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Abstract
In the United States, drought is the second costliest natural disaster, which leads to the need for increased drought mitigation efforts over time. However, drought planning has lagged behind other hazard mitigation efforts, which is likely due to the lack of a national drought planning policy. Although the Federal Emergency Management Agency (FEMA) requires all jurisdictions have a hazard mitigation plan (HMP) to receive pre-disaster mitigation funds, drought has only recently been a requirement in HMPs. In 2012, Nebraska witnessed its worse drought in recent history, which exposed the gaps in drought planning effectiveness at all jurisdictional levels. To address potential drought planning gaps, we developed, conducted, and evaluated a Threat and Hazard Identification and Risk Assessment (THIRA), a FEMA risk assessment process, which solely focused on drought. This drought-specific THIRA consisted of a one-day workshop in which stakeholders and agency experts from the Platte River Basin in Nebraska worked collaboratively to determine the necessary resources for successfully managing a worst-case drought scenario in the region. We analyzed the findings of this workshop and compared them against the current drought planning activities in the Platte River Basin and found that the current drought planning activities would not be effective against a worst-case drought, in terms of reducing drought vulnerability and increasing preparedness and response efforts. Our use of a drought-specific THIRA and drought plan evaluation provides both a quality process to increase drought mitigation efforts and a process to strengthen the integration between stand-alone drought plans and hazard mitigation plans.

Keywords: Drought, Hazard mitigation plan (HMP), THIRA, Mitigation, Planning

1. Introduction

Drought is a natural hazard that causes a deficit of expected water availability resulting in water shortages for some activity or group [1]. It is a complex and often misunderstood phenomenon because its characteristics differ greatly from other hazards. Other hazards tend to be more clearly defined and have definitive beginning and ending points, expected durations, and easily distinguishable direct and indirect impacts. None of these characteristics hold true for drought [1,2]. First, drought does not have a universal definition. The National Drought Mitigation Center (NDMC) at the University of Nebraska - Lincoln provides five disciplinary perspectives for drought (**Table 1**), which reflect ways to measure or track the effects of drought [3]. Second, drought lacks definitive beginning and ending points. Drought has a relatively slow onset and it can be difficult to determine if a period of “drier than normal” conditions will manifest into a drought [4].

Table 1. Drought Type and description.

Drought Type	Description
Meteorological	Meteorological drought is determined by the lack of precipitation and how conditions such as temperature and winds affect the amount of moisture. It is expressed in relation to the average conditions for a region. Meteorological drought is region specific since precipitation is highly variable from region to region.
Agricultural	This type of drought links the characteristics of meteorological drought to agriculture or landscapes. Agricultural drought focuses on precipitation shortages, evaporative demand, and soil moisture deficits. This type of drought is also dependent upon plant type, stage of growth, and soil properties.
Hydrological	Hydrological drought is associated with the effects of rain and snow shortfalls on streamflow, reservoir and lake levels, and groundwater. Because it takes longer for precipitation deficiencies to show up in other components of the hydrological system, this type of drought can be out of phase with the other types of drought.
Socio-economic	Socio-economic drought includes the impact of drought on the economy related to supply and demand. While people typically think of agricultural loss, drought can also affect hydroelectric energy generation, ethanol production, and numerous other items. In addition, drought impacts tourism, public health, infrastructure, and many other components of society.
Ecological	This type of drought results from prolonged and widespread deficits in naturally available water supplies that create multiple stresses across ecosystems. Also, this type of drought emphasizes the link between people and nature in the context of drought. It captures the environmental consequences of drought and its feedback into natural and human systems.

Furthermore, a rain event does not necessarily mean that a drought is over, although it may help alleviate drought conditions. It may take weeks, months, or years for water supplies to return to normal conditions, making it difficult to know when a drought ends [1]. Third, some droughts last months while others can continue for multiple years, making it difficult to forecast an expected duration for any specific drought [2]. Finally, drought impacts are often much harder to classify compared to other hazards. With essentially all other hazards, direct impacts are easily identified by structural damages or loss of life, while indirect impacts are identified by asking how the direct impacts affect society and the economy [2]. Drought impacts are less obvious and spread across larger geographic areas than most other

hazards. The most quantifiable impacts of drought are losses to agriculture and, relatedly, economic downturn. Other impacts, such as a decrease in the quality of life, mental health problems, or ecosystem stress are more difficult to quantify [5].

1.1. Hazard planning

Regardless of the type of hazard, the best way to reduce natural hazard impacts is to have a plan [6,7]. In the United States, the Federal Emergency Management Agency (FEMA) requires hazard mitigation planning among state, tribal, and local governments as a condition of federal disaster assistance support [6–8]. Hazard planning efforts take two forms: hazard mitigation plans (HMPs) and emergency operations plans (EOPs). "The purpose of [HMPs] is to identify local policies and actions that can be implemented over the long term to reduce risk and future losses from hazards" [6 p.1–2], while "EOPs are plans that define the scope of preparedness and emergency management activities necessary for the jurisdiction" [9] [p. 3-1]. Thus, an HMP is a plan that takes steps to reduce risk to hazards before they happen, while EOPs are plans that outline what operations will take place during a hazard event.

Hazard mitigation planning has substantially increased since 2000, especially at the local level. At the time of writing this publication, FEMA reported that 21,073 local governments have approved local mitigation plans, accounting for approximately 87% of the nation [10]. Although the number of people covered under the scope of HMPs has increased, it does not guarantee that an HMP will remove the associated risks from natural disasters. HMPs vary in quality. Plan evaluation research [11–14] has shown that hazard plan goals and implementation are not always adequate to effectively mitigate against or reduce impacts of future hazard events [11–13], especially in rural areas with limited resources [14]. Similarly, the limited research evaluating drought plan quality finds drought plans do not necessarily lead to reduced drought vulnerability [15–17]. However, Brody [12] did find that local HMP plan quality can improve over time when an area includes lessons learned from past experiences and increases public participation in their next plan update.

1.2. Drought planning in the United States

In the United States, a federal requirement for drought planning does not exist. Instead, drought planning happens at multiple levels of government and across jurisdictions [18]. For example, drought plans have been created by states; sub-state jurisdiction, such as counties, natural resource districts, and communities; and at the river basin levels, crossing political boundaries. Drought planning efforts at the state level have evolved over time. For example, in 1982 there were three states with drought plans, while there are currently 45 states with drought plans [19,20]. However, each entity plans for drought differently in that some drought plans focus on mitigation while others are response focused [20]. A mitigation plan implements actions and policies to reduce drought impacts before a drought occurs, while a response plan implements actions and policies to reduce impacts while a drought is occurring [21].

Just as drought planning efforts have grown over time, drought planning efforts at smaller scales and in different planning regimes have changed. At first, drought planning efforts were found in "stand-alone" plans that focused only on drought management at the state level. Over time, drought planning efforts have become more integrated with water management planning at various jurisdictional levels due to the close link between water resources and drought impacts [22,23].

1.3. Hazard and drought planning

In contrast to water planning and drought planning integration, hazard planning and drought planning have been slower to integrate. The Disaster Mitigation Act (DMA) of 2000 does not mandate drought planning as a requirement in hazard planning; thus, jurisdictions do not have to include drought in their hazard planning efforts [24]. However, when a state is creating or updating a hazard mitigation plan, they must include all natural hazards that pose a threat to the state, including drought if relevant [8]. If a state does include drought in their HMP, then all sub-state level HMPs within that state, such as city- or county-level HMPs, must include drought because sub-state jurisdictions must include every hazard in their plan that appears in

the state level plan [6]. This has led to an increase in the number of jurisdictions at multiple levels that have some form of drought planning activity. However, while increased drought mitigation planning efforts are a step in the right direction, their existence does not necessarily lead to reduced drought vulnerability and impacts. To take advantage of these trends in planning, this paper fills two research gaps: A lack of research evaluating the quality of drought planning within the context of all-hazard planning and identifying potential approaches for increasing drought plan quality in all-hazard planning. To fill these research gaps, this paper builds upon the findings of the project presented in the next section.

1.4. Project background

The year 2012 holds the record as Nebraska's driest year since the beginning of the climatological record in 1895 [25]. Despite having a statewide drought mitigation plan in place, the rapid onset and severity of this drought challenged management efforts, causing devastating impacts to agricultural production, water supplies, ecosystems, public health, energy production, and tourism and recreation [26,27]. To help understand the resources needed to manage a drought of great severity and long duration, a research team from the University of Nebraska's Public Policy Center (PPC), National Drought Mitigation Center (NDMC), and High Plains Regional Climate Center (HPRCC) developed and conducted a drought-specific Threat and Hazard Identification and Risk Assessment (THIRA) for the Platte River Basin in Nebraska. The team included experts in disaster preparedness and planning, climate science, drought planning, and public engagement. Although examples that include drought in a multi-hazard THIRA can be found (e.g. City of Philadelphia and Allen County, Indiana), to our knowledge, a drought-specific THIRA has not been conducted within the state of Nebraska, and only a few other jurisdictions across the nation have convened drought THIRAs [28,29]. A THIRA is a FEMA risk assessment process that allows a specific planning jurisdiction to understand their risk and determine the level of capability they need in order to address those risks [30]. THIRA applies the 32 core capabilities from the National Preparedness Goal, with each core capability falling under one of five mission areas: prevention,

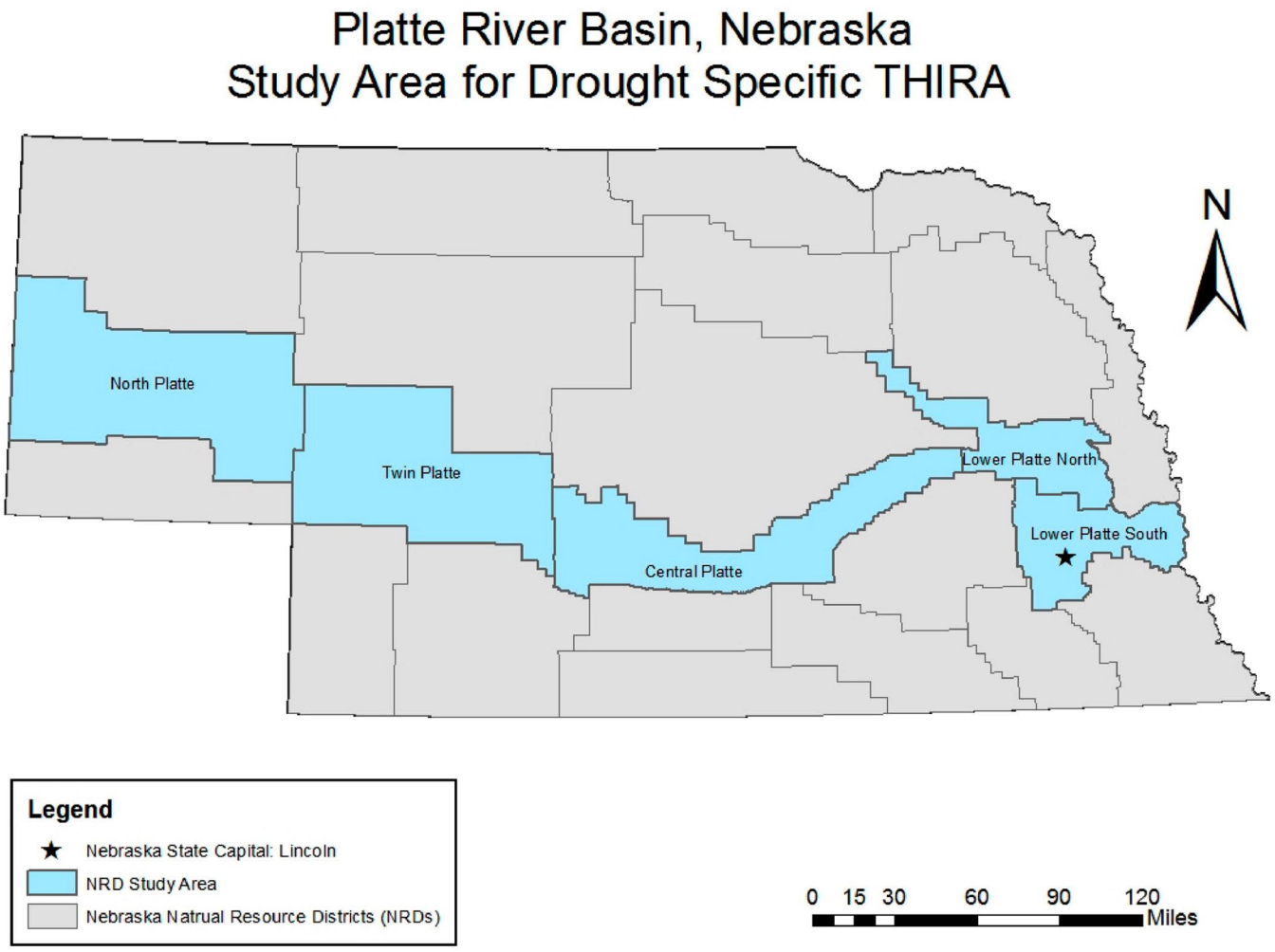

Fig. 1. Natural Resource Districts (NRDs) of Nebraska, highlighting the study area of this drought-specific THIRA (the Platte River Basin NRDs).

protection, mitigation, response, and recovery [30]. A common approach for a THIRA is to address these core capabilities using a worst-case scenario for a common hazard because if jurisdictions plan and prepare for the worst case, they should have the capacity to address a less severe event. Accordingly, the Nebraska research team created a drought-specific scenario using three time points to help decision makers and responders understand their vulnerability and the capabilities needed to prepare for and respond to a worst-case drought scenario. Efforts focused on the Platte River Basin in Nebraska because the basin stretches the full length of the state from west to east and encompasses rural and urban areas and a variety of uses (**Fig. 1**).

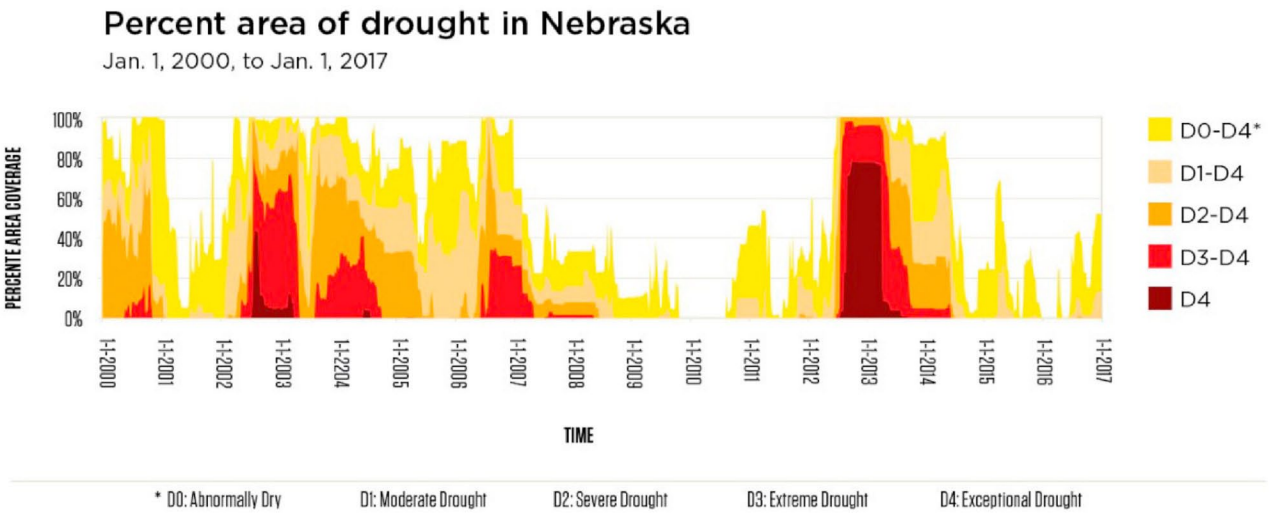

Fig. 2. U.S. Drought Monitor Time Series map of Nebraska, 2000-present [32].

Additionally, significant concerns over water availability have been occurring throughout the Platte River Basin for decades. Most of the basin encompasses regions which have been designated as fully or over appropriated by the state due to high usage rates and limited amounts of projected streamflow and hydrologically-connected water [31]. Applying the drought THIRA to a large river basin encouraged participants to consider how drought manifesting upstream affects overall water availability, as well as other cascading effects of drought, therefore testing trans-jurisdictional drought management and planning.

To challenge the state's resources and management capabilities, the project team created a five-year intense drought scenario by merging two recent drought events from Nebraska's history: the 2002–2004 drought and the 2012 drought (**Fig. 2**). The scenario included actual drought impacts that took place in the past, such as crop failure, decreased water supplies, extreme heat, reduced power production, and public health decline. The scenario included three different time points so participants could consider the resources needed to cope with drought during (1) emergence, (2) intensification to peak extent and severity, and (3) abatement and recovery. These three time points correspond to the three THIRA mission areas in **Table 2**. Finally, a Stakeholder Advisory Group (SAG), comprised of sector experts and decision makers, provided input for the location and timing of sectoral drought impacts to help ensure that the scenario represented a worst-case drought for the region, yet remained plausible.

Table 2. THIRA Mission Areas and Core Capabilities that were applicable for this research.

THIRA Core Capabilities[a]		
Mitigate	Respond	Recover
Planning[b]	Planning[b]	Planning[b]
Public Information and Warning[b]	Public Information and Warning[b]	Public Information and Warning[b]
Operational Coordination[b]	Operational Coordination[b]	Operational Coordination[b]
Community Resilience	Infrastructure Systems[b]	Infrastructure Systems[b]
	Critical Transportation	Economic Recovery
	Environmental Response/Health and Safety	Health and Social Services
	Fire Management and Suppression	Housing
	Mass Care Services	Natural and Cultural Resources
	Logistics and Supply Chain Management	
	Public Health and Medical Services	
	Situational Assessment	

a. For full list of THIRA Mission Areas and Core Capabilities, please visit https://www.fema.gov/core-capabilities [33].
b. There are multiple capability targets that appear in multiple mission areas, denoted with an asterisk. Although some of these core capabilities appear in more than one mission area, only three capability targets were used for each core capability in this analysis (except for situational assessment, which only had one capability target).

The drought scenario was presented at a one-day workshop with stakeholders from across the Platte River Basin and representing various sectors such as water management, agricultural production, energy production, municipalities, and emergency management. The scenario provided the context to discuss the resources required for 16 of the 32 core capabilities (**Table 2**) at the three time points (emergence, intensification, recovery). At the workshop, participants discussed and categorized the available (existing) and needed (missing) resources to manage the drought in light of the 16 core capabilities, providing the foundation for building capability targets. A capability target is a goal that a community or planning jurisdiction works toward to manage a threat or hazard successfully [33]. The capability target discussion includes what resources a jurisdiction has available and still needs to reduce vulnerability. Because the present workshop examined three time points in the scenario, participants set three capability targets for each core capability.

After the workshop, the SAG reviewed each of the capability targets for feasibility (is it achievable?) and effectiveness (will it reduce drought vulnerability within the Platte River Basin?), based on their collective experience. Feasible capability targets are essential. If a planning jurisdiction creates an effective capability target to reduce vulnerability but does not have the resources to meet the capability target, then the capability target is not accomplishable and will serve no purpose in reducing vulnerability. The SAG concluded that the capability targets were both achievable and effective for reducing drought vulnerability in the Platte River Basin.

Table 3. Plans included in this analysis grouped by type of plan, with corresponding year of implementation or last update.

Plan Type	*Planning Jurisdiction*		
Drought Plans	➢ Lower Platte South NRD (2015) ➢ State of Nebraska (2000)		
Hazard Mitigation Plans	➢ North Platte NRD (2016) ➢ Twin Platte NRD (2016) ➢ Central Platte NRD (2017)	➢ Lower Platte North NRD (2015) ➢ Lower Platte South NRD (2015) ➢ State of Nebraska (2014)	
Emergency Operations Plans[a]	➢ Arthur (2017) ➢ Banner (2012) ➢ Boone (2014) ➢ Buffalo (2014) ➢ Butler (2015) ➢ Colfax (2015) ➢ Custer (2014) ➢ Dawson (2015)	➢ Garden (2013 ➢ Hall (2015) ➢ Hamilton (2017) ➢ Howard (2013) ➢ Keith (2017) ➢ Lincoln (2014) ➢ Madison (2012)	➢ McPherson (2017) ➢ Morrill (2014) ➢ Nance (2014) ➢ Platte (2016) ➢ Polk (2015) ➢ Saunders (2014) ➢ Scotts Bluff (2015)

a. Emergency Operation Plans are all at the county level in this analysis.

2. Methodology

With the approval of the capability targets created from the workshop, the project team reviewed current existing drought planning efforts in the Platte River Basin to determine if and to what degree these planning efforts successfully took measures to achieve the capabilities needed to reduce vulnerability to a "worst case scenario" drought such the one identified in the THIRA workshop. Thirty plans were reviewed: two stand-alone drought plans, six hazard mitigation plans, and 22 emergency operations plans. All 22 emergency operation plans were county-based. Five of the six hazard mitigation plans and one of the drought-specific plans were developed by Natural Resource Districts (NRDs), political subdivisions governed by locally-elected boards responsible for natural resource management. The remaining hazard mitigation plan and drought plan were developed by the State of Nebraska.

Plans were scored using a method similar to McEvoy et al. [17], who analyzed ecological drought planning efforts in the Missouri Headwaters region of Montana. In this study, plan triggers (i.e., thresholds for when plan action items are implemented), were given a score of 0 through 3 to indicate the level of explanation and implementation of using triggers for drought response actions. Their results indicate that this method was useful for showing differences in the level of

Table 4. Possible plan scores based on the number of capability targets for each core capability and the possible score for each capability target.

Core Capability	*Number of Capability Targets*	*Possible score for each Capability Target*	*Highest Possible Score*
Planning	3	4	12
Public Information and Warning	3	4	12
Operational Coordination	3	4	12
Community Resilience	3	4	12
Infrastructure Systems	3	4	12
Critical Transportation	3	4	12
Environmental Response/Health and Safety	3	4	12
Fire Management and Suppression	3	4	12
Mass Care Services	3	4	12
Logistics and Supply Chain Management	3	4	12
Public Health and Medical Services	3	4	12
Situational Assessment	1	4	4
Economic Recovery	3	4	12
Health and Social Services	3	4	12
Housing	3	4	12
Natural and Cultural Resources	3	4	12
Total Possible Plan Score	184		

description and implementation of ecological drought monitoring and triggers, resulting in different plan scores.

Similarly, our process was designed to show variation among plans. Instead of analyzing monitoring efforts and plan triggers, we emphasized drought mitigation and preparedness activities based on the degree to which each of the capability target resources were addressed and whether or not plan actions were implemented. Each plan was scored based on its description of the resources needed to meet the capability targets for the core capabilities addressed in the workshop. Our study focused on 16 of FEMA's 32 core capabilities. Three capability targets, corresponded to the three time points in the scenario (except for *situational assessment*, which only had one capability target), were created for each of these 16 core capabilities resulting in a potential score of 46. Thus, each plan was scored for its ability to achieve 46 different capability targets (**Table 4**).

A score of 0–4 was assigned based on the extent to which the plan addressed or met the capability target and whether the strategies and resources discussed in the plan were allocated specifically for drought or were allocated for another hazard but could be applicable

Table 5. Scoring Rubric for each capability target in relation to each plan evaluated.

Score	*Description*
4	A definitive plan action, mitigation strategy, or resource that can meet a capability target and is **implemented** specifically for **drought**.
3	A definitive plan action, mitigation strategy, or resource that can meet a capability target for drought but is **implemented** for **another hazard**.
2	A definitive plan action, mitigation strategy, or resource that can meet a capability target and is **referenced** specifically for **drought**, but not implemented.
1	A definitive plan action, mitigation strategy, or resource that can meet a capability target for drought but is **referenced** for **another hazard**, but not implemented.
0	Nothing in the plan addressed a mitigation action or resource that could be used for meeting a capability target.

*Also referred to as a "mitigation alternative" in the plans.

to drought (**Table 5**). This differentiation allowed us to evaluate how various planning jurisdictions addressed drought preparedness, in terms of developing drought-specific mitigation actions, and how they could increase preparedness by leveraging resources for other hazards to meet the capability statements. An example of plan scores based on ability to meet capability targets is shown in **Table 6**. Based on this scoring scheme, each plan could have a maximum of 184 points (4 points x 46 capability targets) (Table 4).

3. Results

Upon analyzing the 30 applicable plans in the study area; we found; 1) overall plan scores in this analysis were low; 2) leveraging resources from other hazard for drought mitigation results in better plan scores; 3) planning focus and planning language influence plan scores, and; 4) EOPs generally do not address drought and are therefore not adequately equipped to respond and reduce drought impacts. Based on the capability targets and resource requirements identified in the workshop, none of the evaluated plans received high scores for preparing for a worst-case scenario drought, such as the one used in the THIRA workshop. Low plan scores are more likely attributable to these plans not using an all-hazards or drought specific THIRA risk assessment process in their planning processes. Out of 184 possible points, plan scores ranged from 27 points to 46 points (**Table 7**). The State of Nebraska HMP, Lower Platte North NRD HMP, and Lower Platte South

Table 6. Action items in the given plan that allowed them to receive the corresponding score for each Capability target.

Core Capability	*Capability Target*	*Plan statement*	*Score*
Environmental Response/ Health and Safety	Increase number of trained fire fighters available for deployment to fire sites in Nebraska by 1% (n=138)	Increase number of fire fighters and training for urban fire (all hazard context).[a]	1
Natural and Cultural Resources	Establish and ensure water conservation plans and policies are enforced statewide	Create drought specific plans, which may be focused on water conservation (in mitigation alternatives section).[b]	2
Housing	Activate cooling shelters with necessary support and functional needs services in affected communities to serve up to 12,000 people throughout periods of excessive heat	Constructing/updating shelters and having backup generators (all hazard context). [c]	3
Health and Social Services	Deploy psychological first aid (PFA) trained community members to support community resiliency efforts in communities	Provide hotlines for Mental Health in regards to drought impacts. [d]	4

a. Lower Platte South HMP (p. 73).
b. Twin Platte (p. 70).
c. Central Platte HMP (p. 17).
d. Nebraska State Drought plan (Appendix A, p. 2).

Table 7. Resource count for each plan, including weighted score (resource count x score value) for each plan.

Criteria	Score Value	North Platte NRD HMP	Twin Platte NRD HMP	Central Platte NRD HMP	Lower Platte North NRD HMP	Lower Platte South NRD HMP	Lower Platte South Drought Plan	Nebraska HMP	Nebraska Drought Plan
Drought specific strategy implemented	4	1	1	1	3	3	3	6	6
Non-drought strategy implemented	3	4	5	5	3	3	0	6	0
Drought specific strategy referenced	2	2	2	2	2	3	12	0	1
Non-drought strategy referenced	1	10	10	4	12	10	0	4	1
WEIGHTED SCORE		**30**	**33**	**27**	**37**	**37**	**36**	**46**	**27**

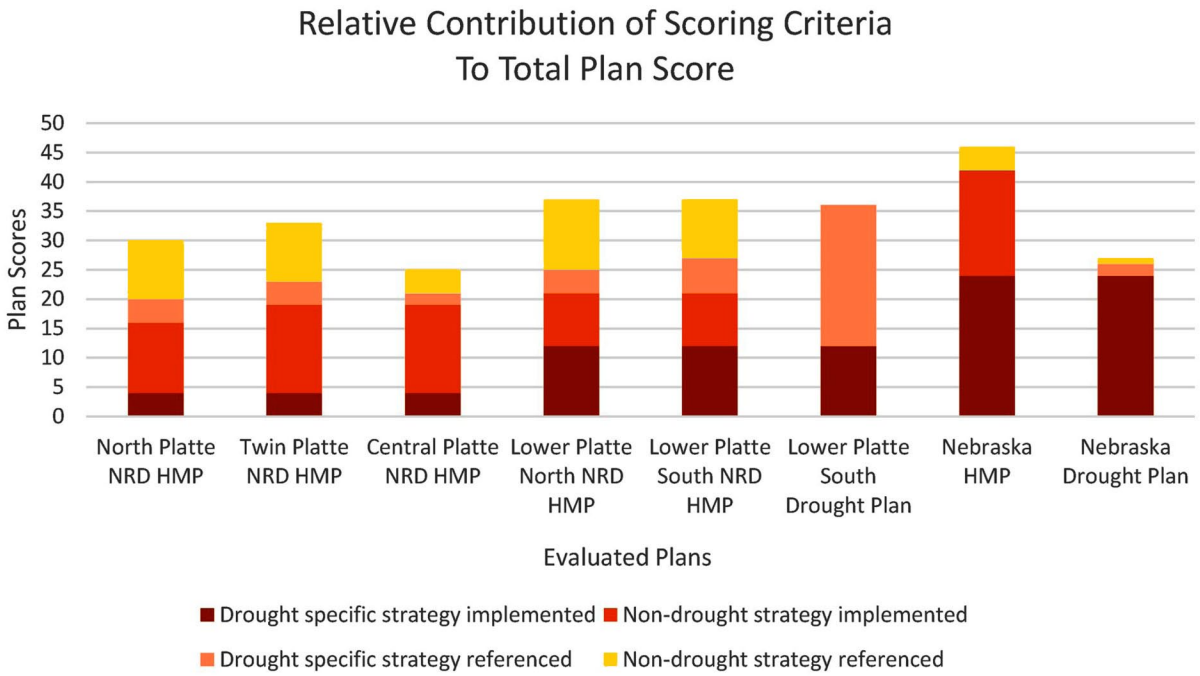

Fig. 3. Plan score composition.

NRD received the highest scores. The state HMP had the highest score because it had the highest amount of total implemented resources (drought and non-drought specific) of any plan (**Fig. 3**).

Fig. 3 shows the variation in each plan scores regarding how each mitigation strategy discussed (suggested or implemented) and the focus of each mitigation strategy (drought or non-drought specific). This table shows that the Lower Platte North NRD HMP and the Lower Platte South NRD HMP had the same plan score (37 points) and had the second highest scores (behind the State of Nebraska HMP, which had the highest plan score) due to a combination of a greater number of drought-specific strategies implemented and referencing resources that could be leveraged for drought (**Figs. 3 and 4**, and Fig. 5). This means that these two plans had higher plan scores than the other NRD level HMPs and both of the stand-alone drought plans. The Lower Platte North NRD HMP and the Lower Platte South NRD HMP had the highest plan scores of all the NRD HMPs because they had more drought specific strategies implemented in the plan, meaning these two HMPs were more drought focused than the other three NRD HMPs. Furthermore, these two plans scored higher than the two

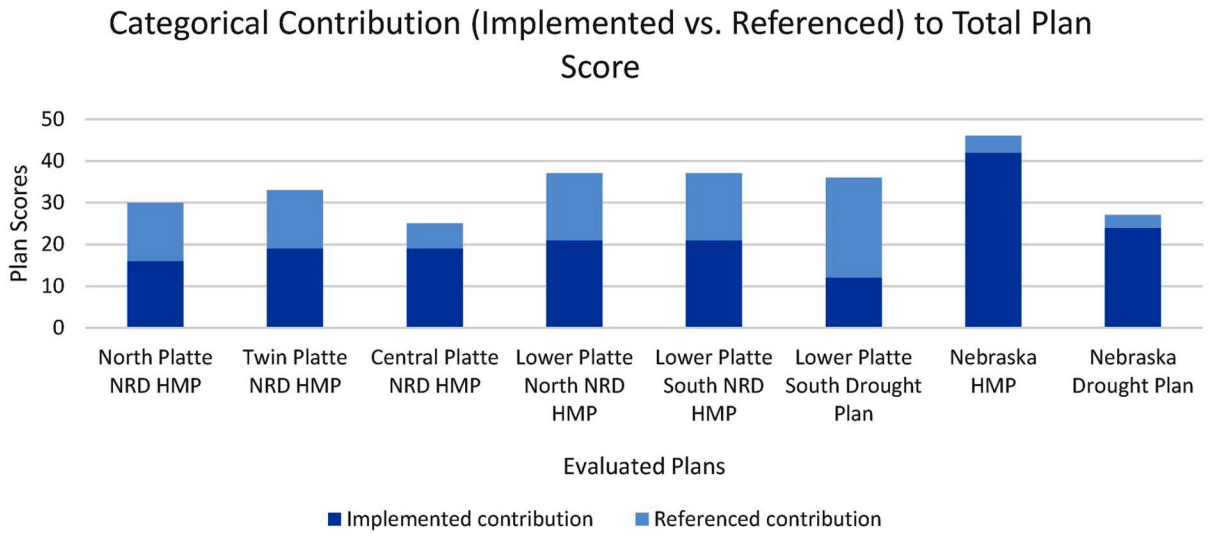

Fig. 4. Plan score variation in total amount of suggested and implemented mitigation actions or resources.

stand-alone drought plans because they had mitigation resources from other hazards that could be leveraged for drought, while the stand alone drought plans had either none or minimal discussion about other hazard resources that could be leveraged for drought. This resulted in lower plan scores for the stand-alone drought plans.

It initially seems counterintuitive that the state drought plan tied for the lowest score since it has the most drought-specific implemented mitigation strategies or resources compared to all other plans in this analysis (**Table 5**). This result can be explained by differences in the planning language and the weighting used in the scoring rubric (Table 5). Although this plan received the most points for implemented drought specific mitigation actions, it received few points for suggesting mitigation alternatives (i.e., referencing actions that could be implemented in the figure) for droughts and other hazards (**Fig. 5**). Since this plan mainly focused on implementing drought specific mitigation actions, it did not include language referencing all-hazard resources that have the potential to be leveraged towards drought mitigation, which in turn, lead to a lower plan score.

It is interesting that there is a nine-point range between the NRD HMP scores since the same consulting company wrote all of these plans within a three-year time span. The newest plan, Central Platte

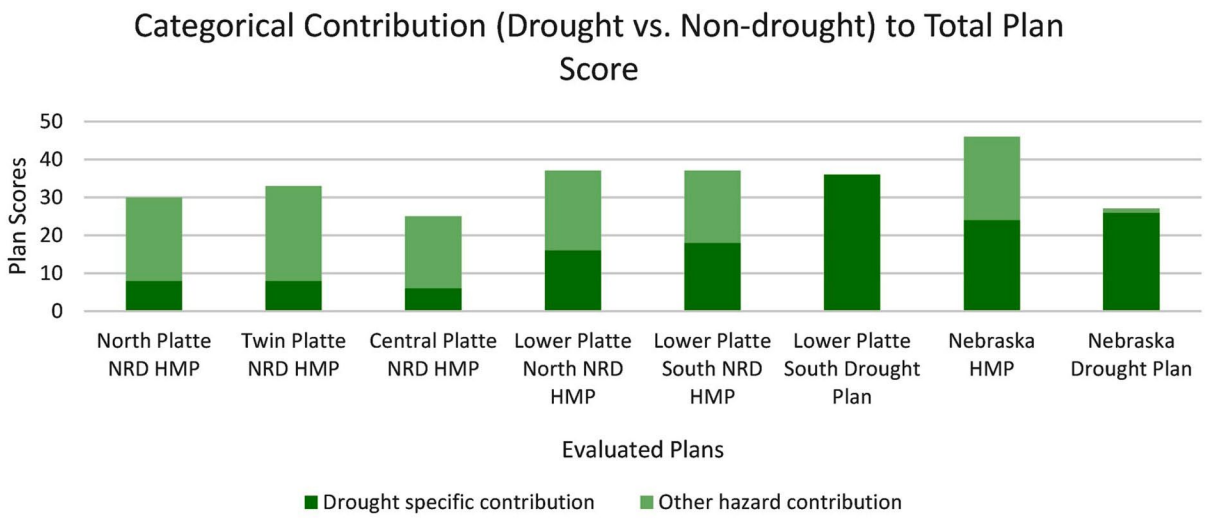

Fig. 5. Plan score variation for drought specific and other hazard mitigation actions or resources.

NRD HMP (2017) received the lowest score, while the three oldest plans (Lower Platte North NRD HMP, Lower Platte South NRD HMP, and Lower Platte South stand-alone drought plan, all 2015), received the highest sub-state scores. In general, the eastern NRD Plans (Lower Platte North HMP, Lower Platte South HMP, and Lower Platte South stand-alone drought plan), scored higher than the western NRD Plans (North Platte HMP, Twin Platte HMP, and Central Platte HMP). The variation in the NRD HMPs and stand-alone drought plans is due to the differences in planning language for mitigation actions and resources (suggested and implemented) and the varying focus on implemented mitigation actions (drought and non-drought specific). Since the eastern NRD HMPs discuss more drought-specific mitigation actions and strategies and they use planning language that links other hazard mitigation to drought mitigation, these plans had higher scores than the western NRD HMPs.

While county-level EOPs were initially part of this analysis (Table 3), results are not shown because of a minimal relationship, if any to drought, leading to low plan scores (< 5). When evaluating each of the county EOPs, we found that only a few mentioned drought in a vague context when discussing all hazards, while most of the plans did not mention drought at all. Furthermore, none of the EOPs discussed mitigation or response actions specifically for drought.

4. Discussion

Overall, low plan scores are most likely because none of the eight plans in this analysis conducted an all-hazards or drought-specific THIRA risk assessment for their vulnerability assessments. Therefore, plan scores would automatically be lower because they used a different risk assessment technique than our drought-specific THIRA vulnerability assessment, leading to different approaches in drought preparedness. However, since the aim of our drought-specific THIRA was to evaluate the preparedness of the Platte River Basin for a worst-case scenario, it is worth evaluating how well the current drought planning activities could handle this worst-case scenario.

Although the overall scores of the plans were low, the findings of this research are similar to past hazard and drought plan evaluation research [13–16]. In their evaluation of hazard mitigation plans in rural counties in the United States Southeast, Horney et al. [14] found that most plans scored low in their analysis. This finding matched our plan evaluations in that much of Nebraska is rural, including much of the area within the Platte River Basin, with the exception of the city of Grand Island in the Central Platte NRD and the city of Lincoln in the Lower Platte South NRD. The lower plan quality in rural areas is most likely due to a lack of available personnel and financial resources compared to more urban areas that can be used for adequate hazard mitigation [14,34].

Additionally, Fu et al. [16], found that many of the current state drought plans still focused on addressing drought during the event (crisis management) rather than planning for drought before an event takes place (risk management). Although our work did not categorize plans into a focus of risk or crisis management, we did find that drought mitigation planning efforts were much lower than the needed level of drought planning across the Platte River Basin that was discussed in the project workshop. Similar to Fu and Tang [15], our study found that even though drought planning efforts are increasing, the level of plan quality for drought mitigation needs to improve along with an increase in drought planning efforts. This finding is also consistent with Lyles et al. [13] in that hazard mitigation efforts are increasing but that does not necessarily mean that effective hazard mitigation is increasing.

We suggest that the variation among scores between similar plan types (HMPs and stand-alone drought plans) may be attributed to jurisdictional resource availability, geography, and plan age. For example, Janssen [34] suggest that rural communities may have a less diversified economic base and fewer financial resources to support disaster mitigation practices or rebuilding efforts. Case in point, the State of Nebraska HMP scored higher than the NRD HMPs because it likely has more resources to leverage for drought mitigation to meet capability targets than a Natural Resource District, county, or municipality. Additionally, the eastern NRDs had relatively higher plan scores than the NRDs in the central and western parts of Nebraska (**Fig. 1**). The Lower Platte North and Lower Platte South NRDs are in the more densely populated eastern parts of the state, where larger municipalities have fewer planning obstacles such as more fiscal resources, greater government capacity, newer or maintained infrastructure, and increased communication owing to greater geographic distances between communities and cross-jurisdiction coordination [34,35].

Geography may have affected the plan scores. The eastern NRDs are located downstream, meaning they are vulnerable to drought induced low flows, which could lead to more awareness for drought mitigation and result in higher plan scores. Jurisdictions further upstream, the western and central NRDs, are also vulnerable to drought, particularly because of the semi-arid climate of western Nebraska. However, these areas are mostly rural, likely resulting in fewer available resources for drought mitigation, which results in lower plan scores.

At the state level, it may seem odd that the State of Nebraska HMP scored higher than the stand-alone drought plan for meeting the capability targets of this analysis. This is primarily due to the sole focus on drought in the stand-alone plans. The stand-alone drought plan contained very little, if any, resources or plan actions that focused on other natural hazards that could be leveraged for drought mitigation to meet the capability targets. With few scores given for other hazard mitigation items that could be or were implemented that applied to drought (scores 1 and 3 in the rubric (Table 5), the stand-alone drought plan did not score as high as the HMPs that received scores for drought-specific resources and plan actions, along with resources and plan actions that could be leveraged for drought. It is worth noting the difference in the age of the plans. The Nebraska state drought plan dates back to 2000, while the state HMP is from 2014. The Nebraska

State drought plan is most likely out of date, in terms of its vulnerability analysis and what resources would be needed to increase drought preparedness, compared to the more current HMP. Additionally, the HMP has gone through several update cycles (as required by law every five years), likely incorporating lessons learned in the process, which would serve to increase plan quality [12] and result in higher scores in our rubric.

The two stand-alone drought plans provide further evidence for the importance of regularly updating plans. The Lower Platte South NRD stand-alone plan scored 10 points higher than the Nebraska State Drought plan, which tied for the lowest score (Table 7). Given that a state would have access to a greater number of resources, we would expect the state plan to score higher. The answer to this most likely lies in the different ages of the two drought plans. The Lower Platte South NRD drought plan is from 2015, while the state drought plan dates back to 2000. The EOPs scores were not included in the results due to a minimal or no mention of drought, with all the EOPs receiving a score of five or less. EOPs are plans that take effect during a hazard event and the lack of drought response in these types of plans shows that emergency managers do not have a plan for responding to drought, potentially leaving it to water managers to respond to drought. Since our drought-specific THIRA workshop brought multiple sectors and planning agencies together, this process allows for integration between hazard and water planning for increased drought response. Furthermore, a drought-specific THIRA could allow quality drought preparedness to increase in both HMPs and EOPs, leading to further integration between hazard planning and drought planning.

5. Conclusion

Although the plans in this analysis scored low for drought mitigation efforts, the opportunity exists to improve plan quality for drought. Since FEMA requires HMPs to be updated every five years, conducting a drought-specific THIRA during the next update period may increase drought mitigation efforts and lead to better integration between hazard planning and drought planning for the plans in this analysis, both of which may lead to increased drought planning quality within HMPs. This integration has potential benefits. First, using a drought-specific

THIRA in an HMP not only allows the jurisdiction to focus on specific drought mitigation efforts, it also allows them to evaluate and leverage other efforts and resources for drought by linking drought mitigation to other hazard mitigation efforts. Second, including drought mitigation planning in an HMP allows for more drought planning exposure for decision makers, planners, and the public, leading to increased drought awareness understanding. Third, using a FEMA vulnerability assessment within a stand-alone drought plan may lead to more coordination between drought and hazard planners. Finally, using a drought-specific THIRA provides a process that any planning jurisdiction can use to prepare for future droughts and may serve to increase overall plan quality. We suggest that the use of a drought-specific THIRA has the ability to increase drought planning quality efforts for both hazard mitigation plans and stand-alone drought plan and the increase the integration between them, for any jurisdictional level.

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Appendix A. Supplementary data is attached to the archive record for this article.

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