New Tools for Assessing Drought Conditions for Rangeland Management

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New Tools for Assessing Drought Conditions for Rangeland Management

By Cody Knutson and Brian Fuchs

On the Ground

- Historical drought assessment and ongoing monitoring is essential for understanding past drought occurrence, the relationships between past drought and its impacts, and for triggering action during current drought events.
- A variety of new products have recently been developed to better monitor drought conditions and assess past occurrences at the local scale.
- A growing number of resources are available to assist rangeland managers to develop a monitoring system and incorporate it into a drought management plan.

Keywords: drought, monitoring, risk atlas, VegDRI, risk assessment, planning.

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Drought is a normal part of the climate for any region and can occur in any type of climate regime around the world. It is also one of the primary risks faced by rangeland managers. Understanding the historical occurrence of drought and its resulting impacts, and monitoring current drought conditions, allows for the implementation of more informed drought risk management strategies. Previous studies have shown that farmers tend to have selective memories, remembering most vividly the first, worst, and last droughts they have experienced.[1] In addition to producing inaccurate recollections of drought frequency, the range of conditions experienced can form a mental model of how drought risk should be managed.[1,2] Therefore, rangeland managers who lack drought experience or have experienced a series of wet years may not have a full understanding of the range of potential drought conditions, resulting impacts, and management strategies necessary to effectively prepare for and respond to drought.

These factors can result in a limited range of experiences and information for rangeland managers to draw upon when choosing strategies to prepare for and respond to drought. Also, not having an accurate historical record limits the ability to evaluate relationships between precipitation and impacts of concern (e.g., forage production, water resources, finances, etc.). For example, research in the northern plains shows that the timing of precipitation can be correlated with herbage yields during the growing season.[3] This type of information can be used to develop an appropriate grazing management strategy, including the identification of critical decision-making dates and thresholds for implementing management decisions during times of drought.[4,5]

Similarly, in the past, Thurow and Taylor[6] pointed out that uncertainty associated with the identification of drought conditions often caused a lag in management decision making by ranchers. However, in recent years, an increasing number of drought monitoring products have become available to assist livestock producers and others to better understand the occurrence of past droughts and current drought conditions, which is critical for selecting and implementing informed drought risk management strategies and plans.

There are currently a variety of tools available for monitoring drought events, from the United States Drought Monitor and the weekly assessment associated with it, to individual drought indices that provide a historical perspective of current conditions and the severity of drought. The National Drought Mitigation Center (NDMC) and its partners have worked with stakeholders to develop a range of new drought assessment and monitoring products in recent years, which will be described in this article.

Drought Monitoring

There are many ways to identify and monitor drought conditions. The simplest concept is to measure precipitation and compare to historical values for like periods. More complex approaches use multiple inputs and data to calculate an index or even use satellite information to measure vegetative conditions. The NDMC works to bring monitoring tools to the public so they can assess drought conditions or compare drought conditions to past events.

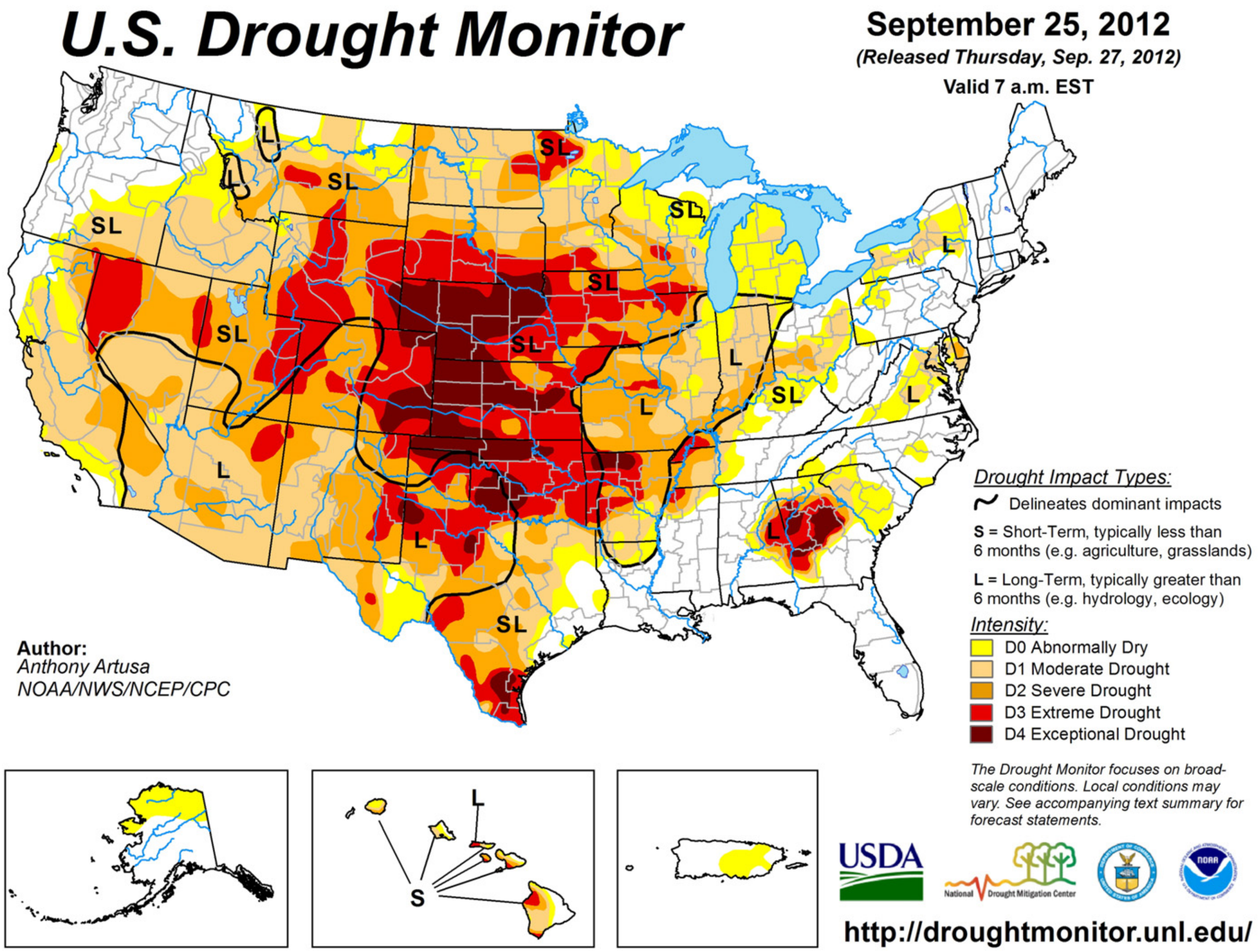

Figure 1. The United States Drought Monitor showing especially severe drought affecting the country in 2012 (http://droughtmonitor.unl.edu).

One of the most widely known tools the NDMC has helped to develop is the United States Drought Monitor, which is a product that is used to assess and identify drought and its intensity each week across the country (Fig. 1). Through a "convergence of evidence" approach bringing together many sets of data (e.g., precipitation, streamflow, soil moisture, etc.), the Drought Monitor has provided a current status of drought conditions across the United States since 1999.[7] It is used as a trigger for several federal relief programs aimed at livestock producers, as well as a number of state drought plans.

In the last few years, two additional tools have also been developed by the NDMC and its partners to assist in monitoring local drought conditions: the Drought Risk Atlas (DRA) and the Vegetation Drought Response Index (VegDRI). Both of these tools are unique in their approaches to drought monitoring and can provide valuable information to livestock producers as part of their drought monitoring and planning activities.

Drought Risk Atlas

Many times questions arise as to the nature of drought occurrence for a particular area. How can current drought conditions be compared to historical events? This was one of the main questions that led to the development of the DRA. The DRA utilizes a database of the most complete, long-term recording stations associated with data collected at cooperative locations within the National Weather Service. It was anticipated that by using data from those locations determined to be the "best" reporting sites, a good historical perspective of drought could be developed.[8] For each station in the DRA, several drought indices were calculated, as well as climatology of precipitation. No single drought index is ideal for identifying and monitoring drought conditions. Therefore, the DRA provides information on the Standardized Precipitation Index (SPI), Standardized Precipitation Evapotranspiration Index, the Palmer Drought Severity Index, the Self-Calibrated Palmer Drought Severity Index, Deciles, and information on the United States Drought Monitor[i]. The variety of information presented allows users to determine the index or indices that best represents drought in their area, which can be used for monitoring the development of drought in the future.

[i] See http://drought.unl.edu/Planning/Monitoring/ComparisonofIndicesIntro.aspx for a description of the drought indices.

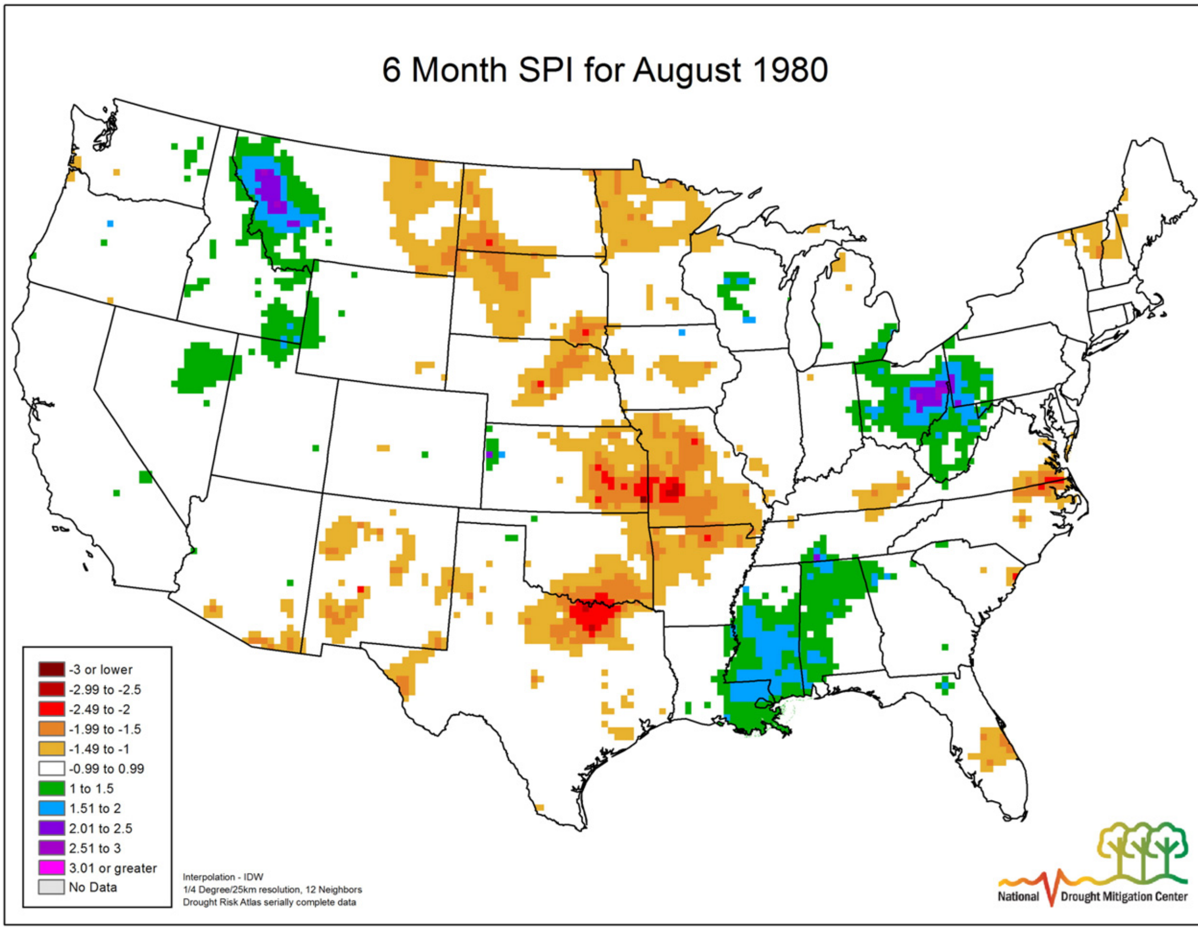

Figure 2. The six-month Standardized Precipitation Index for August 1980 during a drought in the central United States from the Drought Risk Atlas. The negative values represent dry areas and positive values represent areas with above normal precipitation from March to August of 1980 (http://droughtatlas.unl.edu/).

In the DRA, each station selected is unique in that the period during which weather observations were recorded varies amongst the cooperative locations. Some stations have very long histories of recorded data (well over 100 years) while others are much shorter. In most climate studies, it is best to use at least 30 years of data, although longer periods are more ideal. To best represent historical drought events in the DRA, it was determined that each station had to have at least 40 years of data available and is currently still taking observations. The amount of missing observations was important as well, as stations that had the most values present over time are going to be most representative of the climate they are representing. It was determined to use only stations that did not have more than two months of missing data at any period during the records kept. This assured that the longest and most complete stations were used to calculate the drought indices in the DRA. The number of stations identified to be used in the DRA and have drought indices calculated for them was 3,059 stations. Of this number, 349 stations had over 100 years of data, 537 had over 90 years of data, and 1,170 had over 70 years of data. With these many stations with long periods of record available, the DRA is a tool that provides very good information on drought histories in the United States.

However, even with over 3,000 stations in the DRA, not every county or location has data. To solve this issue and to make the DRA usable for anyone, a cluster analysis of the stations was conducted. To develop regions where the climate, and thus the drought indices, were similar for the station used in that region, the characteristics of the station were analyzed. In this process, the precipitation, latitude, longitude, and elevation were used to cluster like stations and then test for homogeneity. The cluster analysis identified 139 unique climate regimes. Within the 139 regions, it was now possible to investigate drought for any location by using the information for the region in determining drought periods and characteristics.

Using the Drought Risk Atlas

The DRA is an online tool[ii] with all the data for each drought index, as well as national maps of drought for any week going back to 1910. For example, Figure 2 shows a national map of spring and summer drought conditions in 1980 based on the 6-month SPI. For more localized information, users decide which data point is closest to

[ii] Access the Drought Risk Atlas online at http://droughtatlas.unl.edu/

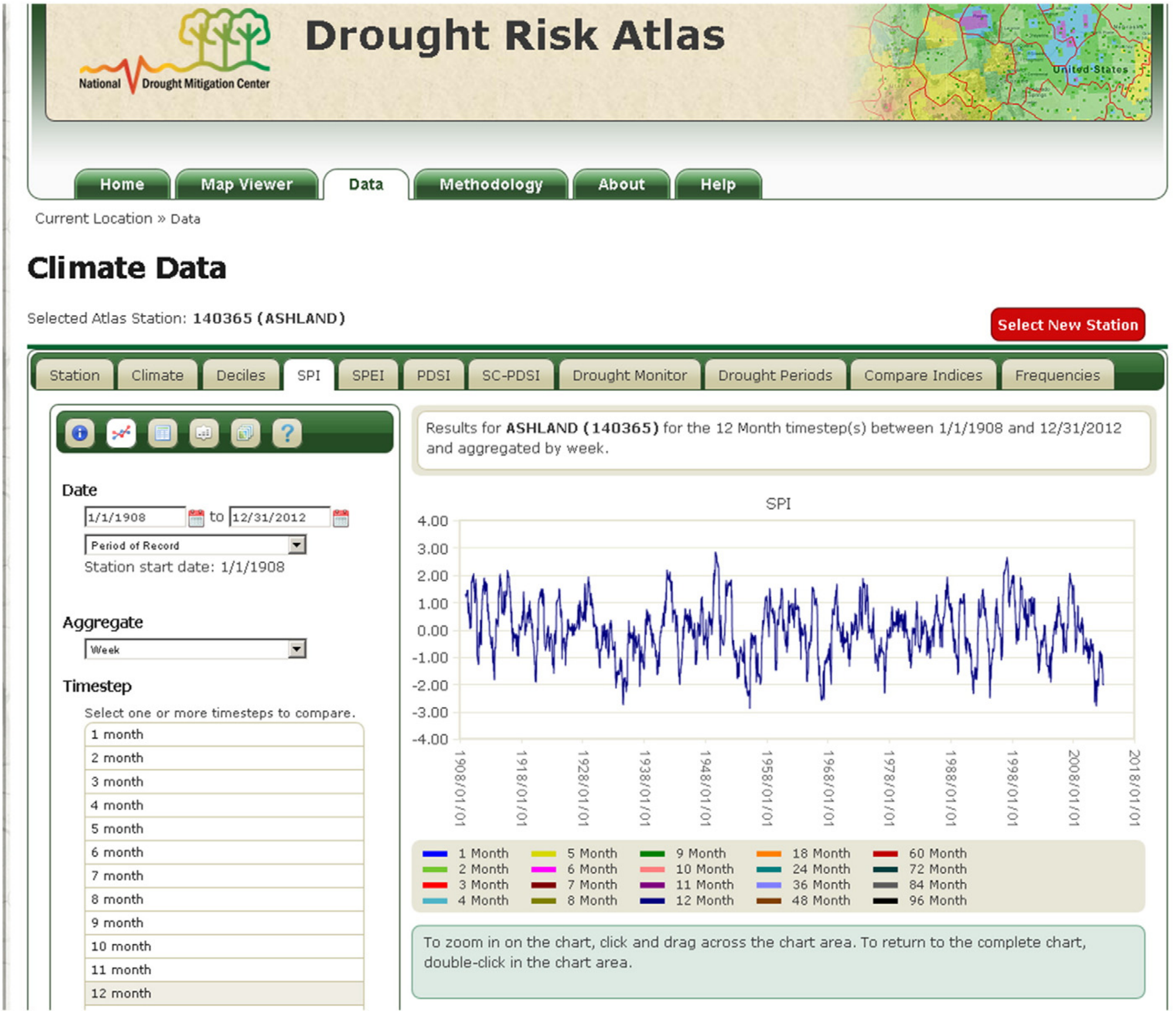

Figure 3. The annual (December 12-month) Standardized Precipitation Index from 1908 to 2012 for Ashland, Kansas using the Drought Risk Atlas tool (calculated at http://droughtatlas.unl.edu).

them, or which stations in the region will be the most useful. The historical information allows users to assess their exposure to past drought, identify the most intense drought periods, how long they lasted, and when they took place. For example, Figure 3 shows the historical annual SPI values for Ashland, Kansas, which is in the southern portion of the state. The graph reveals especially severe droughts in the 1930s and 1950s and several since then. This type of historical information can be used to correlate past drought occurrence with forage and/or cattle production, for example, and serve as the basis for developing a plan to adequately deal with similar droughts that are likely to occur in the future.

The menu options of the DRA guide users along with many choices and options available for gathering and downloading the data. For livestock producers, there are grazing and precipitation periods and critical decision-making dates that are crucial for the operation. The DRA allows users to customize and evaluate the data for the dates or periods of interest. If a producer knows what to look for based on past occurrences, decisions can be made in a timely manner that will have the most positive impact on the overall operation. Currently, the DRA has data through 2012 with an update of the data through 2015 to take place in 2016.

Vegetation Drought Response Index

VegDRI is another important drought monitoring tool for livestock producers. Through high resolution, local-scale maps, the tool shows where vegetation is stressed due to drought conditions. The NDMC has worked with the US Geological Survey (USGS) to produce the high resolution tool by combining satellite data, climate data, and other

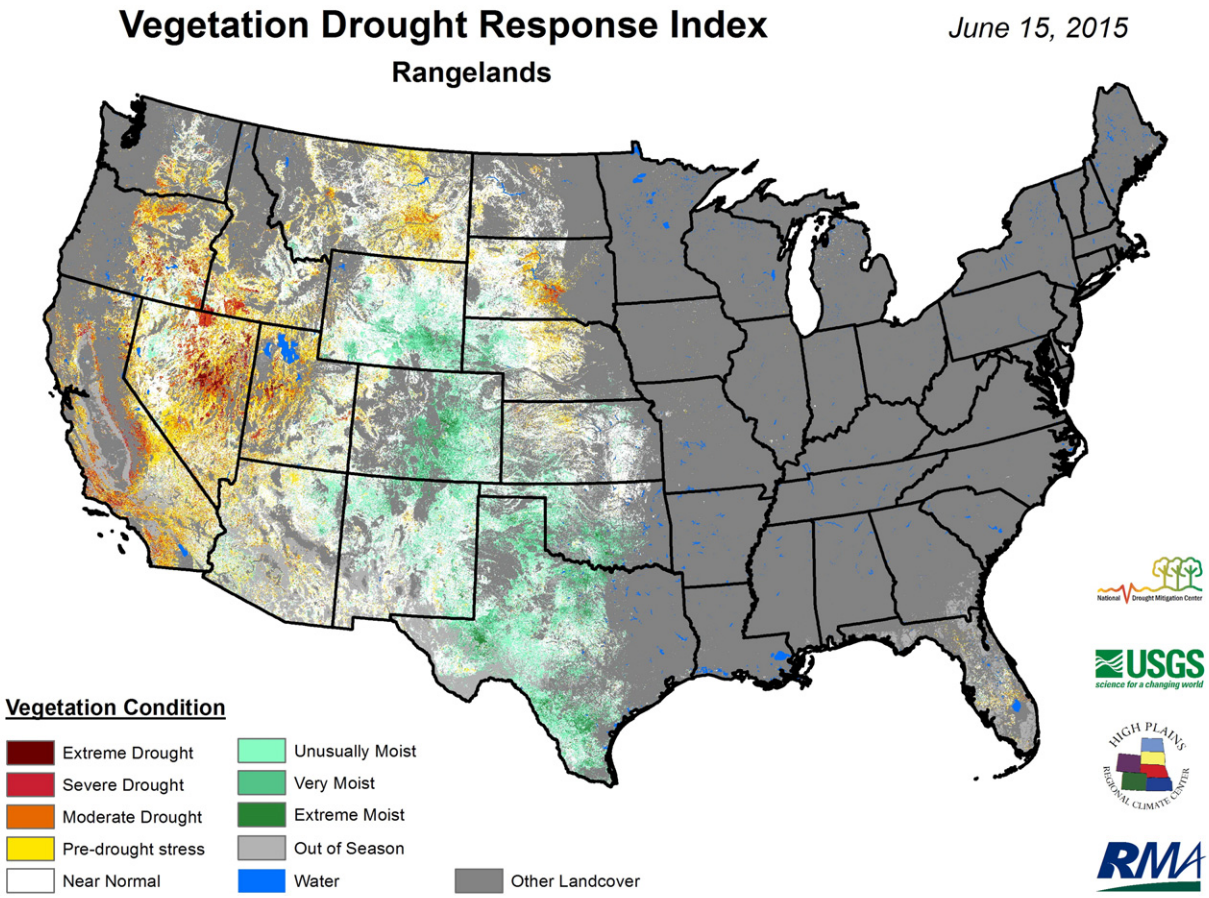

Figure 4. The Vegetation Drought Response Index for rangelands in June of 2015 (VegDRI archive at http://vegdri.unl.edu).

biophysical data, such as land cover and land use, soil characteristics, and ecological settings.[9] The VegDRI product has a 1 km resolution and is produced every two weeks, with an archive back to 1989[iii].

Satellites have been used to monitor vegetation health and greenness in the past. While it has been beneficial, it did not tell the user why there was a change in greenness in the canopy as it could have been due to drought, fire, infestation, disease, crop/plant rotations, etc. What VegDRI does is identify vegetation stress due to drought by using satellite and other climatological and geophysical data. VegDRI is unique in that it also can monitor conditions on rangeland alone, not taking into account other types of crops. The data archive associated with VegDRI is limited due to the satellite record beginning in 1989. Even with a short period of record, VegDRI does do a good job in providing a high-resolution monitoring tool specifically for livestock producers.

Using VegDRI

VegDRI maps are produced every two weeks during the grazing season, which provides the opportunity to monitor changing conditions and potentially serve as another trigger for management decisions (e.g., culling of animals, purchases of hay, etc.). VegDRI allows producers to not only monitor conditions for their area, but it also allows for monitoring other areas where they may ship cattle or buy or sell hay. For example, Figure 4 shows vegetation stress on rangelands due to drought conditions in June of 2015. This map, along with those produced earlier in the growing season, could have been used to assess where drought conditions were occurring, highlighting areas where supplemental forage may be available. They could have also helped prompt producers in the drought areas to evaluate their operations more closely and take appropriate drought management actions.

Monitoring and Planning

It is often said "you can't manage what you don't measure". Ideally, a rangeland manager would establish a comprehensive monitoring system to track climate, forage production, cattle production and other factors of critical importance for making management decisions for their particular operation. As previously mentioned, this is essential for:

- Understanding historical relationships between precipitation and the effects of drought (e.g., forage production, water resources, etc.), which can be used for developing appropriate grazing management strategies and identifying critical dates/thresholds for implementing drought management actions

[iii] Access VegDRI at http://vegdri.unl.edu

- Monitoring drought conditions and triggering management actions during an actual drought event

The tools presented in this article can be an important source of information for rangeland managers developing a local monitoring system, as well as for researchers and other agricultural decision makers.

In addition, an increasing number of resources have been developed to assist rangeland managers in preparing for and responding to drought, including information on utilizing monitoring information for drought risk management and planning. For example, the NDMC released the Managing Drought Risk on the Ranch website in 2011 with funding from the USDA Risk Management Agency[iv], along with a complementary drought planning guide.[10] The NDMC worked with ranchers, advisors, and researchers to develop the planning guide, which includes suggestions for creating a drought monitoring system and utilizing it as part of a ranch drought plan. Relatively new tools such as the US Drought Monitor, VegDRI, and the DRA can provide important historical and current information for assessing past drought and developing a robust drought monitoring system, which is a critical component of any drought risk management plan.

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[iv] See the Managing Drought Risk on the Ranch at http://drought.unl.edu/ranchplan