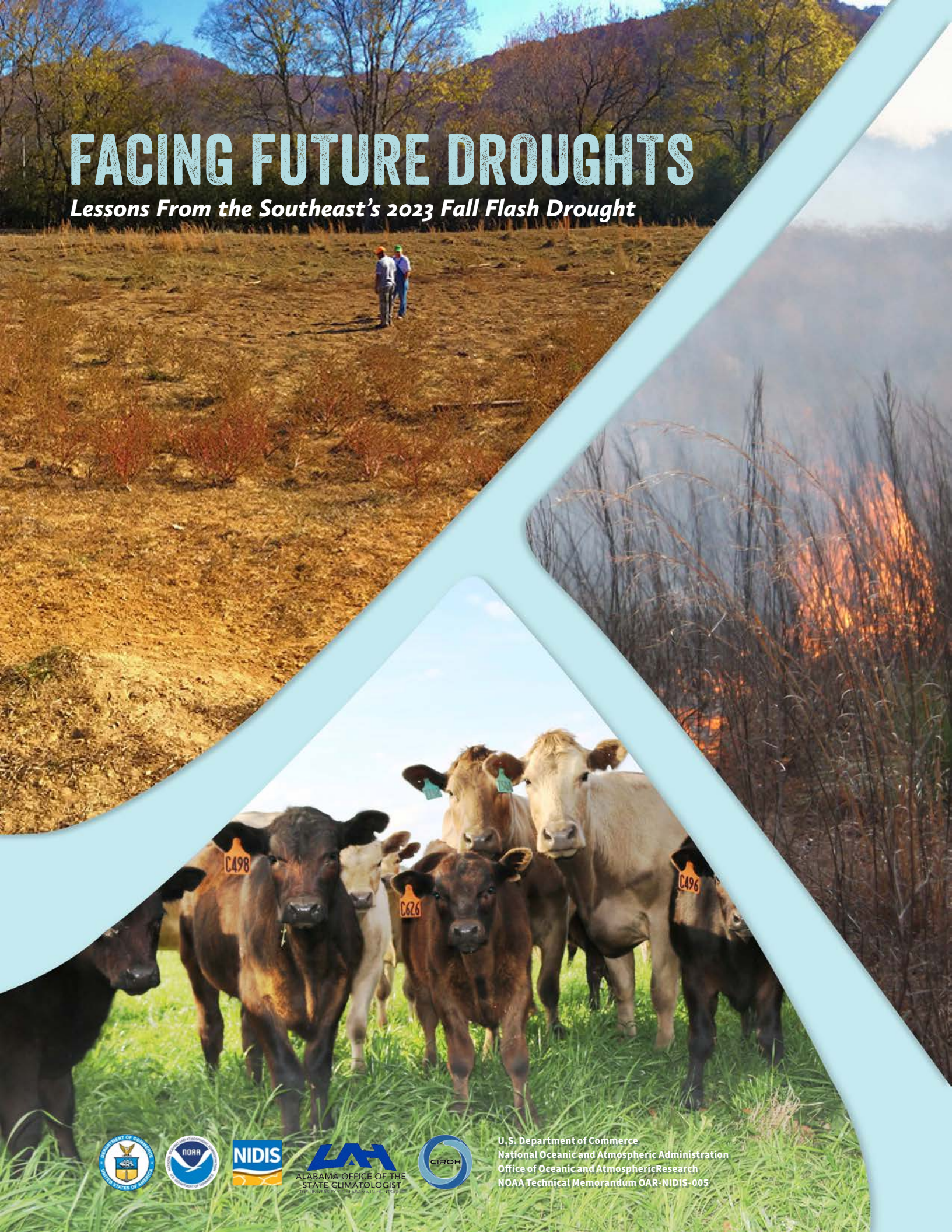

FACING FUTURE DROUGHTS

Lessons From the Southeast's 2023 Fall Flash Drought

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Office of Oceanic and AtmosphericResearch
NOAA Technical Memorandum OAR-NIDIS-005

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The National Integrated Drought Information System (NIDIS) is an interagency program within the Climate Program Office, which is part of NOAA's Office of Oceanic and Atmospheric Research.

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Purpose

This document was developed in response to a growing regional interest to better understand how drought, especially flash drought, affects the Southeastern United States, and how the region can more effectively monitor, communicate, and respond to evolving conditions. The 2019 flash drought exposed critical gaps in early warning and monitoring systems, sparking conversations that continued during the 2022 Southeast Drought Early Warning System (DEWS) Regional Meeting. These discussions highlighted a shared desire among partners to learn from recent drought events and improve coordination across state and sector lines.

This report is the first in a two-document series focused on drought in the Southeastern United States. It provides a retrospective analysis of the 2023 fall drought—how it developed, the impacts it had across sectors, and the lessons learned to improve future response and resilience. A second document, "Understanding Flash Drought and its Implications for Agriculture in the Southeast", will offer a deeper look at the science behind flash droughts, including historical patterns, the region's unique hydrologic systems, and key tools to monitor and forecast rapid drought development.

Key Takeaways

DROUGHT IS NO STRANGER TO THE SOUTHEAST

While the region typically receives high annual rainfall, even short-term precipitation deficits can lead to drought, especially during warmer months when evaporative demand is high. Summer rainfall usually comes from scattered convective storms, and fall precipitation often depends on tropical systems, both of which can be spatially and temporally inconsistent. The Southeast remains especially vulnerable to fall droughts, when the absence of tropical rainfall can trigger rapid drying across the region.

SOUTHEAST AGRICULTURE AND FORESTRY ARE HIGHLY SENSITIVE TO DROUGHT

Most agriculture in the Southeast depends on rainfall, and the region's shallow soils and hot growing seasons make crops, pastures, and livestock especially vulnerable during dry periods. Drought can reduce hay and forage availability, lower crop yields, and increase livestock stress. Forestry risks also increase during dry periods, with heightened wildfire activity, tree stress, and pest outbreaks.

Alabama cattle during drought conditions in October, 2016. There is very little foraging available as cattle search for grazing.
Credit: ACES | Bruce Dupree

STRONG REGIONAL COLLABORATION AND STATE-LEVEL INNOVATION SUPPORT DROUGHT RESILIENCE

The Southeast benefits from a culture of cross-state communication and tailored drought monitoring programs. Partnerships through the Southeast DEWS, as well as innovative state-level tools and networks, have improved monitoring, coordination, and response across the region.

SUB-MONTHLY AND INTER-MONTHLY METRICS ARE ESSENTIAL TO MONITOR SOUTHEAST DROUGHT

Because conditions in the Southeast can shift quickly from wet to dry, drought metrics need to reflect rapid changes to capture emerging impacts. Standard 30-, 60-, or 90-day drought indices may overlook critical transitions. Sub-monthly (ex. 8 to 21 days) and inter-monthly(ex. 45 days) drought indicators help capture evolving conditions and provide earlier warnings for sectors like agriculture and water supply.

OBSERVATIONAL GAPS MAKE IT HARD TO TRACK LOCALIZED CONDITIONS

Limited soil moisture sensors, weather stations, and mesonets leave major portions of the Southeast, especially rural areas, with sparse data. These gaps make it difficult to detect emerging drought and assess sector-specific impacts at the local scale. They can also lead to "false positives," where rain falls at a gauge site but not in the surrounding area. For example, if there are only a few rain gauges in a county or a region of a state, those gauges do not reliably depict the entire surrounding area. Rainfall can vary drastically from county to county and even from one end of town to another.

PUBLIC IMPACT REPORTS PROVIDE CRUCIAL LOCAL CONTEXT FOR MONITORING

Tools like Condition Monitoring Observer Reports (CMOR) and Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS) fill observational gaps by capturing local conditions, especially in areas with limited instrumentation. These reports help those who monitor drought understand how dry conditions are affecting several sectors in real time.

DROUGHT COMMUNICATION MUST BALANCE DATA AND HUMAN EXPERIENCE

Drought often develops quietly, with impacts occurring before official state-level drought task-forces declare changes in drought status or before the U.S. Drought Monitor (USDM) shows degradation in drought categories. This is especially true in the Southeast, where rapid-onset droughts are common and can outpace the tools commonly used to track them. As a result, most state-level task-forces and the USDM are usually not fully equipped to accurately monitor and respond to rapid-onset droughts in a timely manner. As a result, producers and communities may experience hardship even if their conditions and impacts do not match their state's or the USDM drought severity category. The development of sub-monthly and inter-monthly indices will provide more monitoring metrics that align with rapidly developing impacts, which in turn could help enhance state-monitoring task-forces and the USDM in detecting drought earlier to better support the needed response.

OPPORTUNITIES REMAIN TO STRENGTHEN DROUGHT PREPAREDNESS IN THE SOUTHEAST

Regional networks and state programs are already working towards better drought preparedness. Continued investment in monitoring tools, public reporting, agricultural data access, and cross-state coordination will strengthen the region's ability to anticipate, manage, and recover from drought.

Drought induced brushfire in December, 2013. Credit: ACES | Bruce Dupree

Drought Is No Stranger to the Southeast

DROUGHT IN THE SOUTHEAST

The Southeastern United States is often perceived as a water-rich region, with most Southeast states receiving on average at least 50 inches of annual rainfall. The region's humid subtropical climate supports abundant water resources and ecosystems adapted to frequent and substantial precipitation. However, this abundance does not protect the region from drought[1]. In fact, the Southeast regularly experiences both short-term and prolonged dry spells. Ecosystems, soils, and agricultural systems throughout the region depend on consistent rainfall, making them particularly sensitive to precipitation variability. Annual totals of 30 to 40 inches—considered generous in drier parts of the country—can signal drought in the Southeast.

This is especially true during warm months when evapotranspiration and evaporative demand are high. Two key processes drive water loss from the land to the atmosphere—evaporation and transpiration—together known as evapotranspiration (ET). Evaporation is the water loss to the atmosphere from open bodies of water (i.e. rivers, lakes, or snow covered ground) and directly from the soil. Transpiration is the process where plants take up water from the soil and release it into the air through their leaves. Evaporative demand is a measure of how much water the atmosphere wants to pull from the land and plants—like how thirsty the air is—if there were unlimited water available.

Past droughts in the Southeast have ranged in duration from sub-seasonal to prolonged, multi-season events. Long-term droughts, such as the 2007–2008 event, severely strained water supplies, including critically low levels in Lake Lanier, Atlanta's main reservoir for household water supplies. More recent droughts in 2011–2012,

Dryness in Greenville, SC on November 8, 2023 caused conditions to deteriorate for this horse pasture. Image from the National Drought Mitigation Center's Condition Monitoring Reports.

2016, and 2023 brought widespread agricultural losses, water shortages, and significant wildfires. The region's agricultural systems are particularly vulnerable to drought because many crops are rainfed, unlike in other agricultural areas of the country that have deep, water-holding soils or rely more heavily on irrigation.

FLASH DROUGHTS

Some of the most challenging types of drought in the Southeast are flash droughts, when conditions deteriorate in a matter of weeks. Below-normal precipitation paired with high temperatures and/or high vapor pressure deficits can increase evaporative demand. This in turn quickly depletes soil moisture, especially in sandy soils with low water retention. Flash droughts can occur in two ways. In *rapid-onset*, near-normal conditions quickly turn into drought conditions. In *rapid-intensification,* ongoing drought conditions quickly transition from bad to worse.

While many definitions emphasize elevated heat, flash droughts are not only a warm season phenomena. In 2023, for example, drought conditions intensified in portions of North and South Carolina in October and November, leading to the introduction and expansion of Severe (D2) and Extreme (D3) Drought on the U.S. Drought Monitor. During this period, precipitation was

Southeast Drought Early Warning Systems (DEWS)

This assessment covers the area of the Southeast Drought Early Warning System (DEWS) and includes Mississippi as the eastern half of the state shares similar landscape and climate characteristics with neighboring parts of the Southeast DEWS. Mississippi also experienced drought conditions in 2023 that were consistent with those observed across the rest of the Southeast DEWS.

below normal and daily maximum temperatures were above normal. However when paired with shorter days and a lower sun angle at that time of year,the above-normal temperatures did not significantly enhance evapotranspiration rates. Despite the lack of enhanced evapotranspiration, soils dried significantly in these portions of the Carolinas, which impacted winter crop planting and increased fire potential.

Flash drought conditions occur somewhere in the Southeast nearly every year, most frequently during late summer and early fall. In the Southeast, when flash droughts develop from localized conditions and expand to a regionalized event, research has shown that they often begin in the southern parts of the regions and extend northward as the year progresses.[2] Combined with irregular precipitation patterns and limited irrigation infrastructure, this makes Southeastern agriculture especially sensitive to even brief dry spells, which can escalate quickly into high-impact events.

THE SOUTHEAST'S UNIQUE DROUGHT VULNERABILITY

What makes the Southeast particularly vulnerable to drought, especially flash drought, is the region's abrupt transitions between wet and dry periods. From May to September, just two weeks without rain can dry out surface soils and stress vegetation. The combination of highly variable rainfall patterns, high evaporative demand during warm months, and widespread soils with low water-holding capacity creates an environment where drought can develop quickly despite the region's overall water abundance.

Seasonal precipitation patterns further complicate drought dynamics. Winter and early spring typically bring widespread, steady rainfall from large-scale weather patterns, such as frontal systems. As the region transitions into late spring and summer, thunderstorms dominate (convective storms and rainfall) delivering intense but highly localized rainfall. Drought risk increases during these transitions. Rainfall becomes more erratic and temperatures rise, creating windows of heightened vulnerability.

Fall in the Southeast: A Season of Feast or Famine

Among all seasonal shifts, fall represents a particularly precarious period for the Southeast. Fall precipitation is strongly influenced by tropical systems associated with the Atlantic hurricane season, which runs from June 1 through November 30. An active Atlantic hurricane season often delivers the rainfall needed to sustain agriculture, replenish reservoirs, and nourish ecosystems. The same systems can also bring devastating winds, storm surge, and flooding. In the Southeast, rain and destruction frequently arrive hand in hand. This uneasy reality highlights the complexity of the region's water relationship—relief and risk are inseparable. This volatility makes fall droughts particularly acute and impactful in the Southeast.

Peak tropical activity typically occurs in September, which means monthly precipitation totals can vary widely depending on tropical activity, especially along the coasts. This reliance can create a "feast or famine" scenario: when tropical storm development is very active or multiple tropical storms make contact with the region, the region may receive significant rainfall. Tropical storms can also bring timely rains and relief to areas facing dry or drought conditions in summer or fall. In years when storm activity is below normal or hurricanes bypass the region entirely, rainfall deficits can quickly accumulate, leading to the development of new droughts or the worsening of existing ones in both area and severity.

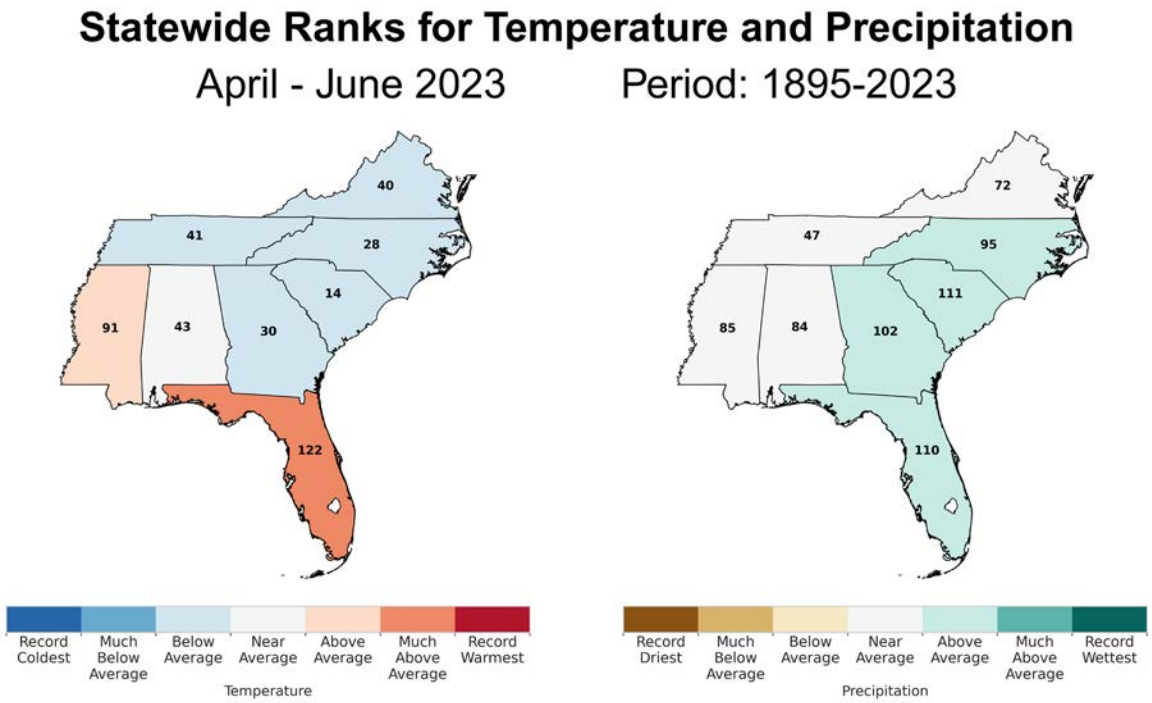
FALL DROUGHT IMPACTS ON AGRICULTURE

Fall droughts are especially problematic for agriculture, as fall is a critical harvest period for many crops and the beginning of the planting season for others. Soil moisture deficits during this time can hamper harvest operations, reduce crop quality, and impede winter crop establishment. Livestock operations are similarly affected. Poor pasture conditions limit available forage, while excessive heat can stress animal health. If the summer was also dry, producers may struggle to grow or bale sufficient hay, increasing reliance on costly supplemental feed. Reduced water availability for forage irrigation and livestock watering compounds these pressures, placing additional strain on both animal health and producer finances.

Agriculture occupies approximately 72 million acres, roughly 30%, of the Southeast's total land area. Of that acreage, about 41% is cropland, 31% is woodland, and 21% is permanent pasture and rangeland.[3] The scale of this land use underscores agriculture's central role in the region's economy and landscape. When drought disrupts harvests, planting, forage, or water availability, the effects ripple far beyond individual producers, impacting employment, food systems, and rural economies across the Southeast.

FALL DROUGHT IMPACTS ON FORESTS

Forestry faces similarly heightened risks during fall droughts. Fall is already the typical wildfire season in the Southeast, so an increase in fire activity is expected during this time of year. However, drought can intensify these conditions, making fires more frequent, severe, and harder to contain. Dry leaf litter and seasonal vegetation dieback create abundant surface fuels, raising the potential for rapid wildfire spread just as forest conditions become more volatile. These fires can threaten ecological integrity, endanger property and lives in wildland-urban interface, and place heavy demands on emergency resources. Drought stress can also reduce tree growth, increase susceptibility to pests and disease, and lead to long-term declines in forest productivity. When coupled with wildfire risks, these conditions pose serious threats to the health and sustainability of Southeastern forests.[4]



Based on data from 1895-2023, Florida and Mississippi experienced above average temperatures from April - June 2023 while the remaining Southeast was either near-normal or slightly below average. The Atlantic coast states, excluding Virginia, also saw above average precipitation, while interior Southeast states were near-normal. Data from NOAA's Climate at a Glance.

The 2023 fall drought exemplified the Southeast's feast-or-famine precipitation pattern and its far-reaching impacts on both agriculture and forestry. It offers a recent and relevant example of how quickly conditions in the Southeast can deteriorate in the absence of seasonal fall precipitation. Several important lessons emerged from this event, which underscore the need for continued improvements in monitoring and preparedness. The following sections outline the progression of the 2023 drought and highlight some of the impacts to agriculture and forestry and lessons learned along the way.

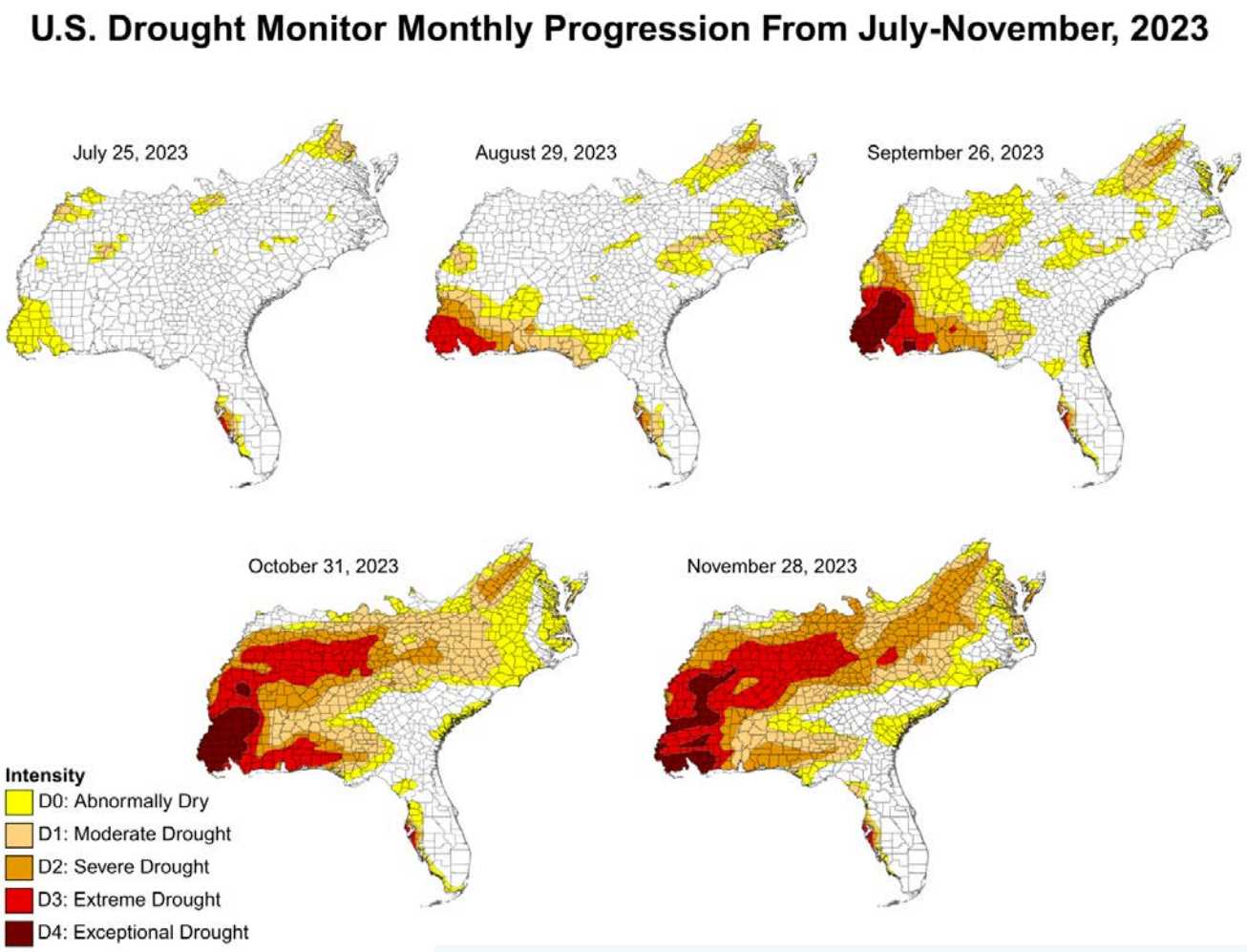
FALL 2023 DROUGHT OVERVIEW

Fall of 2023 illustrated the "famine" side of the Southeast's seasonal precipitation pattern, as much of the region did not receive adequate rainfall from tropical systems. Some tropical activity brought rain to parts of Florida, Georgia, South Carolina, North Carolina, and Virginia. Tropical Storm Arlene in early June, Hurricane Idalia in late August, and Tropical Storm Ophelia in late September are notable examples.However, the western portion of the region missed out on much of this precipitation. This lack of widespread tropical rainfall set the stage for a rapid transition to drought. Precipitation deficits accumulated quickly, and hotter-than-average temperatures intensified the drying. These conditions contributed to a swift and widespread progression of drought that continued to evolve into early 2024.

2023 Drought Progression

Spring to Early Summer (April-June 2023): Precursor to Drought

A multi-year La Niña transitioned to ENSO-neutral conditions by early spring 2023, with El Niño developing rapidly and officially declared by May. The PNA underwent a dramatic shift from strongly negative to strongly positive, while the NAO remained mostly negative. These teleconnections established a broad trough across much of the Southeast, leading to below-normal temperatures and above-normal precipitation in most of the region.



U.S. Drought Monitor (USDM) progression from July - November, 2023. Drought conditions rapidly expanded and worsened across the Southeast during fall 2023. USDM maps are produced weekly, but this figure shows the map that corresponds to the last week of each month (July-November 2023). These dates were chosen in order to map the monthly progression of the drought. Data From the USDM

By June, the Southeast was relatively drought-free, with only portions of the Gulf side of the Florida Peninsula and northern Virginia experiencing drought conditions. As typical during summer months, isolated pockets of Abnormal Dryness (Do) appeared, but drought never extended beyond 2-3% of the region. Southern Louisiana (not pictured here), however, was experiencing severe drought that would eventually expand into the southwestern portions of the Southeast.

July 2023

Prominent Teleconnections

El Niño conditions intensified, becoming a dominant atmospheric driver. The Indian Ocean Dipole (IOD) also strengthened alongside El Niño. A persistent trough dominated the central U.S. through early July, extending partially into the Southeast. By month's end, an expanding ridge from the western U.S. brought increasingly dry conditions to much of the region.

KEY CLIMATE TELECONNECTIONS INFLUENCING THE 2023 SOUTHEAST DROUGHT

To understand the underlying forces that influenced the Southeast's climate in 2023, it's important to consider large-scale climate patterns, known as teleconnections. These patterns affect weather and climate variability across distant regions through atmospheric drivers such as jet stream positioning and pressure anomalies, which can either enhance or suppress rainfall, shift temperature patterns, and influence storm systems.

Producer assessing corn stand quality during early onset drought conditions in July 2023. Drought stress in corn can show up as poorly filled or missing kernels, especially near the top of the ear. Image from Brianne Minton, Alabama Office of the State Climatologist.

Key Teleconnections That May Have Impacted the 2023 Southeast Drought:

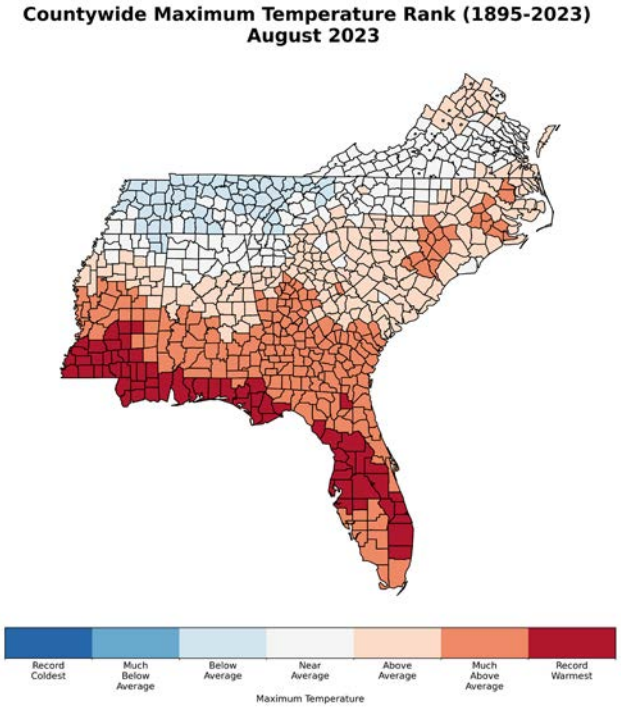
- *El Niño-Southern Oscillation (ENSO): A recurring climate pattern characterized by periodic fluctuations in sea surface temperatures and atmospheric pressure across the equatorial Pacific Ocean, influencing global weather and climate variability.*
- *Pacific-North American Pattern (PNA): A prominent mode of atmospheric variability characterized by alternating areas of high- and low-pressure anomalies extending from the North Pacific to North America, influencing temperature and precipitation patterns across the continent.*
- *North Atlantic Oscillation (NAO): A climate pattern defined by fluctuations in atmospheric pressure in the North Atlantic Ocean, influencing weather patterns across North America, Europe, and North Africa.*
- *Indian Ocean Dipole (IOD): A climate phenomenon characterized by differences in sea surface temperatures between the western and eastern Indian Ocean, affecting monsoons and global weather patterns.*
- *Arctic Oscillation (AO): A large-scale climate pattern defined by variations in atmospheric pressure between the Arctic and mid-latitudes, influencing the strength of the polar vortex and typically winter weather in the Northern Hemisphere.*

Drought Progression
Dry conditions emerged across the Southeast in late July, particularly along Florida's West Coast, where drought rapidly intensified. Several areas experienced extreme heat, with Florida breaking multiple temperature records. Miami, Florida recorded a 16-day stretch with heat indices exceeding 105° Fahrenheit (F), and many locations along Florida's coast experienced their hottest July on record. Precipitation was highly variable—Alabama, Virginia, Tennessee and Mississippi saw above-average rainfall, while central Georgia and the Carolinas experienced significant deficits. Sarasota, Florida experienced its 2nd driest July since 1911, receiving only 12% of normal rainfall. By month's end, drought conditions were sparse, though Florida's Gulf Coast saw Severe and Extreme Drought (D2-D3) emerge.

August 2023

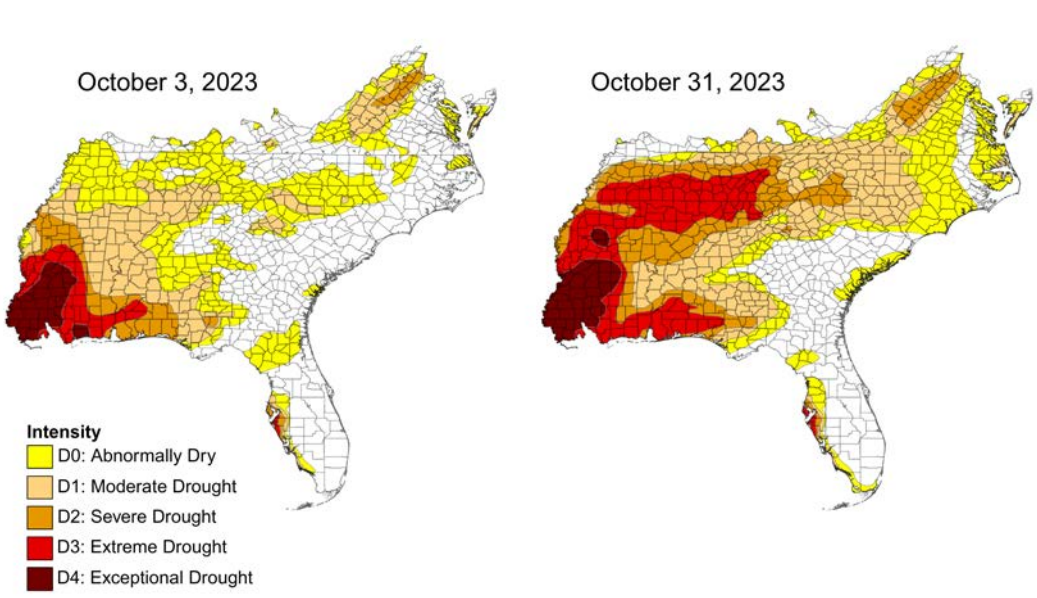
Prominent Teleconnections
El Niño conditions continued intensifying. The most dominant driver was likely the negative AO/NAO pattern, establishing a persistent atmospheric ridge over Texas that contributed to record-breaking heat along the Gulf Coast and Florida while suppressing rainfall.

Drought Progression
Drought conditions worsened significantly, fueled by persistent heat and spotty rainfall. The southern portions of Mississippi, Alabama, and Georgia, and the Florida Panhandle experienced temperatures 2-4°F above average. Mississippi experienced its hottest statewide August on record (4.1°F above 1991-2020 normals) and its 6th driest August. Florida also recorded its hottest statewide August, at 2.7°F above 1991-2020 normals. Cities like Mobile, Alabama and Pensacola, Florida also saw their local hottest August on record. In a bit of a reprieve, Hurricane Idalia provided some relief to Florida and the coastal areas of Georgia, South Carolina, North Carolina, bringing anywhere from 3 to 13 inches of rainfall. However, a strong mid-Atlantic ridge developed in Idalia's wake, limiting moisture from the Gulf.



County-level maximum temperature rankings across the U.S. in August 2023. The colors indicate how each county's maximum temperature ranked over the past 130 years, with blue representing cooler and red representing warmer rankings. Many Southeast counties experienced significantly high ranking, with many counties across the Gulf Coast and Central Florida seeing record-high monthly maximum temperatures.

By late August, about 30% of the Southeast was still experiencing Abnormal Dryness to Drought (D0-D3) conditions, particularly the southwestern half of the region. Moderate to Extreme Drought (D1-3) occurred across South Mississippi, Southwest Alabama, and across the Panhandle (see the USDM figure above). Agricultural impacts included wilted crops in Mississippi, Georgia and Alabama, and parched pastures for cattle operations in Mississippi, South Carolina, and Virginia.



Drought conditions expanded rapidly across the Southeast over a 4-week period from October 3-October 31, 2023. Notable changes include the expansion of Severe to Extreme Drought (D2-D3) across Mississippi, Alabama, Tennessee, and Georgia. Data from the USDM.

September 2023

Prominent Teleconnections
El Niño conditions stabilized while the IOD grew stronger. The intensifying IOD likely contributed to widespread Southeast dryness by modifying upper-atmospheric circulation patterns that inhibited rainfall.

Drought Progression
Dryness persisted and intensified, especially across Mississippi, Alabama, Georgia, and the Florida Panhandle. Many areas received less than half of their normal rainfall. Muscle Shoals, Alabama experienced its second driest September on record. High temperatures in early September further dried out soils; places like Raleigh-Durham, North Carolina reached over 100°F. Tropical Storm Ophelia brought heavy rain to parts of eastern North Carolina and Virginia, however, much of the Southeast remained dry.

The drought footprint expanded to cover 37% of the region, with Severe and Extreme Drought (D2-D3) taking hold across southern Mississippi, Alabama and Georgia. Mississippi saw a rapid three-class degradation resulting in Exceptional Drought (D4). Agricultural impacts worsened. Delayed harvests and below-average hay production forced producers to supplement livestock feed early.

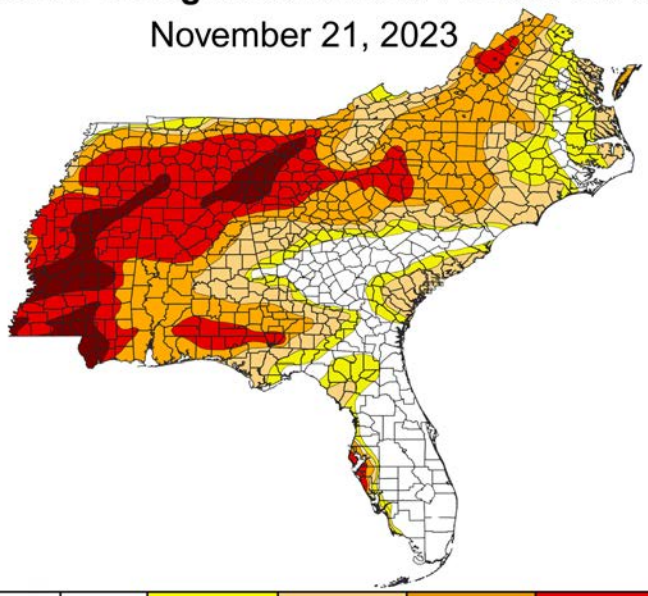
October 2023

Prominent Teleconnections
El Niño conditions intensified again, as did the IOD. Other teleconnections switched patterns throughout the month, making it difficult to identify a clear signal.

Drought Progression
Extreme Drought (D3) emerged in Northern Alabama and Georgia, while Exceptional Drought (D4) expanded further in Mississippi. Although mid-month rainfall offered limited relief in Georgia and Florida, the overall rainfall deficit remained substantial. Severe Drought (D2) also expanded in the Florida Panhandle, with parched soils and deteriorating pastures. This rapid onset drought was mainly due to a prolonged period of lack of rainfall during the usual dry months.

Peak 2023 USDM Drought Conditions Across the Southeast

November 21, 2023



USDM Category	None	D0: Abnormally Dry	D1: Moderate Drought	D2: Severe Drought	D3: Extreme Drought	D4: Exceptional Drought
Percent of the Southeast Experiencing This Category	18.68%	10.85%	17.96%	24.39%	21.42%	6.70%

According to the USDM, peak 2023 drought conditions across the Southeast occurred on November 21, 2023. Moderate to Exceptional Drought (D1-D4) conditions covered over 70% of the region. Mississippi experienced the most widespread and severe drought conditions. Data from U.S. Drought Monitor

This was especially true across the Tennessee Valley and northern Alabama and Georgia, where several dry fronts passed along with several mid-Atlantic ridges that cut off the flow of atmospheric moisture from the Gulf in late September, October, and early November.

Agricultural stress worsened. In Mississippi, Alabama, Georgia and Florida, many farmers harvested below-average peanut and cotton yields and experienced challenges preparing fields for winter crops. Wildfire risk increased with dry fuels and gusty winds, leading to a significant increase in wildfires across the region, especially in Mississippi, Virginia, and Alabama.

November 2023

Prominent Teleconnections

Both El Niño and IOD peaked this month. The IOD may have contributed to persistent dryness across much of the Southeast by altering upper air circulation. However, the dominant driver appeared to be the positive-phase AO, bringing dry conditions to much of the region. Florida was the exception, receiving above-normal precipitation consistent with the ongoing El Niño.

Drought Progression

Drought conditions peaked with over 80% of the Southeast experiencing Abnormal Dryness or Drought (D0-D4). Rainfall improved conditions in the Carolinas and Virginia, but interior portions of Alabama and Georgia remained persistently dry. Drought expanded and Exceptional Drought (D4) was introduced in northern Alabama, Mississippi, and Georgia, while southwestern North Carolina slipped into Severe Drought (D2). This introduction of Exceptional Drought (D4) in Northwest Georgia marked the first time any area of Georgia experienced Exceptional Drought since 2016.

Farmers struggled with hard, dry soils that delayed fall planting. At least 50% of Mississippi, Alabama, and South Carolina pastures were already in poor to very poor condition at the start of the month, forcing ranchers to rely on costly supplemental feed.[5] Pastures in Tennessee increasingly struggled through November, ending the month with 60% in poor to very poor condition. By month's end, nearly 70% of the Southeast remained under Drought or Abnormal Dryness (D0-D4), with little change in the hardest-hit areas.

December 2023

Prominent Teleconnections
El Niño plateaued, appearing to dominate the precipitation signal across the Southeast, especially along the Gulf and Atlantic coasts. A more active weather pattern emerged, partly due to an oscillating AO pattern that shifted the upper-air circulation.

Drought Progression
December rainfall finally provided widespread relief to much of the Southeast. Mid-month storm systems delivered 4–8 inches of rain to the Carolinas and Virginia, with Richmond, Virginia recording its wettest December on record. These rains improved streamflows, replenished soil moisture, and allowed farmers to resume winter grain planting.

Cooler temperatures reduced evaporative demand mid-month, but late December warmth returned to parts of the region. Pastures responded positively where rains were heaviest, but recovery was slower in persistently dry areas of central Alabama and Georgia.

Drought conditions held steady in Mississippi. Pockets of extreme drought lingered in Alabama and Georgia, while Mississippi still had nearly 30% of its area under Exceptional Drought (D4). Despite overall improvements, soil moisture values remained in the lowest percentile according to the Climate Prediction Center's soil moisture model across the western parts of the region.

Early 2024: Drought Recovery

The start of the calendar year marked the onset of the Southeast's wettest season, except for the Florida peninsula. However, even short-term droughts can leave behind substantial precipitation deficits, and full recovery often requires weeks or even months of sustained near-normal rainfall.

In January 2024, rainfall became more consistent across much of the region. Drought improvement generally progressed from east to west. By mid-January, significant drought conditions persisted in Alabama, Tennessee, and Mississippi. Drought was largely alleviated by the end of February, although pockets of dryness lingered. It was not until later in spring 2024 that conditions fully returned to normal across the region.

Prolonged dryness put this pasture in Clay County, MS in very poor condition on November 6, 2023. The stock pond shows extremely low water levels, exposing bare ground along the shoreline, while surrounding grasses provide little to no forage. The lack of water and poor pasture growth highlight the severity of the conditions for livestock maintenance. Image from the National Drought Mitigation Center's Condition Monitoring Reports.

2023 Drought Impacts Across the Southeast

The 2023 drought unfolded rapidly across much of the Southeast, bringing wide-ranging consequences that intensified throughout the fall. Across the region, farmers reported delayed planting and reduced yields for fall-planted crops such as rye, wheat, and hay. In areas with predominantly clay soils, the hard soil and insufficient moisture meant some farmers left fields fallow or saw winter grains fail to germinate. Pasture quality also deteriorated quickly across the region, with one report from Murray County, Georgia noting a 70% loss in fescue. Other areas across the Southeast saw similarly devastating declines in pasture conditions. This left producers with limited options heading into winter. Many were forced to alter planting schedules, reduce

herd sizes, or invest in costly supplemental feed. Drought impacts were especially severe during the flash drought period, when worsening conditions outpaced conventional indicators and left little time for agricultural adaptation.

The effects of the drought extended well beyond the field. Some water supplies showed signs of strain in both public systems and private wells. Several smaller utilities in southeast Tennessee reached the brink of implementing drought plans. Elsewhere, communities imposed voluntary water restrictions in response to lowered reservoir levels. Water sources in various parts of the region were impacted, especially small towns and rural areas. Ecosystems were also affected: North Carolina reported reduced breeding activity among winter-breeding amphibians, while streamflow declines across the region impacted available aquatic habitat for some species. In Oconee County, Georgia, observers noted increased leaf drop, stressed vegetation, and a rise in pests such as pine beetles. Despite these broad impacts, two of the most significantly affected sectors were livestock and wildfire. Livestock producers across the Southeast faced critical pasture and hay shortages, and wildfire activity increased sharply, with several states reporting elevated fire risk, burn bans, and smoke-related air quality issues, such as particle pollution events through late fall.

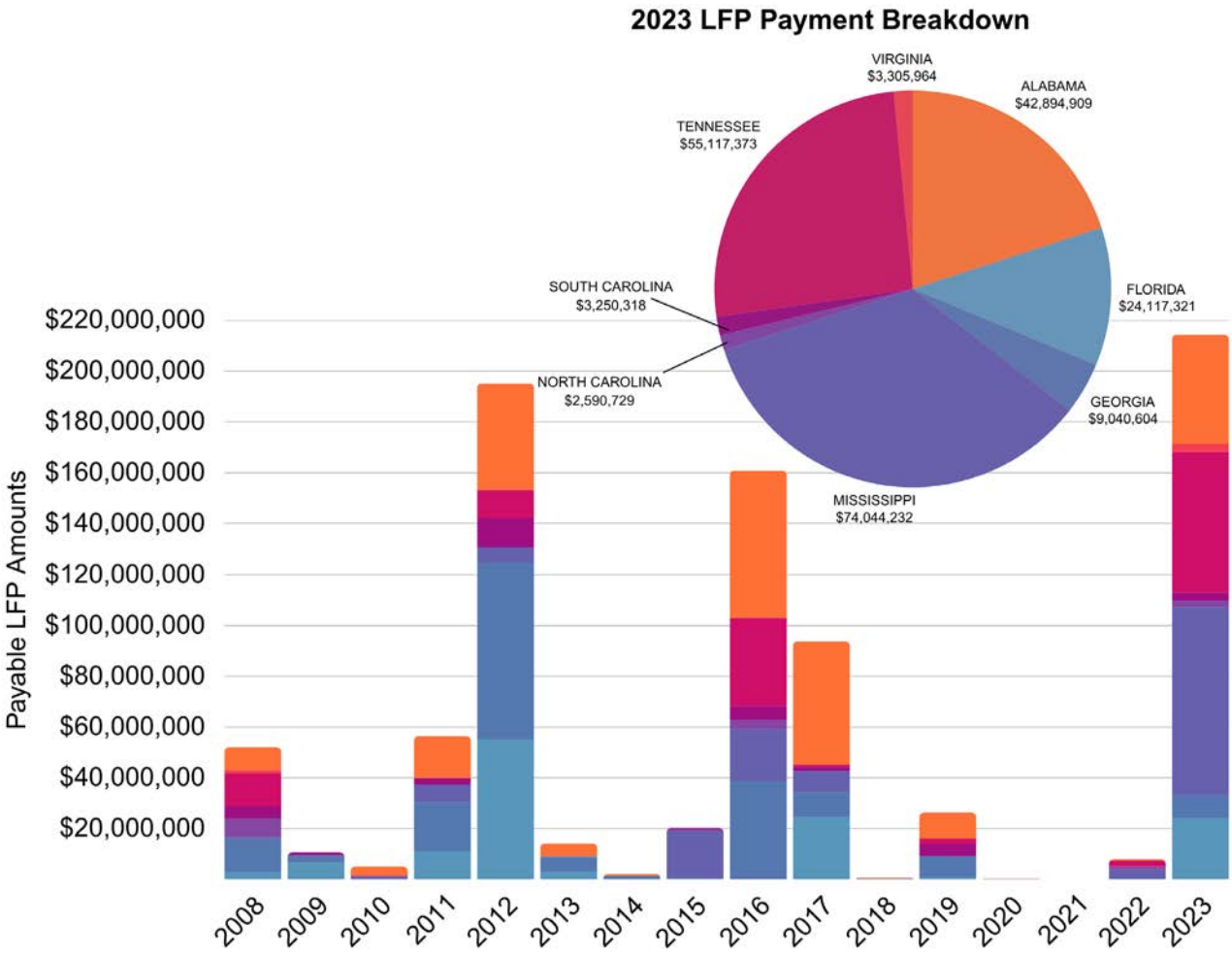
2023 Drought Impacts on Southeast Livestock

Drought poses a serious threat to livestock production by reducing both the quality and quantity of forage.[6] In the Southeast, summer droughts are especially harmful, reducing grazing opportunities and hay yields needed for winter feeding. When drought extends into fall, as in 2023, pastures can become too dry for continued growth, forcing producers to buy supplemental hay earlier. This supplemental hay often comes at a higher price and creates significant financial pressure on producers. USDA National Agricultural Statistics Service (NASS) data shows that while Southeast pastures started the 2023 growing season in relatively good shape, conditions declined rapidly in the fall. By November, at least half of Mississippi, Alabama, and South Carolina pastures were in poor or very poor condition. Virginia and Tennessee were not far behind, with at least a third of pastures rapidly drying out.

Topsoil moisture also quickly declined. By the start of September 2023, Alabama, Mississippi,

State[7]	Percent of Short to Very Short Topsoil First week of Sept. 2023	Percent of Short to Very Short Topsoil First week of Nov. 2023
Alabama	50%	90%
Florida	18%	48%
Georgia	24%	68%
Mississippi	56%	83%
North Carolina	20%	76%
South Carolina	18%	69%
Tennessee	23%	61%
Virginia	59%	63%

The percentage of topsoil that is Short to Very Short according to weekly USDA NASS data from September 3, 2023 and November 5, 2023. During this 2-month window, regional drought and topsoil moisture conditions deteriorated quickly. Data from USDA NASS



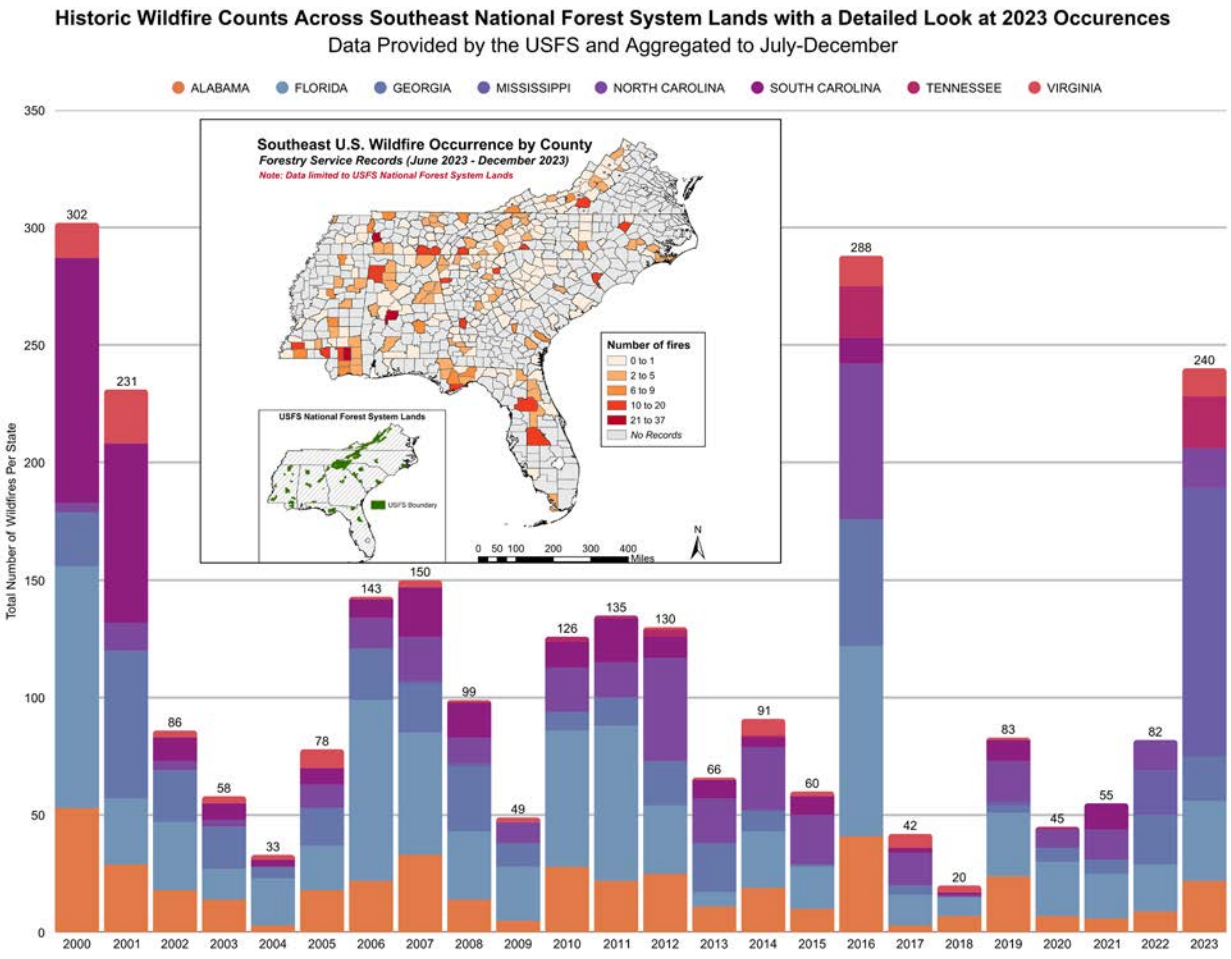
LFP Payment Amounts Across the Southeast Since Program Inception in 2008

Data Provided by the USDA Office of the Chief Economist

Livestock Forage Disaster Program (LFP) payments provided to the Southeast from 2008-2023, with a detailed look at statewide totals for 2023. In 2023, USDA provided the Southeast with the most LFP payments since the program's inception. Mississippi, Tennessee, and Alabama had the largest payouts from the 2023 drought.Data provided by the USDA

and Virginia experienced drier topsoil moisture conditions compared to the rest of the region. By early November, every state in the region except Florida had more than half of its land area in short or very short topsoil moisture conditions. During the same time, over 75% of Alabama, Mississippi, and North Carolina experienced short or very short topsoil moisture conditions. Table 1 shows the percentage of each state experiencing short and very short (combined) topsoil moisture conditions the first week of September and November according to the USDA NASS reports. This table shows how severe the topsoil moisture conditions were in November across the region, and how drastically topsoil moisture conditions changed in a two month period. These poor topsoil conditions in fall 2023 created serious challenges for producers across the Southeast, including poor pasture growth that forced early hay feeding, difficulties harvesting peanuts, and challenges planting winter crops due to dry, hardened soils.

To help offset these impacts, USDA's Livestock Forage Disaster Program (LFP)[8] delivered over $214 million to Southeast livestock producers in 2023—the region's highest allocation since the program began in 2008. Mississippi received $74 million, Tennessee $55 million, Alabama nearly



Historic wildfire records across the Southeast National Forest System Lands from 2000 to the present indicate that 2023 was the third most active wildfire season during the July–December period. The years 2000 and 2016—both marked by severe drought—recorded higher levels of wildfire activity. Data provided by the USDA USFS.

$43 million, and Florida $24 million, with smaller amounts going to other Southeastern states. This distribution reflects both drought severity and the prominence of livestock operations; Alabama, Florida, and Tennessee each devote at least a quarter of their farmland to pastureland. Since its inception, LFP has provided nearly $915 million to the Southeast, with major payment spikes in 2012, 2016–2017, and 2023. Historically, Alabama, Georgia, Mississippi, Tennessee, and Florida received the most aid, underscoring their exposure to recurring drought and extensive pasture and rangeland.

2023 Drought Impacts on Southeast Wildfire Activity

Drought significantly increases wildfire risk by drying vegetation and creating conditions conducive to ignition and rapid fire spread. According to the USDA U.S. Forest Service's (USFS) National Fire Occurrence Point dataset, the Southeast experienced an active 2023 wildfire season, with approximately 240 named wildfires recorded between July and December.[9] This six-month window was selected to focus on the core period of drought and wildfire activity in 2023

and enable direct comparison of 2023 with other drought-impacted years. Based on this timeframe and this USFS dataset, 2023 ranks as the third most active wildfire season in the Southeast, following the severe drought years of 2000 and 2016.

The wildfire activity observed in 2016 prompted several Southeastern states to strengthen preparedness measures in subsequent years. In 2023, many states enacted early burn bans specifically to avoid a repeat of 2016 events. As a result, some areas with elevated fire potential recorded fewer actual fire incidents, illustrating the impact of improved mitigation strategies.

From July through December 2023, the highest concentration of wildfires occurred in Mississippi and Alabama, with several counties—including DeKalb County, Alabama, and Perry County, Mississippi—reporting more than 50 wildfires during this period. While not all wildfires can be directly linked to drought, the 2023 data highlight a clear relationship between dry conditions and increased fire activity across the region. Note that this USFS dataset only counts wildfire activity that occurs on National Forests.

Stand of pine trees in a forest
Credit: ACES | Bruce Dupree

What We Learned from the 2023 Drought

Reflecting on the 2023 drought offers valuable insight into how the Southeast monitors, responds to, and communicates drought risk. To inform this report, the project team—supported and funded by the National Integrated Drought Information System (NIDIS)—conducted a regional survey of drought monitoring entities across the Southeast. The survey gathered input from approximately 20 individuals representing statewide and regional drought coordination teams. The survey asked respondents about their experiences during the 2023 drought, including how they monitored and communicated drought conditions, observed impacts,coordinated efforts between agencies, and what tools, programs, or practices were most effective. They also shared ongoing challenges and identified opportunities for improvement.

From this survey, three key lessons emerged:

Strengths: The Southeast already has strong drought management practices in place.

Challenges: The region faces distinct challenges in drought monitoring.

Opportunities: There are clear opportunities to build on existing strengths to improve resilience.

These themes are explored in the following sections, with specific examples highlighted under the headings **Strength, Challenge,** and **Opportunity.**

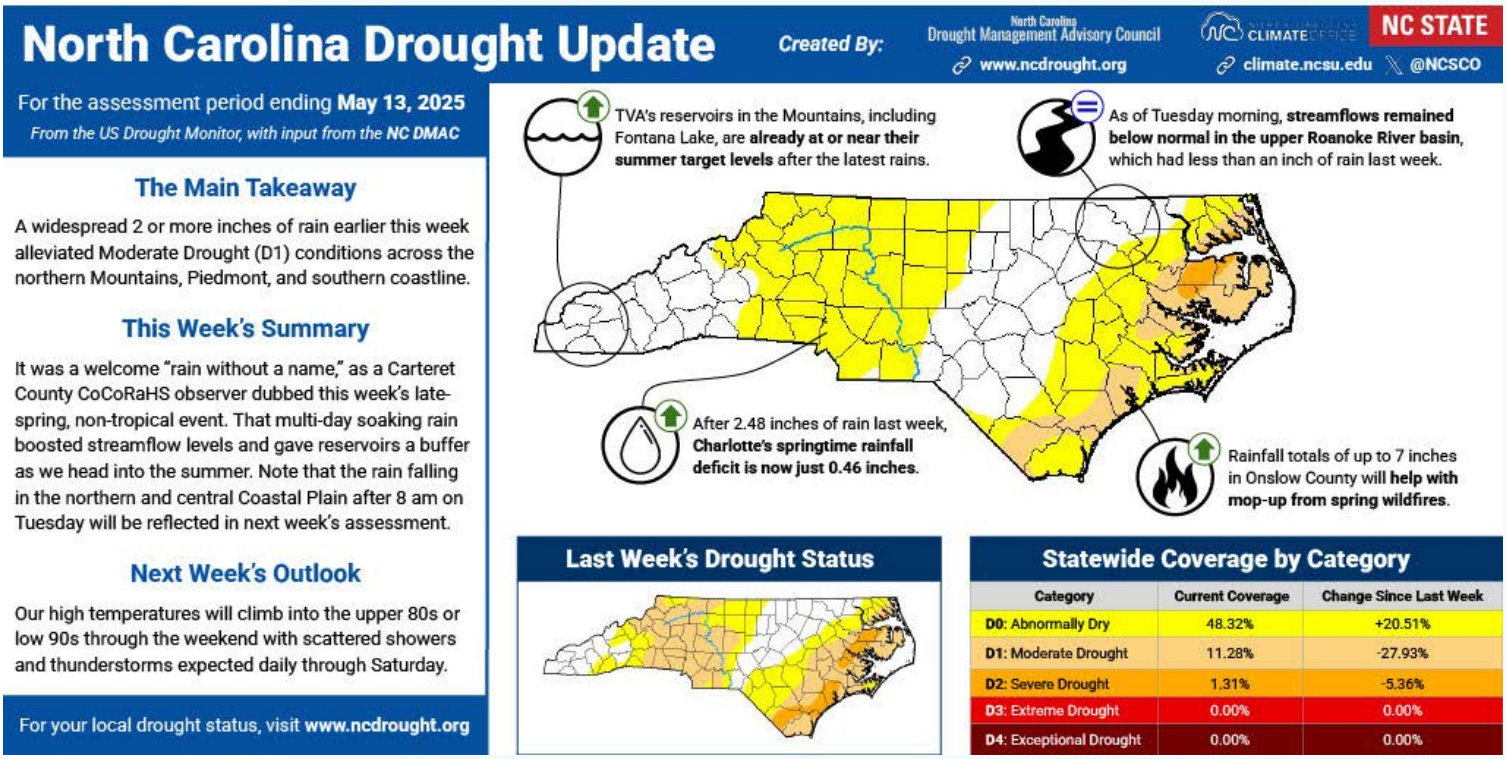
LESSON: THE SOUTHEAST ALREADY HAS GREAT DROUGHT MANAGEMENT PRACTICES IN PLACE

The fall 2023 drought served as a clear reminder of how variable and impactful drought conditions can be across the Southeast. At the same time, it revealed that many states in the region have already established effective systems and partnerships to monitor, communicate, and respond to drought. The following list of successful programs and tactics is not intended to be exhaustive or comprehensive. Instead, it showcases some of the major successes and innovative efforts that have emerged across the Southeast. These examples reflect a broader pattern of regional leadership and collaboration in drought preparedness and response.

Strength: Strong Regional Support from the Southeast Drought Early Warning System (DEWS)

The Southeast DEWS, part of NOAA's NIDIS, plays a foundational role in advancing drought preparedness and communication across the region. Built on trusted partnerships and open dialogue, the Southeast DEWS fosters a culture of collaboration that supports both innovation and consistency in drought monitoring. This regional network helps states stay connected, informed, and responsive in the face of fast-evolving drought conditions. It serves as a space to share ideas and coordinate, creating the kind of cross-jurisdictional trust especially vital during high-impact events like flash droughts. Without this collaborative foundation, the fall 2023 flash drought would have been significantly harder to monitor and respond to in real time.

The Southeast DEWS also helps shape the narrative around how drought manifests in the region, where events like flash droughts, hydrologic whiplash, and feast-or-famine rainfall patterns often dominate. These discussions help contextualize data within the lived realities of Southeastern drought, allowing states to better align monitoring practices and communication strategies.



The North Carolina Drought Update graphic created by the North Carolina Climate Office in partnership with the North Carolina Drought Management Advisory Council. This graphic was distributed throughout the Southeast via Southeast DEWS and has now been adopted by several other state monitoring groups.

Key contributions of Southeast DEWS include:

Monthly Southeast Climate Webinars

Co-hosted with partners such as the Southeast Regional Climate Center, University of Georgia, and National Weather Service, these webinars offer real-time updates and a forum to exchange drought-related observations and concerns.

A Platform to Share Best Practices

The Southeast DEWS creates space for states to exchange tools and templates, like the widely adopted North Carolina drought summary infographic. This kind of collaboration helps keep things consistent across the region while allowing each state to maintain its own approach.

Creates a Culture of Trust Between States

The Southeast DEWS cultivates ongoing relationships between state-level drought monitoring entities and USDM authors, allowing states to quickly share information and validate one another's USDM assessments during rapidly evolving conditions. They help create a culture of trust between state drought monitoring entities that strengthens coordination, encourages open communication, and leads to more accurate, locally informed drought designations.

Advocating for Southeast Regional Drought Metrics

Each state has its own approach to drought monitoring. The DEWS provides a platform for states to share insights about different drought monitoring datasets, including which ones are better at depicting drought impacts for various sectors at different times of the year. The DEWS increased the trust between state-level drought monitoring entities in the region, which enabled

stronger and more consistent monitoring across state lines. The Southeast DEWS serves as a regional voice for the Southeast, working to identify and advocate for drought indicators that more accurately reflect drought conditions in the region. This advocacy also supports a culture of trust in the region.

Strength: Established Cross-State Collaboration

Building on the relationships cultivated through Southeast DEWS, the Southeast developed an especially strong culture of collaboration across state lines. This region-wide communication network is essential for tracking drought in a timely and coordinated way, especially in a landscape where drought can emerge quickly and affect shared resources.

States regularly loop one another into email communications to the USDM, helping to build a real-time, shared understanding of conditions as they develop beyond political boundaries and borders. Communication among the Carolinas and Virginia—often in coordination with Tennessee and Georgia—enabled states to track drought across watersheds and anticipate downstream and multi-jurisdictional impacts. Similarly, Alabama, Florida, Georgia, Mississippi, and Tennessee participate in regular USDM email exchanges, reinforcing a broader culture of information sharing across the Southeast.

This collaborative input process allows for consistency in drought designations and ensures that decisions reflect both local observations and regional trends. The value of this coordination was especially clear during the 2023 flash drought. Without these pre-existing relationships and communication channels, it would have been much harder to identify flash drought conditions in time and recommend appropriate USDM categories across jurisdictions.

NOAA National Weather Service's Southern and Eastern Regions play an especially key role in maintaining and facilitating these region-wide communications. Their inclusive outreach, particularly during high-stakes periods, ensures drought monitoring entities remain informed and engaged. This created a more cohesive, responsive system that can act quickly when conditions change.

Strength: Innovative State-Level Approaches

While regional collaboration is a noteworthy accomplishment across the Southeast, each state also developed innovative drought monitoring and response approaches tailored to their specific needs. Some of these strategies were adopted by neighboring states. By building on these successful efforts, the Southeast can further strengthen its drought resilience amid increasingly variable climate conditions. Please note: while several of these practices are highlighted below, this is not an exhaustive list for each state.

Beef cattle grazing in winter in Autauga County, AL. Credit: ACES | Katie Nichols

Alabama

Alabama has taken a coordinated, multi-agency approach to drought monitoring through its Drought Monitoring Impact Group (MIG), a technical subcommittee of the Office of Water Resources at the Alabama Department of Economic and Community Affairs. The MIG meets regularly to assess drought conditions using stakeholder reports, USDM products, and forecasts to produce statewide Drought Declaration maps. In 2023, the state also launched the Alabama Drought Reach (ADR) program, a collaboration between Auburn University's Water Resources Center, the Alabama Office of the State Climatologist, and the Alabama Cooperative Extension System to connect extension agents with the climate office through internal surveys on agricultural and water-related conditions. These surveys inform weekly USDM updates, support insurance claims, and improve drought literacy through webinars, newsletters, and outreach. ADR earned both state and national recognition.

Florida

The Florida Climate Center facilitates weekly drought monitoring discussions, coordinating closely with the state's five water management districts, National Weather Service Forecast Offices, and other key stakeholders to inform USDM recommendations. The installation and upgrade of soil moisture sensors at over 43 Florida Automated Weather Network (FAWN) sites was a major enhancement to this process. NOAA's Weather Program Office funded these additional sensors. These sites are strategically located in agricultural areas away from urban development and provide accurate soil moisture readings complemented by stakeholder input and condition monitoring observer reports. An emerging relationship between the Florida Climate Center and the Florida Division of Emergency Management is also expanding the state's capacity to integrate real-time impact data into drought assessments, further strengthening Florida's collaborative and adaptive drought monitoring system.

Georgia

Georgia benefits from strong connections between climate monitoring and agriculture through Pam Knox, who serves as both the director of the University of Georgia Weather Network and the Agricultural Climatologist. This dual role strengthens the relationship between the Office of the Georgia State Climatologist within the Environmental Protection Division (EPD) and the University of Georgia Cooperative Extension, fostering greater communication between climate experts and the agricultural community. Georgia EPD's Ambient Monitoring Program also has an extensive air quality monitoring network and provides daily air quality forecasts to protect Georgians' public health. This data is very useful to monitor particle pollution during wildfire smoke events triggered by rapid onset drought conditions.

Mississippi

Mississippi was the inspiration for Alabama's ADR. The Office of the State Climatologist for Mississippi created a survey that gathers input from extension agents about drought conditions in their local communities and provides timely information for the weekly USDM map of Mississippi. This initiative successfully bridged the gap between Mississippi Extension and the state climate office, creating opportunities for greater agricultural input in drought assessment.

North Carolina

North Carolina has long been a leader in drought communication across the Southeast. The North Carolina State Climate Office developed a drought update template now used by several states to clearly explain weekly USDM changes, or lack thereof, to the public. The North Carolina Drought Management Advisory Council has also hosted weekly calls for over a decade, bringing together

agencies like the NC State Climate Office, National Weather Service, U.S. Geological Survey, reservoir operators, and NC State Extension to share data and observations. Additionally, through Project Nighthawk, North Carolina is developing infographics and factsheets tailored to sectors like agriculture, forestry, and water resources. Project Nighthawk will help stakeholders understand drought conditions and the reasoning behind monitoring decisions.

South Carolina

The South Carolina State Climatology Office established a working relationship with local USDA Farm Service Agency (FSA) offices to gather weekly agricultural drought impacts. The South Carolina State Climatology Office incorporates these localized impact reports into a comprehensive map of statewide drought conditions to inform the weekly USDM author. The South Carolina state drought monitoring group, the Drought Response Committee (DRC), also uses these reports for drought monitoring and response within the state. This relationship ensures South Carolina's drought assessments more accurately reflect conditions across the state and take agricultural concerns into account. This approach builds trust between statewide drought monitoring entities and agricultural producers directly affected by drought conditions.

Tennessee

The Tennessee Climate Office leads a weekly drought coordination process that includes partners at National Weather Service Forecast Offices, multiple state agencies (e.g., emergency management, agriculture, environment), the Tennessee Valley Authority, and border states. Additionally, the Tennessee Emergency Management Agency coordinates a monthly Drought & Wildfire Task Force that brings together state and federal partners to report emerging and ongoing sector-specific impacts and response/agency coordination needs.

The Tennessee Climate Office adopted the drought update infographic template from North Carolina in 2022 and distributes the statewide drought update each week. Tennessee is working to strengthen drought response by building relationships between the climate office and extension and FSA agents, recognizing the value of these connections for effective drought monitoring and response. Upon request, the Tennessee Climate Office provides drought information and status updates to extension and FSA agents both in-person and virtually. These sessions resulted in significant increases in CMOR reports across Tennessee.

Virginia

Virginia has a structured and collaborative approach to drought management through the Virginia Drought Monitoring Task Force (DMTF), a multi-agency team consisting of state and federal partners led by the Virginia Department of Environmental Quality. Similar to Alabama's MIG process, the DMTF meets regularly to assess hydrologic and water supply conditions and make recommendations for Drought Stage declarations. Their work follows guidance laid out in the Virginia Drought Assessment and Response Plan. The Department of Environmental Quality also issues regular reports and press releases that display current drought advisories and warnings, while highlighting current drought indicators including streamflow, groundwater, reservoir levels, and precipitation. These efforts contribute to an organized and transparent drought response process across the state.

Moderate drought conditions in late September 2023 resulted in widespread browning and drying of grasses in Jackson County, Alabama. Image from Brianne Minton, Alabama Cooperative Extension.

LESSON: THE SOUTHEAST HAS DISTINCT DROUGHT MONITORING CHALLENGES

Effective drought monitoring is essential for early detection and timely response to developing drought conditions. It is also critical to help communities and agencies prepare for and minimize economic, agricultural, and environmental impacts. Accurate monitoring enables decision-makers to implement appropriate mitigation strategies before drought conditions become severe.

In the Southeast, drought monitoring faces three distinct challenges related to the region's unique characteristics:

- *Effectively tracking conditions within the context of a rapid hydrologic cycle that can shift dramatically in short timeframes,*
- *Addressing significant gaps in observational networks, and*
- *Communicating changing drought conditions to diverse audiences with varying needs and technical understanding.*

These challenges require specialized approaches tailored to the Southeast's climate patterns, landscape diversity, and stakeholder communities.

Challenge: Tracking Drought in a Rapid and Variable Hydrologic Cycle

Traditional drought monitoring metrics and products like the USDM emphasize monthly aggregated indicators that include moving averages (e.g. 30-, 60-, or 90-day indicators) which often overlook or smooth out sub-monthly drought development. This is a critical limitation in the Southeast, where the climate is marked by dramatic swings between wet and dry conditions, sometimes within the span of just a few days or weeks. This hydrologic "whiplash" is intensified by high summer and fall temperatures and a seasonal pattern dominated by convective storms and tropical systems. These weather patterns often produce short-lived, but intense, rainfall events that can briefly saturate the surface but lead to minimal deeper soil moisture recharge as the majority of the rainfall ends up as runoff. A single heavy rainstorm can erase drought signals in long-term metrics, even when underlying drought stress and impacts remain. There is a need for metrics that capture effective precipitation—rainfall that actually contributes to recharging water stores—since a portion of precipitation is sometimes lost to runoff or evaporation. Tools that can effectively distinguish between total and effective precipitation are essential to capture the true state of drought stress on the ground.

This disconnect between conventional drought metrics and on-the-ground conditions is especially problematic for agriculture in the Southeast, where farmers often rely on rainfall rather than traditional irrigation. In this region, drought can develop quickly, sometimes within just a few weeks, leaving traditional monitoring data that often focus on 30-, 60-, or 90-day timeframes (rolling-averaged monthly aggregates) too slow to detect early warning signs. This is particularly true during flash droughts, which intensify rapidly and can cause significant crop and pasture damage before they are captured by longer-term indices.

To address this gap, Southeast decision-makers and producers are increasingly turning to non-traditional monitoring timeframes, such as the 14-, 21-, and 45-day. When paired with traditional timeframes that provide a more comprehensive view of evolving conditions across the region at sub-monthly and inter-monthly intervals. The combined use of these tools are better suited to the Southeast's fast-changing weather, high evapotranspiration rates, limited water reserves, and soils with low water-holding capacity. In rapidly developing droughts, impacts can shift quickly, making it critical to use indicators that reflect real-time conditions rather than delayed signals from monthly or seasonal products. Expanding monitoring metrics to include sub-monthly, monthly, and inter-monthly timeframes is critical to improve drought preparedness and response across the Southeast, especially as the region faces a rapidly changing hydrological cycle marked by more frequent shifts between wet and dry conditions.

Challenge: Gaps in Observational Networks

Survey respondents highlighted another key challenge: significant gaps in observational networks across the Southeast. These gaps limit drought monitoring entities' ability to accurately and timely assess developing conditions. Unlike more densely instrumented regions, parts of the Southeast lack comprehensive statewide mesonets and robust soil moisture networks. Because rainfall in the Southeast is often highly localized, total precipitation amounts can vary significantly from one location to the next. In instances when localized rain falls directly over a monitoring station but not in surrounding areas, the resulting

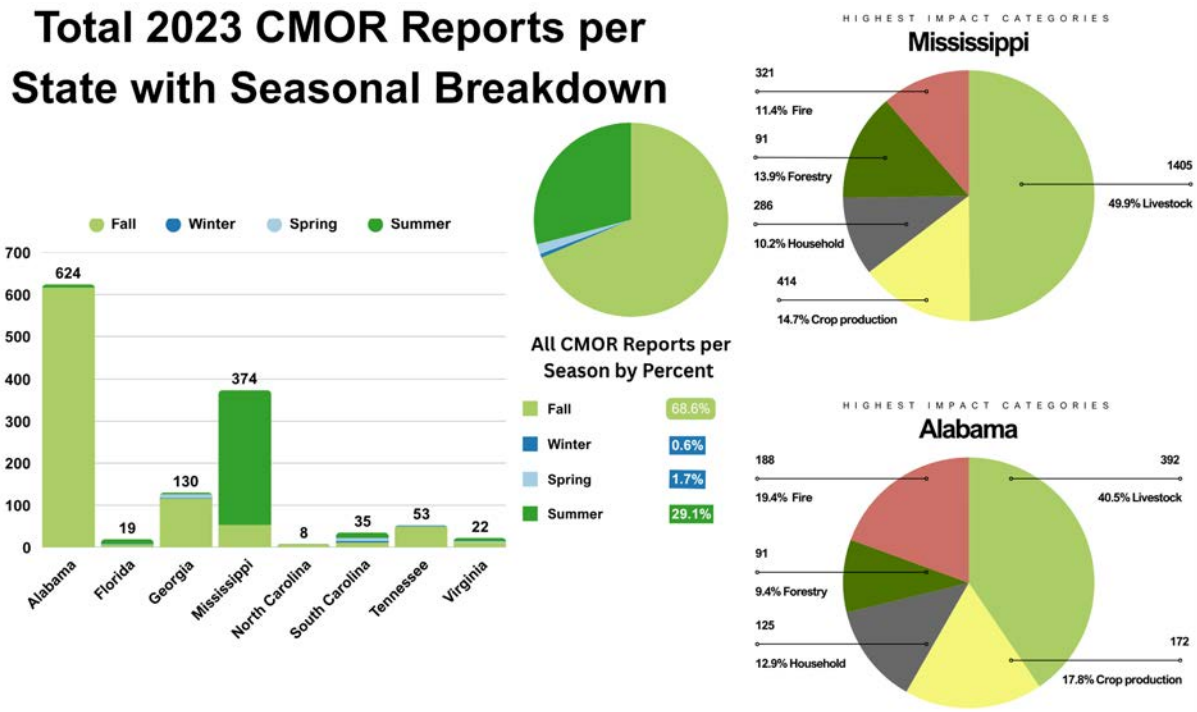
data can misrepresent broader conditions and lead to a "false positive" in drought assessments. Sparse networks cannot reliably capture this variability, especially during convective events. In many rural counties, basic weather data coverage is also limited. Cell service gaps further hamper real-time data collection, compounding the challenge of accurate drought monitoring.

This data gap becomes even more problematic considering the type and frequency of data needed to monitor drought in the region. Mesonets are critical for providing high-frequency data, often at hourly intervals, that capture temperature, wind, soil moisture, and precipitation. Hourly data is especially valuable in identifying effective precipitation: the amount of rainfall actually absorbed by the soil rather than lost to runoff or evaporation. In the Southeast's convective storm-driven climate, where a one-inch rainfall can occur over 10 hours or in just 10 minutes, this distinction is crucial. Without it, drought severity may be under or overestimated. In many Southeast states, the only hourly data available comes from airports or select RAWS (Remote Automated Weather Stations). More common COOP (Cooperative Observer Program) and CoCoRaHS stations only provide 24-hour accumulation totals, which can mask how daily rainfall is distributed and how effective it actually is.

This issue is compounded by the Southeast's geographic and environmental diversity—within a single state, there may be stark differences in topography, soil type, land use, and water availability. Gaps in data mean localized indicators of drought may be missed, especially in communities already vulnerable or heavily dependent on rainfed irrigation. Without comprehensive observations, drought onset could go undetected until impacts become severe.

Some states are actively working to improve this situation. Florida, Georgia, North Carolina, and Mississippi operate statewide mesonets. Alabama is currently building the Alabama Climate Observing Network (ACON), which will combine smaller mesonets into a unified statewide database and public dashboard. The Alabama Office of the State Climatologist is also developing low-cost soil moisture sensors in-house and deploying them throughout the state. In Florida, a recent grant from the NWS Weather Prediction Office enabled the installation of soil moisture sensors at more than 43 FAWN (Florida Automated Weather Network) stations. Tennessee's legislature approved funding for a statewide mesonet in 2025, with phase one providing funds to construct at least one station in every county (95 total) over the subsequent five years. All stations are expected to include multi-depth soil moisture sensors, similar to other statewide mesonets.

Drought caused moderately dry conditions on a farm in Greene County, AL on November 3, 2023. The ground shows widespread dryness with visible cracks and eroded area leaving exposed soil and stressed vegetation. Image from the National Drought Mitigation Center's Condition Monitoring Reports.



CMOR drought reports submitted across the Southeast in 2023, with Alabama, Mississippi, and Georgia contributing the highest numbers. Reporting peaked in the fall, aligning with widespread severe drought conditions. Data from CMOR Reports.

Survey responses also noted the USDA NASS crop progress reports, which provide weekly snapshots of crop development across each state, are somewhat limited in their current form. Because the data is aggregated at the state level, it lacks the county-level granularity needed to understand where specific crop growth stages are occurring. For a region like the Southeast, where growing conditions can vary widely from one area to the next, this creates challenges in assessing whether rainfall is reaching crops during their most water-sensitive periods. Respondents expressed a desire for more disaggregated crop data, even at a coarse level, to help contextualize emerging drought risks at the local scale.

Together, these challenges point to a fundamental limitation: without widespread, high-resolution, and real-time observational networks, drought monitoring in the Southeast will continue to face significant blind spots, especially in rapidly changing or highly localized conditions. Expanding these networks and surveys is essential for capturing the true complexity of drought and strengthening the region's preparedness and resilience.

Challenge: Sparse Local Impact Reports

In addition to observational gaps, Southeast drought monitoring entities also emphasized the need for consistent and diverse impact reporting to contextualize the data and highlight localized drought impacts. While satellite data and climate models provide essential insight, they cannot fully capture the lived experiences of those affected by drought. Crowdsourced observations help close that gap.

Tools like CMOR (Condition Monitoring Observer Reports)[10] and CoCoRaHS (Community Collaborative Rain, Hail & Snow Network)[11] are standout examples of public impact-reporting systems that offer timely, hyperlocal data. CMOR allows anyone to submit qualitative reports and photographs about drought impacts across categories like agriculture, water supply, and ecosystems. These submissions provide a ground-level perspective of overall dryness and help establish historical baselines for both drought and non-drought conditions in local communities.

In 2023, CMOR saw a surge in usage across the Southeast, particularly from agricultural

communities in Alabama and Mississippi during peak drought months. Reports primarily focused on livestock and crop production impacts, but also highlighted localized effects on forestry, household water use, and even public health. While CMOR reports generally aligned with official drought designations from the USDM, some counties, like in central Georgia, reported impacts before drought was officially declared, demonstrating CMOR's value in detecting emerging issues. The tool also revealed reporting gaps, particularly along parts of the East Coast, underscoring the ongoing need for broader public participation and geographically diverse submissions.

CoCoRaHS is another public tool that enables volunteers to collect and submit daily rainfall data using standardized gauges, creating a dense and accessible network of precipitation observations across the nation. In addition to rainfall, CoCoRaHS also features a condition monitoring map where users can report whether local conditions are dry, wet, or near normal. Several reports from across the Southeast began indicating mildly to moderately dry conditions by late July 2023, with worsening reports from Mississippi and Florida through August. By late September, widespread condition monitoring entries reflected mild to severe dry conditions across much of the region, reinforcing observations from other drought monitoring tools.

Programs like CMOR and CoCoRaHS offer more than just data, they provide meaningful pathways for public involvement in the drought monitoring process. These tools empower individuals, including producers whose livelihoods depend on rainfall, to contribute directly to the USDM. Regular participation, even during non-drought periods, is especially important. These "normal" reports help establish local baseline conditions and offer valuable historical context when dryness emerges. "Normal" reporting can also help to quickly alert those involved with drought monitoring when ground conditions transition into dry or drought conditions. This can increase response, particularly when a flash drought is developing. In areas where traditional observation networks are limited, citizen science not only fills critical data gaps but also ensures the monitoring process reflects a broader range of experiences and voices. Together, tools like CMOR and CoCoRaHS, and the people who use them, are essential to building a more responsive and inclusive drought monitoring system across the Southeast.

Challenge: Bridging the Gap Between Data and Lived Experiences

Those monitoring drought in the Southeast frequently raised one final challenge: how to communicate drought in a way that honors both scientific accuracy and the emotional weight of lived experiences. In a region known for lush greenery and high annual rainfall, drought can be difficult to recognize, let alone communicate, until impacts are already severe. Unlike disasters with visible,

Widespread drought conditions over a field in Morgan County, GA on November 12, 2023. Image from the National Drought Mitigation Center's Condition Monitoring Reports.

dramatic damage, drought often unfolds slowly and unevenly. It is personal, emotional, and tied closely to local experience. A central question emerged: how can drought severity be reported in a way that respects the human toll without compromising data integrity?

This tension becomes especially apparent when impacts and indicators do not align. Producers may face devastating losses—withered crops, drying ponds, stressed livestock—while the USDM classifies their area as only "Abnormally Dry" or in "Moderate Drought." This disconnect often leads to frustration or diminished trust in the monitoring process. The USDM, however, defines drought severity using historical context. Drought categories reflect the rarity of current conditions in the historical record, not just present-day impacts. Significant effects on agriculture or ecosystems may occur during events that do not rank among the most severe on record. While those effects remain critical, they may not meet the threshold for more extreme drought designations.

Drought impacts daily life and livelihoods. Every event that brings disruption or loss holds deep personal significance. Yet not all impactful droughts equate to historically rare ones. Communicating that distinction with clarity and care remains a core challenge for the monitoring community.

Effective communication depends on transparency and trust. Those monitoring drought must acknowledge public concerns and should address the limitations of data openly. Clear explanations of how drought categories are determined and why severity levels may not always align with perceived conditions can foster understanding and confidence in the process. Creating space for dialogue and engagement builds a more resilient, informed response to drought.

Ultimately, successful drought communication requires a balance of honesty, empathy, and precision. Emphasizing both scientific consistency and human experience allows for a more complete understanding of drought in a region where its presence is often overlooked.

LESSON: THE SOUTHEAST CAN BUILD ON STRONG FOUNDATIONS TO IMPROVE DROUGHT RESILIENCE

While the Southeast has established strong foundations for drought monitoring and response, the fall 2023 drought revealed several opportunities to further enhance regional resilience. This section outlines strategies and action items to build on existing strengths, address remaining gaps, and better prepare communities and sectors for future drought events. By implementing these strategies, the region can strengthen its overall capacity to anticipate, monitor, and respond to drought.

Opportunity: Integrate Sub-monthly and Inter-monthly Metrics and Teleconnection Insights Into National and State-level Drought Monitoring

During flash drought events, impacts typically develop and intensify in severity at a rate that outpaces the ability of traditional drought monitoring metrics to track conditions and respond effectively. For this reason, flash drought events challenge national and state-level monitoring efforts. However, these challenges also create opportunities to enhance monitoring, metrics, and response. The development of sub-monthly (ex. 8- to 21- days) and inter-monthly (ex. 45- days) monitoring indices for use alongside monthly timesteps (ex. 30-, 60-, 90- days) would provide a more robust approach to evaluate rapidly changing conditions, accumulating impacts, and rapid shifts between wet and dry periods. This would support a more data-informed and responsive approach to accurately link national and state-level drought classifications to rapidly deteriorating conditions and impacts. Drought monitoring entities across the Southeast believe this would better capture the complexity and variability of drought in the region, resulting in stronger drought monitoring, response and communication.

Another opportunity that exists is understanding how large-scale teleconnections influence drought, especially flash droughts in the Southeast. Teleconnection patterns such as ENSO or the MJO can significantly affect precipitation across the Southeast, but their impacts vary across the region and are not yet fully understood. Therefore, this is an important topic and focus for further applied research for monitoring efforts in the Southeast to help inform drought monitoring and response.

Action Items

Create accessible online products focused on sub-monthly and inter-monthly indices

- *Develop and publish these products via drought.gov or regional climate centers*
- *Ensure products are user-friendly and regularly updated*
- *Include clear interpretations of what these indices mean for various stakeholders*
- *Research and create products that capture effective precipitation*

Initiate discussions with USDM authors about sub-monthly and inter-monthly metric needs

- *Organize focused sessions within Southeast DEWS meetings*
- *Form a NIDIS working group dedicated to improving sub-monthly and inter-monthly drought indicators*
- *Develop standardized methodologies for incorporating these metrics into USDM processes*

Review internal state drought monitoring plans

- *Ensure state drought plans in the Southeast account for flash drought and long-term, more traditional type droughts*
- *Include strategies to monitor, change drought classifications, and communicate rapidly changing conditions, which may differ from more traditional approaches.*

Conduct targeted research on the influence of large-scale teleconnections (i.e. ENSO, NAO, MJO) on Southeast drought vulnerability

- *Translate research findings into decision-support tools that clarify how teleconnections impact precipitation and drought risk across the region*

Opportunity: Bolster Relationships With Drought-Related Stakeholders

While some states have established strong connections with the agricultural sector—which is both a major part of the Southeast's economy and often the first to feel the impacts of drought—there remains significant opportunity to deepen these relationships and expand outreach to other drought-affected sectors such as water utilities, forestry, recreation, and energy production. Agriculture can serve as an early indicator of emerging drought conditions, making collaboration with producers especially valuable for early warning. At the same time, it is essential to engage a broader range of stakeholders, as drought impacts are far-reaching. NOAA NIDIS and the Southeast

DEWS could play a key role in facilitating these early conversations by leveraging their extensive regional networks to connect state drought monitoring entities with key stakeholders, helping to build relationships and foster sustained sector engagement.

Action Items

Develop cross-sector training programs

- *Train state-level drought monitoring entities on sector-specific priorities and language*
- *Educate sector representatives on monitoring processes and explain how their input informs decisions*
- *Facilitate regular dialogue between sectors and drought monitoring professionals*

Facilitate discussions around strengthening partnerships and stakeholder engagement

- *Develop case studies on successful programs across the region*
- *Foster conversations that center on the value of stakeholder engagement*
- *Publish guides on effective cross-sector drought communication*

Establish a regional drought reporting working group within DEWS

- *Coordinate regional opportunities for impact report training*
- *Standardize sector-specific drought impact indicators*
- *Develop season-specific messaging about drought impacts for each sector*
- *Create a platform for sharing ongoing challenges and innovations*
- *Create a regional webinar series showcasing successful sector engagement*
- *Feature programs like Alabama Drought Reach and Project Nighthawk*
- *Highlight effective inter- and intra-state-level collaboration models*
- *Document and share best practices from across the region*

Conditions were so dry in Gibson County, Tennessee in early November, 2023, that stock ponds and creeks could not support livestock and water needed to be hauled in. Image from the National Drought Mitigation.

Opportunity: Improve Access to Disaggregated Agricultural Data

There is a clear need for more detailed agricultural data to support drought monitoring and response. While USDA NASS provides valuable information, access to disaggregated, county-level data would significantly improve monitoring capabilities. Recognizing the potential limitations around sharing sensitive data, and establishing a secure data-sharing pathway, would allow authorized users to access critical insights while maintaining confidentiality.

Action Items

Build partnerships between USDA NASS and Southeast climate offices

- *Develop formal data-sharing agreements that maintain confidentiality and protect personal information*
- *Create secure data access protocols for authorized state-level drought monitoring entities*
- *Establish regular data transfer processes that ensure timely availability of information*

Explore technological solutions for secure data sharing

- *Investigate secure platforms that could facilitate data sharing while protecting sensitive information*

- *Develop anonymization techniques that preserve the utility of the data while protecting individual privacy*

Engage extension agents and agricultural offices involved in NASS reporting to expand the network of stakeholders

- *Encourage these reporters to also submit observations to CMOR, a location-based, publicly available tool that can complement traditional datasets*

Opportunity: Encourage Citizen Impact Reporting

Citizen science and public reporting fill gaps in formal observation networks, raise awareness, and provide valuable on-the-ground perspectives. Timely updates, especially as conditions begin to dry, are critical. Early input helps drought monitoring entities identify which indicators best reflect emerging impacts, improving early warning capabilities. Regular reporting, even outside of drought, is just as important. Real-time updates help state drought monitoring entities detect subtle changes before they escalate, offering insight into when and where conditions begin to degrade. Agricultural impacts, in particular, often emerge first and can serve as early warning of more widespread challenges ahead. Many Southeast states already have drought impact reporting processes in place for the agricultural sector, but these systems can be improved and expanded to include other sectors and encourage more widespread, routine participation.[12]

There is no one-size-fits-all method for reporting. While tools like CMOR and CoCoRaHS are useful, many producers do not know these platforms exist. More communication and outreach are needed to raise awareness and provide clear guidance on how to report impacts. Others may prefer private channels of communication, like texting or emailing reports to extension agents and drought monitoring entities, over using public platforms. These reports remain valuable and should be integrated into USDM communications and statewide drought monitoring efforts.

Action Items

Develop and distribute a comprehensive "Drought Reporting Packet"

- *Compile existing communications materials about platforms like CMOR and CoCoRaHS*
- *Include alternative reporting options such as email, text, or direct communication with extension or state drought contacts*
- *Create new, user-friendly guides explaining how and where to report drought impacts, especially during early dry periods*

Distribute materials through multiple channels including state climate offices, extension offices, the National Weather Service, USDA Natural Resources Conservation Service, and community organizations

- *This also builds trusting relationships between various groups*

Create targeted communication resources

- *Develop guides on how to build and utilize relationships with champion partners such as extension offices or Forest Service personnel*
- *Produce materials explaining how impact data is used in the drought monitoring process to encourage participation*
- *Create educational content on conditions vs. impact reporting, emphasizing the importance of consistent reporting—even during non-drought periods—to better track onset and recovery*

Implement regular feedback mechanisms

- *Provide drought impact reporters with updates on how their data is being used*
- *Recognize active contributors to maintain engagement*
- *Share success stories of how citizen reports inform drought monitoring and response*

Opportunity: Strengthen Cross-State Information Sharing

While some states have developed effective drought monitoring and communication tools, there is an opportunity to standardize and share these resources across the Southeast region—an effort that NOAA NIDIS and the Southeast DEWS are well-positioned to support by leveraging their extensive network and convening power to facilitate cross-state collaboration and resource sharing.

Action Items

Create a regional repository of drought communication templates

- *Expand the use of North Carolina's drought update template to other states*
- *Develop adaptable materials that can be customized for local conditions*
- *Establish consistent regional messaging while allowing for state-specific details*

Implement regular cross-state learning sessions

- *Schedule quarterly virtual meetings to share innovations and challenges*
- *Rotate leadership among states to ensure diverse perspectives*
- *Document and distribute lessons learned and best practices*

Conclusion

The fall 2023 drought in the Southeast underscored valuable lessons about how drought behaves in this complex and often water-rich region. It revealed the importance of early and consistent impact reporting, the need for greater integration of sub-monthly and inter-monthly monitoring tools, and the value of strong relationships between drought monitoring entities and sector-specific stakeholders. The event also demonstrated how collaborative frameworks like the Southeast DEWS and innovative state-led programs can drive more responsive and informed drought management.

While the region has made significant progress in building capacity and improving coordination, challenges remain, particularly in monitoring drought in a rapidly shifting hydrologic cycle, closing observational data gaps, bolstering impact reports, and communicating risk in a region where water scarcity often seems counterintuitive.

The 2023 drought serves as a crucial reminder that effective drought management requires treating drought as a persistent challenge rather than an occasional crisis, necessitating proactive preparation, robust monitoring networks, and strong partnerships to minimize impacts and build lasting resilience across the Southeast.

Some producers prepared irrigation equipment in late July 2023 as conditions rapidly started to dry in many areas. For many, irrigation is the only immediate relief during drought; however, access across the Southeast is limited and varying compared to other regions of the country. Image from Brianne Minton, Alabama Cooperative Extension.

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