Success Stories on User Engagement

Global Science & Technology, Inc.

Success Story 6: The U.S. Drought Monitor

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This report examines user engagement with National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information (NCEI) climate and weather data. It demonstrates the value that the free and publicly available provision of NCEI's information provides to the livestock sector. Interviews conducted with key sector stakeholders and supplemental desk-based research illustrate how the livestock sector uses drought information that is developed in cooperation with NCEI. This success story analyzes applications of drought information and its value to the livestock community and federal agencies that administer drought relief. As documented in this report, drought information is of fundamental importance to the livestock sector, a sector which in turn provides food for international and domestic consumption and generates over $100 billion in annual revenue.

Acronyms Used

BLM: Bureau of Land Management
CPC: Climate Prediction Center
CoCoRaHS: Community Collaborative Rain Hail and Snow Network
FSA: Farm Service Agency
IRS: Internal Revenue Service
LFP: Livestock Forage Program
NIDIS: National Integrated Drought Information System
NDMC: National Drought Mitigation Center
NDVI: Normalized Difference Vegetation Index
NESDIS: National Environmental Satellite, Data, and Information Service
NOAA: National Oceanic and Atmospheric Administration
RCC: Regional Climate Centers
SPI: Standardized Precipitation Index
USDA: United States Department of Agriculture
USDA ERS: USDA's Economic Research Service
USDM: U.S. Drought Monitor
VDRI: Vegetation Drought Response Index

Terms and Definitions

Cow: a female bovine animal that has borne at least one calf

Destock: reduce the number of livestock on a range

Drought Management Plan 'Drought Plan': a plan of how to manage livestock needs and/or forage and land resources during drought. Plans may include specific targets, for example, if *precipitation does not reach x% (of normal rain) by Y date, destock by Z cattle* (Beck et al. 2014)

Heifer: a young female cow that has not borne a calf

1. INTRODUCTION

Image 1: Grazing cows
Source: Texas Range Minerals, Inc.

The U.S. livestock and poultry[1] industries are an important part of the U.S. economy, that generate revenues typically exceeding $100 billion per year, creating economic development in rural areas, and meet both domestic and international food demand (USDA ERS, 2017). Livestock operations take place across the country, although are mostly concentrated in the Great Plains, and range from small-scale family owned farms to large-scale industrial operations. Within the livestock and poultry industry, beef production accounts for nearly one third of total production in the U.S. (USDA NASS, 2010).

With abundant grasslands and a large supply of grain, the U.S. has grown into the world's largest producer of beef used both for domestic consumption and export (USDA ERS, 2017). The U.S. is also the second largest beef exporter and the world's largest importer of beef used for lower-value processing (i.e., ground beef; USDA, 2017). Cattle production accounted for $78.2 billion in cash receipts in 2015, representing 21% of the USDA's Economic Research Service forecast of total cash receipts from agricultural commodities (USDA NASS, 2016).

Drought can be an economic and social disaster for the livestock sector, and broader agricultural sector, as its productivity is natural resource dependent. Ranching operations depend on pastures and rangelands, which in turn depend on adequate temperature and precipitation for growth. Having easily accessible tools to monitor drought in near real time is important to a range of stakeholders working in the livestock sector including ranchers, livestock prospectors and traders, livestock associations, and federal and state agencies that administer drought-relief programs.

[1] Livestock sector includes beef cattle and calves, dairy cows and heifers, sheep, lambs and goats, and hogs and

The U.S. Drought Monitor (USDM) is an online drought-monitoring map and accompanying narrative summary that tracks the magnitude, spatial extent, and probability of occurrence of drought across the United States. The USDM is developed through a cooperative effort between the U.S. Department of Commerce's NOAA, the U.S. Department of Agriculture (USDA), and the National Drought Mitigation Center (NDMC). Under NOAA, the NCEI is a key partner in the USDM, producing many climatological inputs that are ingested into the USDM and providing three of about a dozen rotating authors (Fuchs, 2017).

The USDM has varied and important applications within the livestock sector and is used extensively by both federal agencies and livestock producers. The Internal Revenue Service (IRS), USDA, and Bureau of Land Management (BLM) use the USDM as a drought declaration metric for a range of federally sponsored disaster relief programs for livestock producers. Ranchers use it to inform stocking rates, that is, the number of animals per acreage of land, and to speculate on how drought conditions will affect the market prices of grain and feed. Further, the USDM is widely distributed through livestock associations, agricultural economic publications, and university extension offices in order to illustrate the extent and magnitude of drought to their constituents.

This success story focuses on the value of the USDM to federal agencies that support livestock producers and beef cattle ranchers, although not to the exclusion of other types of ranchers (i.e., sheep, lambs, dairy cows, goats). This focus on beef cattle ranchers was chosen due to the high economic output of the beef industry and strong dependence on rangelands and pastures, which are susceptible to drought conditions. This study is based on insights with 20 interviewees including livestock ranchers, livestock associations, agricultural economists, federal and state agencies, university extension agents, and more (see Annex A).

2. DROUGHT

Drought is an insidious phenomenon of nature. It can occur in any climate of the world, although its features differ from region to region (NDMC, 2017a). In general, drought results from an imbalance between natural water supply and demand, where natural water supply is precipitation and natural water demand is evapotranspiration (evaporation due to hot temperatures and transpiration by plants). Typically, reduced water supply is the major cause of drought, while increased water demand tends to exacerbate drought conditions (Heim, 2002).

Drought is commonly characterized in four ways: meteorological, agricultural, hydrological, and socioeconomic (Fuchs, 2012). The first three definitions are concerned with how to define drought as a physical phenomenon, that is, the natural imbalance between precipitation and water demand, whereas the latter is concerned with how to define drought with respect to economic supply and demand, by tracking the impacts of water shortages to society and the economy (NDMC, 2017b).

Drought impacts are the result of interactions between a natural event (i.e., precipitation deficit) and human activities that demand water supply (i.e., agriculture, recreation and tourism, and water consumption) that collectively exacerbate drought conditions (NDMC, 2017a). As normal precipitation and water usage differ from region to region, definitions of drought depend on where water comes from and how it is used (Ding et al. 2010).

Drought is the most common natural disaster in the United States with an average of 14% of the country experiencing severe or extreme drought at any one time (Ding et al. 2010). Unlike other natural disasters such as hurricanes, tornados, and floods, which result in visible damage and occur over a finite period of time, drought develops quietly and slowly and often in the absence of structural and visible impacts. Drought conditions can often go unnoticed until water shortages become severe (Ding et al. 2010).

The long duration, large spatial coverage, and slow pace of drought pose a challenge to quantifying its economic impacts. Unlike other natural disasters that have a defined beginning and end (i.e., a tornado), drought impacts can persist long after the rains have come (Ding et al. 2010). Further, drought creates winners and losers. While ranchers in a drought region are likely to suffer reduced productivity, cattle prospectors and buyers may benefit from depreciated prices of livestock (D. Peel, personal communication, Sept 18, 2017).

Similarly, there are also challenges with quantifying the economic *value of drought information*, and specifically, the USDM. Ranchers depend on a range of resources, including their own expertise and observations, personal networks, and data and indices to understand drought impacts. The value of the USDM alone is difficult to distinguish from other forms of information that often work in tandem with the USDM. Therefore, it is difficult to assess how ranchers' decision-making would be impacted in the absence of the USDM as ranchers would still have to make decisions, albeit with less information at their disposal. While still highly complex, an analysis of the economic value of the USDM to federal agencies administering drought relief may be easier to discern.

3. THE CATTLE INDUSTRY

Modern U.S. beef production is a highly-specialized system that spans from cow-calf operations**,** where a calf grazes on pastureland for 12 to 18 months, to cattle feedlots, where cattle are fed grain from between three to ten months and then slaughtered (USDA NASS, 2016).

Cow-calf operations depend on access to pasture and rangeland. Cows subsist on herbaceous plants such as grass, alfalfa, and shrubs, and raise their calves with little, if any grain input. Cows remains on the pasture year-round and calves remain until they are weaned from the cow. If forage supplies at the time of weaning are abundant, calves may be kept on pastures for additional grazing and growth and sold the following spring. If cattle continue to graze on pasture until slaughter, they are considered "grass finished", whereas if they are sent to a feedlot, they are considered "grain finished" or "conventional". Therefore, regardless of the finish, U.S beef cows generally spend the majority of their lives on pasture, underscoring the importance of rangeland management to the industry (USDA ERS, 2017).

During the cow-calf phase, most of the calf's nutrients are derived from grass, whereas in the feedlot phase, rations are derived from grain and protein concentrates. Cattle remain in the feedlot from three to ten months depending on weight, feeding conditions, and desired finish (USDA ERS, 2017).

Cow-calf operations are generally small scale with an average herd size of 40 head. By comparison, cattle feedlots tend to be industrial-scale operations with a capacity of up to 32,000 head (USDA ERS, 2017). Both cow-calf and industrial-scale operations are vulnerable to drought conditions, the former through reduced grass growth, and the latter through market spikes in the price of grain. However, the cow-calf industry generally faces greater vulnerability to drought due to the small-scale nature of operations, narrow profit margins, and the impact of drought to the land that may take years to regenerate and recover. Further, if cow-calf ranchers cannot feed their cattle with forage and must purchase grain, they would have to do so at a higher market price (D. Peel, personal communication, Sept 18, 2017).

3.1. LIVESTOCK AND DROUGHT

Drought poses a grave threat to animal grazing systems. Prolonged periods of reduced precipitation, particularly in the spring months, combined with above average temperatures impact the quantity and quality of forage and reduce the availability of water resources. Furthermore, drought conditions can cause heat stress to animals as well as limit their conception rates and ability to gain weight (Takahashi, 2012). If plant growth is affected by drought, livestock tend to selectively graze the highest-quality forage first, and the overall forage quality will decline. Reduced forage quantity and quality during drought is much more pronounced than during an average growing season (Scasta et al. 2016).

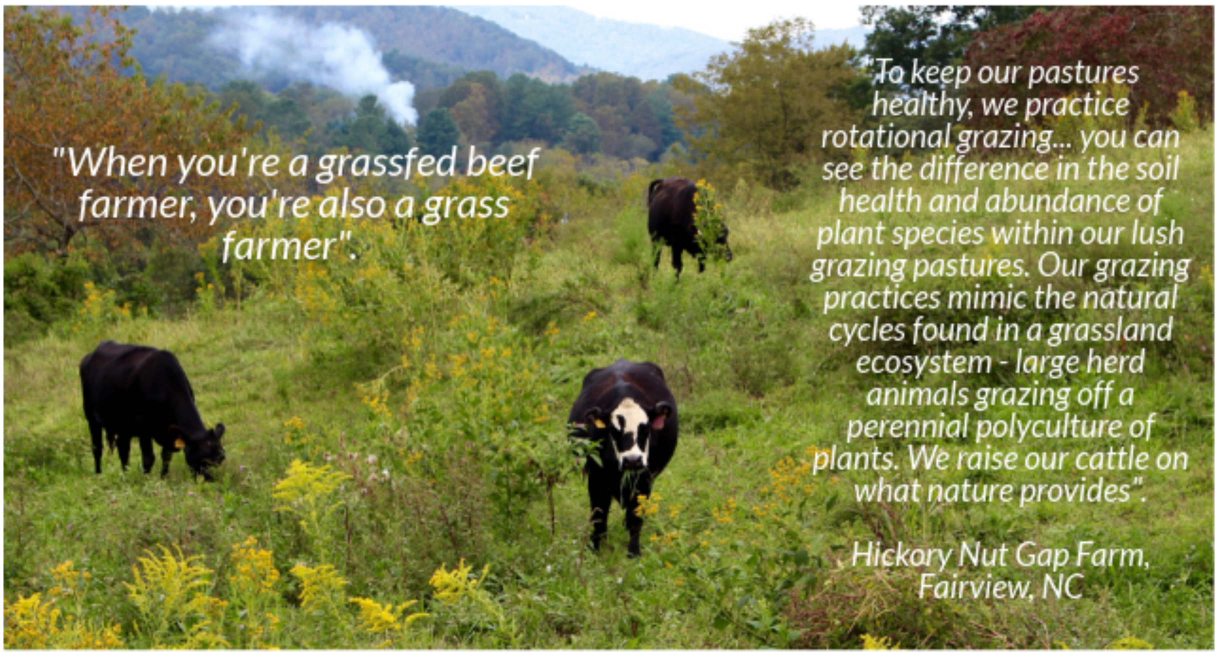

Image 2: Cattle grazing at Hickory Nut Gap Farm in North Carolina. The common sentiment among ranchers interviewed for this study is that they are grass farmers first and cattle ranchers second, as raising cattle is contingent on maintaining the health and integrity of the pastures.
Photo Credit: Amanda Rycerz

Ranchers who do not alter their operations during drought conditions, and therefore do not properly account for reduced availability of forage and water, are likely to experience below average animal performance and, consequently, reduced profits. When drought conditions are triggered, ranchers must make decisions to manage their herds, which may involve destocking, sending cattle to feedlots, leasing additional pasture, or purchasing hay or grain. However, renting pasture is expensive and drought conditions may cause drastic spikes in the market price of grain which may leave ranchers with only one economically viable option—to liquidate their herds (T. Haigue, personal communication, Aug 3, 2017).

4. THE U.S. DROUGHT MONITOR (USDM)

The USDM is a weekly composite drought map and accompanying narrative summary that classifies current drought conditions across the U.S. by consolidating information from drought indicators, climate and hydrological data, soil measurements, models, and local observations. The map displays various characteristics of drought including spatial extent and magnitude, and impacts. Drought intensity is characterized using percentile rankings which are applied to the map through five classifications which denote drought severity (Table 1). The classifications represent how much water is available in streams, lakes, and soils, relative to average conditions at the same time (Svoboda et al. 2002). Drought impacts are denoted according to duration as short term (denoted by S), persisting less than six months, and long term (L), persisting longer than six months. The map also includes a narrative summary for each region (Johnson, 2015).

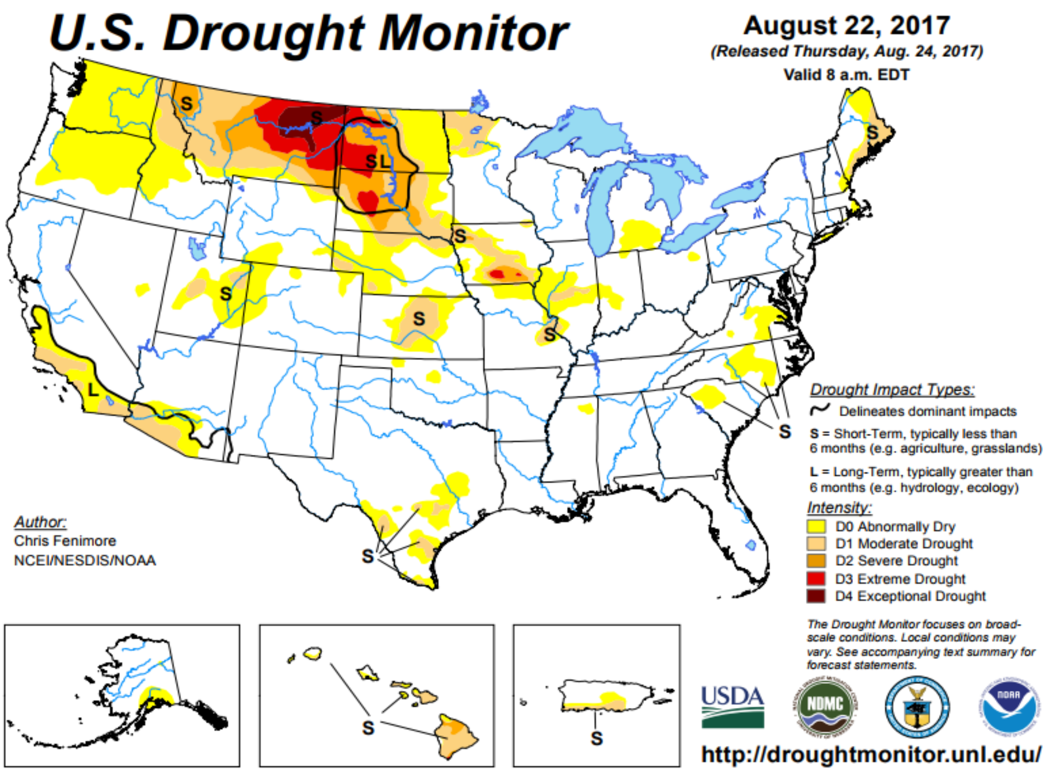

Figure 1: USDM, week of August 22, 2017. D3 and D4 drought conditions persist through the northern Great Plains. **Source**: USDM

Classification	Percentile Ranking	Possible impacts
Abnormally dry (D0)	30st-21th	Drought conditions beginning: ● Short-term dryness slowing the growth of crops or pastures and planting Drought conditions ending: ● Lingering water deficits ● Crops or pastures not fully recovered
Moderate drought (D1)	20th – 11th	● Some damage to pastures and crops ● Some water shortage developing or imminent, low levels of streams, reservoirs, or wells ● Voluntary water-use restrictions (requested)
Severe drought (D2)	10th – 6th	● Water restrictions imposed ● Water shortages likely ● Pasture and crop losses likely
Extreme drought (D3)	5th – 3rd	● Widespread water shortages and restrictions ● Major pasture and crop losses
Exceptional drought (D4)	2nd – 1st	● Widespread and exceptional pasture and crop losses ● Shortage of water in streams, wells, and reservoirs ● Water emergencies

Table 1: Drought and abnormally dry conditions on a 1-5 severity scale and possible impacts.
Source: The National Drought Mitigation Center

The USDM is created through an interagency partnership between NOAA (NCEI, CPC), Regional Climate Centers (RCC), the USDA, the NDMC at the University of Nebraska-Lincoln (Svoboda et al. 2002), and expert input provided by other federal and non-federal partner organizations. About a dozen rotating authors and 350 collaborators contribute to the development of the USDM, which is released weekly on Thursday morning and generated from a week's worth of information ending the previous Tuesday. Every week, hundreds of diverse contributors report drought impacts and observations to the USDM. These contributors may include local drought experts or farmers and ranchers whose livelihoods are affected by drought[2]. A "convergence of evidence" methodology is used for developing the USDM with authors combining their expert judgment with scientific data and local impacts and observations. Indeed, certain products may be more relevant than others in developing maps for certain regions and at certain times of year, e.g. snowpack measurements in the Western part of the country during spring. Understanding the complex interactions between timescales, seasons, geographies, and data products means that the process is not solely quantitative and is, in part, contingent on the author's best judgment and knowledge of the local environment (Johnson, 2015).

[2] Individual contributors work through a USDM representative, for example a state climatologist or NWS forecast office representative, to get information to the drought monitor author. This allows the author to focus on the development of the USDM and not worry about lobbying (R. Heim, personal communication, October 22, 2017)

The data inputs to the USDM are numerous and include drought indices such as NCEI's Palmer Drought Severity Index (PDSI), as well as climate, soil moisture, precipitation, streamflow, and vegetation and fire data. Table 2 outlines some of the primary data products used in the development of the USDM.

Data Type	Combined Climate	Soil Moisture	Precipitation	Streamflow, Surface Water, and Groundwater	Vegetation and Fire
Example Data Products	Applied Climate Information System	CPC Daily Soil Model	Standardized Precipitation Index (SPI)	USGS Streamflow	Vegetation Drought Response Index (VegDRI)
	Palmer Drought Severity Index	NRCS Soil Climate Analysis Network	NWS Precipitation Analysis	Surface Water Supply Index (SWSI)	NDVI Greenness Maps
		USCRN Soil Moisture	NRCS SNOTEL	GRACE Groundwater	Keetch-Byram Drought Index

Table 2: Primary data products used in the development of the USDM. Blue bold denotes data products derived from NCEI.
Source: Johnson, 2015

NOAA's NCEI is a vital contributor to the USDM, both by serving as a rotating author and providing valuable climatological inputs into the USDM. Developed in the 1960s by Wayne Palmer (Heim, 2002), the PDSI was the first drought indicator to assess moisture status comprehensively and is a primary input to the USDM. The PDSI relies on temperature and precipitation data to determine the relative dryness of long-term drought and is considered most effective for nonirrigated cropland (Beck et al. 2014). Other Palmer indices are also used as inputs to the USDM. The *Palmer Z index* responds best to short-term drought and the *Palmer Hydrological Drought Index* considers long-term dryness that will affect water storage, streamflow, and groundwater. Palmer indices are also used in other indices that are inputs into the USDM, for example the Vegetation Drought Response Index (VegDRI) (Dai, 2017).

The Applied Climate Information System (ACIS) was developed by NOAA's RCCs. ACIS integrates historical climate data from NCEI's Global Historical Climatology Network[3] (GHCN-D) and near-real time weather information into an interface that supports operational decision-making through the production of numerous climate-related products and services (ACIS, 2017).

[3] GHCN-daily (GHCN-D) is a global land-based (in-situ) database that collects observations (including temperature and precipitation) from a number of different observing networks (NOAA NCEI, 2017).

In addition to the PDSI and ACIS, other indices used in the USDM rely on data from NCEI. For example, the Standardized Precipitation Index (SPI) relies on precipitation data from GHCN-D and the NCEI climate division dataset. The VegDRI ingests data from the SPI and, therefore, indirectly uses GHCN-D precipitation data. The Normalized Difference Vegetation Index (NDVI) is developed with data from NOAA/NESDIS satellites. Applications of NCEI's data are weaved throughout the USDM, directly through NCEI-developed Palmer products, and indirectly as inputs into other indices including the VDRI, SPI, and NDVI (M. Brewer, personal communication, Sept 18, 2017).

Prior to the creation of the USDM, a complicated network of federal agencies, local governments, and independent studies executed drought monitoring projects. The data this network produced were difficult to interpret, not standardized, and unavailable for large portions of the United States. Thus, the USDM was created in 1999 to consolidate drought monitoring data and be a point of contact between drought scientists, policymakers, and civilians (NDMC, 2017c).

5. APPLICATIONS OF THE USDM

5.1. FEDERAL AGENCIES

One of the biggest USDM user groups includes the BLM, IRS, and USDA, and their state offices. These agencies use the USDM's drought severity categories as thresholds, which once surpassed, trigger certain relief measures or disaster designations.

5.1.1. BUREAU OF LAND MANAGEMENT (BLM)

The BLM manages livestock grazing on 155 million acres of public land. Permits and leases are held by ranchers who graze their livestock, mostly sheep and cattle, for at least part of the year on an allotment. The amount of grazing that occurs each year on BLM-managed public lands is subject to change, based on conditions such as wildfire, drought, and market conditions (BLM, no date).

BLM field offices rely on a range of drought monitoring and assessment tools, including the USDM, to determine the presence of drought and then identify appropriate measures to decrease drought stress on public lands. This may include adjusting grazing use, reducing livestock numbers, altering pasture move dates, shortening the use of the season, changing pastures rotations, closing allotments to grazing use, and more (BLM, 2013). While these measures operate in the interest of preserving public land to achieve and sustain long-term productivity, they also impact ranchers who depend on these lands to graze. This is particularly the case in the western part of the country, where grazing land is largely leased from the BLM. Therefore, while drought monitoring information is important to the agency to enact drought mitigation measures, it may also motivate decisions that impact ranchers' livelihoods (C. McNutt, personal communication, Aug 9, 2017)

5.1.2. INTERNAL REVENUE SERVICE (IRS)

The IRS offers tax deferral and exemption options for livestock producers who sold livestock earlier than planned because of drought. The USDM is used to verify the occurrence of drought. Under International Revenue Code Section (IRC) 451(e), ranchers can postpone reporting taxable gain on the sale of livestock, if the livestock was sold due to weather-related conditions (IRS, 2006). Drought conditions must meet secretarial disaster designations[4], for example consecutive eight weeks in D2 drought, in order to qualify. IRS Section 1033(E) allows livestock producers to be exempt from taxable gain from the sale of livestock, if the producer intends to replace the livestock at a later time. If the producer's county is eligible for federal assistance, the producer is required to replace the livestock after the first drought-free year. The USDM is used to determine when a county is drought free—that is, no weeks in which any part of the county or neighboring counties experienced D1–D4 drought conditions. The adoption of the USDM has made the eligibility process less subjective, and resulted in higher efficiencies, as the IRS depends on one source, the USDM, to verify tax deferral eligibility (NCBA, no date)

5.1.3. USDA FARM SERVICE AGENCY

The USDA's Farm Service Agency (FSA) offers a variety of relief programs to help livestock producers manage drought-related losses. The USDM is used within these programs to designate drought declarations and trigger relief for producers who meet the eligibility requirements. Under the following programs, the FSA determines a county's eligibility for drought relief based on the USDM's disaster designations. Livestock producers who meet the necessary criteria and reside in a drought-designated county are eligible for relief. These programs include:

- **Livestock Forage Program** (LFP): provides compensation to eligible livestock producers who have suffered grazing losses due to fire or drought on native or improved pastureland. The LFP paid out $2.7 billion in 2015 and $488 million in 2016 (FSA, 2017d).

[4] The Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans available to livestock producers suffering losses as a result of the disaster (USDA, 2017).

- **Livestock Assistance Grant Program** (LAGP) (2006): provided $50 million in state block grants to help livestock producers partially recover forage production losses due to drought conditions that occurred in 2006 (FSA, 2017d).
- **Emergency Livestock Assistance Program** (ELAP): provides financial relief to eligible livestock producers for losses due to disease or adverse weather conditions, as determined by the Secretary of Agriculture. ELAP assistance is provided for losses not covered by other disaster assistance programs authorized by the 2014 Farm Bill (USDA FSA, 2017b). ELAP paid out $59 million in 2015 and $19 million in 2016 (FSA, 2017d).
- **Non-Fat Dry Milk Feed Program** (2003): non-fat dry milk sales were made available for eligible livestock producers who were affected by drought conditions in 2003 (FSA, 2017d).

5.1.3.1. Livestock Forage Program

The 2014 Farm Bill authorized the LFP to provide disaster relief to eligible livestock producers who suffer drought-related grazing losses (USDA FSA, 2017a). The LFP is among the most popular livestock drought relief programs administered by the USDA's FSA. Since 2011[5], the LFP has provided over $6.2 billion dollars[6] in relief funds to livestock producers to purchase supplemental feed (USDA FSA, 2017c). Qualifying under the LFP program is based on a county's designated grazing periods (variable on a county-by-county basis) and the USDM's drought designations (see Table 3). A county qualifies for relief once drought reaches a certain designation (D2–D4) and persists for a certain amount of time. Relief funds are determined based on the severity of drought, the size of the livestock operation, and the type of forage used (Rippey, 2017). Ranchers can check their eligibility with the FSA Eligibility Tool[7].

Prior to the adoption of the USDM into the LFP, the FSA's disaster declaration process required FSA staff to conduct on-the-ground assessments to evaluate and determine crop losses. These time-consuming assessments, a lengthy secretarial disaster designation process, and extensive discussions between county, state, and federal officials slowed the overall expediency of the process. The lengthy bureaucracy of the program and the need for independent assessments meant that the process of administering relief was largely ad hoc and subjective. Relief was often administered retroactively and

[5] Even though it was enacted in 2014, under the LFP Program grazing loss compensation was retroactive to 8/1/11.
[6] Updated as of September 6, 2017.
[7] http://droughtmonitor.unl.edu/fsa/Home.aspx

sometimes too late for farmers to purchase supplemental livestock feed if ranchers liquidated their herds as a result of inadequate feed supplies (T. Haigue, personal communication, Aug 3, 2017).

If your county is rated	Your loss during the normal grazing period was:	You may get assistance payments equal to:
D2 (severe drought)	At least eight consecutive weeks	One month
D3 (extreme drought)	At any time	Three months
D3 (extreme drought)	At least four weeks	Four months
D4 (exceptional drought)	At any time	Four months
D4 (exceptional drought)	Four weeks, not necessarily consecutive	Five months

Table 3: LFP payout scheme based on the USDM drought classifications.
Source: disasterassistance.gov

With the implementation of the USDM in 2014, the process of administering relief was depoliticized, as it no longer required the FSA's employees to substantiate drought conditions within their state. Independent regional assessments were replaced with the USDM, and drought designations were now based on pre-defined categories (B. Haugen & B. Olson, personal communication, Sept 11, 2017). This change made the relief eligibility process easier to understand both for ranchers receiving relief and FSA employees administering relief. The automated nature of the process also meant that eligible ranchers were no longer required to maintain detailed farm records, thus eliminating extensive record keeping on the part of the rancher. If drought conditions reached a certain threshold and persisted for a certain amount of time, eligible ranchers who had signed up for the LFP program would receive an automated payment. The systemic nature of the program gained greater popularity among ranchers as it became easier for the FSA to communicate and promote (J. White, personal communication, Sept 8, 2017).

The question of whether or not FSA payments have increased or decreased with the adoption of the USDM is complex and requires an economic analysis that accurately appraises relief costs alongside a host of other factors (M. Brusberg, personal communication, Aug 18, 2017). However, most of the federal agency interviewees consulted for this study believed that the adoption of the USDM led to higher payouts, as a result of reaching more ranchers in need. This increase is not attributable to the USDM alone, but also to restructured relief allocation, greater awareness, improved efficiencies, and a more refined and streamlined relief distribution process. In recent years, greater awareness and outreach surrounding the LFP program coincided with the adoption of the USDM, which meant that more ranchers signed up for the program. Furthermore, ongoing reference to the USDM in drought-condition discussions by major media outlets including *The Weather Channel, CNN, NPR,* and *USA Today* has been helpful for FSA officials to draw greater awareness to the program (J. White, personal communication, Sept 8, 2017). The mandate of the FSA's LFP is to support farmers, ranchers, and agricultural partners through a range of programs and services, rather than cost conservation. The systematic administration of relief through the adoption of the USDM has helped accomplish the FSA's mandate by enabling ranchers to continue to meet both domestic and international livestock demand during periods of drought (M. Brusberg, personal communication, Aug 18, 2017).

RANCHERS

The USDM has many applications to ranchers, some that vary depending on the time of year and the occurrence of drought. This section will provide two case studies that discuss general applications of the USDM to ranchers.

Ranchers in a drought situation monitor the USDM to determine whether they are eligible for relief under various federal drought disaster programs. As discussed, the USDA's LFP uses the USDM's drought designation categories (D0–D4) to determine relief payouts to livestock ranchers. As the payouts are automatically triggered by the USDM's designations, eligible ranchers can track the weekly USDM to see whether relief funds will be released (L. Edwards, personal communication, July 21, 2017).

> Drought Management Plan 'Drought Plan': A plan on how to manage livestock needs and/or forage and land resources during drought. Plans may include specific targets, for example, if *precipitation does not reach X % (of normal rain) by Y date, destock by Z heads* (Beck et al., 2014).

Ranchers who have a Drought Management Plan are likely to have triggers written into it that are contingent on precipitation or moisture thresholds. For example, a rancher may have a plan to destock cattle by June 1st if rainfall does not meet 75% of the long-term average. Determining whether thresholds have been met, may depend on a rancher's own on-farm observations, consulting of drought indices and tools including the Palmer Indices and the USDM, or some combination thereof. The USDM may be particularly valuable for ranchers who do not have all their livestock concentrated in one county and cannot rely on on-farm observations alone. With a range of resources available at their disposal to substantiate their own observations or provide a stand-alone index, the USDM helps ranchers to make better informed management decisions (T. Haigue, personal communication, Aug 3, 2017).

Ranchers use the USDM to speculate on how drought conditions will affect the market price of feed (e.g. hay, grain) or livestock (D. Peel, personal communication, Sept 18, 2017). Drought conditions can lead to a reduced supply of feed and forage which can cause greater demand than supply, leading to a regional price spike. For example, Lynn Myers, owner of Myers-Tippet Ranch in Nebraska, regularly monitored the 2017 drought in the northern Great Plains to speculate how conditions may affect the price of hay in Nebraska. As the price of hay rose in the Dakotas, ranchers were increasingly purchasing hay from the south which began to drive up the price of hay in Nebraska. Lynn observed the spread and worsening severity of drought on the USDM and speculated that this trend would continue. Lynn made the decision to purchase hay in advance, thereby avoiding the large price spike that ensued (L. Myers, personal communication, Aug 16, 2017).

Cattle buyers look to the USDM to see where drought conditions are persisting and where there may be high volumes of cattle for sale. For example, during the 2011–14 drought in the southern Great Plains, ranchers came to Texas from across the country to purchase cattle at a discounted rate. The high volume of cattle at the Texas auctions meant that buyers could purchase herds at a competitive price (D. Peel, personal communication, Sept 18, 2017). The USDM can also be used to identify regions that have drought-free conditions and where grazing conditions are opportune. Some ranchers in drought situations may make the management decision to transport their cattle to better pastures. However, the costs associated with cattle transport and pasture leasing may be cost-prohibitive and, thus, liquidating herds may be more economical (J. Faulstich, personal communication, Aug 10, 2017).

The USDM is used widely to orient ranchers to where drought conditions are most severe and persisting. Although ranchers may not deliberately seek out the USDM maps to alert themselves to drought conditions, they are still likely to indirectly consume this information through agricultural extension offices, livestock associations, FSA outreach, or the media (D. Peel, personal communication, Sept 18, 2017).

CASE STUDY

DAYBREAK RANCH

Image 4: Jim Faulstich of Daybreak Ranch, South Dakota.
Source: NewsOK, Eric Landwehr

Jim and Carol Faulstich are the owners and operators of Daybreak Ranch, an 8,000-acre ranch of native grassland, cropland, conservation land, wetland sloughs, trees, and food plots in Highmore, South Dakota. Jim Faulstich is a third-generation ranch owner and has over 30 years of experience in the business of cattle and land ("Daybreak Ranch," 2009). As a rancher, Jim grazes approximately 350 cow-calf pairs on his pastures, and as a landowner, leases his pasture to other ranchers to graze yearling heifers, a young female cow that has not borne a calf.

Jim is an avid user of the USDM, referring to it as a "tool for market prediction". He regularly uses the USDM to understand drought conditions nationwide and more specifically as a proxy to understand whether drought is going to affect the price of feed and cattle. During drought, unfavorable growing conditions can cause the supply of forage and grain to decrease, thereby causing the market price to increase. The higher price of feed may make the cost of maintaining herds unprofitable (feed costs > beef market value) and, therefore, may compel ranchers to sell their livestock. A greater number of livestock on the market may cause the price to drop, if supply exceeds demand. Selling livestock before the market price drops is optimal, to receive the highest price per head.

Jim uses the USDM to determine the optimal time to sell, based on drought-influenced market conditions. As a part of his drought management plan, each year Jim divides his cattle into three groups: “keep”, “sell” and “to be determined”. The divisions are based on several factors including age, productivity, and genetics. At a certain pre-determined date, the ‘sell’ cattle will go to market, and decisions will be made regarding the ‘to be determined’ group. As drought conditions approached extreme levels (D4) in the northern Great Plains in July 2017, Jim had to revise his drought management plan in order to stay ahead of the potential price drop of cattle. By monitoring the USDM to understand the spatial extent and persistence of drought conditions, and by drawing on his own experience of market trends, Jim decided to transfer more cows into the ‘sell’ group and sell his cattle two months in advance of the original date, to beat the anticipated market price drop. Jim’s speculations proved to be correct, as drought conditions worsened, and many ranchers chose to liquidate at the same time. The benefit of the sale of the cattle plus the savings of forage outweighed the costs of keeping the cattle in drought conditions.

The drought also meant that Jim did not have adequate forage to continue leasing his pastures to other ranchers. Therefore, Jim sent out a two-week notice to ranchers who leased his pastures, in order to preserve the integrity of the land. Jim posits that other ranchers may use the USDM to identify areas to send cattle to areas with better grazing conditions. However, the costs associated with transporting cattle and leasing grass are very expensive, and ranchers are more likely to send their cattle to feedlots.

Jim refers to the USDM every week from early April to the end of the fall season. It helps him affirm the conditions he is observing on his own ranch, and allows him to speculate on market trends. The USDM is also an important component of Jim’s drought management plan, helping him to make management decisions when drought conditions become apparent (J. Faulstich, personal communication, Aug 10, 2017).

ALEXANDER RANCH

Figure 5: Brian and Ted Alexander of Alexander Ranch. **Source:** Water + Energy Progress

Brian and Ted Alexander are the owners of Alexander Ranch, a 7,000-acre grassland ranch in Sun City, Kansas, that has served as a custom-grazing operation for cattle since the early 1980s. The Alexanders are rangeland grass farmers who lease their pastures to cattle ranchers. Ranchers pay a fixed amount per cow, per day to graze their herds on the Alexanders' pastures. The ranch can hold as many as 500 cow-calf pairs and 1,000 yearlings, or 250 cow-calf pairs and 3,000 yearlings (Alexander, no date). However, drought years can impact the quality and quantity of forage and, therefore, limit the number of cattle that the Alexanders' pastures can sustainably accommodate.

The Alexanders are avid users of the Climate Prediction Center's (CPC) U.S. Monthly and Seasonal Drought Outlook, a companion product of the USDM that provides drought projections from one to three months into the future. The Alexanders regularly use CPC's 30-, 60-, and 90-day forecasts as a partial-budgeting tool in the early parts of the year. In the winter months, the Alexanders look at the 90-day CPC Outlooks to anticipate growing conditions in the spring and how they should set their stocking rate. Spring months are critical for grass growth[8], and dry growing conditions combined with overgrazing of the land is detrimental to forage growth. The Alexanders recall that in February 2017 the 90-day outlooks called for dry spring conditions. They reduced the stocking rate accordingly, in keeping with the ranch's Drought Plan to avoid over grazing. The Alexanders continued to monitor the 30-day outlook throughout the season to compare how the 90-day outlook was tracking and to get a sense of the overall trend. While grazing more cattle would generate a higher income for the Alexanders, as

[8] For example, each inch of rain on the Alexander Ranch between April 15–July 15 will grow 150 pounds of grass/acre whereas an inch of rain in November will only grow 40 lbs of grass/acre (T. & B. Alexander, personal communication, Aug 9, 2017).

rangeland producers their objective is to preserve the integrity and health of the mixed-grass prairie ecosystem.

As climate change impacts become more pronounced, the livestock industry is going to be challenged to an even greater extent. The CPC Outlooks provide the Alexanders with a valuable tool for seasonal planning and the ability to identify appropriate management actions (B. and T. Alexander, personal communication, Aug 9, 2017).

6. AREAS FOR IMPROVEMENT

Interviewees suggested areas where the USDM could be improved to better serve their needs. Ranchers emphasized the need for more data collection points to more accurately determine temperature and precipitation variability within a county. For example, in remote areas of South Dakota, there are large counties with only one or two reporting stations. As weather can change drastically within a ten-mile radius, county drought designations may only reflect drought conditions in two areas and not align with overall county conditions (J. White, personal communication, Sept 8, 2017). Ranchers could, therefore, be experiencing drought conditions that are not reflected in a county drought designation. This difference could create inequities if ranchers in drought are not eligible for federal assistance. However, the reverse scenario also holds true. A rancher may not be experiencing drought-related impacts, yet will still be eligible for drought relief if the county is designated as dry. Thus, the system is not capable of discriminating between ranchers' perceived and actual losses (B. Haugen and B. Olson, personal communication, Sept 11, 2017).

The recommendation for improved spatial granularity was also accompanied by a request for information at a shorter time-step. Many ranchers feel that the USDM does not illustrate drought conditions fast enough because the first signs of drought are observed on the ground, weeks before they appear on the USDM. This problem could potentially be resolved with higher spatial resolution, either from additional reporting stations (if available) or on-the ground observations submitted to the USDM. Ranchers, and other community members, can volunteer to be weather observers through the Community Collaborative Rain Hail and Snow Network (CoCoRaHS). Community observers can submit their own rain, hail and snow observations, as well as drought impact reports, to help fill in the spatial gap between official GHCN-D stations. Additionally, ranchers can contact their State Climatologist or local NWS office and relay observations at the first sign of drought, so they can be channeled to the

USDM authors straight away. Another recommendation was to integrate global imaging into the USDM, in order to capture drought impacts at a finer temporal and spatial resolution (J. Faulstich, personal communication, Aug 10, 2017).

USDM partners and state FSA agencies recognize the need for greater awareness and education surrounding the USDM and its role in federal disaster assistance programs. Some ranchers are under the impression that they can lobby the state or the FSA to get drought designations changed, thereby suggesting that constituents are not fully informed about the process by which drought designations are determined. At the same time, some ranchers interviewed for this study were unaware that there is a mechanism, The Drought Impact Reporter[9], by which they can submit local observations to the USDM through the University of Nebraska-Lincoln's NDMC. As the USDM is not a purely quantitative output, local observations may be considered in the development of the weekly maps (J. White, personal communication, Sept 8, 2017).

7. CONCLUSIONS

The livestock industry is foundational to the U.S. economy and way of life, generating over $100 billion annually in revenues, creating employment in rural areas, meeting international and domestic demand for food, and satisfying food preferences and providing nutritional value. Due to a high dependence on natural resources, the economic productivity of the ranching industry is susceptible to a range of environmental factors including drought. While drought is a normal and recurring phenomenon of nature, it can have devastating repercussions for the ranching industry if it is severe, prolonged, and unmanaged. Therefore, ranchers benefit from near-real time drought monitoring tools to make informed management decisions. With its easy-to-understand interface and clear depiction of extent and severity of drought conditions, the USDM has helped ranchers to stay ahead of market price fluctuations of grain and cattle, to understand the national and regional context of drought, and to make decisions regarding the carrying capacity of the land. Beyond its application to ranchers, the USDM is also used extensively by federal agencies, including the IRS, BLM, and USDA, as a drought-declaration metric. The USDM is a cornerstone of the USDA/FSA's LFP program which has administered over $6 billion in relief to ranchers who suffered drought-related feeding losses. The adoption of the USDM brought about numerous efficiencies to the LFP program, as it replaced the need for on-the-ground

[9] http://droughtreporter.unl.edu/map/

assessments, depoliticized the process of administering relief, significantly reduced the turnaround time for payouts, and, most importantly, helped the FSA reach more ranchers in need. The proliferation of use of the USDM by major media outlets also draws greater awareness to federal relief programs, making them easier to promote to ranchers.

The USDM is developed through a cooperative effort between the Department of Commerce's NOAA, the USDA, and the NDMC. Within NOAA, NCEI is a key partner of the USDM providing three of about a dozen rotating authors and developing key climatological inputs that are used in the USDM. Applications of NCEI's data are knit throughout the USDM, directly through NCEI-developed Palmer products, and indirectly as data inputs into other indices including the VDRI, SPI, and NDVI (M. Brewer, personal communication, Sept 18, 2017).

This analysis has shown the extensive socioeconomic value that stakeholders in the livestock sector derive from the USDM. The interviews conducted for this study underscore the value of the USDM and its role in supporting financial decision-making in the livestock sector. Its application as a drought-declaration metric in the LFP has sped up relief payouts, thereby allowing ranchers to recover faster from the impacts of drought, while safeguarding domestic meat supply. While this study has only focused on the livestock sector and specifically beef cattle ranching, the USDM is widely used in a variety of other sectors including water management, tourism and recreation, agriculture (crops), and more. The USDM is valuable to a range of industries that depend on natural resources for economic output and supports decision-making worth billions of dollars.

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ANNEX A: INTERVIEWS

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