ARKANSAS DROUGHT PLANNING WORKSHOP

Summary Report

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American Society of Animal Science. "Arkansas Drought Cattle on Dry Pasture." *Taking Stock*, takingstock.asas.org/?attachment_id=4528.

National Oceanic and Atmospheric Administration. "Dry Reservoir." *Weather-Ready Nation*, www.nws.noaa.gov/com/weatherreadynation/news/152108_drought.html.

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TABLE OF CONTENTS

INTRODUCTION

In June of 2016, representatives serving broad areas of water, natural resources, agriculture, public health, forestry and other management organizations participated in the *Arkansas Drought Planning Workshop*. Hosted in Little Rock, AR, this event was sponsored by the Arkansas Natural Resources Commission (ANRC), the Southern Climate Impacts Planning Program (SCIPP), and the National Drought Mitigation Center (NDMC). This workshop brought together regional, state and federal representatives in Arkansas with the goal of building capacity for better decision-making related to drought planning and adaptation. Discussion focused on the recent 2010-2015 drought events and provided participants the opportunity to share experiences and identify the impacts, challenges, lessons learned, and opportunities for collaborations regarding future drought events.

Research concepts recognized by NDMC (2016) include that "drought frequently causes a wide variety of impacts…some impacts may persist even after a drought is officially declared to be over…certain groups or things may be more vulnerable than others to the effects of drought…this increased vulnerability may be the result of physical, social or economic circumstances." Therefore, the identification of drought impacts on Arkansas' sectors is crucial in increasing the state's resiliency to drought.

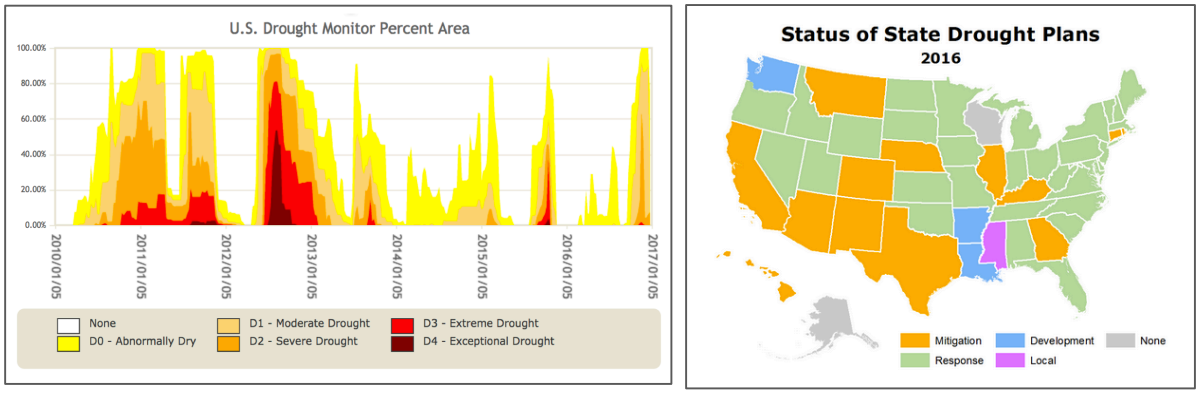

Figure 1: 2010-2016 drought history for Arkansas (left) and current state drought plans (right), source: NDMC.

The Arkansas Department of Emergency Management (ADEM) 2013 All-Hazards Mitigation Plan includes the preliminary report, *The Impact of the 2012 Drought on Field Crops and Cattle Production in Arkansas,* which was prepared by the University of Arkansas Division of Agriculture, Research and Extension Service. This report showcases the 2012 drought's impacts on Arkansas' agricultural sector. Ranchers lost at least $128 million from August 2011 through July 2012, mainly attributable to a short supply of hay and rising hay costs. It states that, "at one time, 85 percent of pastures were in poor or very poor condition."

INTRODUCTION

The report further explains the impacts of drought on the region. "The Arkansas Forestry Commission (AFC) issued burn bans in 55 of the 75 counties as of June 27, 2012, as the fire danger was rated as 'High' across the State." By August 2012, the United States Department of Agriculture (USDA) declared disaster areas over 72 of 75 Arkansas counties to help assist farmers with losses caused by the drought.

ADEM's All-Hazards Mitigation Plan further addresses the crop losses throughout the State of Arkansas. "According to the USDA Risk Management Agency, insured crop losses because of drought conditions for the ten-year period of 2003-2012 totaled $79,487,759," as shown in Table 1. During this period, the greatest annual crop losses occurred between 2010-2012.

Table 1: Total Insured Crop Insurance Paid by Year, 2003-2012.

Year	Crop Insurance Paid
2012	$14,349,712
2011	$15,544,487
2010	$12,165,477
2009	$253,135
2008	$9,463,371
2007	$8,319,294
2006	$8,821,636
2005	$6,856,914
2004	$1,448,884
2003	$2,264,849
Total	**$79,487,759**

Source: USDA Risk Management Agency

Furthermore, NDMC (2016) also states that, "planning for drought is a recommended way in which a community can deal with the vulnerabilities and impacts it identifies." Arkansas is one of four states that do not have a statewide drought plan. One goal of the workshop was to introduce the idea of producing a comprehensive drought response and preparedness plan for Arkansas. The workshop began with discussion on how recent drought events impacted various sectors as well as their statuses and current efforts on drought planning. Participants learned about the history of drought in Arkansas and current drought planning initiatives across the region, as well as available tools to help increase their resiliency. Analyses of both internal and external operations and collaborations focused around drought planning were also explored. Discussion of current efforts indicated a need for additional data and collaboration. The workshop concluded with a reiteration of these requests and discussion of next steps in the drought planning process. This report summarizes the workshop presentations, discussions, and outcomes.

PRESENTATION SUMMARIES

The workshop began with five presentations. Each provided content on various aspects of drought including the variability of drought in Arkansas, indices used to measure drought, available drought tools, and information on how to develop a drought plan.

DROUGHT VARIABILITY IN ARKANSAS

This presentation introduced the topic of drought. Definitions of drought and drought variability were explained, as well as the state's average values for temperature and rainfall. Arkansas is frequently affected by billion-dollar disasters, including drought, which is ranked by the National Centers for Environmental Information (NCEI) as the second costliest event nationwide (between 1980-2011). An analysis of recent drought events across the state were shown.

DROUGHT INDICES

Impacts of drought vary by time scale and can last from weeks to decades. The importance of monitoring drought to suppress these impacts, along with respective drought indices, was highlighted. Discussion focused on the differences between each index including the climate variables used, the variables monitored, and the sectors to which the data is catered.

DEVELOPING A DROUGHT PLAN FOR ARKANSAS

Arkansas is one of few states that lacks a state drought plan. The importance and benefits of a plan were expressed, followed by an overview of the components needed to develop a drought plan. The "10 Step Drought Planning Process" emphasizes planning across all scales, starting at the local level. Examples from states across the region were shown to display ways in which a plan can be developed, as well as various resources, guidelines, and first steps.

CREATING A DROUGHT EARLY WARNING SYSTEM (DEWS)

The components of a drought plan were emphasized further, revealing key ideas for effective drought management. Although monitoring drought is important, it is not sufficient for increasing resiliency. The idea of developing a DEWS for Arkansas was introduced. A drought planning process is an effective way to evaluate risks and identify strategies to reduce vulnerabilities.

THE DROUGHT RISK ATLAS

The final presentation revealed the current tools available for drought preparedness efforts through an interactive guide. The National Drought Mitigation Center offers numerous tools to analyze drought characteristics including individual years or multiple time periods, the frequency of droughts, and the ranking of severity in comparison to past events.

BREAKOUT DISCUSSION OUTCOMES

Overview

The workshop provided an opportunity for open dialogue between sectors in an effort to increase awareness of drought impacts and assess available tools and coordination. The dialogue took place during two large group discussion periods and two small group discussion periods. The sectoral diversity in the small group discussions encouraged a broad range of perspectives to learn about and discuss drought issues and opportunities.

Discussion during the workshop focused on four topics, each of which is explained in more detail below. The topics were:

- Open Discussion: How Does Drought Impact your Operations?
- Small Group Discussion 1: Monitoring, Forecasting, and Research
- Small Group Discussion 2: Coordination Among Agencies
- Drought Workshop Outcomes

Open Discussion: How Does Drought Impact Your Operations?

The first discussion focused on how drought had impacted the participants and their respective fields. Impacts occurred across multiple sectors including water, agriculture, forestry, health, and game & fish, as well as across multiple levels of representation including local, state and federal. The most widespread impacts occurred around water issues. Other common impacts included the strain on smaller watersheds as they have the highest water restrictions and the fewest interconnections, the effect of a reduced stream flow on wildlife and navigation, and the worsening of wildfire conditions from excessive rainfall followed by drought. Other common impacts included challenges with coordination and insufficient monitoring.

WATER

Drought has a wide range of impacts on public water systems. Issues revolve around water quality, capacity, restrictions, interconnection, and conservation, and are commonly interrelated. Water quality may diminish during drought if harmful algae blooms develop in the water. For streams, the increased concentrations of pollutants during periods of low flow impede the passing of water quality standards. Low flow also decreases the amount of water allowed for

discharge permits. Additional effects from poor water quality include the ceasing of non-riparian permits for fracking and stricter discharge regulations on the paper industry.

The lack of water during drought sets pressure on demand, with the most recent drought from 2010-2015 seeing higher than historical peak capacities for well systems and surface water systems. The most severe declines in agricultural wells due to increased demand have occurred in the Coastal Plain Alluvial Aquifers. The trend to pump wells more often and at maximum capacity has resulted in adverse effects on the quality of the wells. One way to address the quality of wells is to repair leaks, which are not well monitored in rural areas. For example, some systems have leaks in their water distribution pipes and pumping is often increased to offset the water loss. During times of drought, such as in 2015, this pumping was exacerbated and wells ran dry. This resulted in the activation of city emergency plans, which included installing a second well. On the local level, low water availability has led to vandalism of fire hydrants.

As drought worsens and supply levels are reduced, restriction issues develop. One of the most predominant issues includes the regulation of water use after a well reaches capacity. The implementation of restrictions depends on the available resources, the capacity of the treatment plant, and the number of wells in the system. Smaller watersheds are most at risk for facing restrictions due to their natural seclusion. During worsening drought conditions, larger water systems commonly restrict sales to these smaller systems.

The level of interconnection between regions can further explain capacity and restriction issues. Many watersheds in the state are connected with other systems; however, that is not always possible, especially in rural areas. The 2011 drought spurred conversation about interconnections. Terrain, financing, and the distance between regions were identified as key interconnection factors. A recent effort to increase coordination between smaller regions included creating a larger regional water system for 22 smaller systems. Another way to combat capacity issues is to practice conservation. It was found that there is no consistency in conservation measures across the state and the topic is often not received well at the local level. Multiple examples, such as from the Beaver Water District, revealed that a lack of consistency and capacity leads to very local social impacts and issues, especially across boundaries.

AGRICULTURE

Water is a necessity for both livestock and crops, and has a tremendous impact on operations including planting and production. During 2011, pastures in western Arkansas were severely impacted due to the lack of rainfall and high evapotranspiration rates. Many ranchers were forced

to reduce their herd sizes. There were further long-term impacts as the farmers recognized a need to restore pasture health to lessen impacts from runoff, soil degradation and erosion. Drought has varying degrees of impact to rural crops such as aquaculture and rice production, the state's third-highest agricultural industry. Aquaculture deals with water quality problems focused on salinity, pH levels, and water temperatures. Rice dependent regions, such as eastern Arkansas, requires fields to be flooded, a process which pulls an overabundance of water for production and may further strain groundwater resources in the Sparta Aquifer. Higher value commodities, such as rice, get water precedence over other crops. These other crops such as soybean and corn may then suffer as they get less water distribution than rice during dry times. Energy costs are a key driver in the decision for watering crops. The required energy needed to move water to fields drives the pumping costs. Additional drought impacts on production include a lack of seed quality and honey production, the resort for poultry producers to receive water from fire departments, and a negative effect on landscape jobs and nursery sales.

Drought occurring in other states affect the agriculture production in Arkansas. Hay is an important food source for livestock, and drought-induced hay shortages place an economic burden on livestock operations. Farmers then have to resort to inflated prices from nearby states such as Kansas and Missouri. An indirect effect of purchasing hay from other states included the introduction of invasive species. Specifically, fire ant infestations caused lasting impacts, even after quarantine efforts.

Weather extremes, specifically drought and flooding, are often destructive to crop development. These two tend to follow one another in occurrence, and impact the length of the crop season. Row crops suffer if conditions go from too wet to too dry in a short time frame. Significant rain prior to the growing season makes it difficult to plan planting and water schedules. Specifically, in 2012 planting was delayed because of spring flooding. In addition, due to an abundance of near-surface soil moisture, plants may not develop extensive root systems. Consequently, as it dries, they may be unable to access deeper soil moisture. This range and frequency of extremes led to the extended use of irrigation throughout the year.

FORESTRY

The intensity of wildfires is highly dependent on drought conditions. Most notably, the seasonality of drought affects fire conditions, specifically during a year with both excess rainfall and flash drought. Excess rainfall during springtime can lead to an above normal growth of vegetation. As conditions dry out in the summertime, this vegetation often becomes the primary source of fuel for fires. The subsequent wildfires tend to be very intense, smaller in size and widespread.

BREAKOUT DISCUSSION OUTCOMES

Destructive wildfires in 2012 were a result of these fluctuating conditions. Wildlife populations, including wild turkey, were harmed by these fires. Although sources of ignition are commonly sporadic and unidentifiable, they can range from human interaction to natural events such as lightning strikes. Beyond the drought itself, the capacity of personnel and equipment affects how great the wildfire impacts will be. The most susceptible locations for fires include the state's Wildland Urban Interface and plantations, where a greater tree density leads to more crown fires. Water stress may also impact the control of wildfires, especially for rural fire departments. In 2012, various water towers, which are the primary source to combat fires, were depleted of water.

Beyond enhancing the formation of wildfires, drought affects the longevity of timber. The slow-onset of timber deterioration brings both short and long term impacts. During high temperatures, trees produce high moisture and subsequent humidity. This humidity may impact human health if it leads to advisories for high heat indices and heat stroke. When drought conditions worsen, such as in the summer of 2011, dry soils place stress on trees, such as on the oaks in the Ouachita Mountains. The deterioration of oak trees lingers from one to three years; therefore, the trees that were stressed in 2011 resulted in dying trees in 2012 and 2013. Secondary effects continued as the wildlife that feed on acorns, such as feral hogs, had to expand their range to find sufficient food sources. Other secondary impacts following the lengthy death of trees include insect infestation. The red oak borer infestation that occurred in 2000-2001 was a direct result of the 1999-2000 drought. Alternatively, one positive impact from drought was that logs obstructing rivers could be removed more easily.

GAME & FISH

A lack of water hinders the use of streams and lakes for recreational purposes in Arkansas. Low water levels result in unusable boat ramps and lakes, which are commonly not refilled after maintenance procedures during drought conditions. Consequently, streams and rivers dry up. The lack of water prohibits many recreational activities including canoeing, kayaking, boating, and float fishing. Additionally, low water years, especially when in succession, impact the quantity of fish production for commercial fisheries. Streams are significantly impacted when highly fragmented landscapes impound streams. Various types of fish and mussels are not able to migrate freely, as seen in the Little Red River. Low water levels allow temperatures to heat up quickly, leaving uninhabitable conditions for certain types of sport fish and endangered species. As water quantity lowers, the quality of water diminishes quickly. Low water quality then leads

to harmful algae blooms, and along with the release of impaired water from rice farming, these conditions can increase fish mortality.

HEALTH

Extreme weather events may impact health, especially from the increased exposure of certain pollutants and pathogens. The risk for contamination is amplified most often during flooding. Outbreaks in E Coli, as well as the increase of tick-borne illnesses and poison ivy, occur more frequently because of flooding. Additionally, drought can magnify health problems when the buildup of contaminants, such as fertilizers and herbicides, lead to an increased chance of exposure when runoff events occur.

NAVIGATION

Navigational efforts are highly dependent on streamflow. During periods of high power demand, the Arkansas River can experience rapid declines. If the streamflow becomes reduced during drought conditions, the federal government gains control over the river and governs the option to dredge. The flow of water also impacts the state's leading renewable energy source, hydroelectric power, as one of the facilities is located on the Arkansas River. The U.S. Army Corps of Engineers (USACE) controls and manages the flow of the Arkansas River based on Oklahoma's water supply, whose downstream amounts source most of the Arkansas Basin and corresponding lakes.

Both flooding and drought impact performance on rivers. In 2011, widespread flooding in the White River Basin combined with flooding from the Upper Missouri River Basin and produced record crests along the Mississippi River. The following year, drought in the Midwest caused near-record low flow in the Mississippi River. Both instances halted barges and reduced navigation. Also in 2011, exceptional drought conditions in southeastern Oklahoma and southwestern Arkansas decreased the water quality of the Ouchita River and threatened to shut down navigation. However, this threat was avoided due to swift communication that led to an early release of the lakes to maintain flow levels for mobility.

Negative impacts are dependent on the characteristics of drought and are often highly variable. Planning could help lessen negative impacts to the navigational industry during unexpected times of flooding and drought.

BREAKOUT DISCUSSION OUTCOMES

Small Group Discussion 1: Monitoring, Forecasting & Research

Following the open discussion, participants divided into four small groups and were encouraged to interact and learn about current drought efforts across sectors. Topics in the first small group discussion focused on internal relationships and coordination. Individuals were invited to share how their sector prepares for and handles drought.

The first round of discussion consisted of three different focus topics:

- What current tools are used to analyze and monitor drought?
- How did those tools perform (evaluation of tools)?
- What types of information and/or tools could aid in future efforts?

CURRENT TOOLS & DATA

Multiple sources of data and tools are used to monitor drought. The tool sources range from federal to state to local and are used across multiple sectors. In general, the types of tools and information depends on the audience of the sector.

The most popular tool is the U.S. Drought Monitor. Following the monitor, the next most commonly used tools are the drought indices, including the Keetch-Byram Drought Index (KBDI) and the Palmer Drought Severity Index (PDSI). They are useful for a wide variety of practices, including forestry efforts, National Weather Service (NWS) forecasts, and USACE allocations on lakes. Other popular sources of tools include farming instruments such as soil moisture sensors and flow meters. Other frequently used data includes U.S. Geological Survey (USGS) streamflow, soil moisture, seasonal averages, and the rate of water loss.

Information and data are most often accessed from the NWS and USGS. Data from the NWS and climate counterparts are used by the navigation, forestry, emergency management and agriculture sectors. Local Arkansas weather forecast offices provide regional weather forecasts, a local drought monitor, spring outlooks, and briefings. USGS is popularly used for streamflow data. The University of Arkansas also provides useful services such as public education and outreach, and the Cooperative Extension.

An overview of the variety of tools and data used by sectors are shown below:

BREAKOUT DISCUSSION OUTCOMES

Tools	• U.S. Drought Monitor • Keetch-Byram Drought Index (KBDI) • Palmer Drought Severity Index (PDSI) • Farming instruments: Soil moisture sensors to determine the time to irrigate land, and crop specific in-line flow meters coupled with precipitation and soil moisture to measure groundwater levels.
National Weather Service (NWS)	• Highly used amongst all sectors • Sends regional weather forecasts to the Mississippi River Commission (MRC) • Local forecast offices send out a drought report • Climate Prediction Center is used in NWS spring outlooks • Spring outlooks given at Agricultural Extension meetings • Provides flood briefings to ADEM
United States Geological Survey (USGS)	• Various sectors, especially farmers, use streamflow data • Outreach for how drought impacts groundwater use • NWS uses USGS rainfall data to calibrate radar-estimated rainfall • MRC uses USGS stream gauge data to monitor water levels
University of Arkansas	• Offers educational services to the public on storm water drainage and water quality • Cooperative Extension Service is used by Arkansas Association of Conservation Districts (AACD)
Other Sources of Data	• County Foresters • Feedback from local land owners • Updated model by ANRC that helps answer how likely a point of contamination will drain into a specific reservoir. • Community Collaborative Rain, Hail & Snow Network (COCoRaHS): rain gauges

BREAKOUT DISCUSSION OUTCOMES

TOOL EVALUATION

Following the identification of what tools and data are most commonly used during drought, the conversation shifted toward evaluating the usefulness of the tools, both going into and coming out of drought. Four sectors, water, agriculture, forestry and game & fish, spoke about evaluating their use of drought tools. The sectors concluded that monitoring tool use during drought is difficult due to the varying differences of systems. Of these sectors, forestry most actively monitors drought tools. The NWS is highly dependent on other agencies' drought tools and utilizes many of the available national tools to develop products for their users.

WATER

A variety of tool assessments were recognized, especially following the most recent drought. During that time, some municipal region's water demands reached over 80 percent of capacity and they acknowledged the need for increased monitoring. Arkansas ranks within the top five states nationally for groundwater pumping, and dry, hot summers exacerbate the groundwater demand. A suggestion was made to increase the functionality of wells by incorporating real-time data for drought conditions. In recent years, the need for an integrated water resources management process, which combines the management of both surface and groundwater, has been identified. An existing effort between USGS and ANRC revealed that groundwater modeling, which is used to predict aquifer levels, focuses more on long-term impacts. Evaluations also showed that hydrologic conditions validate, but do not monitor, drought. ANRC's current monitoring efforts with USGS reveal that on average there is a one-foot loss per year on groundwater resources.

Stream gauges, which provide water quantity and capacity data, are beneficial to monitoring the function of reservoirs. During the last drought, USGS increased the number of stream gauges by placing them in additional locations. These additional data points will serve to help better understand existing drought conditions.

The Center for Advanced Spatial Technology (CAST) at the University of Arkansas performs assessments on irrigation, the impacts water has on soil, and how it affect wells. Although groundwater systems are robust and usually do not experience intense declines, pumping needs to be monitored in rural areas, especially in regions with only one well. Additional recommendations for water systems have been prevalent during the recent years of drought. This adaptive outlook has led to the question of how and when is it appropriate to improve upon recommendations.

BREAKOUT DISCUSSION OUTCOMES

AGRICULTURE

The largest problem pertaining to tools within the agriculture sector is the lack of organized communication networks, both locally and federally. During recent droughts, a lack of communication between row crop farmers and ranchers meant that row crop farmers were unaware that their feed could be used by ranchers on opposite sides of town. At the state level, there was a lack of resources due to the lack of a federal insurance program for livestock. Since recognizing this need, the state has adapted the Non-insured Crop Disaster Assistance Program. AACD receives services from the University of Arkansas Extension Office; however, there is a need for more tools and to expand the resource across all districts in the state.

FORESTRY

Public data sources, specifically the U.S. Drought Monitor and on-the-ground data, have been useful for County Judges. AFC mentioned that many do not recognize the need for improved observations on drought and wildfires; therefore, adjustments and monitoring have been limited. This viewpoint is often driven by the fact that decision making for the management of fires is subjective; motivated by practical yet political reasons. State forestry agencies exchange informal processes in collaboration and integration, attributable to the state's smaller size. The development of these informal working relationships occurred from the recognition that forestry agencies need to work well together to become successful. Additionally, the state and federal forestry agencies also work well together.

GAME & FISH

Monitoring and evaluation tools are lacking for operations reliant on water. Existing water monitoring systems are crucial for many operations, including for fish hatcheries. However, many water systems lack monitoring, including most of the lakes in the state. Temperature gauges are absent across most of the state, partly attributable to USGS requirements. Drought planning was expressed to be a lesser priority for this sector, with most preparations for extreme events organized from a post-disaster approach.

BREAKOUT DISCUSSION OUTCOMES

FUTURE TOOLS & DATA

The identification of drought impacts and the assessment of tools used to prepare for and respond to drought led to the discussion of what future data and information is needed. A variety of suggestions were given. There were numerous ideas of how drought planning could be improved and topics ranged from increasing education and monitoring to adding more data/tools. The most common request for data revolved around the addition of more water monitoring. Results are displayed as research and outreach suggestions below.

EDUCATION

- Use California's public service announcements as an example of increasing educational outreach.
- Share examples of how to communicate messages effectively.
- Increase educational efforts on the definition of groundwater.
- Perform more "Weather 101" sessions across the state.

RESEARCH

- Identify the relationship between the amount of water in a stream and the amount of fish.
- Determine the stream flow needed to maintain ecosystem services.
- Identify where groundwater supplies recharge.
- Distinguish the seasonal variations of impacts on drinking water.
- Determine the difference in water needs between urban sprawl and agriculture.
- Explore sedimentation problems in reservoirs and the potential issues that arise from it.

MONITORING

- Increase the quantity of real-time data throughout the year to better identify demand spikes and fluctuations.
- Improve the review of implementation measures and maintain infrastructure quality.
- Monitor long term gradual drought conditions in addition to flash drought.
- Improve the water-monitoring network by increasing flow gauge capacity for reservoirs.
- Consider adding a monitoring system, such as remote sensing, for smaller lakes.
- Improve water quality monitoring of the Alluvial and Memphis aquifers to reduce productivity issues during drought.
- Introduce water usage restrictions for the Sparta Aquifer in eastern Arkansas to minimize damage due to the overuse of water during rice production.

BREAKOUT DISCUSSION OUTCOMES

- Consider conservation methods such as an alternating wet/dry project in Grand Prairie to reduce increased irrigation usage.
- Increase monitoring and feedback from local citizens about drought impacts/preparedness and tools.

DATA/TOOLS

- Add more stream gauge and temperature data and update availability for online access.
- Increase the amount of data on groundwater and surface water interactions.
- Increase wildfire data on two scales: short-term data on dryness for wildfire prediction and response, and long-term data in the form of outlooks to help timber investment decisions.
- Provide soil condition data to farmers, including wet/dry status and the condition depth.
- Increase the opportunity for state and rural fire departments to perform prescribed fires.
- Provide corporate farmers with a long-term outlook during times of drought.
- Examine the most effective resources and tools for the state.
- Update the frequency of data for co-operative sites to improve reliability.

BREAKOUT DISCUSSION OUTCOMES

Small Group Discussion 2: Coordination Among Agencies

The second small group conversation shifted from internal capacity to external communications. Topics included current coordination efforts at the state, federal and non-state levels, the challenges that arise amongst these relationships, and any financial support/assistance programs offered or used.

INTERACTION AND COORDINATION

Conversation focused on the interaction between state and federal entities during both drought and flood, including with whom they work and why. Both levels identified a difference between flood and drought coordination, with more developed relationships for flooding events. There was not much knowledge of with whom sectors interact during drought.

STATE AGENCIES

ADEM: During the drought of 2011, ADEM assisted AACD in lessening drought impacts. Critical efforts included helping farmers install water facilities and lines from rural water facilities, and helping rescue animals from adverse conditions. However, there is currently limited interaction between ADEM and AACD.

Fish & Wildlife: Collaborations exist with highway departments to consult on the design of culverts for times of low streamflow.

Forestry: Communication amongst the forest industry is strong during extreme events. Forestry depends on relationships with country judges, fire departments, and emergency management. During wildfire events, they collaborate with rural fire departments and partner with other states. They also work with the Arkansas Game & Fish Commission to patrol floodwaters for undercut levees.

AACD: Collaborations exist with the Arkansas Agriculture Department and the University of Arkansas Extension Offices. AACD also assists the Arkansas Department of Environmental Quality on issues such as fish kills.

Other entities: Other common coordination among sectors includes state parks, the Arkansas Municipal League, mayors, city halls, the Arkansas Rural Water Association, Arkansas Nuclear One, and Arkansas Entergy.

BREAKOUT DISCUSSION OUTCOMES

FEDERAL AGENCIES

The top three agencies with which sectors work are NRCS, USGS, and NWS, although mostly regarding flooding. NRCS coordinated the most consistent drought efforts.

NRCS: There are multiple ways in which NRCS interacts with stakeholders. Available assistance infiltrates down to the local level. Many programs within NRCS are available for financial and technical assistance, although they vary based upon the location within the state. Financial support includes grant funding for projects and technical assistance includes mapping and staff support. NRCS also houses the conservation districts, which in return provides varying logistical assistance. During drought, NRCS programs offer support for farmers. Their programs are distributed amongst farmers through the collaboration with AACD.

USGS: USGS was the most mentioned agency for support in water data and assistance. The agency focuses on the monitoring of groundwater systems and provides stream gauge data for the water management sector. USGS collaborates with ANRC, most often on assisting well monitoring and maintaining the stream gauge system. For flooding issues, they commonly interact with NRCS, as well as provide hunting area closures for Fish & Wildlife. At the national level, a partnership with the NWS allows USGS to provide live inundation mapping that incorporates stream gauge data and NWS stream forecasts.

NWS: Beyond partnering with USGS to provide inundation mapping, the NWS provides information to multiple sectors, most commonly in the form of forecasts and outlooks. This includes a fire weather forecast for the National Forest Service and the Weekly Weather and Crop Report. A significant portion of NWS outreach is with the public.

USACE: USACE has governing power over the streams and reservoirs. Currently, only the water management sector works directly with USACE. Participants agreed on the need to increase sector involvement with USACE and mentioned the importance of including them in the Arkansas drought preparedness discussion.

Other entities: Additional collaborations, primarily during flood events, include the U.S. Department of the Interior, the U.S. Fish and Wildlife Service, the Nature Conservancy, rural fire programs, watershed groups (most commonly the Beaver Lake Watershed Alliance), and the U.S. Department of Agriculture(USDA). However, USDA could improve its collaboration with USGS and NWS.

BREAKOUT DISCUSSION OUTCOMES

FINANCIAL/OPERATIONAL SUPPORT

Beyond communication, there is often a financial requirement for managing drought conditions. Participants explored the programs and financial assistance they received and/or provided during recent drought events. The most common entities to provide financial support were NRCS and AACD.

- **NRCS:** NRCS was mentioned as one of the leading providers of program assistance. From the farmer's perspective, the state conservationist assisted in the improvement of programs and financial aid to the state. Their Agriculture Water Enhancement Program focuses on practices related to water conservation. NRCS also offers varied assistance through the Environmental Quality Incentives Program.
- **AACD:** Offers technical and financial assistance to farmers. This assistance is voluntary; therefore, requiring many farmers to seek outside loan assistance.
- **AFC:** The Landowner Assistance program focuses on conservation practices through mitigation. Additional assistance is offered through low-interest loans, which can also help lower homeowner insurance rates.
- **Arkansas Game and Fish Commission:** Offers a Private Lands Program.
- **Student Assistance:** The Environmental and Spatial Technology (EAST) Program by Searcy High School aided in updating the city's fire hydrant map with GPS/GIS.
- **ANRC:** Provides water development division low-interest loans for public entities, as well as tax credits for water conservation measures.
- **USGS:** Cooperative operations with ANRC average about 1.1 million dollars for surface water and groundwater works. Joint funding agreements exist between the two entities to help fund gauges, with currently 219 deployed.
- **Department of Homeland Security:** Rural fire departments have benefited from their large contribution in excess equipment over the past 30 years.
- **NWS:** Provides operational support to multiple sectors.
- **Former governor Mike Beebe declared a drought emergency in 2012** to assist with the transport of hay during Arkansas' severe drought.

WORKSHOP OUTCOMES

The topics presented and discussed during the workshop encouraged the idea of developing a drought plan for Arkansas and motivated action to begin doing so. The group's proposed first step in improving drought preparedness was to assemble a drought committee. A representative from any organization that is affected by drought, works with drought, and/or helps resiliency measures would be appropriate for the committee. Listed below is a summary of the key entities to include for a drought preparedness conversation for Arkansas, along with additional key suggestions as mentioned throughout this document.

DROUGHT PREPAREDNESS OUTCOMES:

- Discuss potential individuals for a drought committee:
    - Ideal committee represents varying sectors and individuals interested in drought.
    - Seek personnel who can speak technical drought conditions in layman's terms.
    - Consider limiting group to 5 or 6 people.
- Key entities to invite to the committee:
    - ADEM
    - USACE
    - Farmers
- Research which meetings appeal to farmer involvement (such as crop meetings), and suggest timely meetings that do not overlap with farming seasons.
- The subject matter is very important when discussing a plan and outreach efforts.
- Determine topics that require closed discussion within the committee while maintaining public access to as much discussion as possible. Learn how to serve all sectors with the plan.
- Utilize funds more and offer more funding opportunities.
- Consider immediate data that could be served in real time.
- Perform more public service announcements.
- Emphasize the impacts that occur beyond drought.
- Identify potential pitfalls with developing a drought plan.
    - Plan may become stagnant unless a drought is active.
- Consider how drought affects various regions of the state differently.
- Continue open discussion for plan importance:
    - Further explore the impacts and issues Arkansas experienced during drought conditions, such as in 2012.
    - Discuss the need for Arkansas to develop a drought preparedness plan.

WORKSHOP OUTCOMES

Recommended organizations to include in a drought preparedness conversation:

- Arkansas Agriculture Department
- Arkansas Chapter of Trout Unlimited
- Arkansas Department of Emergency Management
- Arkansas Department of Environmental Quality
- Arkansas Department of Parks and Tourism
- Arkansas Ducks Unlimited
- Arkansas Farm Bureau
- Arkansas Forestry Commission
- Arkansas Game and Fish Commission
- Arkansas Natural Resources Commission
- Arkansas State Plant Board
- Arkansas WaterWays Commission
- County Judges Association of Arkansas
- County Representatives
- Entergy Arkansas Nuclear One
- Farmers
- Large municipal suppliers: mayor, city hall, etc.
- Mississippi River Navigation Commission
- National and State Parks
- National Weather Service
- State Climatologist
- University of Arkansas
- Upper and Lower Buffalo River Associations
- USDA Natural Resources Conservation Service
- U.S. Army Corps of Engineers
- U.S. Department of Energy
- U.S. Fish & Wildlife Service
- U.S. Forest Service
- U.S. Geological Survey
- Water Associations

CONCLUSIONS

Presenters and participants learned from each other during their interactions and discussions at the workshop. Arkansas is one of only four states not to have some form of a state drought plan. The questions and interaction amongst sectors throughout the workshop brought to light the large impact drought has on the state and the lack of current preparedness measures for it. Conversations highlighted the significant impacts of the recent drought, especially including water issues such as streamflow quality and capacity. Additionally, the evaluation of tools was broadly unclear or absent, with the suggestion to monitor future data and tools better, notably streamflow monitoring.

Arkansas experiences both flooding and drought, however, preparedness and response initiatives are much more advanced for flooding due to the more frequent occurrence of heavy rainfall and the quick onset of events. Drought, on the other hand, was expressed as more "rare" and has the greatest effect on farmers, a relatively small group compared to the state. Currently, few relationships exist to address drought challenges and sectors seldom know with whom they partner. This lack of communication was the largest challenge across the entire coordination and collaboration discussion.

Given the lack of drought preparedness, communication, and monitoring, participants provided an ample amount of suggestions for future data and collaborations. There was a large emphasis on the involvement of multiple state and federal entities, most notably ADEM and USACE. Additionally, on a local level, farmers were identified as a core stakeholder that needed to be included in future conversations. The suggested outcomes of building working groups will serve as the first steps in preparing Arkansas for a state drought plan. As mentioned at the workshop, structuring a drought plan is reliant on the unique entities and characteristics of the state. Those present at this workshop, as well as those suggested to include moving forward, will have the ability to shape the focus of Arkansas' drought preparedness and offer firsthand input in increasing the state's resiliency to drought.

APPENDIX A: WORKSHOP AGENDA

Arkansas Drought Planning Workshop

Arkansas Natural Resources Commission
101 E. Capitol Avenue, Suite 350, Little Rock
June 8, 2016

9:00 Welcome & Logistics

9:15 Causes & Impacts of Drought

9:45 Key Components of a Drought Early Warning System

10:15 Break

10:30 Drought Indicators

11:15 Open Discussion: How Does Drought Impact Your Operations?

12:00 Working Lunch

1:00 Small Group Discussion: Monitoring, Forecasting and Research
- What tools do you use to monitor the drought and recovery?
- In the past few years, how did those tools perform, both going into and coming out of drought? Did you make any adjustments along the way?
- Were there tools or type of data that you wished you would have access to during the event?

2:00 Developing a Drought Plan

2:30 Break

2:45 Small-Group Discussion: Coordination Among Agencies
- How do you interact among state agencies during both the drought and flood; do you interact with some agencies in one case but not the other? Why?
- What federal agencies provide sources of information and/or support for operations?
- What other non-state agencies/entities are important in monitoring or managing these events?
- What challenges do you encounter when working with other agencies / entities?
- What financial or operational assistance programs do you offer or use (state, federal, local, non-governmental, charities)?

3:45 Next Steps & Recommendations

4:00 Adjourn

APPENDIX B: PARTICIPANT LIST

Name	Organization
Adrian Baber	Arkansas Natural Resources Commission
Jim Battreal	Arkansas Natural Resources Commission
Ryan Benefield	Arkansas Natural Resources Commission
Ken Brazil	Arkansas Natural Resources Commission
Dennis Cavanaugh	National Weather Service
Brian Clark	United States Geological Survey
Tabitha Clarke	National Weather Service
Mike Daniels	University of Arkansas
Richie Donahou	University of Arkansas
Song Feng	University of Arkansas
Bob Fowler	Arkansas Natural Resources Commission
Joe Fox	Arkansas Forestry Commission
D. Todd Fugitt	Arkansas Natural Resources Commission
Jaysson Funkhouser	United States Geological Survey
Colene Gaston	Beaver Water District
Andrew Grobmyer	Agricultural Council of Arkansas
Cody Harrington	Arkansas Natural Resources Commission
Michael Hayes	National Drought Mitigation Center-University of Nebraska-Lincoln
Gene Higginbotham	Arkansas WaterWays Commission
Leah Kos	Southern Climate Impacts Planning Program
Larry Lloyd	Beaver Water District
Martha Manley	Arkansas Association of Conservation Districts
Steve Martin	Arkansas Association of Conservation Districts
Debbie Moreland	Arkansas Association of Conservation Districts
Caleb Osborne	Arkansas Department of Environmental Quality
Jeff Quinn	Arkansas Game and Fish Commission
Darcia Routh	Arkansas Natural Resources Commission
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Kelly Smith	National Drought Mitigation Center-University of Nebraska-Lincoln
Steve Stake	Arkansas Natural Resources Commission
Dennis Sternberg	Arkansas Rural Water Association
Mark Stoll	Arkansas Agriculture Department
Edward Swaim	Arkansas Natural Resources Commission
Trevor Timberlake	Arkansas Natural Resources Commission
Drew Westerman	United States Geological Survey
Elliot Wickham	National Drought Mitigation Center-University of Nebraska-Lincoln
Bill Wolfe	United States Geological Survey

APPENDIX C: REFERENCES

Arkansas Department of Emergency Management, *State of Arkansas All-Hazards Mitigation Plan*. Sept. 2013, http://www.adem.arkansas.gov/aem/wp-content/uploads/2016/02/Arkansas%20All-Hazards%20Mitigation%20Plan%20-%202013%20FINAL.pdf

National Drought Mitigation Center, *Drought Tournament Playbook*. North Platte Natural Resources District Invitational Drought Tournament, November 18, 2016, PDF.

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