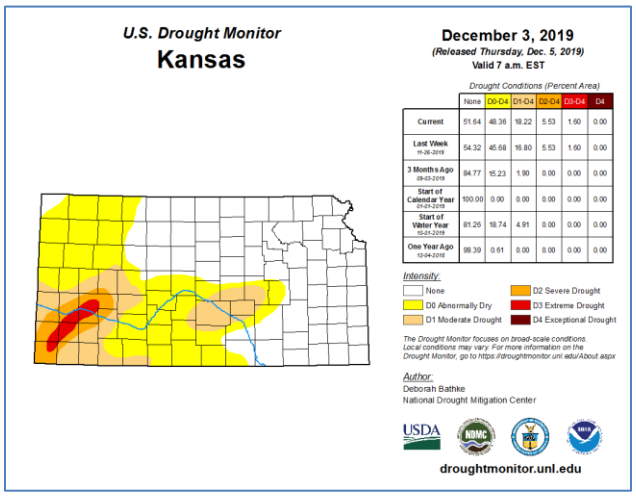
T - Trace; M - Missing; --- no normal value from which to calculate departure or percent of normal

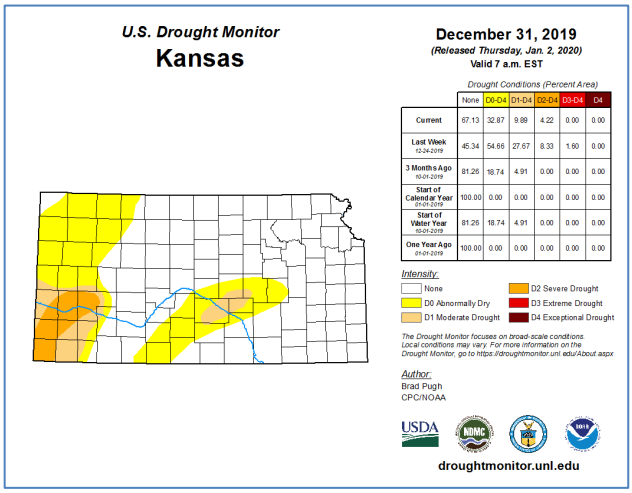
Source: National Weather Service F-6 Climate Summaries

KANSAS CLIMATE UPDATE
December 2019 Summary

Highlights

- U.S. Drought Monitor indicated continuing and expanding areas of abnormally dry (D0), moderate drought (D1), severe drought (D2) and moderate drought (D3) in western and south central Kansas conditions though December however, the wet end to the month allowed for improvement in the drought conditions.

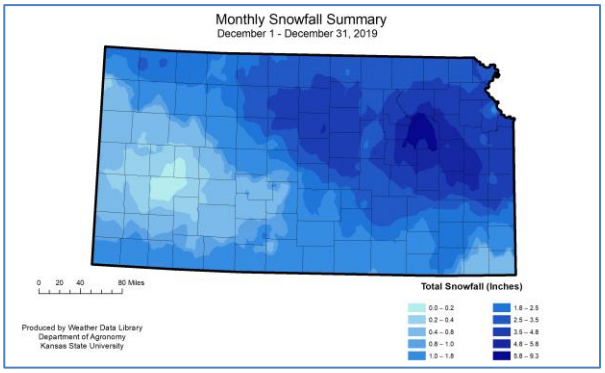




- KSU ranks December 2019 as the 28th wettest, and 15th warmest December in Kansas.

- Statewide average precipitation for December was 1.27 inches, 123% or normal

- December set 40 records for daily snowfall, with as much as 9 inches



- Kansas average temperature in 2019 was ranked overall as the 72nd warmest year (54th coolest) by NOAA. (NOAA National Centers for Environmental information, Climate at a Glance: Statewide Time Series, published January 2020, retrieved on January 14, 2020 from https://www.ncdc.noaa.gov/cag/)

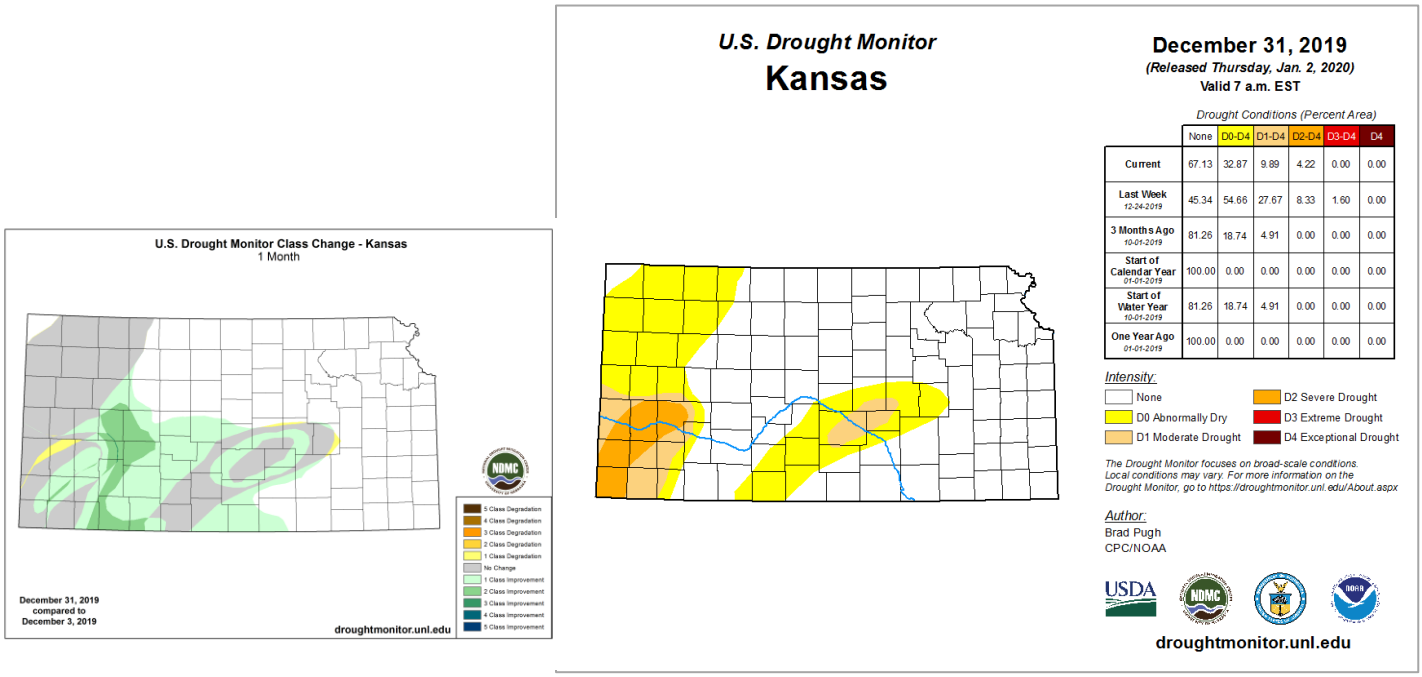
- Kansas average precipitation in 2019 was ranked overall as the 5th wettest year (121st driest) by NOAA. (NOAA National Centers for Environmental information, Climate at a Glance: Statewide Time Series, published January 2020, retrieved on January 14, 2020 from https://www.ncdc.noaa.gov/cag/)

- Drought Outlook favors drought continuing for the current area of drought in extreme western Kansas, with equal chances of below, near or above normal temperatures and precipitation likely in January for all of the state.

General Drought Conditions

The U.S. Drought Monitor indicated dry and drought conditions in parts of western and central Kansas throughout the month. These drought conditions expanded and intensified in parts of South Central and Southwest Kansas before improving some at the end of the month. The condition at the end of the month is shown below in Figure 1. Change in drought classification over the month is also shown.

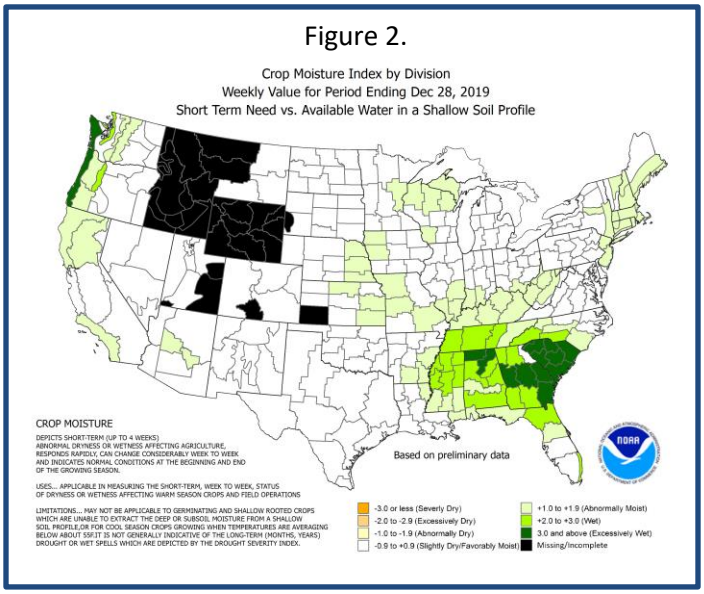
Figure 1. U.S. Drought Monitor Maps of Drought status



More information can be found on the U.S. Drought Monitor web site https://droughtmonitor.unl.edu/ .

Palmer Drought Severity Index (PDSI) - The Palmer Drought Severity Index is an indicator of relative dryness or wetness and is one factor used the U.S. Drought Monitor. The Crop Moisture (Figure 2) component evaluates short term needs and available water. More information on the PDSI and its parts can be found at http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml.

Figure 2.



Climate Summary - Precipitation

December was wetter than normal. Statewide average precipitation for the month was 1.27 inches, 123 percent of normal. This ranks as the 28th wettest December in the 125-year record by KSU-Weather Data Library. The North Central Climate Division had the greatest percent of normal, with a divisional average of 1.54 inches, 176 percent of normal. The Central Division had the highest average amount, with an average of 1.55 inches, 167 percent of normal. The highest 24-hour rainfall total for a National Weather Service Cooperative station was 2.21 inches at Girard, Crawford County, on the 29th. The greatest 24-hour rainfall total for a Community Collaborative Rain, Hail and Snow network station was 2.66 inches at Hays 5.6 N. Ellis County on the 28th. The greatest monthly precipitation totals for December: 2.73 inches at Sylvan Grove, Lincoln County (NWS); 2.66 inches at Hays 5.6 N. Ellis County (CoCoRaHS). Table 1 summarizes the monthly precipitation (KSU Weather Data Library).

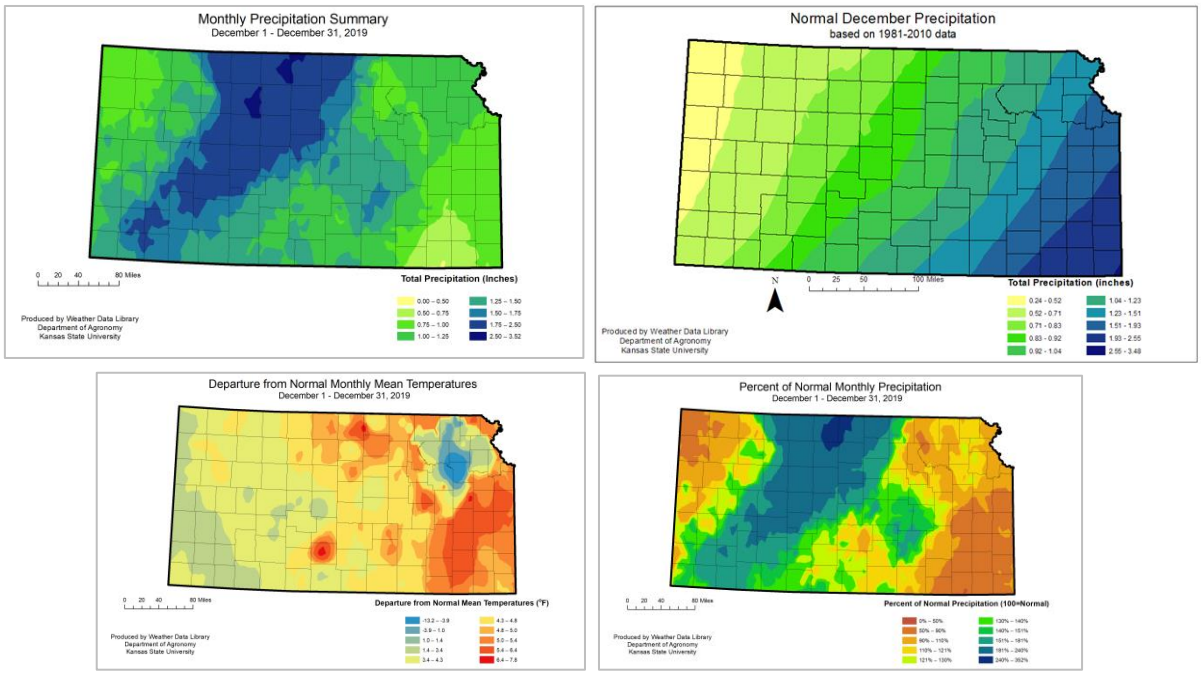
Table 1.

Kansas Climate Division Precipitation Summary (inches)

Climate Division	December 1 - 31, 2019			January 1 – December 31, 2019			April 1, 2019 – December 31, 2019			Sept 1, 2018 – December 31, 2019		
	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal	Actual	Depart Normal*	% of Normal
Northwest	0.44	-0.13	77	24.08	2.72	113	21.72	2.66	114	2.75	-1.72	62
West Central	0.91	0.28	144	22.23	1.46	107	18.94	0.67	104	2.8	-1.67	63
Southwest	1.13	0.46	169	19.89	-0.01	100	16.6	-0.92	95	2.48	-1.98	56
North Central	1.54	0.65	173	34.28	6.24	122	30.64	6.08	125	6.01	-0.72	89
Central	1.55	0.62	167	34.54	5.25	118	30.77	5.43	121	5.03	-1.78	74
South Central	1.38	0.26	123	40.04	8.72	128	36.03	9.33	135	7.43	-0.42	95
Northeast	1.26	0.04	103	44.36	9.36	127	39.12	8.33	127	7.69	-1.65	82
East Central	1.53	0.13	109	46.08	8.16	122	40.7	7.7	123	7.46	-2.85	72
Southeast	1.49	-0.33	82	57.40	15.91	138	51.47	15.97	145	11.14	-0.95	92
STATE	1.27	0.24	123	35.81	6.42	122	31.72	6.18	124	5.89	-1.50	80

The maps of Figure 3 below summarize precipitation for the month. (State maps by KSU are based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.)

Figure 3. Monthly Precipitation maps



Climate Summary-Temperature

Temperatures for December were warmer than normal. Statewide average temperature for the month was 36.0 ºF, which is 4.7 degrees warmer than normal. This ranks as the 15th warmest December on record by KSU-Weather Data Library. The East Central Climate Division had the greatest departure with an average of 36.7 ºF, 5.2 degrees warmer than normal. The Northwest Division was the warmest, with an average of 32.7 ºF, 4.2 degrees warmer than normal. Even with the warmer pattern, all divisions saw lows in the 10-degree and cooler range. The warmest maximum temperature was 75 ºF at 75 oF at Elkhart, Morton County, on the 24th. The coldest minimum temperature was 1 ºF at Hill City 1E, Graham County, on the 7th. There were 27 daily record high maximum temperatures and 28 daily record high minimum temperatures. There were no new record low maximum or minimum temperature. Table 2 summarizes the monthly temperatures (KSU Weather Data Library).

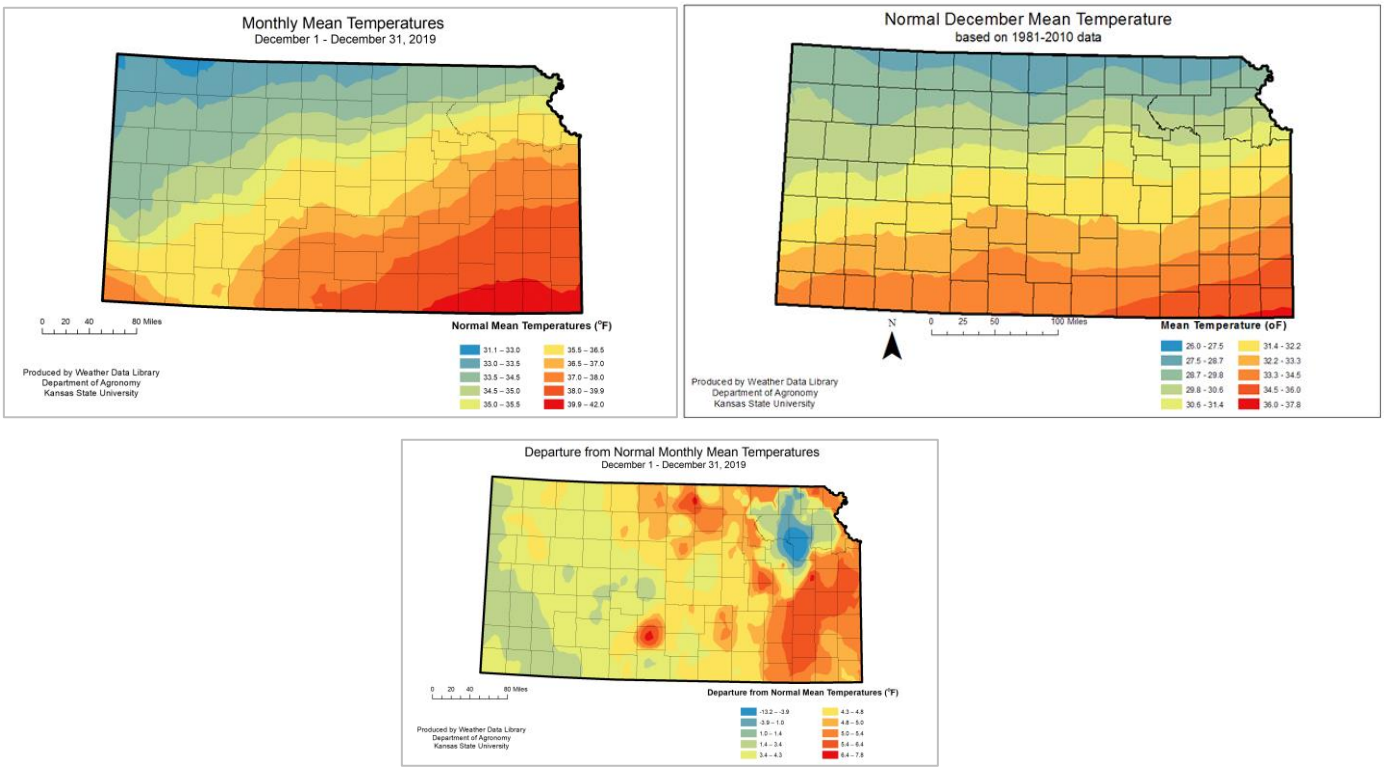
Table 2.

Climate Division	Kansas Climate Division Temperature Summary (ºF) December 2019							
	Maximum	Minimum	Average	Departure*	High	Date	Low	Date
Northwest	46.4	20.1	33.2	4.2	74	23	1	7
West Central	48.9	21.2	35.0	4.5	71	24	8	17
Southwest	51.8	22.2	37.0	4.3	75	24	8	17
North Central	45.6	23.1	34.3	4.9	64	23	7	17
Central	48.2	23.9	36.0	4.6	68	7	4	17
South Central	50.2	25.7	37.9	4.6	70	26	10	17
Northeast	45.3	24.0	34.7	4.8	66	26	9	18
East Central	47.2	26.3	36.7	5.2	67	26	7	18
Southeast	49.8	28.3	39.1	5.0	71	26	6	17
STATE	48.2	23.9	36.0	4.7	75	24th	1	7th

*Departure from normal is departure from the base period of 1981-2010, KSU Weather Data Library.

The maps in Figure 4 below summarize temperature for the month. (State maps based on data from the Cooperative Observer and Kansas Mesonet, and provided by KSU Weather Data Library. State weekly maps of precipitation information can be accessed at http://climate.k-state.edu/maps/weekly/.) Some maps obtained from the High Plains Regional Climate Center, ACIS system.

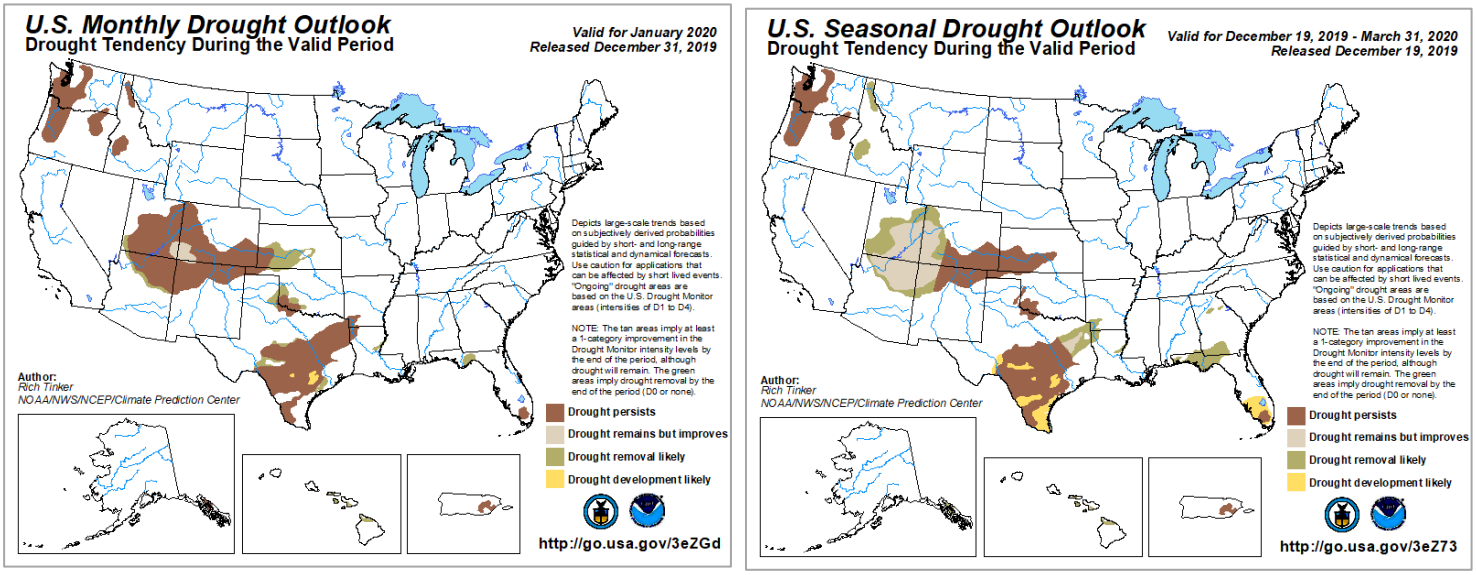
Figure 4. Monthly Temperature Maps



Outlooks

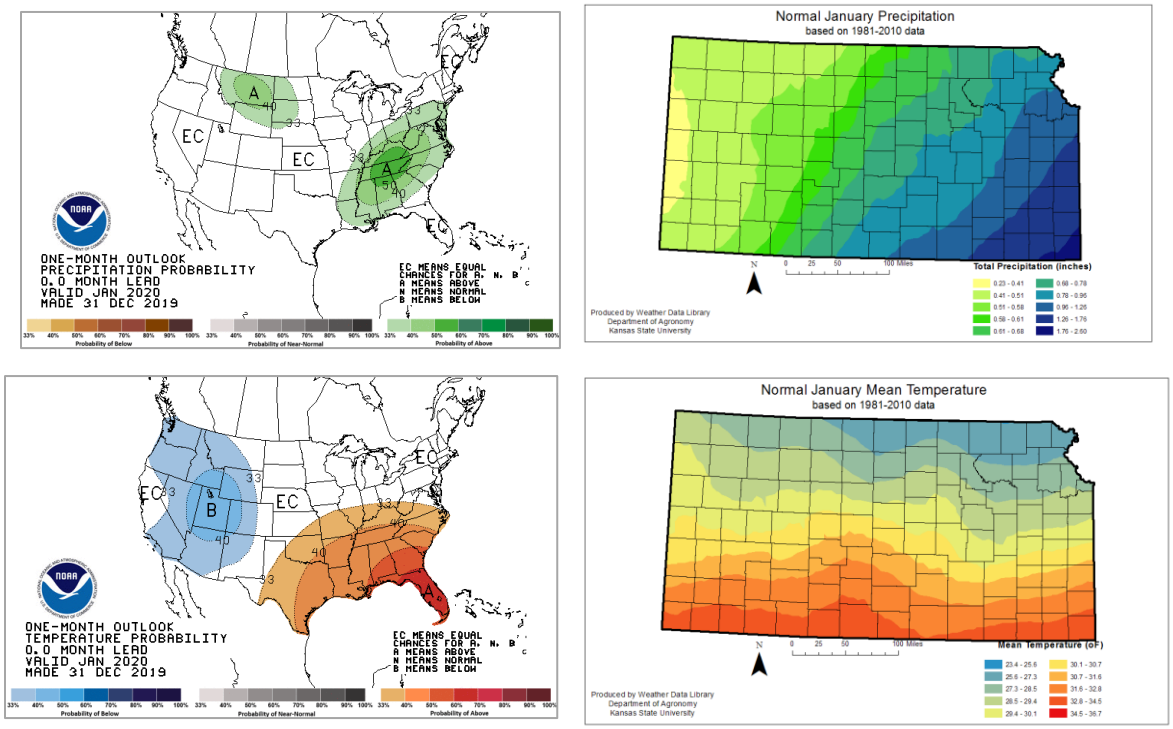
The Monthly Drought Outlook issued December 31, 2019 indicates drought conditions in southwest Kansas to persist, with removal likely moving slightly eats into south central Kansas. The Seasonal Outlook (3-month) favors the area of drought in Kansas persisting in the late-December through March period. The individual temperature and precipitation outlooks that contribute to these outlooks are available below.

Figure 5. Drought Outlooks



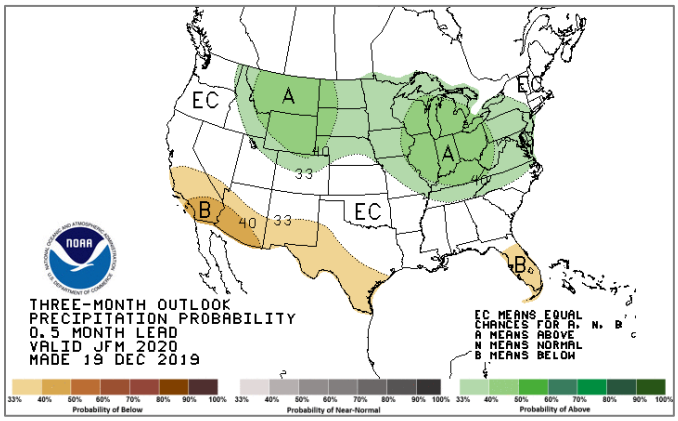
The monthly precipitation outlook has equal chances of below, near or above normal precipitation across all of Kansas. The temperature outlook indicates equal chances of below, near and above normal temperatures across the state, except for the south east where above normal is favored. One month outlooks are provided in Figure 6.

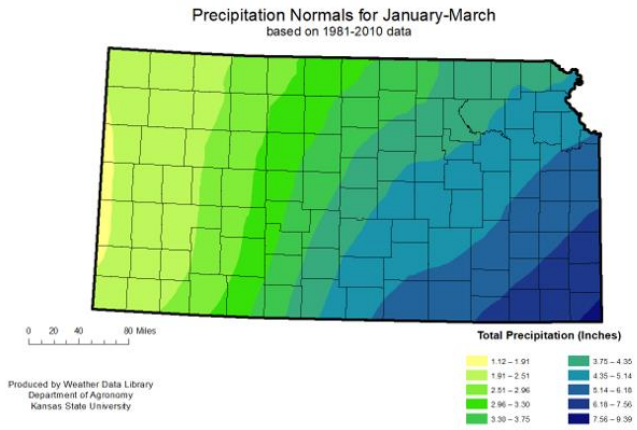
Figure 6. Next Month Precipitation and Temperature Outlooks

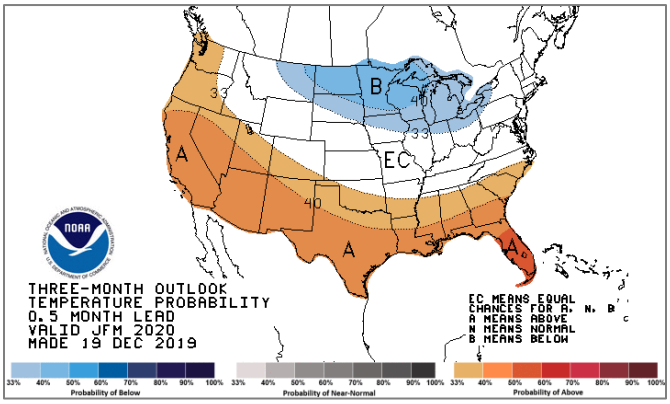


The U.S. three month outlook for January through March suggests equal chances of above, normal or below -average precipitation and temperatures for the state.

Figure 7. Three Month Precipitation and Temperature Outlooks







Additional outlooks for various timeframes are available from the national CPC for up to 13 months. (http://www.cpc.ncep.noaa.gov/products/predictions/90day/)

Reservoir Storage

At the end of the month most reservoir conservation pools were full or almost full except Keith Sebelius, Cedar Bluff and Lovewell. Reservoir releases consider the entire Missouri basin system so releases continue in many locations to reduce flood pool storage accumulated from the above normal precipitation and runoff earlier in the year. Table 3 provides conservation pool status for each federal reservoir.

Table 3. Kansas Federal Reservoir Conservation Pool Levels

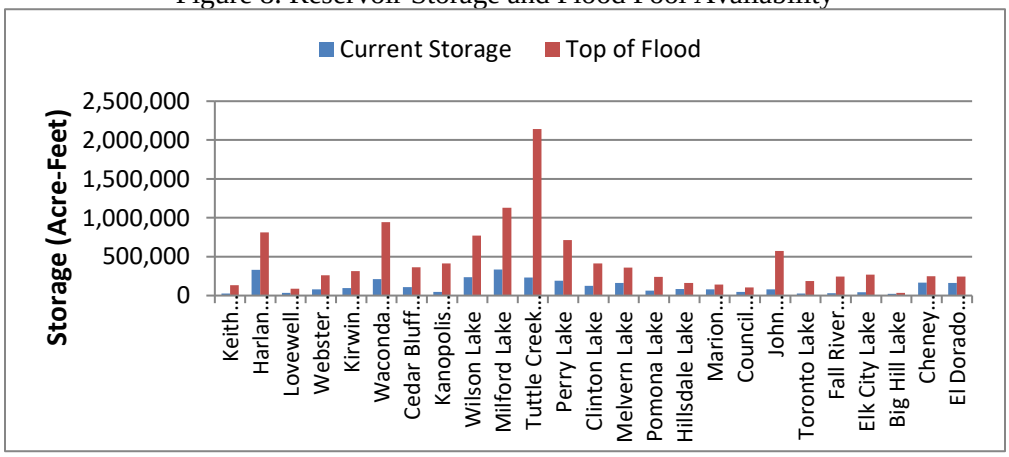
Reservoir	Top of Multipurpose / Conservation Pool (Feet MSL)	Multipurpose/Conservation Pool Elevation (Feet MSL)	Change from Top of Pool (Feet)	Percent of Conservation Pool Full
Kansas River Basin		**12/30/2019**		
Keith Sebelius Lake[1]	2304.3	2299.93	-4.37	74.8%
Harlan County Lake NE	1945.73	1946.95	1.22	100.0%
Lovewell Reservoir[1]	1582.6	1582.65	0.05	100.0%
Webster Reservoir[1]	1892.45	1892.99	0.54	100.0%
Kirwin Reservoir	1729.25	1729.27	0.02	100.0%
Waconda Lake[1]	1455.6	1455.06	-0.54	96.9%
Cedar Bluff Reservoir	2144	2133.49	-10.51	63.7%
Kanopolis Lake[1]	1463	1462.59	-0.41	97.5%
Wilson Lake[1]	1516	1515.45	-0.55	98.0%
Milford Lake[1]	1144.4	1141.78	-2.62	89.6%
Tuttle Creek Lake[1]	1075	1072.76	-2.24	90.9%
Perry Lake[1]	891.5	890.55	-0.95	95.2%
Clinton Lake[1]	875.5	876.59	1.09	100.0%
Melvern Lake[1]	1036	1037.52	1.52	100.0%
Pomona Lake[1]	974	976.14	2.14	100.0%
Hillsdale Lake[1]	917	918.61	1.61	100.0%
Arkansas River Basin		**12/30/2019**		
Marion Reservoir[1]	1350.5	1350.32	-0.18	98.6%
Council Grove Lake[1]	1274	1274.92	0.92	100.0%
John Redmond Reservoir	1041	1042.36	1.36	100.0%
Toronto Lake	901.5	905.51	4.01	100.0%
Fall River Lake	948.5	951.87	3.37	100.0%
Elk City Lake	796	797.13	1.13	100.0%
Big Hill Lake	858	858.48	0.48	100.0%
Cheney Reservoir	1421.6	1421.51	-0.09	99.5%
El Dorado Lake	1339	1339.18	0.18	100.0%

[1]Lake level management plan in place — Source: U.S. Army Corps of Engineers, U.S. Bureau of Reclamation and U.S. Geological Survey

Note: The conservation pool is the water storage for non-flood purposes of the reservoir, set by the elevation of the top of the pool.

In Figure 8 the blue bars indicate water in storage at that reservoir, with red bars indicate top of the flood pool storage. Some reservoirs have storage space remaining for flood flows but the available space varies.

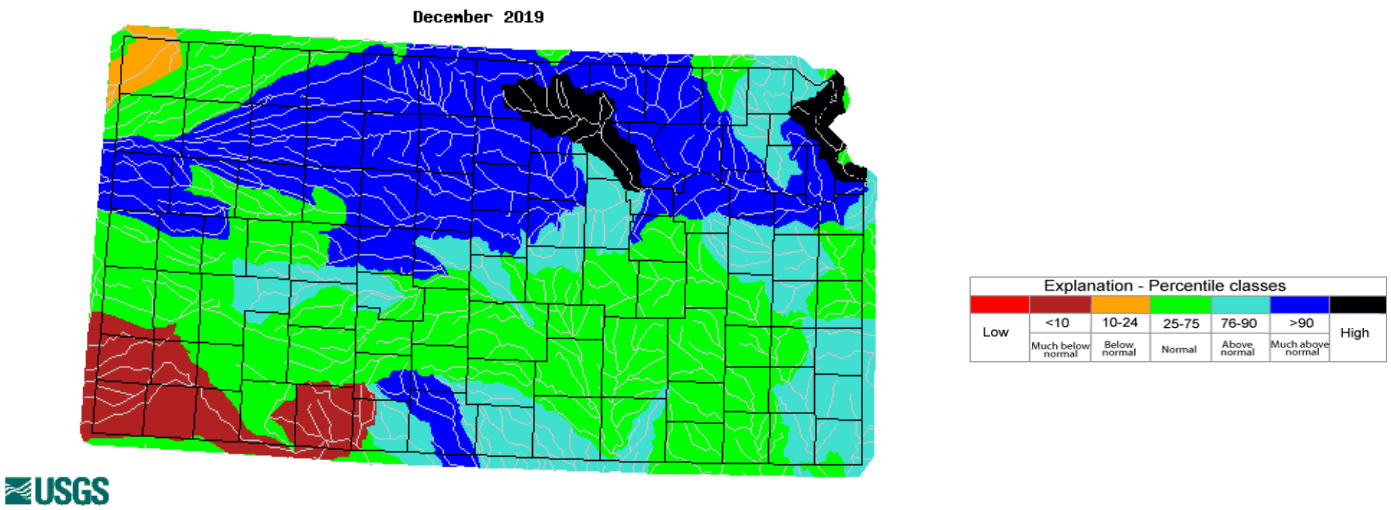
Figure 8. Reservoir Storage and Flood Pool Availability



Streamflow Conditions

WaterWatch summarizes streamflow conditions in a region (state or hydrologic unit) in terms of the long-term typical condition at stream gages in the region. In general, a streamflow which is greater than the 75 percentile is considered *above normal*, a streamflow which is between 25 and 75 percentiles is considered *normal* and a streamflow which is less than the 25 percentile is considered *below normal*. Color codes are for basins with streamflow averages less than 25 percent of historic values. This comparison aids in evaluating water resources conditions for a time period. A summary of flooding in is found later in this report. Figure 9 summarizes streamflow.

Figure 9. Monthly streamflow compared to historical streamflow



Minimum Desirable Streamflow: Low flows may be reflected at gage locations when the flow does not reach Minimum Desirable Streamflow (MDS). MDS requirements are in place to ensure base flows in certain streams to protect existing water rights and to meet in-stream water uses related to water quality, fish and wildlife and recreation. The Kansas Department of Agriculture, Division of Water Resources monitors 23 streams and rivers at 33 locations for minimum desirable streamflow. When flows drop below an established threshold, pumping restrictions are imposed on permits or water rights granted after the minimum desirable streamflow provision was made into law in 1984.

Although no water right administration was in effect in this month, the table below notes locations of concern including those below MDS.

Table 4.
Streamflows of Note

Gaging Station	Dec 2 Flow	Dec 9 Flow	Dec 16 Flow	Dec 23 Flow	Dec 30 Flow	Dec MDS	Comment
Rattlesnake Creek near Macksville	6.27	5.97	5.8	6	6.5	5	No surface water diversions junior to MDS above gage
Rattlesnake Creek near Zenith	19	18	19	18	29.3	15	
South Fork Ninnescah River near Pratt	12.2	12.4	12.4	12	13.3	10	No surface water diversions junior to MDS above gage

Lake Safety

Harmful Blue-Green Algal Blooms (lake water safety)
KDHE samples public use lakes only in response to complaints of human or animal illness or visual sighting of possible blue-green algae by the public or lake officials. The season for harmful algal blooms (HABs) monitoring is April 1-October 31.

Lakes affected in the end of the season were Warnings for Elkhorn Lake, Jackson County; Jerry Ivey Pond, Saline County; Lake Jeanette, Leavenworth County; Lakewood Park Lake, Saline County and Watch for South Lake, Johnson County. More information can be found at http://www.kdheks.gov/algae-illness/index.htm.

Vegetation, Soil Moisture and Crops

Vegetative Conditions
The Vegetative Condition map depicts vegetation stress. It is produced using satellite data by the National Drought Mitigation Center https://vegdri.unl.edu/Home.aspx and often customized for Kansas by the Kansas Biological Survey in the GreenReport. December is out of season for the vegetative conditions, so is not part of this report.

Soil Moisture and Rangeland
The Climate Prediction Center (CPC), monitors soil moisture and predicts future soil moisture. Anomalies are defined as deviations from the 1971-2000 monthly climatology. The monthly soil anomaly is shown in Figure 10. (.http://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml).

Within Kansas soil moisture is now being measured through the Kansas Mesonet and Kansas State University the percent of soil saturation (representative of grassland vegetation) is shown in Figure 10. (http://mesonet.k-state.edu/agriculture/soilmoist/)

Figure 10.

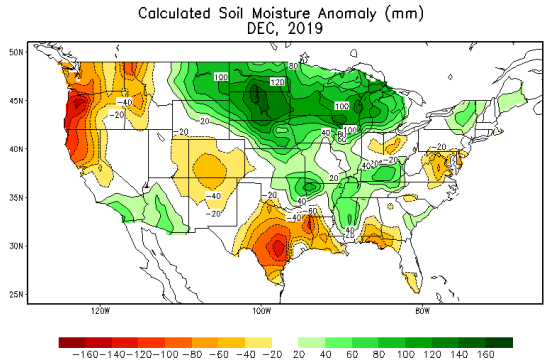
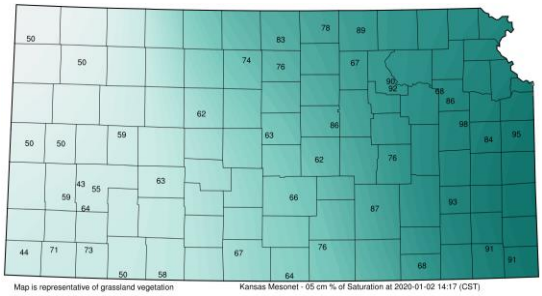
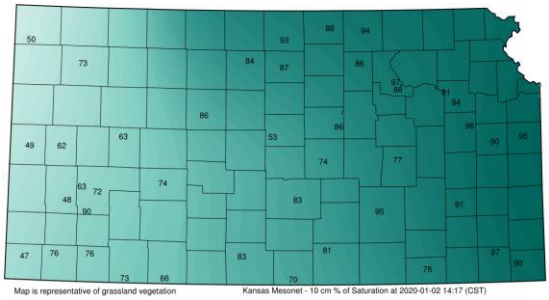


Figure 11. Percent of Soil Saturation as of January 1, 2020

5 cm (2 inch)



10 cm (4 inch)



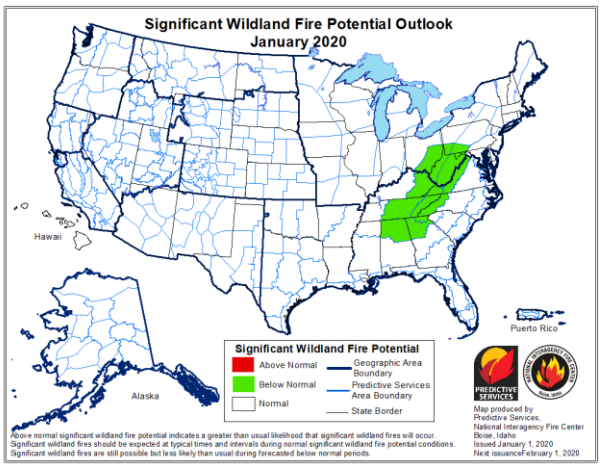
The National Agricultural Statistics Service, USDA Crop Progress and Condition provides a summary of the climatic effects on soil and crops. For the month of December 2019, topsoil moisture supplies rated 9 percent very short, 31 short, 56 adequate, and 4 surplus, according to the USDA's National Agricultural Statistics Service. Subsoil moisture supplies rated 10 percent very short, 28 short, 60 adequate, and 2 surplus.

Field Crops Report:
Winter wheat condition rated 5 percent very poor, 16 poor, 39 fair, 36 good, and 4 excellent.

Fire

The National Weather Service issues Red Flag Warnings when conditions favoring wildfire are at an increased risk. These are issued daily when needed. A Significant Wildland Fire Potential Outlook is issued monthly for the United States. Figure 12 is the most recent outlook for possible wildfires tor the next month. Additional forecasts can be found at https://www.predictiveservices.nifc.gov/outlooks/monthly_seasonal_outlook.pdf .

Figure 12. Wildfire Outlook



Disaster Designations

A total of 70 Kansas counties are now identified in Federal Emergency Declarations, DR-4449 due to storms, winds, tornadoes, flooding, landslides and mudslides. The President's action makes federal funding available to state, eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and repair or replacement of facilities in Allen, Anderson, Atchison, Barber, Barton, Bourbon, Brown, Butler, Chase, Chautauqua, Cherokee, Clark, Clay, Cloud, Coffey, Comanche, Cowley, Crawford, Dickinson, Doniphan, Douglas, Edwards, Elk, Ellsworth, Ford, Franklin, Geary, Gray, Greenwood, Harper, Harvey, Hodgeman, Jefferson, Kingman, Leavenworth, Lincoln, Linn, Lyon, Marion, Marshall, McPherson, Meade, Miami, Montgomery, Morris, Nemaha, Neosho, Ness, Osage, Osbourne, Ottawa, Pawnee, Phillips, Pottawatomie, Pratt, Reno, Rice, Riley, Rush, Russell, Saline, Smith, Sumner, Wabaunsee, Wallace, Washington, Wilson, Woodson and Wyandotte counties.

Federal funding is also available on a cost-sharing basis for hazard mitigation measures statewide. Some additional counties may be eligible for federal declaration and aid in the future once damage assessment is completed by FEMA.

Producers in 57 counties may be eligible for agricultural emergency loans as USDA has designated 25 counties as primary agricultural disaster areas for crop year 2019 due to flooding or excessive rain. Primary counties are Allen, Anderson, Atchison, Barton, Bourbon, Chase, Chautauqua, Cherokee, Cowley, Doniphan, Franklin, Gove, Johnson, Labette, Leavenworth, Linn, Lyon, Miami, Montgomery, Neosho, Osage, Wallace, Wilson, Woodson, Wyandotte. Additional, contiguous counties are: Brown, Butler, Coffey, Crawford, Douglas, Elk, Ellsworth, Graham, Greeley, Greenwood, Jackson, Jefferson, Johnson, Lane, Linn, Logan, Marion, Miami, Morris, Ness, Pawnee, Rice, Rush, Russell, Scott, Sedgwick, Shawnee, Sheridan, Sherman, Stafford, Sumner, Thomas, Trego, Wabaunsee, and Wichita. No Kansas county was designated as a drought disaster in 2019.

The Additional Supplemental Appropriations for Disaster Relief Act of 2019 was signed into law by President Trump on June 6, 2019. Congress appropriated $3.005 billion in assistance for a wide array of losses resulting from disasters throughout 2018 and 2019, including loses related to prevented planting of insured crops in calendar year 2019. In Kansas, WHIP+ is available only for crops affected by flooding, snowstorm, tornado and wildfires. Eligible crops are those in a Secretary or President-declared disaster county, or those with COC-accepted documentation of the qualifying disaster event.

Kansas Climate Summary

The Kansas Weekly Climate Summary and Drought Report are compiled at least monthly, more frequently when conditions warrant, by the KWO. Information from various federal, state, local and academic sources is used. Some of the data is preliminary and subject to change once final data is available. The KWO web site, http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response , contains additional drought information including links to other agencies with drought information and past issues of the Kansas Climate Summary and Drought Report. Mary Knapp, at the Kansas Climate Office, Weather Data Library is the primary source of the narrative on weather. She works closely with meteorologists throughout the state and region. Details of current conditions at such as precipitation, temperature, evapotranspiration (ET), soil moisture and more are available at http://mesonet.k-state.edu/

RESOURCES and REFERENCES

Kansas climate data is provided by Kansas State University, Weather Data Library through the Kansas Mesonet. (http://www.ksre.k-state.edu/wdl/). Soil moisture data was added in 2018 (http://mesonet.k-state.edu/agriculture/soilmoist)

The U.S. Drought Monitor, from the National Drought Mitigation Center at the University of Nebraska-Lincoln, provides a "big picture" perspective of conditions across the nation. In the Kansas county drought stage scheme, a Drought Watch equates roughly to moderate drought in the U.S. Drought Monitor, while a Drought Warning is the equivalent of severe drought. A Drought Emergency is reserved for extreme or exceptional drought. Palmer Drought Severity Index - The Palmer Index (PDSI) is one indicator used in the U.S. Drought Monitor.

The High Plains Regional Climate Center (https://hprcc.unl.edu/) has precipitation and temperature summary maps available for the state, region and nation.

The U.S. Geological Survey (USGS) Drought Watch provides information average streamflow measured at long-term gaging stations and compares them to normal flows.

The Kansas Department of Agriculture-Division of Water Resources monitors stream flow using the USGS gages for determination of administrative needs. Administration may be needed due to Minimum Desirable Streamflow (MDS) requirements, impairments and reservoir release protection. (https://agriculture.ks.gov/divisions-programs/dwr/water-appropriation/minimum-desirable-streamflow.)

The water levels of the federal lakes fluctuate during a year according to the management plan. Lake level Management plans are posted on the Kansas Water Office web site www.kwo.ks.gov .

The Kansas Applied Remote Sensing Program (KARS) at the University of Kansas produces a Kansas Green Report each week during the growing season. For a full set of national and regional ***GreenReport***® maps, go to: http://www.kars.ku.edu/products/greenreport/greenreport.shtml. This Kansas Vegetation Drought Response Index map is developed weekly by the Kansas Biological Survey using state drought triggers as its key. In addition, the National Drought Mitigation Center also produces VegDRI maps which may be found at http://vegdri.unl.edu/.

The National Weather Service (NWS) provides fire weather products and services for Kansas that include the Rangeland Fire Danger Index, Fire Weather Forecasts, Red Flag Watches/Warnings and Spot Forecasts. The five NWS offices that serve Kansas websites may be accessed from the NWS Offices' page.

The Monthly and Seasonal Drought Outlooks, developed by the NOAA Climate Prediction Center, assess the likelihood for improvement, persistence or deterioration in drought conditions for areas currently experiencing drought as identified by the U.S. Drought Monitor. (http://www.cpc.ncep.noaa.gov/) Also see: http://www.noaa.gov/.

Responding to Drought: A Guide for City, County and Water System Officials provides an overview of Kansas county drought stage declarations, local planning and coordination, disaster declarations and available state and federal assistance. The 2007 Municipal Water Conservation Plan Guidelines and the Drought Vulnerability Assessment Report, both by KWO, provide guidance regarding drought preparedness and response. These are available at http://www.kwo.ks.gov/reports2/climate-and-drought-monitoring-response.

USDA Drought Programs and Assistance website (https://www.usda.gov/topics/disaster/drought/usda-drought-programs-and-assistance) listing the various USDA programs and agencies to assist with drought issues.

The National Interagency Coordination Center in Boise, Idaho, produces wildfire potential outlook maps monthly. (https://www.predictiveservices.nifc.gov/outlooks/outlooks.htm)

Please contact Diane Knowles at the Kansas Water Office (785) 296-3185 or diane.knowles@kwo.ks.gov should you have any questions or suggestions.

APPENDIX A
Monthly Weather Summary

December Summary	Precipitation (inches)			Temperature °F			
						Extreme (Date)	
Station[1]	Total	Departure[2]	Percent Normal	Mean	Departure[2]	Highest	Lowest
West							
Burlington, CO	0.38	-0.05	88%	35.4	6.5	71 (22)	8 (17)
Dodge City	1.32	0.48	157%	37.7	4.9	67 (25)	18 (18,17)
Garden City	0.95	0.43	183%	35.5	3.8	65 (25,23)	10 (17)
Goodland	0.30	-0.16	65%	35.2	5.3	71 (22)	11 (17)
Guymon, OK	0.84	0.20	131%	39.8	4.7	75 (23)	15 (18)
Hill City	1.15	0.46	167%	35.3	5.0	69 (22)	15 (19)
Lamar, CO	0.30	-0.10	75%	34.1	4.5	65 (25,3)	5 (19,17)
McCook, NE	0.37	-0.27	58%	33.6	5.6	65 (22)	13 (19)
Springfield, CO	0.59	0.08	116%	36.4	4.1	74 (23)	8 (17)
Central							
Concordia	1.98	1.13	233%	36.7	6.7	62 (25,24)	18 (17)
Hebron, NE				33.9	6.0	59 (5,3)	14 (18,17)
Medicine Lodge	1.54	0.62	167%	37.9	3.2	69 (25)	14 (17)
Ponca City, OK	0.61	-0.81	43%	42.1	5.5	72 (25)	16 (18)
Salina	1.45	0.51	154%	35.5	3.2	65 (25)	4 (17)
Wichita (ICT)	1.77	0.57	148%	38.9	5.1	68 (25)	10 (17)
East							
Bartlesville, OK	0.93	-1.28	42%	41.2	4.7	72 (25)	17 (18)
Chanute	1.13	-0.62	65%	41.2	6.4	69 (25)	17 (18)
Falls City, NE	0.65	-0.33	66%	34.9	5.9	64 (25)	12 (18)
Johnson Co. Exec. Apt	1.22	-0.42	74%	37.2	4.8	66 (25)	11 (18)
Joplin, MO	1.37	-1.45	49%	42.0	4.8	70 (25)	17 (18)
Kansas City (MCI), MO	1.73	0.20	113%	37.9	6.4	66 (25)	14 (10)
St. Joseph, MO	1.40	-0.12	92%	35.7	6.3	65 (25)	9 (18)
Topeka (TOP)	2.23	0.88	165%	37.7	5.7	67 (25)	10 (18)

1. Airport Automated Observation Stations (NWS/FAA)

2. Departure from 1981-2010 normal value

T - Trace; M - Missing; --- no normal value from which to calculate departure or percent of normal

Source: National Weather Service F-6 Climate Summaries