Report on the Republican River Basin Drought Planning Exercise

Nebraska Department of Natural Resources Lower Republican Natural Resources District Middle Republican Natural Resources District Tri-Basin Natural Resources District Upper Republican Natural Resources District November 15, 2023

Summary

This report provides an account of the 2022 drought planning exercise project in the Republican River Basin of Nebraska (Basin). The report includes a brief history of drought in the region, details about project development, exercise objectives, key takeaways, and recommended actions to help the Republican River Basin Natural Resources Districts (NRDs) and the Nebraska Department of Natural Resources (NeDNR) better prepare for and manage drought.

Table of Contents

1.0	Introduction	3
1.1	Background	3
1.2	Drought History and Economic Impact	5
1.3	Existing Controls Used During Drought or Dry Periods	8
2.0	Drought Planning Exercise	8
2.1	Phase 1: Research and Identification of Exercise Framework	8
2	2.1.1 Scenario Based Exercises Background	8
2.2	Phase 2: Basin Study and Scenario Development	11
3.0	Drought Planning Exercise Event: Phase 3A	16
4.0	Drought Planning Exercise Outcomes/Evaluation: Phase 3B	17
4.1	Survey Outcomes	17
10		~~~
4.2	Exercise Outcomes	20
4.2 5.0	Exercise Outcomes Future Planning Actions	20 21
4.2 5.0 5.1	Exercise Outcomes Future Planning Actions Develop a Basin-Specific Drought Plan	20 21 21
4.2 5.0 5.1 6.0	Exercise Outcomes Future Planning Actions Develop a Basin-Specific Drought Plan Conclusion	20 21 21 22
5.0 5.1 6.0 7.0	Exercise Outcomes Future Planning Actions Develop a Basin-Specific Drought Plan Conclusion References	20 21 21 22 23

1.0 Introduction

1.1 Background

The Republican River and its tributaries are vitally important to parts of the Central Great Plains of North America. Covering roughly 16 million acres across portions of eastern Colorado, southwest Nebraska and northwest Kansas, the Republican River Basin¹ includes highly productive agricultural lands, large reservoirs with recreational and wildlife habitat features, and established communities that rely on the agriculturally driven economy and the water supplies that sustain it.

Following an extensive drought in the 1930s and a devastating flood in 1935, the three Basin states negotiated the Republican River Compact, which became effective in 1943. The compact continues to provide an apportionment of the Republican River's water supply between the three states. Years in which NeDNR's analysis indicates Nebraska may not be in compliance with the Republican River Compact unless additional management actions are taken are designated as <u>Compact Call Years</u> (CCY) (handout is under the "Links and Related Materials" section). In a CCY, Nebraska must take additional action to meet its Compact obligations by reducing consumption or generating additional streamflow.

In Nebraska, surface water and groundwater resources are managed differently. Surface water rights are managed by NeDNR and are administered based on a prior appropriation doctrine. This means that surface water rights are prioritized based on the date they are issued and therefore, in times of shortage, junior rights can be shut off until senior rights are fulfilled. Groundwater, however, is managed as a correlative resource by local NRDs. This means that groundwater is shared among users as a common resource regardless of when a permit is issued. Because groundwater and surface water are hydrologically connected in areas throughout the Basin, the Upper Republican, Middle Republican, Lower Republican, and Tri-Basin NRDs and NeDNR work together to jointly manage the Basin's water resources and ensure compact compliance.

In 2004, the Nebraska Legislature passed LB 962, which requires the development of an Integrated Management Plan (IMP) for any NRD located within a fully appropriated river basin. IMPs outline the usage and management of hydrologically connected surface

¹ United States Geological Survey Hydrologic Unit Code: 102500

water and groundwater resources at the NRD level. *Nebraska Revised Statute* § 46-715 provides the statutory requirements for IMP development.

Furthermore, *Neb. Rev. Stat.* § 46-755 requires that a Basin-Wide Plan (BWP) be established when a river basin includes three or more NRDs with IMPs required under *Neb. Rev. Stat.* § 46-715. Therefore, in 2019, a BWP for the Republican River Basin was created and implemented. This plan helps to ensure compact compliance and provide consistency between the Basin's IMPs.

Neb. Rev. Stat. § 46-715, subsections (1)(a) and (2)(a)

(1)(a) Whenever the Department of Natural Resources has designated a river basin, subbasin, or reach as over appropriated or has made a final determination that a river basin, subbasin, or reach is **fully appropriated**, the natural resources districts encompassing such river basin, subbasin, or reach and the department shall jointly develop an integrated management plan for such river basin, subbasin, or reach.

(2)(a) An integrated management plan shall include: Clear goals and objectives with a purpose of sustaining a balance between water uses and water supplies so that the economic viability, social and environmental health, safety, and welfare of the river basin, subbasin, or reach can be achieved and maintained for both the near term and the long term.

Action item 2.8.1 of the BWP tasks the four Republican Basin NRDs and NeDNR to develop and participate in a drought planning exercise within the first four years of the plan's implementation. To plan the exercise, the NRDs and NeDNR partnered with the National Drought Mitigation Center (NDMC). The exercise was held in May of 2022.

Some areas of focus for the exercise, as stipulated in the BWP, are:

- Increasing understanding of the needs for and logistics of storing water for use during a drought.
- Evaluating the existing and potential new management actions to determine the long-term availability trends that provide carry-over storage to meet crop-water needs during drought.

• Developing metrics that could be used to evaluate whether conservation of water for future use during a drought is successful.

1.2 Drought History and Economic Impact

The Basin has historically cycled between years of above and below average precipitation. Consecutive dry years and acutely dry years have resulted in numerous droughts within the period of recorded climate data (beginning 1895), including significant droughts in the 1930s, 1950s, mid 2000's, and 2012-2014. Figure 1 shows the percent of the Basin in Drought per the U.S. Drought Monitor (USDM) from 2000 – 2022. Figure 2 depicts the percent of the Basin experiencing drought conditions in each year from 1895 – 2021 rated from abnormally dry (D0) to exceptional drought (D4) and conversely wet conditions ranging from abnormal (W0) to exceptional (W4) on the Standardized Precipitation Index (SPI), which is a measure of meteorological drought.

The NOAA National Center for Environmental Information (NCEI) estimated the total economic losses from drought in the United States at \$290.7 billion from 1980 – 2020 (NCEI, 2022). Nebraska was estimated to have lost \$1.2 billion in 2002 due to drought (Hayes et al., 2004; cited in Knutson et al., 2011). The NCEI estimated an average of \$7.1 billion in economic losses per year due to drought in the U.S. since 1980, and others estimated the figure at \$10 - \$14 billion (Kuwayama et al., 2018).



Figure 1: Percent of Republican Basin in Drought per U.S. Drought Monitor (USDM) 2000 - 2022



Figure 2: Standardized Precipitation Index (SPI) Percent Cover in Republican Basin: 1895 - 2021

1.3 Existing Controls Used During Drought or Dry Periods

Information about actions taken by the Republican NRDs during Compact Call Years is outlined in the NRDs' <u>IMPs</u> and the <u>BWP</u> (under the "Planning" tab), and <u>CCY handout</u> (under the "Links and Related Materials" section) on the NeDNR website.

Examples of groundwater controls include groundwater allocations, a moratorium on new wells and irrigated acres, and requiring metering of all groundwater uses. Examples of surface water controls include recognizing the priority date of February 26, 1948, for Kansas Bostwick Irrigation District and Nebraska Bostwick Irrigation District, closing junior water rights as required by controlling RRCA documents, and protecting storage releases from Harlan County Lake for delivery at Guide Rock from surface water diversions.

2.0 Drought Planning Exercise

The project ran from August 2020 to January 2023. A committee of experts from the NeDNR, the NDMC and a Graduate Research Assistant from the University of Nebraska-Lincoln was assembled to develop the exercise with the cooperation and consultation of the four Republican Basin NRDs.

The project was staged into three phases (Figure 3). Phase 1 was dedicated to researching and establishing a framework for the drought exercise. Phases 2 and 3 were dedicated to the development of scenario exercises, conducting the drought exercise event and reporting.

2.1 Phase 1: Research and Identification of Exercise Framework

In Phase 1, a considerable amount of research and literature review was conducted to understand how water resources are managed in the Basin and determine which type of scenario-based exercise best meets the requirements of the BWP.

2.1.1 Scenario Based Exercises Background

Scenario based exercises provide innovative ways to engage community leaders, regulators, and other stakeholders in collaborative discussions about planning and policy-oriented issues. Commonly used to prepare for complex problems like drought, they bring together participants with different perspectives to work through difficult scenarios and discuss how to approach complex challenges. These types of exercises are particularly useful because they:

- Stimulate creative thinking for mitigation, response, and adaptation strategies.
- Help participants learn about different views and perspectives on drought.

- Identify gaps in existing regulation and potential vulnerabilities.
- Foster better communication and relationships among participants/stakeholders.
- Clarify agency/organizational roles and responsibilities.
- Test and improve coordination among organizations involved in drought response.
- Practice making drought management decisions using the available operational tools.

The coordination committee evaluated materials published by the NDMC that detailed four distinct exercise types then outlined resource requirements for each type based on desired outcomes. Table 1 provides a brief description of the benefits, drawbacks, and most effective applications of the four exercise types (Bathke, 2019):

																			Pha	ase	1								Ph	ase	2									P	has	e 3	l.	
	2019									20	20						2021												2022															
	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June		August	September	Votoper	December	January	February	March	April	May	June	Alut	August	September	Uctober	Docember	Jaquiaban	January	rebruary	March	April	IVIAY	anuc	, And	August Contomhor	October	Votoper	December
Basin-Wide Plan Effective																																												
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Research, Planning and Implementation

Important Dates and Deadlines

Figure 3: Drought Planning Exercise Timeline

Table 1. Scenario Exercise Types

Exercise Type	Description
Workshop	Requires fewer resources, encourages collaboration and coordination among stakeholders, and encourages participation of the general public.
Tabletop	Requires fewer resources, good for education and training, encourages consensus building, collaboration, and coordination among stakeholders, good for plan evaluation and modification.
Game	Moderately expensive to use, encourages collaboration and coordination among stakeholders, and encourages participation of the general public.
Functional	Most expensive to use, good for already existing plans, has limited interaction with experts, more realistic and tense, good for emergency response.

Given the unique objectives and expectations of this project, a hybrid of the workshop and tabletop formats was selected for the exercise. Benefits and desired outcomes of each exercise type are listed below:

Workshop

- Encourage coordination and collaboration among stakeholders
- Identify potential opportunities for better drought preparedness
- Identify and prioritize uncertainties in water resources planning.
- Build a specific product, such as a list of planning resources

Tabletop

- Familiarize and expand participant knowledge of drought impacts, mitigation, and adaptation strategies in the Basin
- Assess existing management and mitigation strategies and discover any gaps that might exist

2.2 Phase 2: Basin Study and Scenario Development

The goal of Phase 2 was to gather information and develop scenarios for the exercise. To achieve this, it was important to study past impacts of drought in the Basin and gain an understanding of existing regulations and strategies for managing water. To help prioritize specific drought impacts for scenario development, an online drought impacts survey was administered to learn how people in the Basin have been impacted by drought in the past. The following groups were asked to respond:

- Republican Basin NRD managers and staff,
- Water suppliers
- Emergency Services Managers
- Individuals living or working the Basin
- Stakeholders from the Republican BWP process

The survey was open from May 24 to November 30, 2021, and available at <u>https://go.unl.edu/rrbdimpacts</u>. Areas of focus identified in the survey are listed in Table 2.

Drought Impacts Category	Drought Impact Areas of Focus
Crop production	Water for irrigation, crop stress, crop disease and reduced crop yield
Livestock production	Reduced grazing, increased mortality, and increased animal stress
Domestic water supply	Water quality issues and low/dry well water level
Public health	Declines in air quality (due to dust, pollen or smoke), stress (mental health issues)
Households	Less water for gardens and increased power bills
Fire	Increased wildfires, property damage and bans on fireworks or controlled burns
Business and industry	Closed businesses and bankruptcy, reduction in production and sales
Recreation and tourism	Reduced water activities, public recreation areas closed and reduced hunting and fishing
Wildlife	Invasive plant and animal species, change in migration, wildlife foraging near people and wildlife disease or mortality

Table 2. Drought impact exercise areas of focus

To learn more about how the Basin's NRDs use available tools and management strategies to manage and mitigate drought, a questionnaire was distributed to the four NRD managers. This questionnaire, with NRD manager responses, is attached as Appendix A.

Scenarios for the exercise were developed using information from the drought impacts survey, NRD questionnaire, 2021 Republican River Basin forecast, and data from other drought monitoring and management tools such as the Drought Atlas (NDMC, n.d.). At the time of the exercise, the Republican River Basin in Nebraska was in the midst of severe and extreme drought, according to the U.S. Drought Monitor (NDMC, 2022). Ranchers and farmers were experiencing problems caused by the drought. Devastating wildfires burned pastures and cropland, destroyed central pivot irrigation systems and fencing, and killed livestock. Some firefighters lost their lives or were badly injured. Gusty winds eroded topsoil, created dust storms, and closed highways.

To recognize the severity of the ongoing drought situation and the losses suffered by the communities, the exercise development team used a combination of real and hypothetical conditions to build the scenarios. Five scenarios were developed to provide a realistic set of conditions over a two-and-a-half-year period. Each scenario consisted of a map of the U.S. Drought Monitor, a Seasonal Drought Outlook, reservoir levels and a narrative. To encourage realistic conversations through the scenarios, participants were grouped according to their respective NRD. Scenario specific questions helped focus table and large group discussions.

The scenarios primarily focused on actions needed to maintain compact compliance, interactions between agencies, public communication, and identifying policy gaps. Additionally, the scenarios looked at other important aspects of drought resilience such as conservation dynamics, emergency response and economic stability. Each scenario session included a facilitated small group discussions where ideas were shared and recorded. Figure 4 summarizes the scenario conditions and discussion topics used for the exercise.

Scenarios Timeline for the Republican River Basin Drought Planning Exercise



Figure 4: Scenario timeline for the Republican River Drought Planning Exercise

To ensure inclusive Basin representation in the exercise, a list of participants was developed, and invitation letters were sent. The list included:

- Republican Basin NRD staff and directors
- Municipal water suppliers
- Farmers and ranchers
- Rural water districts
- Business owners/representatives
- Emergency Management Professionals
- Nebraska Department of Natural Resources staff and director
- Irrigation Districts
- Nebraska Department of Environment and Energy
- US Bureau of Reclamation
- Nebraska Department of Agriculture



3.0 Drought Planning Exercise Event: Phase 3A

Figure 5: Participant affiliation in the Basin by sector/agency

The Republican River Basin drought planning exercise event was held on May 19th, 2022, at the Cambridge Community Center in Cambridge, NE. The event agenda can be found in Appendix B. The exercise was attended by 29 participants with various affiliations from across the Basin. These included agricultural producers, NRDs, Nebraska Extension, irrigation districts, local/municipal government, state agencies, federal agencies, Natural Resource Conservation Service (NRCS), and others (Figure 5). Participants were assigned to tables representing each NRD and were asked to engage in the exercise from the perspective of their assigned NRD.

For each of the five scenarios, participants were presented with a set of conditions, a list of problems, and some questions to help facilitate discussion. The NRD groups were then given 15 minutes to talk about the scenarios and record key points of discussion. At the

end of each scenario discussion, each of the groups reported back to the large group where ideas were shared, discussed and recorded.

At the end of the event, a wrap-up session was also conducted to capture major themes and identify potential actions moving forward. Each discussion group was facilitated by staff from the NeDNR.

4.0 Drought Planning Exercise Outcomes/Evaluation: Phase 3B

A total of 29 participants representing various sectors in the Basin participated in the exercise. At the event, participants were asked to fill out pre-event and post-event surveys. Out of a total of 29 survey pairs handed out, 26 pre-event and 22 post-event surveys were completed and turned in. The purpose of the surveys was to assess and evaluate the efficiency of the exercise in achieving set goals. Pre-event and post-event survey results can be found in Appendix C.



Figure 6: Survey participation by sector/agency

4.1 Survey Outcomes

Before the exercise, participants had a fair understanding of drought and the associated impacts in the Basin. All participants were familiar with and already using at least one of the drought monitoring metrics available in the Basin. An overview of the results is presented below.

Participants were generally the least familiar with:

- "How to plan for hazards such as drought" (42% not at all or slightly familiar)
- "How drought is managed with regard to compact compliance in the Republican River Basin" (43% not at all or slightly familiar)

Participants were generally the most familiar with:

- "Where to find resources that can help or inform me or my organization during drought" (89% moderately or extremely familiar)
- "My role (or my organization's role) during drought" (77% moderately or extremely familiar)
- "How to manage during drought to minimize impacts or harm" (73% moderately or extremely familiar)
- "What I (or my organization) can do to aid compact compliance and reduce conflicts during drought" (73% moderately or extremely familiar)

When asked what their expectations were for the exercise, participants expected to:

- Learn about drought and associated impacts, resources available, regulations that must be followed so they can improve drought preparation in the Basin
- Identify weak points and collaboration opportunities related to drought management in the Basin
- Learn about their personal/organizational responsibilities for drought management and establish good lines of communication in the Basin
- Brainstorm ideas that may be helpful in time of drought
- Learn to make informed decisions on resource management during drought and work with multiple agencies to coordinate education outreach in the Basin
- Network, meet new people, learn new ideas and perspectives

After the exercise, participants were more knowledgeable about various drought issues in the Basin. For instance, participants were more decisive in their responses to questions about Basin drought preparedness in the post-survey compared to the pre-survey. Before the exercise, about 20% of the participants responded with "I don't know" whereas, after the exercise, no participant responded with "I don't know" (Figure 7).



Figure 7: Percent difference between pre-exercise and post-exercise survey responses on drought preparedness. Positive numbers represent an increase from pre-exercise survey responses to post-exercise survey responses; negative numbers represent a reduction from pre-exercise survey responses to post exercise survey responses.

At the beginning of the exercise, most participants were somewhat or moderately satisfied with communication and coordination among agencies/organizations, and moderately satisfied with communication to the public in the Basin. After the exercise, more participants indicated they were "Not at all satisfied" with communication and coordination among agencies in the Basin. This result indicates the exercise provided participants with sufficient information to shift their opinions on the status of drought communication and coordination in the Basin (Figure 8).



Figure 8: Percent difference between pre-exercise and post-exercise survey responses on drought communication and coordination. Positive numbers represent an increase from pre-exercise survey responses to post-exercise survey responses; negative numbers represent a reduction from pre-exercise survey responses to post exercise survey responses.

4.2 Exercise Outcomes

At the end of all the scenario discussions, participants came together for the wrap-up session where they shared lessons learned from the exercise and discussed potential future courses of actions. Based on discussions from the wrap-up sessions and survey responses, the following were the outcomes of the exercise:

- Increased knowledge of the following:
 - Personal and organizational responsibilities during drought in the Basin
 - How existing policy, developed to ensure compliance with the Republican River Compact and district IMPs, is implemented in times of drought to protect surface water and groundwater
 - Resources available during drought
- New relationships were built from interactions during the drought exercise event.
- A realization of the following:
 - There is interest in a Basin-specific drought dashboard and drought plan. These tools would help improve drought monitoring, response, and communication between agencies/organizations and the public in the Basin.

• There is interest in exploring more water conservation options that could increase water availability during drought in the Basin.

The following potential courses of actions were identified:

- If staff and resources are available, develop a Basin-specific drought plan that will outline clear resource management guidelines and establish lines of communication and coordination between agencies and to the public.
- If staff and resources are available, develop a Basin-specific drought dashboard that will help track and monitor drought triggers.

5.0 Future Planning Actions

Based on the outcomes of the exercise and conversations with the NRD managers, and depending on available staff and resources, future plans are:

5.1 Develop a Basin-Specific Drought Plan

In this context, a drought plan is a written document that will include strategies that the Basin will implement before, during and after a drought event. Development of a drought plan is dependent on availability of staff and resources. The proposed drought plan will be specific to the Republican River Basin in Nebraska and will include the following:

- Communications Planning
 - Develop strategies for better communication among stakeholders, SW & GW users and the public during droughts and ensure the abovementioned groups understand how and why NeDNR and the Republican NRDs maintain compact compliance.
 - Coordinate with emergency management agencies and rural fire departments to better mitigate and respond to wildfires and natural disasters.
 - Leverage outside funding sources, such as federal grants, for projects and programs to better mitigate and respond to drought and increase drought resiliency in the basin.
- Drought Dashboard
 - Provide real time data to SW & GW users, the public and natural resource managers with basin specific drought information.
 - Provide irrigators with educational information or a practical decision-making tool.
- Conservation Projects

- Develop drought resiliency and mitigation projects which could benefit from federal/state funding.
- Develop projects or programs that improve public awareness and increase water conservation practices during drought.

6.0 Conclusion

The Republican River Basin Drought Planning Exercise project was successful. In no particular order, NeDNR, the NDMC, and the Republican Basin NRDs wish to thank and acknowledge the following for their commitment and support to this project:

- Nebraska Extension
- Irrigation districts in the Republican River Basin
- Local/Municipal governments in the Republican River Basin
- U.S. Department of Agriculture
- Nebraska Emergency Management Agency
- Agricultural producers in the Republican River Basin
- Natural Resources Conservation Service
- Mayor of the City of Cambridge

7.0 References

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Appendices

Appendix A: Responses to the NRD Questionnaire

	1. What products, tools or services do you use to monitor drought conditions in your district?
• • • •	 High Plains Climate Center, national and regional drought maps NERAIN rainfall data NOAA climate Data NeDNR/USGS stream gage data US Drought monitoring tools from NDMC National Weather service MAO Project Groundwater modeling software Local producer information Local weather stations Soil moisture data from automated soil moisture probes
	2. What management actions have you used in the past to address drought in your district?
	 Temporary groundwater transfers to supplement limited SW deliveries. Monitoring of groundwater levels and streamflows. Water Conservation Incentive Program: intended to improve drought resilience by reducing groundwater consumption. Groundwater pooling agreements available to producers. Multi-year allocations that allow irrigators to "bank" groundwater not used in wetter years so that it can be used during drought. Hard cap on groundwater allocations during Compact Call years. Dry year lease program Reduction of consumptive use

3. What management actions do you anticipate using in the future, in the event of a significant drought?

- Considering whether it would be useful to use incentives or regulations to limit groundwater use by irrigators who have access to surface water in years when surface water is readily available. This could leave more groundwater available for use when surface water supplies are inadequate.
- Improve accessibility of drought related information to landowner through District website
- Hard Cap on groundwater pumping during Compact Call years.
- Modifications to rules and regulations that will encourage or require less water usage to promote adoption of more water-saving technology by producers, and better management of their 5-year allotment of water allocation
- Augmentation
- Building new storage facilities in designated watersheds for retiming of releases during drought conditions.
- Working to with UNL to develop real-time, field specific evapotranspiration estimates, and forecasts. New technologies can improve efficiencies.
- Agreements with NBID to transfer water into KS account in HCL when needed.
- 4. Who in your district do you communicate with regarding drought or water shortage issues?
- Irrigation districts

Industrial entities

Municipalities

- UNL Extension
- Rural water districts

• Well owners

Appendix B: Drought Planning Exercise Agenda

	Time	Description
Room preparations & participant arrival	8:00-9:00AM	
Pre-event survey	09:00-09:30AM	
Introductions & welcoming remarks	09:30-10:00AM	
Scenario 1: January 2022	10:00-10:20AM	Drought early warning & preparedness
Scenario 2: March 2022	10:20- 10:40AM	Drought response
Group discussion for scenarios 1&2	10:40-11:00AM	
Scenario 3:	11:00-11:30AM	Compact compliance in drought
Group discussion for scenario 3	11:30-11:50AM	
Working lunch	11:50-1:00PM	Presentation (WaterSmart Grant process)
Scenario 4:	1:00-1:20PM	Drought recovery
Group discussion for scenario 4	1:20-1:40pm	
Scenario 5:	1:40-2:00PM	Wildcards
Group discussion for scenario 5	2:00-2:20PM	
Wrap up session	2:20-2:40PM	What? So what?
Post-event survey	2:40-2:55PM	
Closing remarks	2:55-3:00PM	

Appendix C: Pre and Post Exercise Survey Results

Republican River Basin Drought Exercise

Pre and Post Exercise Survey Results

Drought Exercise Participants

- In total, **26** pre-event and **22** post-event surveys were completed by Drought Exercise participants.
- About 1/3 of participants were affiliated with NRDs, 1/3 were from State or Federal agencies, and 1/3 were from other sectors (Irrigation districts, UNL Extension, Local/Municipal government).
- Most participants were decision makers, provided information/advice to decision makers, or both.



Question 2 (Pre): What is your role with regard to drought related management decisions?



Q10 (Pre-Survey): Finally, in your opinion, what should the upcoming Drought Exercise accomplish?

- Help us identify weak points and collaboration opportunities related to drought
- Discuss options for different levels of drought and where to find resources
- Learn about different agencies and what their roles maybe
- I am just here to learn
- Establish good lines of communication and what responsibilities each NRD are responsible for
- Improve drought preparation
- Better awareness of what is available and regulations that must be followed
- To brainstorm ideas that maybe helpful in time of drought
- Bringing players together and understanding the roles they play
- Understand everyone's role during drought
- Help make informed decisions on resource management during drought and work with multiple agencies to coordinate education outreach
- New ideas, different perspectives
- Preparation for long range projections



Q3 (Pre-Survey): How would you describe your level of familiarity with the following?

• Overall, familiarity with the above drought topics is evenly distributed.

- Participants were generally the least familiar with:
 - "How to plan for hazards such as drought"(42% not at all or slightly familiar)
 - "How drought is managed with regard to compact compliance in the Republican River Basin" (43% not at all or slightly familiar)
- Participants were generally the most familiar with:
 - "Where to find resources that can help or inform me or my organization during drought" (89% moderately or extremely familiar)
 - "My role (or my organization's role) during drought" (77% moderately or extremely familiar)
 - "How to manage during drought to minimize impacts or harm" (73% moderately or extremely familiar)
 - "What I (or my organization's) can do to aid compact compliance and reduce conflicts during drought" (73% moderately or extremely familiar)

Q3 (Pre-Survey): How would you describe your level of familiarity with the following?





Q4 Pre-Survey: How familiar are you with using the following drought metrics?

- Participants were generally the least familiar with:
 - GRACE (89% not at all or slightly familiar)
 - QuickDRI (77% not at all or slightly familiar)
 - EDDI (65% not at all or slightly familiar)
- Participants were generally the most familiar with:
 - Daily weather reports (85% moderately or extremely familiar)
 - Groundwater levels (84% moderately or extremely familiar)
 - US Drought Monitor (81% moderately or extremely familiar)

Q4 Pre-Survey: How familiar are you with using the following drought metrics?





Q5 Pre-Survey: In your opinion, how prepared are the following sectors to deal with drought in the Republican River Basin?

- In general, participants found the following sectors to be the least prepared for drought:
 - Fish & Wildlife (27% not at all or slightly prepared)
 - Public Health (23% not at all or slightly prepared)
 - Fire Management (20% not at all or slightly prepared)
- In general, participants found the following sectors to be the most prepared for drought:
 - Irrigation Districts (76% moderately or extremely prepared)
 - Natural Resources Districts (73% moderately or extremely prepared)
 - Agricultural Producers (73% moderately or extremely prepared)

Q6: In your opinion, how prepared is the Republican River Basin to do each of the following in case of severe drought?





Q6 (change): In your opinion, how prepared is the Republican River Basin to do each of the following in case of severe drought?



- After the exercise, participants were more decisive in their answers to question 6.
 - There were no "I don't know" answers to question 6 in the post-survey, which indicates that the exercise impacted how participants felt about the above actions.
- Following the exercise, participants felt that the Basin was most prepared to address drought by augmenting water supplies.
- Participant opinions about administrative and regulatory processes, and inter-agency/inter-jurisdictional coordination didn't change much as a result of the exercise.
- Participant opinions about public information and warning preparedness decreased in the "moderately prepared" and "extremely prepared" categories and increased for the "slightly prepared" category.

Q7 (Change): To what extent do you think each of the following groups should be responsible for conserving water during drought in the Basin?



- Only 85% of survey respondents answered question 7 on the post-event survey. This accounts for much of the change between surveys.
 - The perception that public drinking water systems are "not responsible at all" increased by 8%
 - The perception that village/city residents are "not responsible at all" increased by 4%
 - The perception that village/city residents are "very much responsible" increased by 8%



Q8: In general, to what extent do you agree or disagree with the following statements?



Q8 (change): In general, to what extent do you agree or disagree with the following statements?



- Only 85% of survey respondents answered question 8 on the post-event survey. This accounts for much of the change between surveys.
 - Notable changes between surveys include:
 - There was a 12% increase in respondents indicating that they "strongly agree" with the statement "You **can't** trust anyone in the Basin to effectively conserve water during drought".
 - There was a 15% increase in respondents indicating that they "somewhat agree" with the statement "You **can** trust industrial water users to conserve water during drought".



Q9: How satisfied are you with communication and coordination between agencies, organizations and the public with regard to drought management in the Republican River Basin?



Q9(change): How satisfied are you with communication and coordination between agencies, organizations and the public with regard to drought management in the Republican River Basin?



- Only 85% of survey respondents answered question 8 on the post-event survey. This accounts for much of the change between surveys.
 - Notable changes between surveys include:
 - There was a 4% (1 participant) increase in respondents reporting that they are 'Not at all satisfied" with "Communication and coordination among orgs/agencies.
 - There was an 8% increase in respondents reporting that they were 'Very satisfied" and a 4% increase in those reporting that they are "Somewhat satisfied" with "Communication with the public"

Q10 (Post-Survey): Did the scenario exercise identify or reinforce lines of communication that are more satisfactory to you?





Q11 (Post-Survey): Based on your experience, would you recommend the use of a scenario exercise for the following purposes?