



Camp Ashland, Nebraska, is under floodwater March 17, 2019. / Nebraska National Guard Staff Sgt. Herschel Talley [via Flickr](#)

## STATE COULD SEE MORE RAIN AHEAD

**AL DUTCHER, NSCO**

**N**ebraskans are ready for spring. After a relatively warm start to the first two months of winter, February temperatures plummeted across much of the northern half of the United States. An active northern jet stream pattern resulted in the eighth coldest February for Nebraska since records began

in 1895. Additionally, monthly snowfall totals were in the 12- to 24-inch range across a substantial portion of the northeastern two-thirds of the state.

Unfortunately, these cold temperatures continued through the first 10 days of March, with statewide average temperatures during the first five days 20-30 F

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below normal (location dependent). A strong low pressure system entered the Central Plains from Feb. 12 to 15, resulting in blizzard conditions in the cold sector to heavy rain in the warm sector.

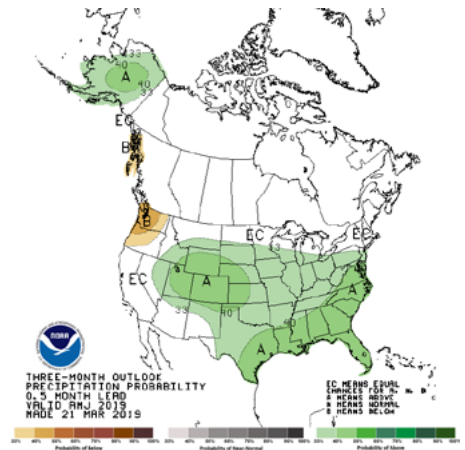
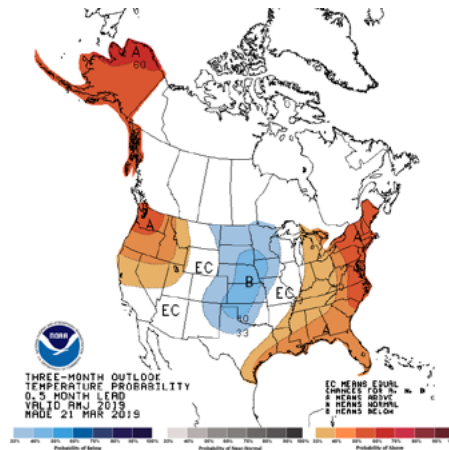
Within a 24-hour period, our deep snowpack and ice-covered rivers totally disappeared under massive flood conditions. At least two deaths were reported, and damage estimates for Nebraska are now in excess of \$1 billion, with another \$1 billion to \$2 billion worth of damage estimated to surrounding states. Agriculture was particularly hard hit with flooded fields, field debris, soil erosion, washed out roads, and significant loss of cattle.

As Nebraska attempts to address the substantial damage issues across the state, attention is now turning to our spring weather and what it will mean for flood repairs and agricultural production in 2019. Although we had five weeks of well-below-normal temperatures, temperatures have actually been above normal from mid-March through the first week of April. We have seen two above-normal average temperature days for each below-average day.

Soil moisture is of little concern for drought consideration at this time, but with wet surface and sub-surface soil conditions, excessive moisture will elevate our flood risk until temperatures warm sufficiently to promote rapid vegetative growth and subsequent crop water demands. Simply put, until we see vegetative water demands exceed soil recharge by rain events, we will remain prone to flooding.

If we look to the atmosphere for answers regarding our temperature and precipitation outlook through the end of June, two underlying factors will likely influence North America's jet stream pattern and how surface low pressure systems impact the United States. First, the current El Niño event bears watching as it is on the cusp of a multi-year event. Second, the position of the northern jet will determine what part(s) of the country are likely to experience cooler-than-normal temperatures during the next three months.

The Climate Prediction Center has declared that the Equatorial Pacific is now in El Niño conditions, an abnormal warming of the Equatorial Pacific. According



to CPC, there is an 80% chance that this event will last through June and a 60% chance this event will continue into this fall based on a large blob of anomalous heat now moving to the surface in the eastern Equatorial Pacific. This heat blob extends to the central Equatorial Pacific, but there is anomalous heat all the way westward to Australia.

Based upon the extensive amount of heat below the Equatorial Pacific that has yet to reach the surface, I firmly believe we will see a second consecutive El Niño fall and winter. With sea surface temperatures above normal, the additional heat will increase evaporation and this additional moisture will likely get entrained into mid-latitude storms entering the west coast. California at the beginning of April had its fourth largest snowpack in the past 40 years, a testament to how much moisture these atmospheric rivers can provide to these West Coast storms.

Eventually the storms progress east and have led to a significant snowpack in the central and southern Rockies, as well as the central and southern High Plains. With abnormal warmth in the Equatorial Pacific, evaporative moisture from the sea surface should continue to juice up storms hitting the West Coast. This trend should continue through the month of May, at a bare minimum.

The northern jet, which was particularly strong from late January through early March, has relaxed recently, has since weakened dramatically. This may be in response to a disappearance of a small cold pocket in the eastern Equatorial Pacific that was particularly noticeable from mid-January through mid-March. As the northern jet weakened, more storm activity

developed with the southern jet stream that is most active during El Niño events.

CPC's 30-day-long lead outlooks issued April 18 for the month of May indicates that the southwestern half of Nebraska has an elevated chance for above-normal moisture, while the remainder of the state has equal chances of receiving above-normal, normal, or below-normal precipitation. Nebraska lies on the northern periphery of an area forecasted toward above-normal precipitation, including Texas, Oklahoma, Colorado, Wyoming, and western Kansas. There are equal chances for above-normal, normal, or below-normal temperatures across the entire state. Below-normal temperatures are forecasted for the western third of Texas and Oklahoma, plus the southwest corner of Kansas. Above-normal May temperatures are projected for all areas east of the Mississippi, the west coast states, and the northern tier of states along the Canadian border.

Therefore, the 90-day outlooks that were issued April 18 have a cold bias in them from the preliminary 30-day April outlook. The southern half of Nebraska is forecasted to have a tendency for below-normal temperatures and extends southward to include the western two-thirds of Kansas, western third of Oklahoma, the Texas Panhandle and the eastern third of Colorado. Above-normal temperatures are forecasted for the western and eastern third of the United States, with equal chances for above-normal, normal, or below-normal temperatures for the remaining areas of the central third of the United States. The May to July forecast indicates a tendency for above-normal precipitation for all areas except the upper

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Great Lakes, the northeastern U.S., and the west coast states abutting the Pacific Ocean. Ultimately, the position of the northern jet will determine where thunderstorm activity is likely to occur. If its mean position is over the Great Lakes, then dry conditions may develop across the northern Plains region of eastern Montana and western North Dakota. This is also supported by a below-normal snowpack across the northern Rockies.

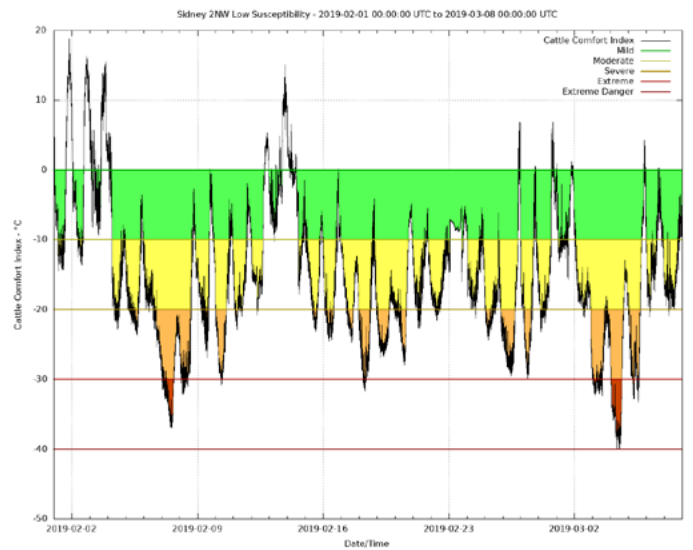
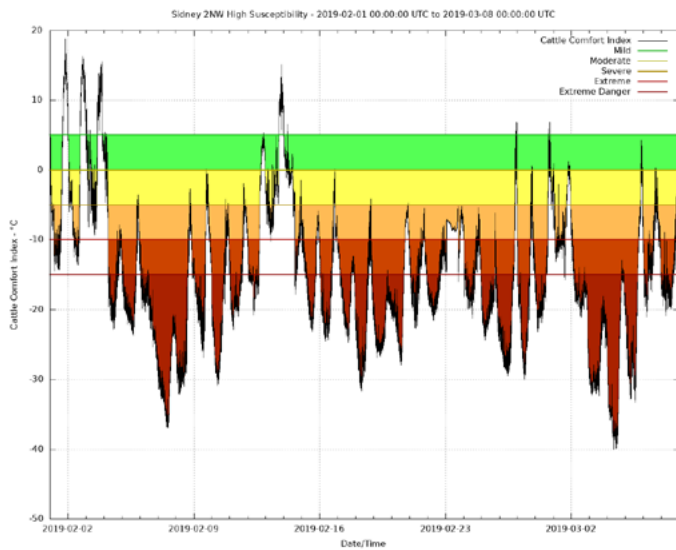
If the northern jet lies across the northern Plains, dryness will likely develop over the southeastern U.S., as systems come

out of the western U.S. and head northeast toward the Great Lakes. This pattern, in conjunction with a heavy Colorado snowpack, should result in above-normal precipitation for the southern and central High Plains.

Although the tendency of the models is to paint above-normal moisture for our already saturated state, there are potential benefits. First, if El Niño behaves as expected, there will be moisture available in the southern stream to generate robust precipitation events. That means an increased chance of above-normal moisture, but the separation between individual events is generally greater than

being stuck under a northwest flow aloft where we can get multiple events with little drying time between events.

In addition, if the southern stream is active, temperatures would be inclined to average above-normal in the absence of a strong northern jet. Although moisture chances increase, above-normal temperatures could help above-normal moisture through increased plant water demands. Until soils dry out sufficiently to handle several inches of moisture in a 24-hour period without significant runoff, our flood risk will remain elevated.



NEBRASKA STATE CLIMATE OFFICE

Mesonet data was used to determine high susceptibility (left) and low susceptibility thresholds for cattle comfort for Nebraska counties affected by severe cold between Jan. 1 and March 17.

# STATIONS SAFE FROM FLOODING

USDA also utilizes Nebraska Mesonet data for producer assistance.

Nebraska Mesonet weather stations throughout the northeastern part of the state survived unharmed through last month's historic flooding that brought billions of dollars in damages.

The network, made up of nearly 70 stations, includes about 10 located in areas most affected by flooding. Each of those were installed above floodplain levels.

The weather stations, which record observations every 5 minutes every day of the year, capture soil moisture data, as well as precipitation, wind speed and temperature. They recorded localized information as the bomb cyclone crossed

the state.

All of that data feeds into the regional and national datasets, which painted a bigger picture of exactly what led to the massive flooding in Nebraska. You can read about that here in ["Nebraska's most challenging 60 days"](#), co-authored by Al Dutcher, of the Nebraska State

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Climate Office, and Tyler Williams, of Nebraska Extension and NSCO, for our university partner, [CropWatch](#).

Those same observations were used to help the U.S. Department of Agriculture respond to emergency aid requests after severe cold and wet conditions persisted through winter — and during calving season — in the many parts of the state. Data pulled by the Nebraska Mesonet was used to determine the cattle comfort index, a formula that looks at temperature, humidity, wind, precipitation and sunlight and how that affects cattle health.

“Using the cattle comfort index is not that uncommon, but is typically used during the summer for heat stress because that can have a deadly impact in just one day,” Williams said. “Using it during the cold season is relatively uncommon because most cattle — except newborn calves — can handle a day or two or a week of very cold conditions.

“This scenario was different because it was such a long period of time and many healthy cows/calves were dying. You could not feed them enough feed to give them the amount of energy they were requiring to survive.”

Leann Nelson, director of the Farm Service Agency in York, said she started getting reports of livestock losses in York and Hamilton counties in February, but the FSA Livestock Indemnity Program, which compensates producers for livestock losses in excess of normal mortality due to adverse weather conditions, listed specific weather conditions considered to be eligible loss conditions. What producers were facing didn’t seem to fit.

After reaching out to Nebraska Extension, and then other University of Nebraska-Lincoln staff, she received an email including two cattle comfort index graphs created by Stonie Cooper, Mesonet manager at NSCO. They showed that for weeks, the cattle had been in severe to extreme danger due to weather conditions.

“The graphs made me realize how severe the combination of excessive moisture, extreme temperature, wind chill and lack of sunshine stressed the calves as well as the adult cattle,” she said.

So armed with the data, as well as oth-



#### NEBRASKA STATE CLIMATE OFFICE

*Solar radiation sensors, or pyranometer, are calibrated on the roof of Hardin Hall at Nebraska East Campus. Over the spring and summer, Nebraska Mesonet staff will replace the sensors at each mesonet site. They are calibrated each winter.*

er maps provided by Williams and UNL, the Nebraska State FSA Office informed FSA County Committees they were authorized to establish eligible adverse weather events that cause livestock deaths, providing they have the documentation.

Cattle comfort index maps created by Cooper for each Mesonet station in the state were made available for the time-frame between December and the first week of March. It is one piece the county committees are using to establish adverse weather events for the LIP.

“This tool, and the other data provide by UNL, has been extremely helpful to many of the counties in implementing the LIP program to the producers of Nebraska,” Nelson said.

### Looking ahead

The Nebraska Mesonet anticipates adding two new weather stations to the network during the spring and summer

months in 2019, all while ramping up site visits from two a year to four a year. The increased number of visits is in keeping with the network’s new status as a [National Mesonet Program](#) member.

Stonie Cooper, mesonet manager, and Glen Roebke, mesonet technician, started their site visits already before the last snow fell, and will continue throughout the spring, summer and fall months. During their visits, the two will perform any other required maintenance and/or calibration checks, and will replace any instruments not performing to factory standard.

“The first round of visits is nearly complete,” Roebke said this week, “and we are preparing for the next round, which will include the annual maintenance routine.”

If you see them in the field, be sure to say hello.

— SHAWNA RICHTER-RYERSON

# SITE TO FEATURE CLIMATE TRENDS DATA

The brightly colored Nebraska maps broken down into the state's eight climate division have popped up in Nebraska State Climate Office and Nebraska Extension presentations, illustrating in the simplest way what our climate future could look like.

In one, labeled to show the rate of change for fall's average temperature, the map flips from light oranges, signaling a 0.5-degree long-term rate of change, to a deep magenta, signaling a 4-degree-or-more short-term rate of change. It illustrates vividly that based on the past 30 years of data, temperatures could increase more and faster than in the past.

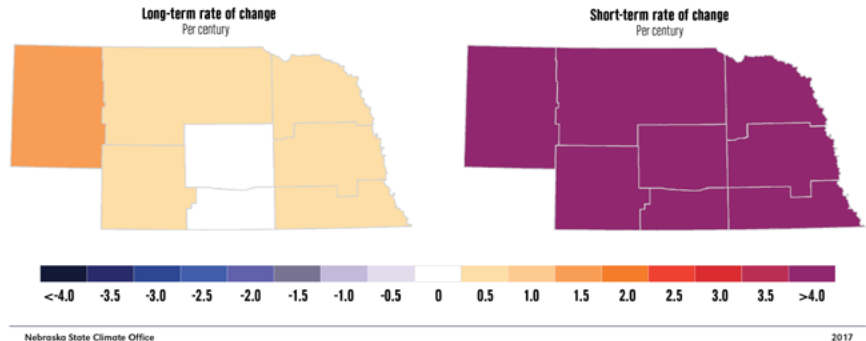
The maps, comparing the average, minimum and maximum temperatures, as well as precipitation totals, are only one form of the data, collected and analyzed by Al Dutcher, Extension climatologist with the NSCO, over the course of several months. The information also is available in chart and graph form, and soon will be available as an interactive web experience on an updated Nebraska State Climate Office website.

"The interactive graphic is just getting designed, but it will allow the user to easily and quickly interact with these maps and customize which maps they want to view," said Tyler Williams, Extension climatologist and key partner on the project. "We will incorporate the long-term and short-term trends, as well as the projections for each climate division. The user will be able to select the month, season, or time frame they want to look at, and will be able to click and see a chart showing the annual variation over time for each Nebraska climate division. This visual tool provides a nice way to play around with the data in an easy-to-use format."

One key element on the presented information is that it is broken down to the climate division level, because the state lies at the intersection of a semi-humid and semi-arid environment. Normal annual precipitation decreases an average of 1 inch for each 25 miles from southeast Nebraska — where average annual precipitation is about 34 inches — to the northwest

## FALL AVERAGE TEMPERATURE (°F) NEBRASKA CLIMATE TRENDS

These maps show the climate trends over the long term and short term for the state's eight climate divisions based on industry-standard data from the National Centers for Environmental Information of the National Oceanic Atmospheric Administration. Long term trends use data collected between 1895 to 2016; short-term trends use data from 1986 to 2015.



### NEBRASKA STATE CLIMATE OFFICE

*This comparison map is just one of hundreds that will be available on an interactive webpage that will allow users to access, compare and contrast climate data in a variety of forms. The interactive page will be a part of an updated Nebraska State Climate Office website, nsco.unl.edu, expected to be released this summer.*

— where the average annual precipitation is just 15 inches.

"When the NSCO monthly updates indicate Nebraska ranks XX since 1895, the state value is determined by an area weighting of the eight climate divisions in Nebraska," explained Dutcher. But the divisions aren't equal in size, so the Panhandle and north-central division — the more arid parts of the state — have more weight in the state average. But, Dutcher said, most of Nebraska's population is in the east central district, where values may or may not fall in line with those of the west.

By breaking the information into climate divisions, Nebraskans can more easily see local trends, as well as see the diversity across the state by month or season.

"To address climate change issues (short and long term), it is important to separate divisions because they can be measuring different climate regimes, their impacts are not equal, and a state number weighted toward a drier area of the state will likely underestimate the rates of change in the more humid eastern portion

of the state," Dutcher said.

"Climate change in Nebraska cannot be discussed accurately unless you start to dig into the data," Williams added. "Getting warmer and wetter does not tell the whole story because of the seasonal and geographical differences. These maps allow the user to see it visually without having to decipher a host of charts and tables."

If charts and graphs are your thing, don't worry. All versions of the data, collected from the National Oceanic Atmospheric archive and ground-truthed with Nebraska Mesonet data, will be available on the new website, expected to be released in summer 2019. Also available will be written guides, providing future projections and a climate and geographic history of each climate division.

"Nebraskans are very interested in understanding our patterns of variability, our climate history and our climate future," said Martha Shulski, director of the NSCO. "It's our hope this tool will provide some answers to these climate change questions."

— SHAWNA RICHTER-RYERSON

# TOOLS HELP PLAN FOR FUTURE CLIMATE

Planning for climate change isn't easy. The complexity of the issue itself is hard to digest, let alone translate into action items. But a [new suite of tools](#) designed by a group of University of Nebraska-Lincoln researchers gives municipal planners a clearer climate picture of what to expect and prepare for.

"Climate is not always tangible," said Natalie Umphlett, co-lead on the project, [dubbed Climate for Cities](#), and regional climatologist with the [High Plains Regional Climate Center](#). "But our website offers tangible tools you can use and interact with to help make better decisions when planning for the future.

The project, funded by the National Oceanic and Atmospheric Administration Climate Program Office [Sectoral Applications Research Program](#), provides climate data in a variety of forms, including historical trends and future projections, for a range of climate variables. The potentially greatest display of that information comes in the form of [the "sister city" tool](#).

The tool covers the 10 states in the Missouri River Basin, and pairs up 100s of cities of varying sizes, providing a literal look at what one's possible climate in the future looks like today. By 2055, for example, Lincoln's annual temperature could be like Wichita, Kansas, and by 2099, like Joplin, Missouri, under a scenario where efforts have curbed greenhouse gas emissions enough to reduce the current trajectory.

The web tool also opens the door to see how that sister city has handled current climate issues, such as drought, mosquitoes or excess heat.

"Many communities do not have the resources to develop climate reports and tools on their own," Umphlett said, but this site can help change that. "This gives towns, both big and small, the chance to begin to explore their climate; no one is left behind."

Users will also find a searchable database for planning documents from 18 municipalities, detailing current and potential issues and solutions.

"We've cataloged all these plans by various topics. So, when you search for, say green streets or sustainable infrastructure, the results will take you to the exact page of the plan that covers the topic you are

## City Data Explorer - Sister City Tool

Find a "sister city" with current normals similar to your projected normals.



## HIGH PLAINS REGIONAL CLIMATE CENTER

*The sister city tool on the new website, Climate For Cities, tells users what city would have the most comparable climate currently to projections 30, 50 and 100 years out.*

interested in," Umphlett said. "It's beneficial to see how others have implemented policies around these topics."

The website is the result of [two years' worth of work](#) with 11 cities in Nebraska, Iowa, Kansas and Missouri, and with university partners Martha Shulski, co-lead on the project from the Nebraska State Climate Office; Zhenghong Tang, of Community and Regional Planning; Tarik Abdel-Monem, of the University of Nebraska Public Policy Center; and the Bureau of Sociological Research, as well as Frank Uhlarik of the City of Lincoln.

The project was designed to help municipalities prepare for changes in climate, including warmer temperatures, increased rain events, and more erratic weather, all of which affect city services, utilities, industries, public health and city budgets.

Each of those 11 cities received personalized [climate reports](#), which describe their expected change in temperature and precipitation, as well as the implications of those changes. Lincoln's indicates the city will see more single- and multi-day heavy rain events, which could lead to more frequent flood events, soil erosion and decreased water quality, but the city also is likely to see more drought.

The researchers are cognizant that the reports represent a snapshot in time, and while the online suite won't replace the report, it can certainly enhance its use as the climate data available will always be up-to-date, pulling the most recent numbers from the [Applied Climate Information System](#), a management system

for the complex stream of climate data maintained by NOAA Regional Climate Centers.

Early feedback has shown users expect to use the website to develop mitigation or adaptation plans and to validate decisions being made, as Lincoln plans to do.

"The climate report for Lincoln reaffirms earlier work by UNL published in 'Understanding and Assessing Climate Change (2014)' and forms a solid foundation for the city to ramp up mitigation and resiliency efforts," Uhlarik said. "While we have included various mitigation goals in our 2017 'Lincoln Environmental Action Plan,' we fully intend to more broadly address resiliency efforts both in our comprehensive plan updates and Utilities master plans in 2019/2020."

That won't be the end, though, for the researchers at Nebraska. Over the next few years, they intend to continue garnering feedback to improve and refine the tools, potentially expanding the site to cover specific industries or additional states.

"This work represents stakeholder-driven research that provides cities with a suite of usable climate information to help reduce risk to local climate change impacts," Shulski said. "We learned a great deal about municipal decision-making and climate communication, and the users are provided with synthesized and actionable planning tools."

All steps forward in handling the complex issue.

— SHAWNA RICHTER-RYERSON



SHAWNA RICHTER-RYERSON

Al Dutcher, Extension climatologist with the Nebraska State Climate Office, presents on climate trends during the Nebraska Climate Summit hosted March 21 at Nebraska Innovation Campus.

## CLIMATE SUMMIT ‘RIVETING’

The Nebraska Climate Summit brought together leading experts in climate, health, agriculture, public policy and planning, and put them in a room March 21 at Nebraska Innovation Campus. That room was full of their key stakeholders — Nebraskans.

For an entire day, they talked about climate change, what changes people are likely to see in their lifetimes and what researchers are doing to help inform the issue and potentially foster change. In the audience were people of all ages, from a multitude of industries, with a diverse set of experiences.

“This was a great opportunity to bring together people to learn more about the multitude of efforts going on in Nebraska surrounding climate and climate change,” said Tyler Williams, Nebraska Extension climatologist and co-organizer of the event. “It is so often people get in their own bubble and focus on their own interests, so having this wide-ranging summit hopefully provided a glimpse into something new for everyone.”

Participants were given a crash course in Fourth National Climate Assessment; learned about Nebraska’s weather and water monitoring programs; heard about



### WE’RE ON YOUTUBE

The Nebraska State Climate Office now has a [YouTube channel](#), where you’ll find clips from our recent Nebraska Climate Summit; Al Dutcher’s weekly climate forecast, filmed by Market Journal; and more.

new technology in planning for worst-case climate scenarios; learned about current research and monitoring opportunities in the agriculture industry; focused on public health in the face of warmer temperatures; and learned how municipalities are preparing for changes in climate.

“The summit was the best one of this type I have attended over nearly a decade of being involved in state climate change efforts,” wrote Kim Morrow, of Verdis

Group, after the summit. “I was riveted the whole day on really interesting, original research and practices I had not seen before that have been created in and for our region.

“Together we are becoming much more sophisticated in talking about climate impacts to our area, and thus are helping to build our state’s resiliency to what lies ahead.”

It is the hope of Williams and Martha Shulski, event co-organizer and director of the Nebraska State Climate Office, to keep those conversations going in the future with stakeholder and industry groups across the state.

“Climate change is affecting us now,” Shulski said, “and the effects go beyond the immediate impacts.”

With discussion, with planning, she knows Nebraskans can tackle climate changes issues facing the state together.

### The discussion

The Nebraska Climate Summit was livestreamed. [The videos are now available here.](#)

The speakers also made their presentations [available here.](#)