10-2018

Tracking Drought Perspectives: A Rural Case Study of Transformations Following an Invisible Hazard

Theresa Jedd
University of Nebraska - Lincoln, tjedd2@unl.edu

Deborah J. Bathke
University of Nebraska-Lincoln, dbathke2@unl.edu

Duane Gill
Oklahoma State University, duane.gill@okstate.edu

Bimal Paul
Kansas State University, Manhattan, KS, bkp@k-state.edu

Nicole Wall
University of Nebraska-Lincoln

See next page for additional authors

Tracking Drought Perspectives: A Rural Case Study of Transformations Following an Invisible Hazard

THERESA JEDD,[a] DEBORAH BATHKE,[a] DUANE GILL,[b] BIMAL PAUL,[c] NICOLE WALL,[a] TONYA BERNADT,[a] JACOB PETR,[d] ANTHONY MUCIA,[a] AND MILAN WALL[e]

[a] *National Drought Mitigation Center, School of Natural Resources, University of Nebraska–Lincoln, Lincoln, Nebraska*
[b] *Department of Sociology, Center for the Study of Disasters and Extreme Events, Oklahoma State University, Stillwater, Oklahoma*
[c] *Department of Geography, Kansas State University, Manhattan, Kansas*
[d] *Department of Earth and Atmospheric Sciences, University of Nebraska–Lincoln, Lincoln, Nebraska*
[e] *Heartland Center for Leadership Development, Lincoln, Nebraska*

(Manuscript received 28 June 2017, in final form 12 June 2018)

ABSTRACT

Rural towns are especially susceptible to the effects of drought because their economies are dependent on natural resources. However, they are also resilient in many ways to natural hazards because they are rich in civic engagement and social capital. Because of the diverse nature of drought's impacts, understanding its complex dynamics and its effects requires a multidisciplinary approach. To study these dynamics, this research combines appreciative inquiry, the Community Capitals Framework, and a range of climatological monitoring data to assess the 2012–14 Great Plains drought's effect on McCook, Nebraska. Community coping measures, such as water-use reduction and public health programs, were designed to address the immediate effects of heat and scant rainfall during the initial summer and the subsequent years. Residents generally reported the community was better prepared than in previous droughts, including the persistent multiyear early-2000s drought. However, the results highlight wide variation in community perspectives about the drought's severity and impacts, as well as divergent experiences and coping responses. Despite these factors, we find evidence of the transformative potential of moving from drought coping to drought mitigation. We attribute the city's resilience to the ability to draw upon prior experience with droughts, having a formal municipal plan, and strong human and social capital to coordinate individual knowledge and expertise across agencies. We suggest that droughts have served a catalytic function, prompting the community to transform land-use practices, water conservation planning, and built infrastructure in lasting ways.

1. Introduction: Detecting drought recovery

McCook (population 7526)[1] is located in southwest Nebraska, where the strong cultural independence of the western United States joins the moderate midland semiarid prairies (Woodard 2011). It is located in the Republican River basin, with fertile soils, little air pollution, adequate surface and groundwater supplies, and well-known wildlife habitat. Despite ecological similarities with neighboring states, it retains a strong connection to the heritage of Nebraska. Red Willow County is home to the Buffalo Commons Festival, and its residents celebrate farming and ranching, which contribute to the agricultural productivity of the state. McCook's natural features create economic opportunities for agricultural producers, businesses, and tourism operators that increase the community's resilience to natural hazards. Extended droughts challenge that resilience by reducing lake and pond levels, with rippling effects on overall surface water supply, increased reliance on groundwater, and diminished fish and wildlife habitat.

In 2012, the warmest July on record drew attention back to the devastating effects of the Great Plains drought 10 years earlier (NOAA/NCEI 2012). By January of 2013, conditions had worsened, and counties in 14 states were declared natural disaster areas from drought

[1] U.S. Census Bureau QuickFacts: https://www.census.gov/quickfacts/fact/table/mccookcitynebraska,US/PST045216.

Corresponding author: Theresa Jedd, tjedd2@unl.edu

DOI: 10.1175/WCAS-D-17-0067.1

(USDA 2013). In Nebraska, surface water use was prohibited because of low river levels; in some cases, groundwater irrigators used as much water by mid-July as they would during the entire growing season (NOAA/NCEI 2012). The early signs of the drought were difficult to ignore because they involved a range of sectors.

While drought is sometimes viewed as a rare, random phenomenon, it is actually a normal, recurrent feature of climate; it originates from a period of deficient rainfall that is sufficiently long enough to cause adverse effects to a sector, a group, or the environment (Wilhite and Glantz 1985). Drought is relative, defined in terms of what is normal or expected for a particular region or time of year. Drought also reaches across context and perspective. An agronomist may measure drought in terms of plant growth, a meteorologist may focus on precipitation decline, and a hydrologist might be concerned with streamflow and reservoir levels, whereas a suburban resident may only notice drought when shortages interfere with the ability to water a lawn (Saarinen 1966). Since drought cuts across disciplines, it follows that approaches to building institutional capacity emphasize understanding the full range of impacts, particularly with regard to how they affect society (Wilhite et al. 2007).

Temperature and precipitation deficits (Dyer 2000), vegetation stress, soil water capacity (Brown et al. 2008), groundwater levels, and snowpack (Hayes et al. 2012) are critical components of early drought detection. However, once drought sets in, a cascade of impacts is triggered across society (NDMC 2018). Understanding these impacts is key to increasing the capacity to cope with and recover from drought (Wilhite and Buchanan-Smith 2005). This research uses a social science framework to understand the dimensions of drought recovery, with the purpose of informing rural community resilience. The following sections introduce the background on rural risk to natural hazards (section 2), define the methodology (section 3), outline the meteorological and climatological features of the drought in McCook (section 4), present the results of the analysis (section 5), offer a multidimensional discussion and recommendations (section 6), and conclude by situating results in the context of community resilience (section 7).

2. Background: Natural hazard risk and resilience under the Community Capitals Framework

Media accounts of natural disasters in the Great Plains describe the devastating impacts and the initial attempts toward recovery. Narratives regularly emphasize the importance of volunteer help from coworkers, friends, and neighbors; services and materials provided by local governments and faith-based organizations; and wise utilization of financial assistance from federal agencies (Aldrich 2012). Local government and civil society build programs addressing the unique needs of small town residents. Without them, a natural disaster can strain a community beyond coping capacity.

Scholars and practitioners have conceived various explanations for why some communities thrive under a range of conditions, while others struggle to retain cohesion, claiming that successful rural communities understand their underlying vulnerabilities (Adger 2006; Wilhite et al. 2000) before a hazard occurs. Having an inventory of assets and vulnerabilities is valuable for dealing with drought because the root causes, dynamic pressures, and unsafe conditions that put people in harm's way are not direct features of the environmental threat (Blaikie et al. 1994). Because of their unique features, rural communities are simultaneously at risk from and resilient to drought (see Fig. 1).

Rural communities often have limited diversity for economic livelihoods. Many of the financially lucrative activities center on natural capital (see Table 1), so a decline in water resources can have profound effects. Furthermore, a limited demographic base and an aging population (U.S. Census Bureau 2016) can have negative consequences for the labor workforce. On the other hand, rural communities are resilient to disasters because they are rich in social capital of tightly connected family networks and local experts (Pretty 2003). Schools are hot spots for developing future leaders, and communities may pride themselves in providing kindergarten–grade 12 (K–12) education (Donehower et al. 2007). The local economy may benefit as irrigation techniques advance and production becomes more efficient with crop selection and pest management (Howell 2001). Finally, the abundance of natural resources can be an asset to attract tourism business and maintain a high quality of life (Butler 2014).

A community's relationship with its environment and development of assets affects how it prepares for and responds to natural hazards. The Community Capitals Framework (CCF) asserts overall resilience comes from focusing on the assets in place across multiple dimensions (defined in Table 1).

Natural capital forms the basis of other capitals in rural communities (Flora et al. 2015). Ecosystems with high levels of air and water quality (abundant natural capital) provide financial capital for productive croplands (Flora et al. 2015), creating conditions for stable built facilities if political capital is in place to recognize citizen concerns and administer resources. In this way, each of the capital areas relates to the others (see Fig. 2).

For a community to rebound successfully from a disaster, it must have a degree of resilience. Resilience is

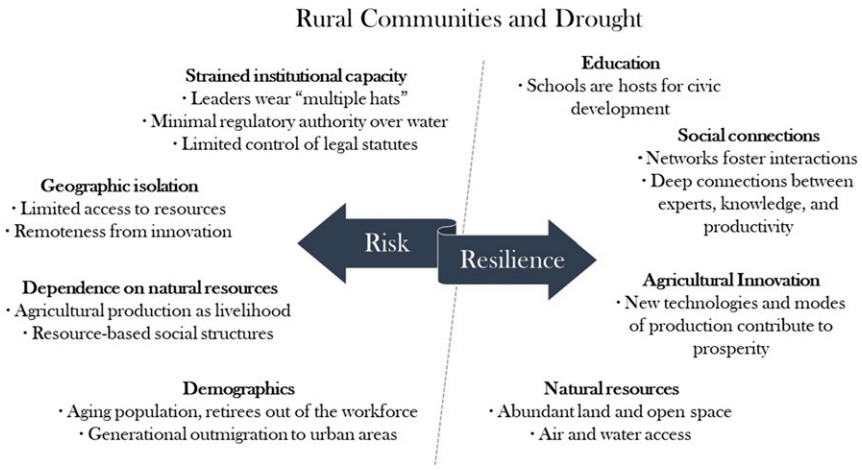

FIG. 1. Rural communities possess risk factors to drought but are also resilient because of their inherent features.

the ability to withstand a loss and to recover when or if it occurs (Buckle 2006, p. 90). The CCF asserts that all communities have resources within them; as these resources are reinvested to produce new resources, they become capitals (Flora et al. 2015). The resilience paradigm introduced the importance of social science in understanding environmental change, explicitly acknowledging that the changes made in response to environmental conditions can alter standards of living (Folke et al. 2005). Unpacking the social response to drought has been a particularly pressing need (Wilhite and Buchanan-Smith 2005), and the CCF provides systematic understanding of the key recovery features within a community.

3. Method: Drought detection and asset inventory

This research was conducted with focus groups and interviews as the primary sources of data. Secondary materials included climatological monitoring products produced by the National Drought Mitigation Center, documents provided by community members, U.S. Census statistical data, and water pumping volumes and price data from the McCook municipal water utility. A culminating workshop was used to validate results.

Purposive participant sampling was conducted for data collection (Creswell and Creswell 2018). Focus group and interview participants were selected from city leadership (the mayor, city manager, fire chief, and economic development director), county and federal government personnel (public health director and water manager), natural resource experts (university extension agents, local seed dealer, farmer, and rancher), and others identified in a snowball sample by the primary participants (e.g., utilities director and clerk and city council member).

These mixed methods were crucial in determining the extent and severity of the drought, what changes were triggered in the community, how residents responded, and what longer-lasting transformations may have resulted. The climate background and initial impact assessment

TABLE 1. The operationalization of the community capitals [adapted from Flora et al. (2015)].

Capital	Assets
Financial	Resources used as investments that can be easily translated (or liquidated) into monetary or other assets.
Built	The permanent and physical constructed facilities supporting productive activities.
Political	The organization, connections, voice, and power that citizens use to turn norms and values into codes, rules, and regulations.
Social	Human interaction characterized by reciprocity and mutual trust formed among and between groups to reinforce collective identity and action.
Human	The assets that people possess (health, formal education, skills, knowledge, and leadership) to reach their potential.
Cultural	The priorities placed on values and knowledge about social and economic advantages.
Natural	The consumable land, water, biodiversity, and climate features that contribute to a high standard of living.

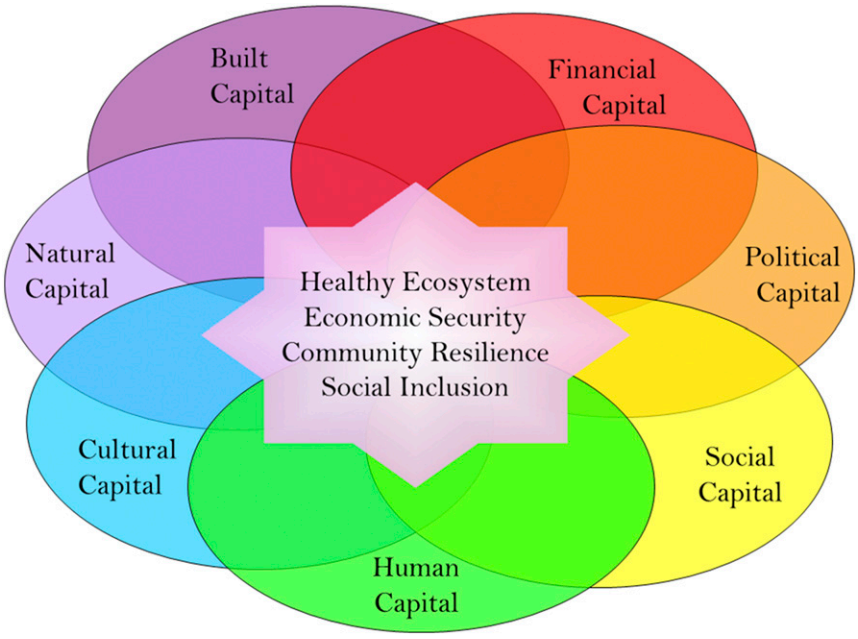

FIG. 2. The CCF model is a lens that researchers and communities can use to understand the full complexity of what helps a community to stay healthy and resilient [adapted from Flora et al. (2015)].

was shared with focus group participants. Fieldwork, analysis, and validation was conducted in 2016 and 2017 with a research team spanning climatology, sociology, geography, political science, natural resources, meteorology, and public participation.

a. Data collection

Project meetings began in January of 2016. An initial consideration of U.S. Census data provided community demographics, population size, economic status, housing, and road networks. Other secondary data (from agricultural census documents and commissioned reports) were used to build a profile of the capitals. The community profile informed the research team of McCook's assets. An introductory webinar meeting was held in April 2016 with an advisory team, which consisted of local university extension personnel. These three individuals work in agricultural education fields and were selected because they serve in or near the study location and are familiar with the town's residents. This advisory team meeting uncovered social connections within the community and began a dialogue on how to meet residents' needs regarding drought. The advisors showed familiarity with recent droughts and comfort discussing them with each other and the research team. The advisory team identified additional key participants and pretested the focus group and interview questions.

Subsequently, three focus groups convened in May of 2016 to solicit perceptions of drought response and recovery.[2] In total, focus groups and interviews involved 26 participants. All sessions were conducted in an educational format, with a presentation on the drought conditions including basic information about the monitoring tools and the CCF. Participants were given time to introduce themselves, review the materials, ask questions, and begin discussion. Structured questions in each of the capital areas guided the conversation for approximately 2 hours. These questions pertained to formal and informal roles in disaster management, drought awareness, vulnerable groups in the community, major concerns during the 2012 drought, preparedness, resources, organizational learning, and overall drought resilience. A full focus group interview protocol is included in the appendix.

Individual interviews supplemented focus groups to be respectful of participant availability and/or their familiarity with the community or sector.

[2] The first focus group was held with city council and the utilities department at the McCook city building. The second was with producers, co-op dealers, and a federal water resource manager in a conference room at Mid-Plains Community College. The third group with public health officials, law enforcement, and natural resource managers took place in the boardroom of the Southwest Nebraska Public Health Department.

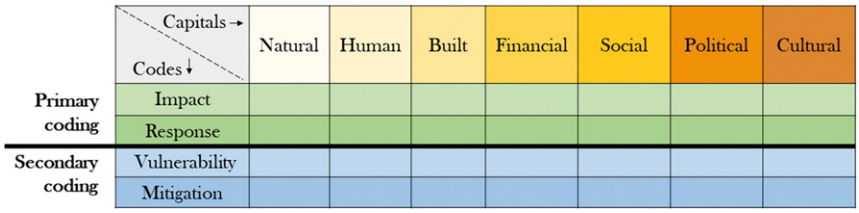

FIG. 3. This coding schematic depicts the primary categories used in the initial phase of the coding and the secondary categories used in the second phase. In both phases, the capital areas were also linked with the data.

For example, in the case of the fire department chief, who had managed the department during multiple drought periods, an individual semistructured setting was most appropriate. The team interviewed the mayor/YMCA director, an economic development director, and a representative of the financial sector similarly.

Additional documentation involved photographing the community and collecting local newspapers and publicity materials. To discover how leaders have used political assets, we analyzed policy documents and reports shared by administrators. Smaller telephone focus groups in August of 2016 included key leaders unavailable during the field visit. Phone follow-up interviews covered cultural, financial, and built capital with the town historian, the Commons festival director, a banking sector representative, and the utilities director.

Information about the coping responses was collected using appreciative inquiry (AI). AI is a self-calibration method used to select appropriate research questions and gather information through in-person dialogue (Cooperrider and Srivastva 1987). AI is based upon positive psychology seeking to uncover what worked rather than what went wrong, allowing researchers to gather information from communities without alienating individuals or groups (Nyaupane and Poudel 2012).

Action-oriented data collection techniques (Gergen 2015), which involved collaboration with community partners, helped ensure that this research would not only generate scientific knowledge, but also produce findings that were meaningful to the community (Small and Uttal 2005). For example, the research team actively engaged with residents throughout the process of identifying participants, determining focus group questions, securing interview locations, and disseminating findings. This two-way information exchange between the team and the community has been shown to be effective in revealing social dynamics related to sensitive water topics (Wutich et al. 2010) and in creating drought resilience (Wall and Hayes 2016). Furthermore, self-help is a central tenet: throughout the process, we recognized the capacity that individuals and communities have to solve local challenges.

b. Data analysis and validation

Interviews and focus groups were recorded by the researchers and transcribed verbatim. All content was uploaded into QSR NVivo qualitative analysis software for coding. Primary codes were created for each capital area, impacts, and coping responses. Axial codes were designed in the secondary phase to address several additional dimensions (Saldaña 2016), including the intent of the actions (monitoring, coping, and mitigation) or the underlying and/or preexisting vulnerability of the capitals themselves (see Fig. 3).

The data were coded entirely by consensus by two to three researchers at a time. This involved team dialogue as the codes were assigned to transcript materials. Where there was disagreement, adjudication and dialogue were used to reach agreement (Saldaña 2016). For visualization purposes, these impacts were mapped using Gephi network software to show their distribution per capital (Figs. 6 and 7).

After the study results were compiled, the research team assisted with a larger disaster and hazards workshop within the context of rural community development. In the workshop, 60 participants from communities in nine states, including four leaders from McCook, reflected on and learned about natural hazard recovery. Discussions with key community members were used to validate the results and refine the discussion.

4. Drought in McCook

Time series and spatial data on drought occurrence and extent were used in the educational materials and the introduction for each focus group to help participants to recall their experiences and to expose them to potential new sources of climatological monitoring tools.

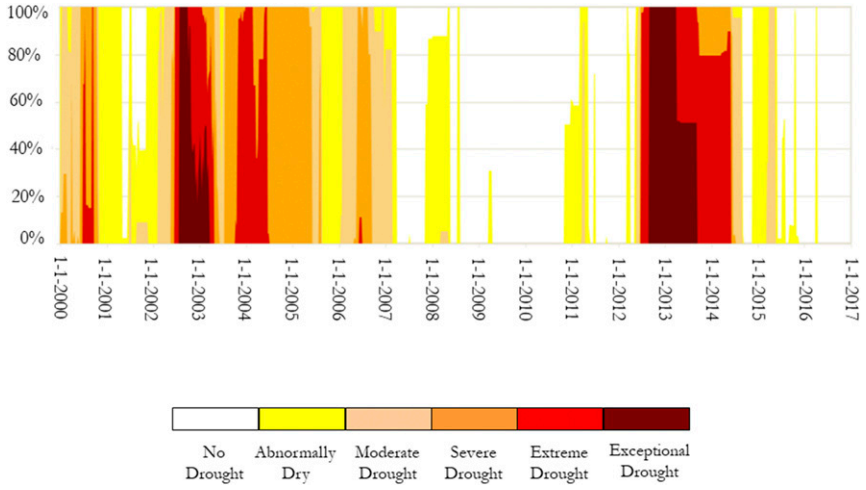

FIG. 4. USDM statistics for Red Willow County from Jan 2000 to Jul 2016 (source: http:droughtmonitor.unl.edu). The percentages along the *y* axis represent the extent of drought-class coverage in the county; 1 January is labeled for each year along the *x* axis.

a. Meteorological and climatological monitoring

The U.S. Drought Monitor (USDM)[3] established the timing of the drought event. The USDM is a joint product of the National Drought Mitigation Center at the University of Nebraska–Lincoln, the United States Department of Agriculture (USDA), and the National Oceanic and Atmospheric Administration (NOAA). It assesses the spatial extent and intensity of dryness by synthesizing multiple types of climate information, impact reports, and expert scientific assessments. The output portrays a range of conditions, including temperature, precipitation, soil moisture, vegetation health, streamflow, and snow levels. For each county, state, and region, the USDM tabulates the percent area affected by different drought statuses, enabling the comparison of conditions through time.

b. The drought event

According to the U.S. Drought Monitor, severe drought has affected the McCook area during nine years since the turn of the century. The highest category, "exceptional drought," was present twice from July 2002 to March 2003 and began again in August 2012, persisting through September 2013 (Fig. 4).

The first indication that McCook was headed into a dry spell in 2012 came with the release of the 13 March USDM (Fig. 5). This map introduced "abnormally dry" (D0) conditions in Red Willow County in response to weeks of below-normal rainfall and abnormally high temperatures. By 10 April, enough rain had fallen to eliminate this short-term dryness. In the following weeks, warm, dry weather returned, causing conditions to deteriorate again. In the first half of May, the McCook airport recorded 0.07 in. (1 in. = 2.54 cm) of rain, about 5% of normal, leading to the reintroduction of D0 classification on 15 May.

Dryness continued to develop as rainfall remained below normal, and temperatures exceeded normal values on all but a handful of days. By 29 May, the status was downgraded to "moderate drought" (D1) in Red Willow County. Conditions continued to deteriorate throughout the summer as rainfall deficits continued, and record-high temperatures were set. On 26 June, the McCook Municipal Airport station recorded its hottest maximum temperature at 115°F (HPRCC 2017). One week later, on 3 July, the USDM depicted "extreme drought" (D3) over Red Willow County as triple-digit temperatures, combined with limited precipitation, depleted soil moisture levels and caused a decline in crop conditions. By 24 July, D3 encompassed just over 64% of the state, resulting in additional impacts to the agricultural sector. Statewide, irrigators struggled to meet water demands for crops as 95% of top soil was either dry or far below the requirements for normal plant development (USDOC/USDA 2012). Additionally, 72% of the state's pasture/rangeland was in poor to very poor condition, causing the release of Conservation Reserve Program (CRP) lands for emergency foraging and the sale of livestock. On 4 September, the USDM depicted exceptional drought (D4) over Red Willow County, meaning that conditions fell in the second percentile, equating to a 1-in-50-yr event (Svoboda et al. 2002).

[3] The U.S. Drought Monitor was established in 1999, and data layers are available beginning in January 2000 and continuing through the present at http://droughtmonitor.unl.edu/.

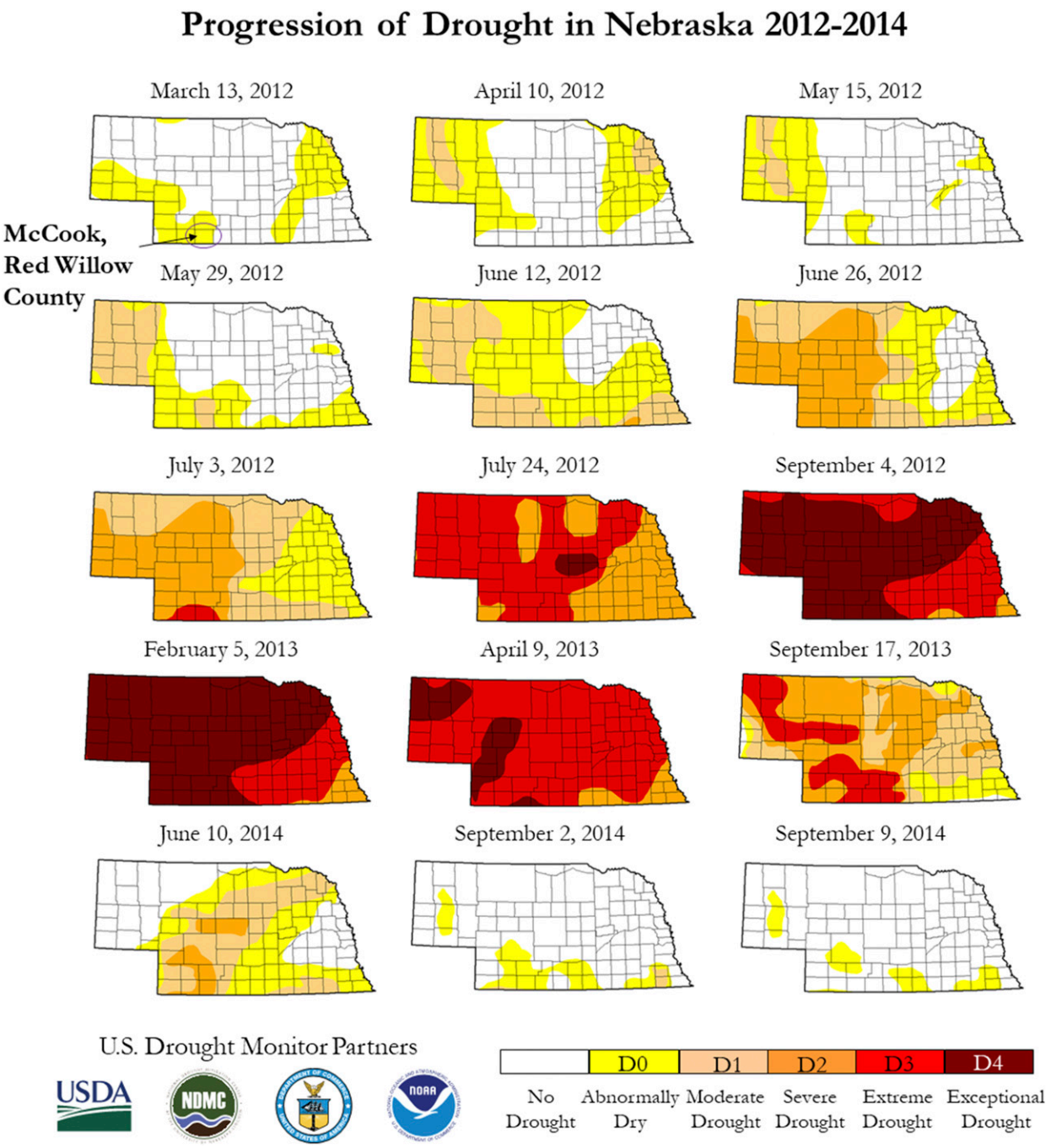

FIG. 5. The USDM for selected dates during the 2012–14 drought in Nebraska (source: http:droughtmonitor.unl.edu).

5. Results: Perspectives on drought impacts and coping responses

Three central themes emerged: the interdependency of impacts, divergent experiences and coping responses, and the transformative potential in moving from drought recovery to drought mitigation. These themes are based on secondary consensus coding and reflect an effort to systematically engage concerns and insights of the research participants.

a. Interdependency of impacts

Drought impacts did not always fit neatly within a single capital area, and often an impact in one area had ripple effects onto others. Surface water depletion was

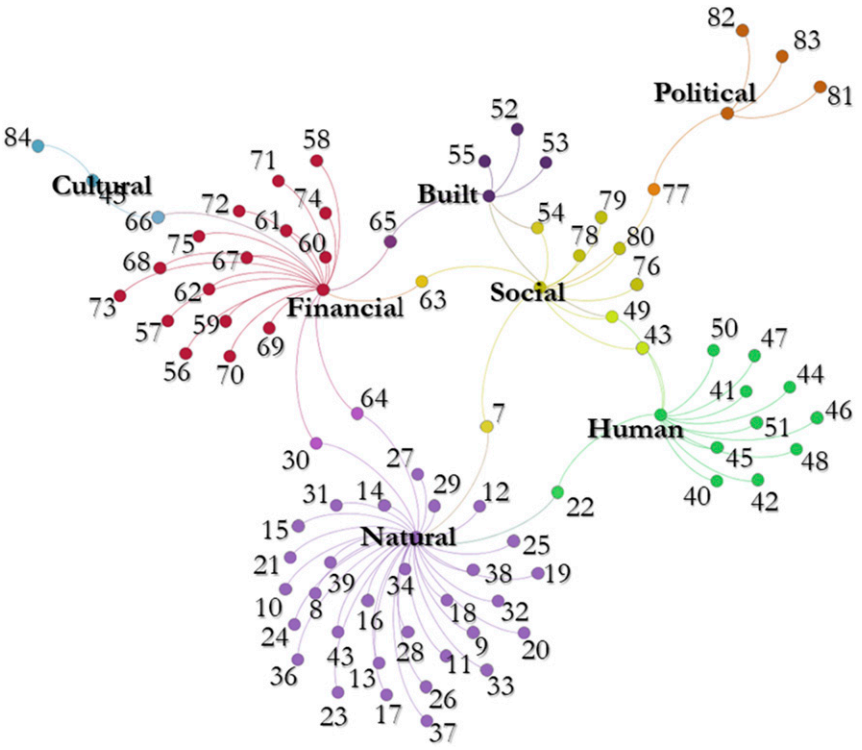

FIG. 6. The impacts distributed onto their capitals (source: authors; see Table 2 for data list).

prominent. Participants reported that irrigators experienced a shortage early on. High prices and scarce hay and water supplies led ranchers to relocate, cull, or sell their herds at below-normal prices. Meanwhile, recreational visitors to neighboring lakes were deterred by reduced water levels and toxic blue-green algae. Fishing also suffered. Stakeholders mentioned that outdoor activities declined, and ''water-based recreation came to a near halt.'' Hotels, outfitters, and gear shops lost revenue because of a decreased number of hunters.

Natural capital declined because of a shortage of water for key ecological functions (Fuchs et al. 2015). Wildlife suffered. Red Willow County is particularly renowned for its pheasant habitat, enriched by the interspersion of corn, milo, and wheat fields near grassy rangelands and prairie lands protected by the Conservation Reserve Program (Duggan 2010). Drought reduces the cool-season alfalfa grasses that CRP lands tend to have (King and Savidge 1995). The Game and Parks department documented over a 70% reduction in the pheasant population from the spring of 2012 to the spring of 2014. A wildlife biologist noted, ''People don't realize how interconnected things really are in rural areas. Pheasant populations can attract hunters from around the state and the country. [This] brings in a lot of outside money.'' The sentiment reflects the source of pride found in local hunting and a recognition of the value in natural resources. The impacts to natural capital were more numerous relative to the other capitals, as shown in the network plot in Fig. 6.

Social impacts were related to heat, including ''hot tempers'' during games held early in the afternoon. The mayor reported it was too hot to comfortably go motorcycle riding. Town residents complained the lawns were suffering, and outside town the pastures were brown. Reservoir levels for recreation were reduced because of increased irrigation. Community access to wildlife became limited, in terms of lost hunting opportunities. Finally, people began to act ''owly'' and spend time inside due to heat stroke risk (see Table 2 for detailed impacts to social capital).

Financial impacts were noteworthy. Decreased surface water irrigation supply affected the local and regional economy. Producers noted that high land values, singly and in combination with severe drought conditions, affect the ability of small landowners to remain operational, which has cascading effects on various agribusinesses. Resulting market fluctuations included a decrease in market price of hay, corn, soybeans, and cattle. Additional impacts included a decrease in tractor sales and farm equipment. With decreased moisture levels, forage production suffered as plants struggled to produce mass. In dryland corn production, it is possible to see the effects of heat and water loss quite

rapidly. Farmers in McCook referred to this phenomenon as ''reacting to what you know today.'' The turn of conditions during the summer came on quickly. Corn plants ''curled'' their leaves within a matter of a single day.[4] Farmers felt helpless to recover their crop viability, noting that once the plants reached a certain level of heat stress, it was impossible to bring them back.

Producers expressed concern for rangelands. Once a drought begins, it can harm livestock as increasing evapotranspiration concentrates salts in soils and plant forage, making livestock thirstier. A participant noted that visiting Red Willow County rangelands during the major drought ''was depressing to me. Every step you're going crunch-crunch-crunch like you are walking through wheat stubble.''

The drought also affected transportation for farming operations as the combination of high winds and ongoing drought conditions caused several dust storms, which reduced visibility, altered air quality, and made driving hazardous. Wildfires spread across the border in Oberlin, Kansas, worsened by the high winds and dry conditions. The fires destroyed numerous cornfields, pastures, and wheat fields (Discoe 2012). The consensus from the financial sector was that the drought had significant economic repercussions.

Community member perspectives on built capital differed. While some reports maintained that the city infrastructure was unaffected, others reported strain to varying degrees. Mild effects included that the YMCA swimming pool was not as clear because of the use of blending and backwashing water-conserving techniques. Municipal water infrastructure strained to meet demand during peak hours [from 0400 to 1000 local time (LT)]. The utilities director reported that the city's single 24-in. pipe proved marginally capable of handling the daily volume requirements. As a result, the pressures increased to nearly 100 lb $in.^{-2}$ (psi; 689.5 kPa). A new 16-in. supplemental pipe relieved the strain on the main line. The more severe effects related to wastewater and water treatment.

In stark contrast, from a fire management perspective, the impacts were minimal. No major structure fires were reported in town, and the fire department was confident that the hot, dry conditions posed little risk to buildings. While there were numerous effects on the surrounding rural and agricultural areas, conditions were closer to normal in the municipal area. One city official remarked, ''it was just another hot, dry typical summer.''

However, one producer noted that farmers and ranchers were still suffering from the 2002–03 drought and that it took longer for water levels to return to normal after the mid-2000s. This created a vulnerability in political capital in terms of future water management as surface and groundwater irrigators could have been pitted against one another. Some of this could be attributed to drought or to other factors already present, such as ongoing state legislative battles (L.B. 701; Nebraska Legislature 2007) and the interstate Republican River Compact agreement (Public Law 696; U.S. Congress 1942). Overall, 2002–03 had a worse impact on this producer as it seemed hotter and lasted longer, which caused multiple subsequent years of water management issues.

b. Divergent experiences and response programs

Monitoring and communications were essential to McCook's response and recovery. The city manager was noted as a strong leader in the community (because the city needs to supply the community with an adequate amount of water), along with the fire chief and Red Willow sheriff's office. University extension also led the agricultural sector by providing drought information to the *McCook Gazette* (2006–15) and local radio stations. Teachers and students were educated on the impacts of drought, and discussions with both groups have taken place through various leadership programs, such as 4-H and Future Farmers of America. Other trusted sources of information included communications from the local Natural Resources District (NRD) and the health department. Individuals within these agencies worked to educate the public. Table 3 displays the response data.

The responsibilities of the health department included mosquito census for West Nile virus in two counties in the district. It was also tasked by the state to do surveillance on illnesses in hospitals and schools on a weekly basis. School nurses were concerned about the increasing number of occurrences of asthma in children, which was an ongoing concern for decades. The health department receives reports from the state on the quality of public water systems, and they also monitor reports on lake water quality related to blue-green algae blooms.

Nebraska Game and Parks provided educational and pond management materials and tailored habitat and wildlife protection plans. Conservation-based programs involved preventive prescribed burns to preserve natural capital, as well as alternative-income programs to allow private landowners to seek income from hunters. Farmer education programs centered on water conservation during drought. Emergency responders took fire

[4] Curling, or ''rolling,'' happens when the leaves begin to turn inward as heat stress affects their ability to hold enough water to maintain proper osmotic pressure (Nielson 1996). Leaf rolling is a natural response mechanism, giving plants a defensive posture against moisture deficits. It is common to see this response for shorter periods, but once it reaches more than 12 h in a day, problems with reduced grain yield are likely (Nielson 1996).

TABLE 2. Impacts listed by capital area (in italics). Impacts in multiple capitals are denoted with an asterisk.

Observed impact	Ref. no.	Observed impact	Ref. no.	Observed impact	Ref. no.
		Natural			
Lawns were dry	7	Two-year reduction of pheasant population (70%)	19	Boaters, hunters, fishers, and campers affected	30*
Hot during the summer	8	Decline in pheasant and quail hunting	64*	Changing plant populations	31
Hot during the year	9	Four-year reduction of pheasant population (25%)	20	Concentrated water pollutants	32
Many wildfires in the area (outside city limits)	10*	Habitat destruction: ''nothing grew back''	21	It was dustier	33
Reduced air quality	11*	Presence of crickets, gnats, or moths in homes	22*	Dry lightning strikes led to grass fires	34
Reduced humidity	12	Lack of insects for pheasants	23	Dirt and smoke in the air	35
Reduced pasture water	13	15–20 days of 100°F+ temperatures	24	Reductions in morning dew (for pheasants and quail)	36
Little pasture grass	14	Worsening wildfires	25	Deer affecting crops	37
Increase in toxic blue-green algae (June and May)	15	Lack of huntable wildlife	26	Fibrous feed with lower protein and digestibility	38
Southwest part of the state received little rain (April–September)	16	Fish were dying	27	Lingering soil moisture loss	39
Grassland acres were denuded	17	Increase in fish habitat water temperature	28		
Sheriff patrol saw fewer pheasants and quail	18	Lakes were low	29		
		Human			
Increase in heat related illness	40	Presence of crickets, gnats, or moths in homes	22*	Mutual aid requests for manpower from fire department	49*
Volunteer firefighter exhaustion	41	Increased awareness of low landscape health	45	Reduced water pressure affected human health	50
Stress and anxiety	42	More people seeking advice	46	Strain on heat responders: ''running our staff thin''	51
People were ''owly'' and crabby	43*	Increased understanding and awareness of possibilities	47		
Mental health effects on boaters and fishers	44	Bringing ''everyone back to reality''	48		
		Built			
Changed emphasis on projects (water ahead of roads)	52	Mutual aid requests for manpower from fire department	49*	Boat ramps out of the water	65*
Wastewater and water treatment issues	53	Increasing awareness of rural structure fires	54*		
		Financial			
Layoffs	56	Word of mouth that crops are not productive	63*	Boaters, hunters, fishers, and campers affected	30*
Declining tax revenues	57	Decline in pheasant and quail hunting	64*	Reduced grain prices	70
Farmers decreased their purchasing	58	Boat ramps out of the water	65*	Easier and less costly to do wetland restoration work	71
Decrease in irrigation water supply	59	Reduced opportunity for fishing and boating	66*	Operations and maintenance payments decreased	72
Economic burden of feeding livestock	60	Camping numbers substantially reduced	67	Increased deferments for water payments	73
Imbalance between crops: positive wheat production, low for others	61	Increase in serving court documents for delinquent bills	68	Sale of penetrometers (soil probes) increased	74
Failing crop production	62	Fuel prices increased	69	Commodity prices were higher	75

TABLE 2. (*Continued*)

Observed impact	Ref. no.	Observed impact	Ref. no.	Observed impact	Ref. no.
		Social			
Lawns were dry	7*	People were ''owly'' and crabby	43*	Mutual aid requests for manpower from fire department	49*
Word of mouth that crops are not productive	63*	Increase in reported thefts	78	Informal social communication that it was getting hotter and drier	80
The drought map appeared frequently in newscasts	76	Increased awareness of drought through tight-knit population	79	Additional informational calls from state public health agencies	77*
Additional informational calls from state public health agencies	77*	Increasing awareness of rural structure fires	54*		
		Political			
Interest in expanding new conservation program acres	81	Sped up process for ''LB-1098'' to declare the basin overappropriated	82	Irrigation scheduling legislation for increasing efficiency	83
		Cultural			
Contentious dynamic between residents and visiting hunters over reduced pheasants	84				

calls from neighboring towns, working together to meet staffing needs. Risk-mitigating campfire or firework bans were on reserve, even though they were not deployed. Public service announcements and in-person safety education by fire department personnel contributed to community awareness of fire danger, particularly regarding fireworks during the unusually dry Fourth of July. Personnel also visited vendors to hand out firework safety information. The network plot in Fig. 7 highlights the role of leadership within human and social capital.

The *McCook Gazette* staff conducted interviews with local leadership in a timely manner, along with the radio stations in town that regularly host community groups and businesses. Monthly radio reports covered farm management. Multiple faith-based organizations served as information sources. For those not affiliated, city leaders mentioned that local cafes, restaurants, and a well-loved bakery are common information-exchange locations.

Plotted on a radar graph of the capitals and responses, variation between impacts and response is evident, with a notable volume of impacts on natural capital, while the majority of responses originated from human and social capital (see Fig. 8).[5]

As depicted in the radar plot in Fig. 8, 13 coping responses took place on built capital. The drought prompted infrastructure repairs and improvements in the city's schools, which were retrofitted with air conditioning. The YMCA shut the sprinklers off and watered at night. Showerhead timers in the locker rooms reduced consumption. Municipal supply authorities advised residents to use water as carefully as possible. The city asked its residents to refrain from outdoor irrigation, relying on voluntary enforcement. The economic development director mentioned that the skate park was a space where youth could engage in activities that did not require access to water. The city helped the most vulnerable people, such as the poor, the elderly, and children, to cope with the heat. It distributed fans to lower-income residents and opened stations with cooling facilities for the elderly. The senior center provided a cooling facility for residents, particularly elderly without air conditioning.

Organizations responded to individual concerns during the summer.[6] Volunteer organizations, such as the American Legion, accommodated the need for cooling during extended exposure. For example, organizers

[5] Impact counts and remediation efforts are coded from interview and focus group transcripts and notes. Both of these are plotted onto their corresponding capitals. A complete list is included in Tables 2 and 3.

[6] There are many opportunities for individuals to connect with each other in semiorganized formats, such as ''Coffee with a Cop,'' in which law enforcement meets in an open, casual forum with community members. In nondrought years, these meetings provide an alternative venue for voicing concerns about issues (e.g., the installation and operation of traffic lights). These events were support venues to voice concerns about the extended dry period. When used in this way, these settings can serve as opportunities to pair individuals with the community organizations to enact change.

TABLE 3. Response measure data for each capital (italics). Items numbered with an asterisk appear in more than one capital area.

Response measure	Ref. no.	Response measure	Ref. no.
	Natural		
Monitor air quality	7	Study wildlife mortality for health risk	10*
Expand dryland pasture	8*	Test corn forage before feeding	11
Assist with rangeland improvements	9	Test for nitrate runoff	12
	Human		
Extension education on how to manage farms during drought	13*	Slow driver signs where dust would blow	22
Set up a cooling site at the senior center	14*	Use knowledge about livestock grazing limits	23
Provide water for elderly and special functional needs	15*	Staff IV rehydration therapy and cooling	25*
Disaster trailer prepared to respond to human health threats	16	Develop a cooling station plan	26
Meet needs of those in homes with a fan giveaway	17	Manpower for emergency response	27*
Home Health Agency care for elderly	18	Staying aware of trends and evaluate preparation	28
Collaborate with home health providers to give away fans	19*	Use efficient irrigation design	45*
Workforce responded to wildfires	20	Focus on elderly heat risk	29
Study wildlife mortality for health risk	10*		
	Built		
Retrofit buildings with air conditioning	30	Manpower for emergency response	27*
Set up a cooling site at the senior center	14*	Respond to structure fires	36
Disaster trailer for human health threats	31	Collaborate with home health providers to give away fans	37*
Extend boat ramps	32	Partner with rural fire department for water tankers	38*
Increase installed irrigation capacity	33*	Use backup sources of water	39
Caution with water usage	34	Shifting cultural norms about lawn watering	83*
Establish open hours at the cooling stations	35		
	Financial		
Adjust park budget	40	Liquidate livestock	48
Reduce irrigated acreage	42	Transition out of livestock agriculture	49
Recognize economic burden when ranchers purchase animal feed	41	Use poor corn as feedstock	50
Repossess private property to auction during financial hardship	43	Reduced quality standards for alternative cattle feed	51
Increase water consumption	44	Let alfalfa hay grow longer	52
Use efficient irrigation design	45*	Utilize crop insurance claim procedure	53
Reduce cow herds	46	Convert marginally irrigated acres to dryland	54
Stock fewer livestock on pastures	47	Expand dryland pasture	8*
	Social		
Collaborate with home health providers to give away fans	37*	Informal social communication, it was hotter and drier	62
Extension education on how to manage farms during drought	13*	Reliance on outside agencies to assist with heat	63
Extension programs stayed active during drought	55	Calling in outside agencies for general response	64
Provide water for elderly and special functional needs	15*	Staff IV rehydration therapy and cooling	25*
Collaborate with home health providers to give away fans	37*	Understanding and cooperation from residents	65
Collaboration between agencies on air quality	55	Fire department visited firework stands frequently to educate public	66
Game and Parks commission assisted with wildfire assistance	56	Fire department PSAs on the radio and on Facebook page	67
Collaboration between agencies on water	57	Partner with rural fire department for water tankers	38*

TABLE 3. (*Continued*)

Response measure	Ref. no.	Response measure	Ref. no.
Volunteers in the Pine Ridge fire (from around the state)	58	Manpower for emergency response	27*
Maintain willingness and connections for wildfire assistance	59	Local and rural fire department collaboration on water, labor	68
Fire chief and emergency responders from sheriff department work together	60	Fire department plan implemented by city manager	69
Universities and NRD provide information/ webinars	61	Voluntary water reductions to build water quantity back	70
Manpower for emergency response	27*		
	Political		
Utilities and city council asked residents not to water outside	71	Water rationing	78
Prioritized public works watering	72	Request from local fire department ordinances to allow firework ban	79
Adjusted school hours for the heat	73	City council approved ordinance allowing fire department to ban fireworks	80
City council budgeting adjustment discussions	74	Other surrounding communities banned fireworks	81
Higher-level controls on surface water irrigation	76	Create a municipal plan to carry more backup water	21*
Game and Parks leveraged as public agency to generate concern for wildlife	77	Used the city drought plan	82
	Cultural		
Shifting cultural norms about lawn watering	83*		

recognized during state baseball tournaments that the umpiring staff in dark safety gear were especially susceptible to heat stress. They allowed additional breaks between innings and games, as well as spritzing water. Pitchers and players also received extra cooling breaks and were encouraged to drink water.

District officials adjusted school hours, and ''heat days'' provided relief from extreme heat. When they were in session, schools had restrictions on recess and football practice. Summer programs engaged children in activities where they were kept cool. Schools were required to start the year late or dismiss early in order to compensate for not cooling the buildings sufficiently.

Cultural capital was also evident during the 2012 drought. Nebraskans, as a whole, are proud of their self-reliance. This spirit of individual competence is evident in McCook; its residents are quick to help others in need but are perhaps slower to ask for help from others, including from higher levels of government (McCook Daily Gazette 2006). This tendency was put aside, to some extent, once the devastating impacts of drought in the 2000s reached new levels.[7]

While agricultural producers noted severe financial impacts, the banking sector did not see it that way. The overall impact was not considered severe because of the engrained conservative banking approach and the perceived short duration of the drought. Bankers felt farmers had a trust in and reliance on government-funded crop insurance and other recovery programs that supplement livelihoods during dry years. As one participant stated, ''Farmers and ranchers get addicted to the game of chance, and the gamble that comes with it. Drought is a part of it. They play that game and they love it. Although they won't admit they love it.''[8]

The financial sector responded with loan programs and debt restructuring led by the producers. A bank CEO reported that crop insurance, coupled with technological advances and sector diversity, provides short-term coping capacity on a 1–2-yr time frame. Successful producers made financial investments in equipment and technologies

[7] While it may have been difficult to singularly categorize or gauge the entire cultural milieu of the region, the local perceptions were well captured by the town's newspaper. Senator Ben Nelson named the 2002 drought ''Drought David'' as part of an effort to call attention to its severity and account for the economic losses incurred.

[8] This statement reflects the inherent risk in farming in an area with an annual average of 22 in. of precipitation, paired with a recognition from this particular leader that there is a need to manage for it. Data are for McCook Municipal Airport: U.S. Climate Normals, 1981–2010, NOAA.

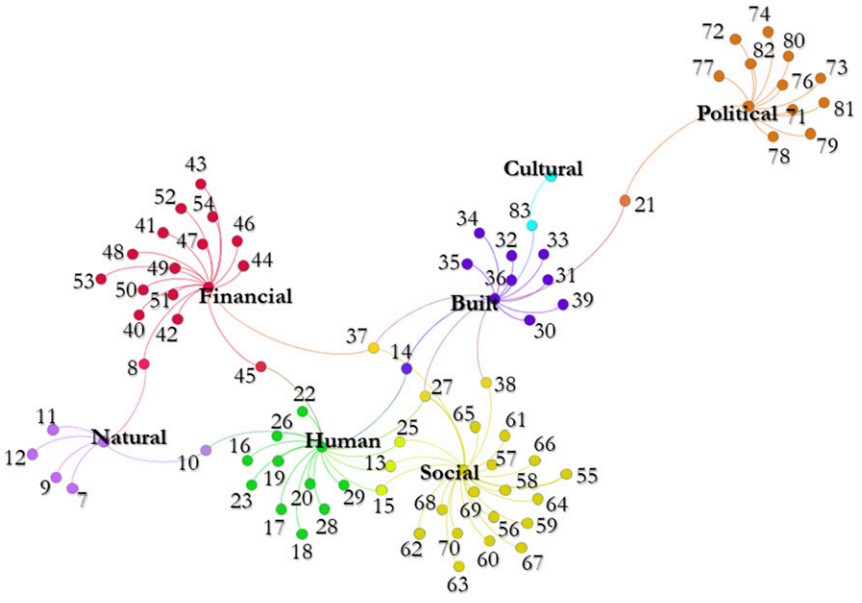

FIG. 7. Programs and response mapped onto the capitals (source: authors; see Table 3 for data list).

that maximize irrigation efficiency and hold a diverse portfolio of land irrigated by surface water and groundwater, as well as a livestock component. Banks have working knowledge of the local economy, and agricultural producers rely on bankers as a trusted source of information. As a local banker observed, "Over time the agricultural producers have become good business managers and marginal operators have all disappeared. Today's producers are savvy and manage around issues." Financial institutions worked with producers to restructure debt, enhanced by the strong local representation on boards of directors for most financial institutions.

c. *The transformative potential of moving from coping response to mitigation*

We classify "coping responses" as actions taken to immediately relieve suffering during a crisis event or emergency. This is consistent with the drought policy literature, which views these emergency assistance programs as reactive crisis interventions (Wilhite 2017). Responses, then, were only coded as such if they took place during the 2012–14 drought. A high coping capacity is also referred to as disaster preparedness—or appropriate awareness, resources, and management "in normal times as well as during disasters" (Cutter 2018). Disaster preparedness is connected to the ability to deploy responses efficiently during a crisis and is an important dimension of global policy for disaster risk reduction (Aitsi-Selmi et al. 2015).

Disaster mitigation, on the other hand, encompasses the planning process to reduce risk and vulnerability to future hazardous events. Mitigation represents the phase of a risk cycle that encompasses decision-making process, knowledge, policies, and institutional structures (Papathoma-Kohle and Thaler 2018). Though mitigation requires forethought and planning, it is not entirely distinct from operational management during an event. Mitigation activities function best when they occur throughout all phases of disaster management and when they are marked by collaboration between community managers and planners (Pearce 2003). In evaluating our results, we found that coping responses from 2012 were leveraged as longer-term risk mitigation practices for future drought events.

Our analysis showed that the 2012 drought did not trigger significant detectable migration from McCook. The population decreased by about 50. This decrease was a part of the trend since 2000, and other measures show few effects of population reduction. For example, single-family new house construction building permit volumes remained stable. The city issued five building permits each year for 2012–14. In 2011, the city issued only three building permits.[9] Similarly, the drought seems to have had little to no effect on unemployment and crime rates of McCook. The unemployment rate consistently decreased since 2010. Crime rates (robberies, assaults, burglaries, theft, and auto theft) either remained the same or slightly increased in 2012 relative to the previous year. Although there was a slight increase in heat-related emergency medical incidents, community medical services reported handling these cases.

[9] Report compiled for NE 6901. Source: www.city-data.com/city/McCook-Nebraska.html. Last accessed 23 October 2016.

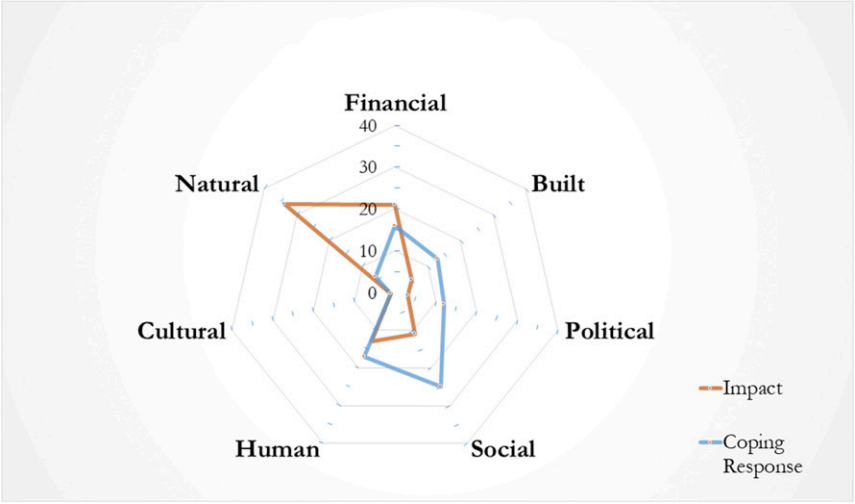

FIG. 8. McCook impacts and response: a radar plot of the numbers of impacts and the programs designed to address them. The orange line represents impacts, and coping responses are shown by the blue line. Axis lines appear at every tenth count, with tick marks on every fifth count. (Data are shown in long form in Tables 2 and 3.)

The mayor noted that, during a drought, "a fire could be disastrous" because fires spread more rapidly under hot conditions. However, there were no major fires in 2012, and the nine full-time firefighters and 24 volunteers were able to meet city needs. The fire chief emphasized that disasters have minimal lasting damage on integrity, saying, "through all of those things McCook is still strong. We see just enough of everything . . . to help us get through things. I feel good coming to work every day knowing that we could probably handle anything that comes our way." This cohesion has persisted. Human capital—or the education, skills, and knowledge that community members possess—is still evident in the strong leadership tradition. A resident historian and newspaper columnist stated, "McCook has a reputation of having governors and senators from here. Part of that stems from participatory democracy, there is a collective wisdom in that. If we have a problem, we solve it with hands-on participation." Social capital—interactions characterized by reciprocity and trust—and built capital combine in the city's single, multipurpose administrative building that houses the city council, the fire department, utilities, and police departments. Standing as a physical manifestation of the intersection of assets, this new building is a source of pride for residents. Collaboration across agencies was, and still is, facilitated by having multiple departments in the same headquarters. The city administrators develop a strong sense of comradery and collegiality in this working environment.

Initially, the recognition of an impact leads to a coping measure, but subsequent reflection and planning can result in the integration of efforts to build long-lasting mitigation. When leadership recognized and acted on the opportunity for change, we observed multiple positive transformations. Some political and financial impacts served as catalysts to alert community members to take stock of what they wanted to change: for example, the drought revitalized interest in CRP when marginal cropland producers realized the potential to earn alternative income from less-productive acreage. The drought event was also viewed as an opportunity to do wetland restoration when it became possible (and less costly) to move equipment into the areas. Additionally, participants showed evidence of a transformation of thought, moving toward viewing drought as a hazard that is in the same category as tornadoes, floods, and hailstorms.

6. Discussion

A reduction in rainfall accompanied by excessive heat can challenge a community in unanticipated ways. Drawing upon experience with prior droughts, a formal city plan, and strong interagency coordination, McCook was able to respond and limit damages during the drought. Furthermore, the drought served as a catalyst that prompted the community to transform capitals in lasting ways, namely, by institutionalizing collaboration.

a. The importance of a drought plan

McCook enacted voluntary water restrictions at the beginning of the 2012 summer as the level of the Republican River dropped. Once the extreme heat and low humidity set in and water usage increased, the restriction was elevated to mandatory between 1000 and 1800 LT to reserve water supplies for firefighting efforts, should the need arise

(City of McCook Civic Alert 2012). Having a plan reduced barriers for officials to make decisions related to allowable water usage. The literature supports this call for local management to accommodate drought planning (Fu and Tang 2013). The plan's water-use classes were essential to setting critical human needs apart from aesthetic uses. Because the plan[10] was in place almost a decade before the drought, the community did not scramble to coordinate actions.

The community was ready to respond to the drought early in the summer. One of the keys to was being able to act quickly but in a well-coordinated fashion and to rely on voluntary water conservation measures. The city's ability to rely on these voluntary measures signaled high levels of public trust. This allowed for escalating response based on water-use class (see Table 4).

The plan's restrictions did not meet public opposition. However, as one participant said, "If the drought had lasted longer, it would have been difficult to adjust." To enact these class-based restrictions, future efforts may be wise to consider the length of the drought event and threshold values for temperature and precipitation deficits (and their combined effect). City officials could update the drought plan by including "trigger" values for each restriction class. Linking plan actions with monitored values would support water managers' and city authorities' operations.

b. *Institutionalizing collaboration*

Wilhite (2017) suggests that reliance on emergency relief interventions can contradict local drought-coping capacity. Traditional government assistance for livestock producers, for example, is often slow to arrive, rewards those who do not reduce their risk, and may not be available when it is most needed (Wilhite 2017). Instead of relying on a higher public authority to deliver aid, multiple and overlapping groups and organizations contributed to the success of McCook's response to drought. Various leaders are responsible for reporting natural hazard damage under the local emergency operation plan to the Nebraska Emergency Management Agency (NEMA). Participants stated that this process is mostly used for flooding and tornadoes but that drought impacts would have been reported to NEMA if they were severe, especially in the case of fire damage or deaths. The general goal in relaying information about drought, as one extension officer saw it, was to build on the self-reliant culture while maintaining transparency in decision-making to boost public trust.[11]

TABLE 4. Class-use definitions and included purposes for the Water Conservation, Drought, and Emergency Plan (City of McCook 2004).

Section 52.62	Included purpose for classes of water use
Class 1	Water used for outdoor watering: either public or private, for gardens, lawns, trees, shrubs, plants, parks, golf courses, playing fields, swimming pools, or other recreational areas; or the washing of motor vehicles, boats, trailers, or the exterior of any building or structure.
Class 2	Water used for any commercial or industrial purpose, including agricultural, except water actually necessary to maintain the health and personal hygiene of bona fide employees while the employees are engaged in the performance of their duties at their place of employment.
Class 3	Domestic usage, other than that that would be included in either Classes 1 or 2. Water necessary only to sustain human life and the lives of domestic pets and maintain standards of hygiene and sanitation.

When it came to preventing heat stroke, the health department partnered with a private home health agency. This was required because, as one health department representative put it, "they had a lot of elderly folks that did not have air conditioning. Those elderly just sit in their homes . . . like the frog in the kettle. They just sit there and smoke themselves because they don't . . . even realize they are frying in their own homes."[12] The health department is a strong leader in monitoring and reporting over a 15-county region. This coordination role positions it as a "hub" for emergency preparedness. The department responded to the intense heat by giving away fans to vulnerable groups. However, the level of response would not have been possible without proper coordination between agencies. In addition to the health department, the fire chief was also concerned about heart attacks and heat-related illnesses. The health department filled capacity gaps by partnering with the fire department to set up cooling stations and with the home health agency to deliver fans to those who were homebound.

c. *Potential challenges*

Though numerous response programs facilitated recovery, challenges exist. One possible barrier with regard to using cultural capital most effectively could have been the self-called "conservative political culture" that calls for individual autonomy and a mindset that advocates for

[10] The city's drought plan is posted on the NDMC repository of drought-planning materials as an example of proactive, evidence-based drought policy.

[11] An offered example of a coordinating space for this to happen is the Natural Resource District, to link science and monitoring with practical guidance.

[12] This was noted in the Health and Emergency Management focus group.

small government and sometimes espouses the ''stay out of my business'' viewpoint. Without public trust and cooperation, public measures to reduce water consumption may have been seen as unduly onerous.

Furthermore, inadequate information delivery may have slowed the city's response. Some city authorities reported that they were not aware that the 2012 drought was coming, while residents mentioned turning to university-extension reports that provided information about crop conditions and soil moisture levels [such as Klein et al. (2016)]. Gaps between monitored trends and public awareness indicate a need for enhanced communication. Health officials recalled increased mental health problems due to financial stress [in line with Vins et al. (2015)], but did not have large-scale data to establish a trend that year.

From a water provision and utilities perspective, several noteworthy gaps will warrant further attention. First, the utility director wants to monitor segmented use of residential use of water. Knowing which proportions are used for household drinking and bathing or landscape maintenance would assist the utilities department when it coordinates voluntary and mandatory water-use restrictions. Smart metering technology for lawns would be one way to accomplish this. Additionally, consulting with the private sector on water needs for landscaping would also facilitate water conservation.

d. Drought as a catalyst for transformation of the capitals

When coping responses were effective, the community took steps to institutionalize them. Examples include creating guidelines for cooling stations and shelters, providing heat relief and rehydration therapy for first responders, and conducting dialogue about using the storage tanks as a backup for the town's supply. The community may wish to reflect further on the ways that coping responses could be operationalized in written guidelines and lasting programs. The CCF posits that measured outcomes should include positive changes in community characteristics (Flora et al. 2005). While the collected evidence suggests that the drought had tangible impacts, further consideration is needed as to whether the coping programs resulted in long-term alteration of the capitals.

In ongoing evaluations, longitudinal data on program maintenance would inform whether and how drought responses shape capitals (Emery and Flora 2006). For example, when residents noted the impact of high water demand, they responded by reducing irrigated areas and municipal use. In the longer term, the community and environment may be transformed if these marginal areas remain in conservation status or if water-saving devices are accepted (see Fig. 9). These changes in culture and practice may lead to a more resilient community going forward. Since communities are dynamic and their populations are in flux, some solutions may be presented and discarded while others will take hold (Tobin 1999).

Over time, responses become institutionalized as programs. These programs may become a staple of the community as they are shored up with permanent facilities, staff, assets, and equipment. As programs become independent of the hazards they address, they can have long-lasting benefits in other areas. Reflecting on the CCF led to a consideration of the differences between temporary practices and long-term changes. The unspoken and unwritten component of many capital areas is the institutional capacity behind them. Institutional capacity, viewed as the ''rules or habits'' that create opportunities and barriers to action (Nooteboom 2007), is embedded in each of the capital areas.

Drought may be particularly transformative because addressing it requires rethinking practices related to crop viability, farming practices, irrigation techniques, animal health, and land-ownership patterns (Maskrey 1989). This study included a range of drought impacts and a mix of coping responses implemented to address them. In the next logical phase, there is space for capital transformation. Though it was originally outside the scope of the primary stage of analysis, the results of secondary coding suggest higher-order shifts (the type of long-duration change explored in Fig. 9). Transforming a community's built capital would have cascading effects onto other capital areas as the city realizes savings through reduced policing costs (financial), new skills are acquired (human), well-being and fitness levels are praised (cultural), and city planning efforts are codified to account for strong recreation structures (political).

At its inception, resilience thinking referred to the ability of a system to absorb shocks and maintain functionality (Holling 1973). Recently, it took on a more ambitious and forward-looking character (Berkes and Seixas 2005). In this sense, it requires adaptation and positive transformation that allows communities to function better than they did in their prior states (Berkes et al. 2003; Folke 2006; Lebel et al. 2006). Waves of transformation connect the CCF conceptually to broader theories of resilience. During a drought, capitals are reorganized. In the reorganization, if conflict is reduced, cohesion grows stronger (Folke et al. 2005). Drought may not be preventable, but its damages can be limited through preparation and planning. Furthermore, if responses are adopted in durable programs, a community can be stronger afterward.

7. Conclusions: Drought as a human challenge

Evidence suggests that the combined effect of precipitation decline and high temperatures threatens

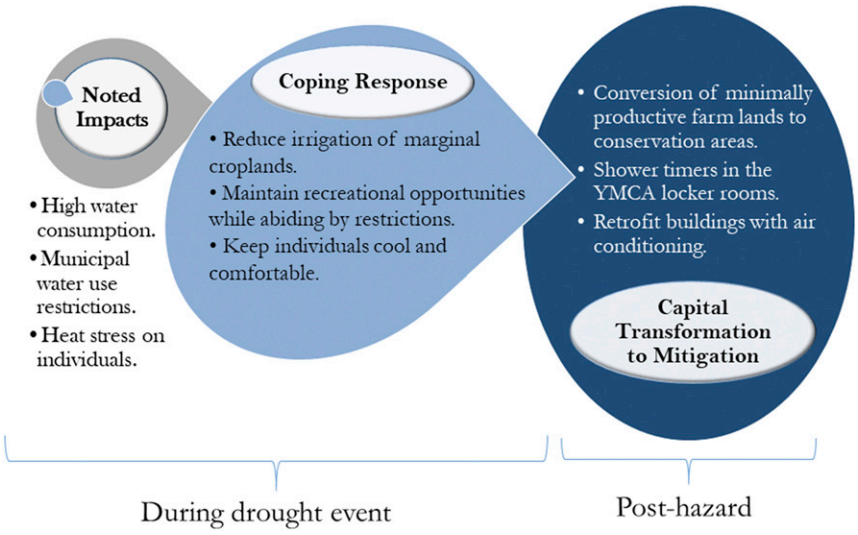

FIG. 9. Examples of community transformations following a drought event. As the community observed impacts, it responded with programs to address the negative repercussions. If these programs are successful in the longer term, they have the potential to transform the capital itself.

community capitals. The meteorological monitoring indicators incorporated in the USDM show that the drought's extent and severity in 2012 were significant and that it persisted into subsequent years. The shortage of rainfall in 2012 was accompanied by high temperatures that rural residents noticed as early as spring. As the effects of drought manifested in outlying areas, crops began to suffer, wildlife habitat was reduced, and surface water storage dropped. When the effects manifested themselves in the municipal area, leaders within the community took action to protect residents. The leaders' focus on protecting residents was one of the more effective strategies for mitigating drought.

We found the CCF is an effective evaluation tool for identifying drought impacts and rural response mechanisms. Furthermore, we found evidence to extend the theory to examine the types of transformation that can take place in a community as capitals are reconfigured following a disaster. Employing the appreciative-inquiry method for understanding community dynamics allowed for observing program design that could result in waves of transformation. When communities develop capacity to address drought, they could be fundamentally transformed in ways that extend beyond hazards management. Impact and asset mapping is meant to inform future work involving community members to interactively map their programs and response mechanisms. Other small municipalities with a city management governance structure may find this approach useful as a realistic way to map assets for rapid assessment processes.

As drought status is elevated, rural communities can prepare themselves by focusing on their assets. This study shows that it is particularly critical for a community to have drought policies in place and leadership to implement them. Under proactive, preventive leadership, drought need not pose a significant burden on citizens. Some residents of McCook did not realize how severe the drought was in 2012. Rather than a monitoring failure or a lack of public awareness campaigns, we see this as a planning success. After various capitals are mobilized to cope with drought's effects, there is value in reflecting from multiple perspectives. In doing so, capitals may be harnessed in proactive ways in the future to create longer-standing institutions.

Acknowledgments. This research was partially supported with an FY 2015–16 grant from the North Central Regional Center for Rural Development (NCRCRD) called "Successful Disaster Recovery Using the Community Capitals Framework." Additional support was provided by the National Oceanic and Atmospheric Agency (NOAA) Climate Program Office/Sectoral Applications Research Program (SARP) competitive grant that funded the Decision and Risk Management Research Center (DRMRC) at the National Drought Mitigation Center at the University of Nebraska School of Natural Resources. The authors are grateful for comments they received from two anonymous reviewers and from researchers in the other hazard case studies, including Gary Goreham at North Dakota State University and Kurt Mantoya at the Heartland Center for Leadership Development.

APPENDIX

Interview Protocol

Focus groups and interviews were conducted using the following questions:

1) Generally speaking, what role—formal or informal—does your organization(s) have in disaster management?
2) When did you become aware of the drought?
3) What groups (vulnerable or otherwise) were impacted?
4) What were your organization's major concerns during the 2012 drought? To what extent was your organization prepared to meet these concerns/issues? Did your organization have adequate resources and the needed support?
5) What did you learn? Are there any new initiatives?
6) How drought resilient is McCook and the region? Is there anything else you would like to share?

REFERENCES

Adger, W. N., 2006: Vulnerability. *Global Environ. Change*, **16**, 268–281, https://doi.org/10.1016/j.gloenvcha.2006.02.006.

Aitsi-Selmi, A., S. Egawa, H. Sasaki, C. Wannous, and V. Murray, 2015: The Sendai Framework for Disaster Risk Reduction: Renewing the global commitment to people's resilience, health, and well-being. *Int. J. Disaster Risk Sci.*, **6**, 164–176, https://doi.org/10.1007/s13753-015-0050-9.

Aldrich, D. P., 2012: *Building Resilience: Social Capital in Post-Disaster Recovery*. University of Chicago Press, 232 pp.

Berkes, F. J., and C. Seixas, 2005: Building resilience in lagoon social–ecological systems: A local-level perspective. *Ecosystems*, **8**, 967–974, https://doi.org/10.1007/s10021-005-0140-4.

——, J. Colding, and C. Folke, 2003: *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*. Cambridge University Press, 416 pp.

Blaikie, P., T. Cannon, I. Davis, and B. Wisner, 1994: *At Risk: Natural Hazards, People's Vulnerability and Disasters*. Taylor and Francis, 304 pp.

Brown, J. F., B. D. Wardlow, T. Tadesse, M. J. Hayes, and B. C. Reed, 2008: The vegetation drought response index (VegDRI): A new integrated approach for monitoring drought stress in vegetation. *GISci. Remote Sens.*, **45**, 16–46, https://doi.org/10.2747/1548-1603.45.1.16.

Buckle, P., 2006: Assessing social resilience. *Disaster Resilience: An Integrated Approach*, D. Paton and D. M. Johnston, Eds., Charles C. Thomas, 88–104.

Butler, R., 2014: Rural recreation and tourism. *The Geography of Rural Change*, 2nd ed. B. Ilbery, Ed., Routledge, 211–232.

City of McCook, 2004: Water conservation, drought, and emergency plan. *McCook Code of Ordinances*, section 52.60, http://library.amlegal.com/nxt/gateway.dll/Nebraska/mccook_ne/titlevdepartments/chapter52water.

City of McCook Civic Alert, 2012: News flash home: City of McCook civic alert—Mandatory water restriction. City of McCook, accessed 28 September 2016, http://www.cityofmccook.com/CivicAlerts.aspx?AID=79&ARC=148.

Cooperrider, D. L., and S. Srivastva, 1987: Appreciative inquiry in organizational life. *Res. Organ. Change Dev.*, **1**, 129–169.

Creswell, J. W., and J. D. Creswell, 2018: *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 5th ed. SAGE Publications, 304 pp.

Cutter, S. L., 2018: Linkages between vulnerability and resilience. *Vulnerability and Resilience to Natural Hazards*, S. Fuchs and T. Thaler, Eds., Cambridge University Press, 257–270.

Discoe, C. J., 2012: Grassfire scorches Oberlin-area farms. *McCook Gazette*, 27 June, http://www.mccookgazette.com/story/1864782.html.

Donehower, K., C. Hogg, and E. E. Schell, 2007: Constructing rural literacies: Moving beyond the rhetorics of lack, lag, and the rosy past. *Rural Literacies*, Southern Illinois University Press, 1–36.

Duggan, J., 2010: Spotlight on pheasants. *Lincoln Journal Star*, 31 October, http://journalstar.com/sports/recreation/outdoors/spotlight-on-pheasants/article_ff7264bc-e4ab-11df-874f-001cc4c03286.html.

Dyer, J. A., 2000: Drought monitoring for famine relief in Africa. *Droughts: A Global Assessment*, Vol. I, D. A. Wilhite, Ed., Routledge, 223–233.

Emery, M., and C. Flora, 2006: Spiraling-up: Mapping community transformation with Community Capitals Framework. *Community Dev.*, **37**, 19–35, https://doi.org/10.1080/15575330609490152.

Flora, C. B., M. Emery, S. Fey, and C. Bregendahl, 2005: Community capitals: A tool for evaluating strategic interventions and projects. North Central Regional Center for Rural Development Rep., 2 pp., https://www.ffa.org/SiteCollectionDocuments/lts_communitycapitals.pdf.

——, J. Flora, and S. P. Gasteyer, 2015: *Rural Communities: Legacy + Change*. Avalon Publishing, 488 pp.

Folke, C., 2006: Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environ. Change*, **16**, 253–267, https://doi.org/10.1016/j.gloenvcha.2006.04.002.

——, T. Hahn, P. Olsson, and J. Norberg, 2005: Adaptive governance of social-ecological systems. *Annu. Rev. Environ. Resour.*, **30**, 441–473, https://doi.org/10.1146/annurev.energy.30.050504.144511.

Fu, X., and Z. Tang, 2013: Planning for drought-resilient communities: An evaluation of local comprehensive plans in the fastest growing counties in the US. *Cities*, **32**, 60–69, https://doi.org/10.1016/j.cities.2013.03.001.

Fuchs, B., D. Wood, and D. Ebbeka, Eds., 2015: From too much to too little: How the central U.S. drought of 2012 evolved out of one of the most devastating floods on record in 2011. Drought Mitigation Center Faculty Publication 118, 99 pp., http://digitalcommons.unl.edu/droughtfacpub/118.

Gergen, K. J., 2015: From mirroring to world-making: Research as future forming. *J. Theory Soc. Behav.*, **45**, 287–310, https://doi.org/10.1111/jtsb.12075.

Hayes, M. J., M. D. Svoboda, B. D. Wardlow, M. C. Anderson, and F. Kogan, 2012: Drought monitoring: Historical and current perspectives. *Remote Sensing of Drought: Innovative Monitoring Approaches*, B. D. Wardlow, M. C. Anderson, and J. P. Verdin, Eds., CRC Press/Taylor & Francis, 1–19.

Holling, C. S., 1973: Resilience and stability of ecological systems. *Annu. Rev. Ecol. Syst.*, **4**, 1–23, https://doi.org/10.1146/annurev.es.04.110173.000245.

Howell, T. A., 2001: Enhancing water use efficiency in irrigated agriculture. *Agron. J.*, **93**, 281–289, https://doi.org/10.2134/agronj2001.932281x.

HPRCC, 2017: COOP Station: 255310; McCook Municipal Airport. High Plains Regional Climate Center, accessed 23 October 2017, https://hprcc.unl.edu/stationtool.php.

King, J. W., and J. A. Savidge, 1995: Effects of the Conservation Reserve Program on wildlife in southeast Nebraska. *Wildl. Soc. Bull.*, **23**, 377–385.

Klein, R., R. Tigner, P. Hay, K. DeBoer, R. Seymour, and C. Burr, 2016: Wheat condition and soil moisture reports. CropWatch, 8 April, https://cropwatch.unl.edu/Wheat%20Condition%20and%20Soil%20Moisture%20Reports.

Lebel, L., J. M. Anderies, B. Campbell, C. Folke, S. Hatfield-Dodds, T. P. Hughes, and J. Wilson, 2006: Governance and the capacity to manage resilience in regional social-ecological systems. *Ecol. Soc.*, **11**, 19, https://www.ecologyandsociety.org/vol11/iss1/art19/.

Maskrey, A., 1989: Disaster mitigation: A community based approach. Development Guidelines, No. 3, B. Pratt, Ed., Oxfam Rep., 114 pp.

McCook Daily Gazette, 2006: Numbers show just how serious drought damage is. *McCook Daily Gazette*, 23 August 2006, accessed 28 September 2016, https://news.google.com/newspapers?id=AYQpAAAAIBAJ&sjid=BWoFAAAAIBAJ&pg=1899%2C6102317.

NDMC, 2018: Drought basics: Types of drought. National Drought Mitigation Center, accessed 17 January 2018, http://drought.unl.edu/DroughtBasics/TypesofDrought.aspx.

Nebraska Legislature, 2007: Legislative Bill 701: Creation of the Riparian Vegetation Management Task Force. Nebraska Legislature Doc., 21 pp., https://nebraskalegislature.gov/FloorDocs/100/PDF/Slip/LB701.pdf.

Nielson, R. L., 1996: Some of those corn plants are thirsty! *Purdue Pest Management and Crop Production Newsletter*, 12 July 1996, accessed 28 September 2016, https://www.agry.purdue.edu/ext/corn/news/articles.96/p&c9633.htm.

NOAA/NCEI, 2012: State of the Climate: National Climate Report for July 2012. NOAA National Centers for Environmental Information, accessed 9 January 2018, https://www.ncdc.noaa.gov/sotc/national/201207.

Nooteboom, B., 2007: Social capital, institutions and trust. *Rev. Soc. Econ.*, **65**, 29–53, https://doi.org/10.1080/00346760601132154.

Nyaupane, G. P., and S. Poudel, 2012: Application of appreciative inquiry in tourism research in rural communities. *Tour. Manage.*, **33**, 978–987, https://doi.org/10.1016/j.tourman.2011.10.009.

Papathoma-Kohle, M., and T. Thaler, 2018: Institutional vulnerability. *Vulnerability and Resilience to Natural Hazards*, S. Fuchs and T. Thaler, Eds., Cambridge University Press, 98–124.

Pearce, L., 2003: Disaster management and community planning, and public participation: How to achieve sustainable hazard mitigation. *Nat. Hazards*, **28**, 211–228, https://doi.org/10.1023/A:1022917721797.

Pretty, J., 2003: Social capital and the collective management of resources. *Science*, **302**, 1912–1914, https://doi.org/10.1126/science.1090847.

Saarinen, T. F., 1966: Perception of the drought hazard on the Great Plains. University of Chicago Department of Geography Research Paper 106, 183 pp.

Saldaña, J., 2016: Second cycle coding methods. *The Coding Manual for Qualitative Researchers*, 3rd ed. SAGE Publications, 233–272.

Small, S. A., and L. Uttal, 2005: Action-oriented research: Strategies for engaged scholarship. *J. Marriage Fam.*, **67**, 936–948, https://doi.org/10.1111/j.1741-3737.2005.00185.x.

Svoboda, M., and Coauthors, 2002: The Drought Monitor. *Bull. Amer. Meteor. Soc.*, **83**, 1181–1190, https://doi.org/10.1175/1520-0477-83.8.1181.

Tobin, G. A., 1999: Sustainability and community resilience: The holy grail of hazards planning? *Global Environ. Change*, **1**, 13–25, https://doi.org/10.1016/S1464-2867(99)00002-9.

U.S. Census Bureau, 2016: Percent of the total population who are 65 years and over—United States—Urban/rural and inside/outside metropolitan and micropolitan area. United States Census Bureau, accessed 10 January 2018, https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk.

U.S. Congress, 1942: Public law: An act granting the consent of Congress to the states of Colorado, Kansas, and Nebraska to negotiate and enter into a compact for the division of the waters of the Republican River. 77th Congress, chapter 545, public law 696, https://www.loc.gov/law/help/statutes-at-large/77th-congress/session-2/c77s2ch545.pdf.

USDA, 2013: USDA designates 597 counties in 2013 as disaster areas due to drought: USDA offers emergency loans to producers ahead of 2013 crop season to help combat persistent drought. USDA Press Release 0002.13, 9 January, https://www.usda.gov/media/press-releases/2013/01/09/usda-designates-597-counties-2013-disaster-areas-due-drought.

USDOC/USDA, 2012: Highlights: July 15–21, 2012. *Wkly Wea. Crop Bull.*, **99**, 1–42, http://usda.mannlib.cornell.edu/usda/waob/weather_weekly//2010s/2012/weather_weekly-07-25-2012.pdf.

Vins, H., J. Bell, S. Saha, and J. J. Hess, 2015: The mental health outcomes of drought: A systematic review and causal process diagram. *Int. J. Environ. Res. Public Health*, **12**, 13 251–13 275, https://doi.org/10.3390/ijerph121013251.

Wall, N., and M. Hayes, 2016: Drought and health in the context of public engagement. *Extreme Weather, Health, and Communities*, S. L. Steinberg and W. A. Sprigg, Eds., Extreme Weather and Society Series, Springer, 219–244.

Wilhite, D. A., 2017: Drought management and policy: Changing the paradigm from crisis to risk management. *Eur. Water*, **60**, 181–187, https://www.ewra.net/ew/pdf/EW_2017_60_25.pdf.

——, and M. H. Glantz, 1985: Understanding the drought phenomenon: The role of definitions. University of Nebraska–Lincoln Drought Mitigation Center Faculty Publ. 20, 17 pp., http://digitalcommons.unl.edu/droughtfacpub/20.

——, and M. Buchanan-Smith, 2005: Drought as a natural hazard: Understanding the natural and social context. *Drought and Water Crises: Science, Technology, and Management Issues*, D. A. Wilhite, Ed., Taylor and Francis, 3–20.

——, M. J. Hayes, C. Knutson, and K. H. Smith, 2000: Planning for drought: Moving from crisis to risk management. *J. Amer. Water Resour. Assoc.*, **36**, 697–710, https://doi.org/10.1111/j.1752-1688.2000.tb04299.x.

——, M. Svoboda, and M. Hayes, 2007: Understanding the complex impacts of drought: A key to enhancing drought mitigation and preparedness. *Water Resour. Manage.*, **21**, 763–774, https://doi.org/10.1007/s11269-006-9076-5.

Woodard, C., 2011: *American Nations: A History of the Eleven Rival Regional Cultures of North America*. Penguin, 386 pp.

Wutich, A., T. Lant, D. D. White, K. L. Larson, and M. Gartin, 2010: Comparing focus group and individual responses on sensitive topics: A study of water decision makers in a desert city. *Field Methods*, **22**, 88–110, https://doi.org/10.1177/1525822X09349918.