Drought and Water Shortages:
South Carolina's Response Mechanisms, Vulnerabilities, and Needs

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Abstract. The South Carolina Drought and Water Shortage Tabletop Exercise took place on September 27, 2017, at the South Carolina Emergency Operations Center in West Columbia, SC. The exercise gathered 80 participants, representing federal and state agencies, public water suppliers, county and municipal governments, industry, consulting companies, and nonprofit organizations. The purpose of the exercise was to review plans and procedures that govern state-, basin-, and local-level responses to drought and water shortages. Many of South Carolina's drought response mechanisms were updated by the 2000 Drought Response Act and Regulations, but a systematic effort has not been made to review or assess their effectiveness. Attendees walked through a series of exercise responses to gradually worsening drought scenarios and an activation of the Emergency Operations Plan. The event helped to identify strengths and weak points of the state's drought response and opportunities to proactively prepare for future droughts. The key needs discussed by participants included updated drought response *plans and procedures* to ensure a coordinated and timely response to droughts; greater *educational opportunities* to enhance agencies' familiarity with the Drought Response Program and their role in drought response and mitigation; more effective *communications* before, during, and after drought events, across agencies and with the public; and enhanced *data and information products* that can be used to build common understanding of drought risks, impacts, and vulnerabilities.

SOUTH CAROLINA DROUGHT RESPONSE

One goal of the tabletop exercise was to familiarize the participants with the legislation, regulations, plans, and procedures that recommend and require responses at different drought stages (Figure 1). The South Carolina Drought Response Act (S. C. Code Ann. §49-23-10 et. seq) and the supporting regulations (R.121-11.1–121-11.12, for §49-23-10 et seq., S. C. Code of Laws) formally establish and describe the responsibilities of the South Carolina Drought Response Committee (DRC), the state's major drought decision-making entity. The Drought Response Act also requires that all public water suppliers develop and implement local drought plans and ordinances.

In coordination with the South Carolina Department of Natural Resources (DNR) and State Climatology Office (SCO), the DRC monitors and evaluates drought-related data and information, consults with stakeholders about conditions and impacts, designates drought levels as defined by the Drought Response Act for affected counties, and disseminates drought status information to the public (R.121-11.8). South

Carolina has four drought alert phases—incipient, moderate, severe, and extreme. The Drought Regulations detail the indicators and indices used to determine drought status. These include streamflow and groundwater levels, the Palmer Drought Severity Index, Crop Moisture Index, Standardized Precipitation Index, Keetch-Byram Drought Index, and United States Drought Monitor.

The DRC is composed of statewide and local members. State agency members include the Emergency Management Division (EMD), the Department of Health and Environmental Control, the Department of Agriculture, the Forestry Commission, and the Department of Natural Resources. Local members are organized according to the state's four Drought Management Areas (Figure 2) and represent counties, municipalities, public service districts, private water suppliers, agriculture, industry, domestic users, regional councils of government, commissions of public works, power generation facilities, special purpose districts, and soil and water conservation districts.

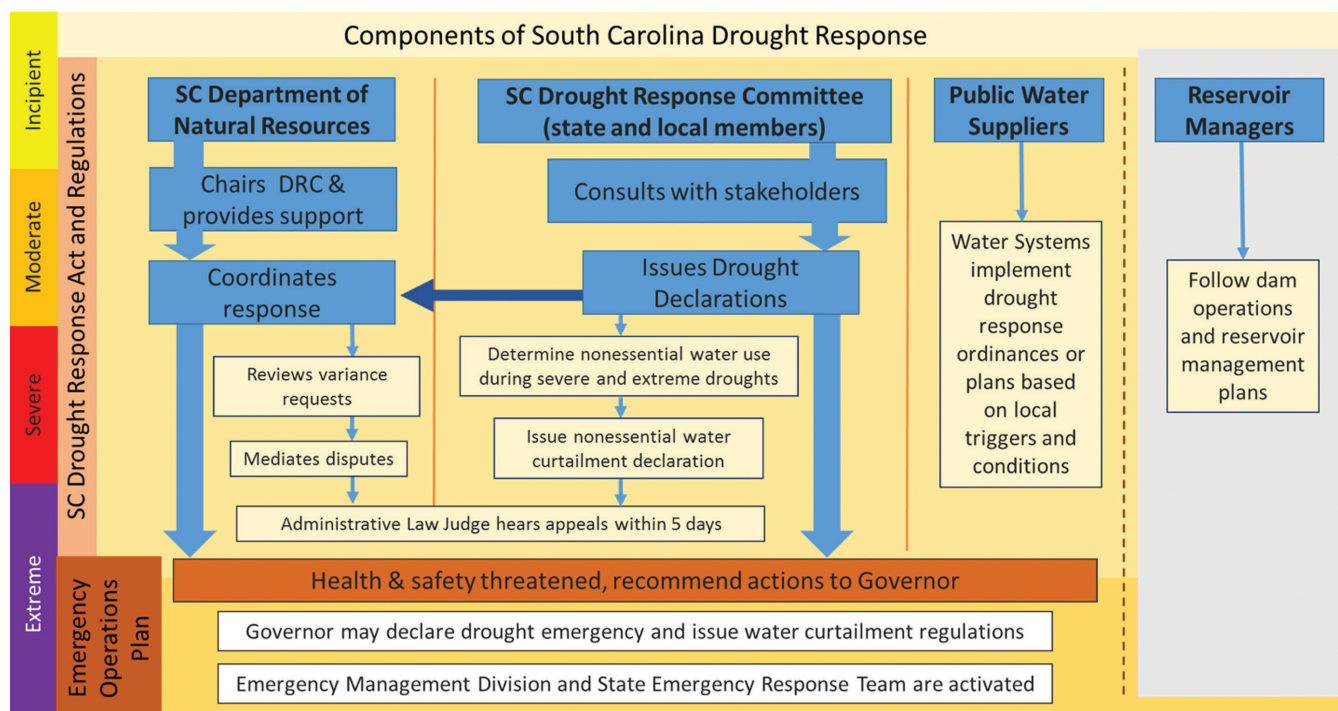The DRC may recommend mandatory reduction or curtailment of nonessential water use when drought

Components of South Carolina Drought Response

Figure 1. Components of South Carolina Drought Response and flowchart of responsibilities and actions

conditions escalate to severe or extreme drought (R.121-11.6). The DRC is also responsible for reviewing and determining which nonessential water uses should be curtailed. DNR is responsible for issuing and disseminating curtailment declarations, reviewing variance requests, and mediating disputes arising from competing demands for water.

The Emergency Operations Plan (EOP) (Appendix 10) may be activated when a drought management area, or a portion of a drought management area, is seriously threatened or impacted. Examples of such impacts are as follows: the risk of drinking water supply depletion; threats to public health, safety, and welfare; and the inability of local resources and actions to provide for citizens' safety. At this

point, state-level actions and resources are necessary to provide relief from impacts.

The EMD maintains the EOP and leads multi-agency responses to hazard events. Upon an activation of the EOP, EMD and the State Emergency Response Team (SERT) assemble in the South Carolina Emergency Operations Center to coordinate the state's response.

OVERVIEW OF THE EXERCISE

The state routinely exercises for hurricanes and other hazardous events but has never conducted an exercise for a drought or water shortage emergency. Over the last two decades, South Carolina has experienced several severe, statewide and regional droughts, highlighting the need for coordination across multiple agencies and organizations to manage water resources effectively (Collins et al., 2016; Schwab, 2013; Wilhite et al., 2014). Specific events occurred during 1998–2003, 2007–2009, and 2010–2013. The Upstate experienced extreme drought conditions during 2016–2017.[1]

While recent droughts have provided "opportunities" to implement the procedures as outlined in the State Drought Response Act and the accompanying regulations and local plans, a systematic effort has not been made to review and assess the effectiveness of response actions. Tabletop exercises are often used to test the implementation of plans, identify any shortcomings, train staff, and enhance the readiness of participating organizations (Whelton et al., 2006; Whitler and Stormont, 2011). The goal of this exercise
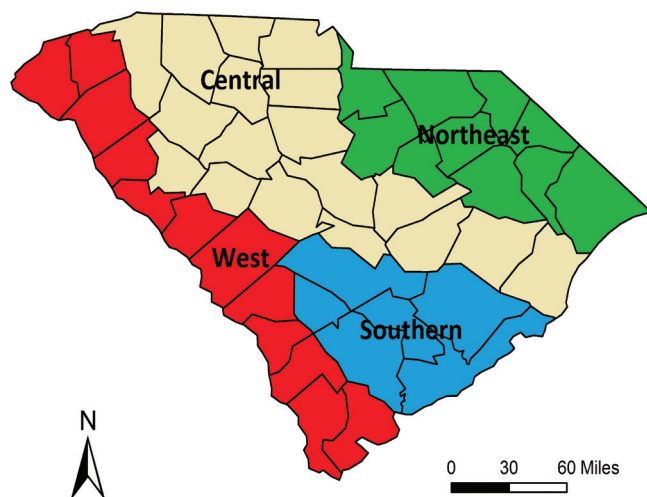

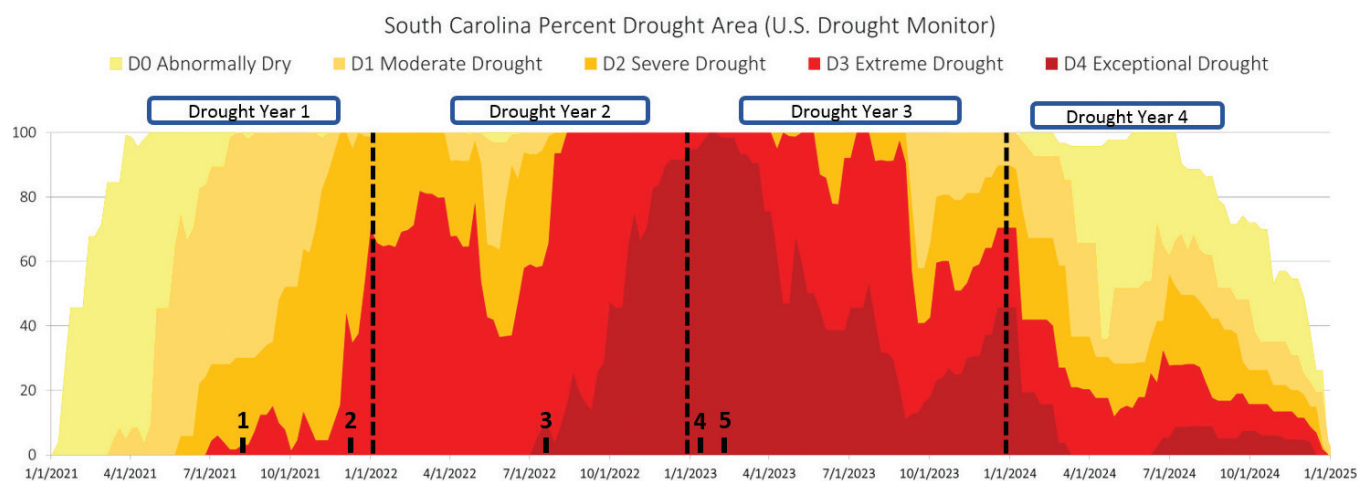**Figure 2.** South Carolina Counties and Drought Management Areas

Figure 3. Drought timeline for the South Carolina Drought and Water Shortage Tabletop Exercise. The figure shows a hypothetical four-year drought, modeled after the United States Drought Monitor. The scenario time points are noted on the graph: 1—*Moderate Drought Statewide* (July–August 2021), 2—*Severe Drought Statewide* (December 2021), 3—*Extreme Drought Statewide* (July–August 2022), 4—*Extreme Drought Intensified* (January 2023), and 5—*Emergency Operations Plan is Activated* (February–April 2023).

was to generate ideas that will be used to enhance South Carolina's drought response and preparedness. The exercise provided an opportunity for water resource and emergency managers to discuss the "uncharted territory" of activating the EOP and responding to a water shortage emergency in the state.

Specific objectives included the following:

1. Identify and understand the strengths and constraints in the SC Drought Response Act, SC Drought Regulations, SC Emergency Operation Plan, and local drought plans and procedures.

2. Improve awareness of local, state, and federal players in South Carolina's drought response.

3. Identify key mission areas for each State Emergency Support Function (SERT).

4. Collect ideas and strategies for future exercises.

The exercise was divided into several segments. An introduction provided an overview of the relevant legislation and outlined the goals and objectives of the exercise. The attendees then walked through an intensifying multi-year drought scenario with five time points (Figure 3). For each time point, a set of maps, graphs, and other visualizations was presented to show drought conditions, impacts, and response.[2] Drought conditions were shown using drought indicators and indices described in the state's drought regulations. Figures showing worsening wildfire and hydrological impacts were similar to those typically presented at SC DRC meetings. Response actions were based on those outlined in South Carolina's Drought Response Act and Regulations, as well as in other plans operating in the state.[3] While South Carolina has never activated the EOP for drought, the scenarios were designed to plausibly exercise

for these conditions and to evaluate key agency actions and functions in response to a water shortage emergency.

At Time Point 2, streamflow, groundwater, and lake levels were below normal levels, and water systems were beginning to request voluntary and mandatory water conservation from their customers. At Time Point 3, the SC Forestry Commission reported higher than normal fire activity, depletion of local firefighting resources, and the need for state resources to assist with fire suppression. At Time Point 4, impending water supply shortages threatened public health, safety, and welfare, necessitating the activation of the EOP at Time Point 5.

The participants were asked to consider questions designed specifically to reveal strengths and areas for improvement at each time point. Two recurring questions centered on communications and organizational resources and capacity to respond to drought. Table 1 summarizes the impacts, response actions, and discussion questions at each scenario time point. The final session ("hot wash") included a dedicated block of time for participants to review what they learned, provide feedback about the event, and recommend the next steps.

NEEDS AND NEXT STEPS IDENTIFIED BY PARTICIPANTS

The prevalence of formal plans to guide decisions and actions contributes to South Carolina's capacity to respond to drought events. However, having many different plans can make coordination difficult and hamper the development of consistent and clear public communications. This section summarizes the needs and recommendations for next steps as discussed by participants at the exercise.

Table 1. Impacts, response actions, and discussion questions for each time point in the multi-year drought scenario. Conditions and impacts are realistic representations based on historical records. Response actions are outlined in formal plans and legislation.

Example Impacts	Selected Response Actions	Main Discussion Questions
All Time Points and Drought Stages		
• What and how is your organization communicating with the public? • What would help your organization more effectively respond to and prepare for drought?		
Time Point 1: Moderate Drought Statewide (July–August 2021)		
• Declining water levels • Withering crops • Need for irrigation increases	• State agencies, local water systems, and reservoir managers monitor conditions • Voluntary water conservation measures are requested	• Does your organization have a plan for monitoring, responding to, and preparing for drought? • Are drought response plans and ordinances up to date and current?
Time Point 2: Severe Drought Statewide (December 2021)		
• Surface and groundwater levels continue to drop • Increasing number of wildfires • Poor grazing and agricultural conditions	• State agencies increase monitoring and communications • Affected sectors (agriculture, forestry, industry) request assistance • Water systems require water conservation	• How do inconsistencies at different levels (state, local, basin) affect drought response and communications? • Are local ordinances and plans consistent with other drought plans in neighboring areas?
Time Point 3: Extreme Drought Statewide (July–August 2022)		
• Widespread impacts to agriculture, forestry, water systems, and water-dependent businesses	• Forestry Commission requests that the Governor activate the National Guard to assist with fire suppression • Governor issues a press release requesting voluntary conservation • More water systems require water conservation	• How do inconsistencies at different levels (state, local, basin) affect drought response and communications? • Are local ordinances and plans consistent with other drought plans in neighboring areas?
Time Point 4: Extreme Drought Intensified (January 2023)		
•Safety, health, and welfare are threatened •Water systems report diminishing water supplies and water quality issues (for example, saltwater intrusion in coastal water supplies)	The Drought Response Committee: • Recommends state measures • Evaluates nonessential water uses for curtailment • Requests public statements from the governor's office regarding voluntary and/or mandatory water restrictions	• What resources, information, or additional capacity does the DRC need to assess non-essential water use and to curtail certain uses? • How will appeals to the administrative law judge affect the timeliness of conservation and response efforts? • When exactly, and for how long, will the Emergency Operations Plan and State Emergency Response Team (SERT) be activated?
Time Point 5: Emergency Operations Plan is Activated (February–April 2023)		
• Water systems and citizens are without or are losing access to water	• The State Emergency Response Team (SERT) is activated to lead the state-level response to the water shortage emergency	• Are the necessary resources, expertise, and capacity available? • What tasks or actions are not listed in the EOP, but should be included? • How will SC coordinate with other states?

PLANS AND PROCEDURES

It is important to update drought response legislation and procedures to ensure a better coordinated and timely response to drought. The current Drought Response Act, regulations, and guidance for local plans were established in 2000. Many local plans have not been revised since the early 2000s. Although the Emergency Operations Plan is regularly reviewed and updated by EMD, many participants had limited knowledge of the EOP Drought Response Plan prior to the exercise. It was clear that at least a partial activation of the EOP and involvement of the governor's office at earlier stages of drought would be beneficial. The exercise also highlighted the need to reexamine the DRC structure and membership, fill vacancies, and streamline the process for appointing new members.

COMMUNICATIONS

Improved information sharing across agencies and with the public will help South Carolina to better prepare for and respond to drought events and potential emergencies. This would include the development of clear and consistent messages for the public about drought conditions and coordination across different agencies to enhance current communication processes. For example, earlier involvement of the EMD Public Information Officer could help to ensure that the content, timing, and coordination of messages are efficient and appropriate at different stages of drought.

EDUCATION AND AWARENESS

The need for greater awareness of drought and drought impacts, as well as the plans and procedures that guide drought response, was prevalent across different agencies and audiences. Many SERT members noted that their agencies lacked familiarity with the Drought Response Program and were uncertain about their specific role(s) and responsibilities for drought response. As many of these agencies have not typically been involved in drought response and planning, additional training or resources would be beneficial for this group. More generally, participants noted a need for greater public awareness of drought, the effects of drought on different resources and communities, and the water conservation actions to take during drought.

DATA AND INFORMATION

Fulfilling the need to identify, collect, and update information could enhance drought response and planning. This includes new resources and tools being developed by agencies such as the National Weather Service to assess and forecast drought, weather, and climate events, as well as using and expanding existing networks to monitor conditions (e.g., the Community Collaborative Rain, Hail & Snow Network [CoCoRaHS].[4] Other types of information (e.g., water system connections, water demand, and the economic effects of drought) would help build a common understanding of drought risks and vulnerabilities across different communities, sectors, and regions of the state.

RECOMMENDED NEXT STEPS

Participants voiced support for future exercises that would take place on the regional or watershed level and delve deeper into local vulnerabilities and response actions. The exercise helped to identify and provide momentum for actions that could be implemented in the near term. Next steps include following up with the governor's office to update the DRC membership, developing education and training modules for emergency managers and others to learn more about drought, and working with water suppliers to review local plans and ordinances. The participants recommended more substantial changes to legislation, regulations, and policies, but these will be more difficult to achieve. One important issue to consider is the need to balance the benefits of local flexibility in responding to drought with the need to develop more consistent messaging and response actions during severe events. In addition, recent efforts to allocate more resources and funding to the State's Drought Response Program have been unsuccessful. The state currently lacks a full-time, dedicated drought response coordinator, a position that could lead many of the efforts recommended at the exercise.

CONCLUSIONS

As the first such event in South Carolina (and one of only a few conducted across the country), this tabletop exercise provided an important opportunity to identify the strengths of South Carolina's drought response and areas to improve. Feedback from the participants indicated the importance, relevance, and value of the event to improve drought preparedness in the state. Attendees learned about important drought issues, increased their awareness about roles and responsibilities in drought response, and expressed a willingness to work together in future exercises and efforts. Follow-up activities to the tabletop exercise are expected to contribute toward the goal of proactively preparing the state for future extreme droughts before these events escalate into emergencies. A well-prepared state will be more resilient to climate extremes and variability in the future.

ACKNOWLEDGEMENTS

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NOTES

1. Several resources were used to identify past droughts: South Carolina Drought Response Committee reports (http://www.dnr.sc.gov/climate/sco/Drought/drought_press_release.php), the United States Drought Monitor map archive (http://droughtmonitor.unl.edu/Maps/MapArchive.aspx), and *Carolinas Precipitation Patterns & Probabilities*, An Atlas of Hydroclimate Extremes (http://www.cisa.sc.edu/atlas/index.html).

2. The planning team consulted materials developed by the University of Nebraska for the North Platte Natural Resources District Invitational Drought Tournament (http://droughtthira.unl.edu/index.php).

3. Exercise materials and additional information are available on the websites of the State Climatology Office (http://www.dnr.sc.gov/climate/sco/) and CISA (http://www.cisa.sc.edu/projects_drought-response.html).

4. CoCoRaHS (https://www.cocorahs.org/) is a national network of citizen scientists who record daily precipitation observations. By increasing the density of local data, this network serves an important role in drought and rainfall monitoring in South Carolina.