Water, Drought, and Resource Planning

NARUC Summer Policy Summit

San Diego, July 19, 2022

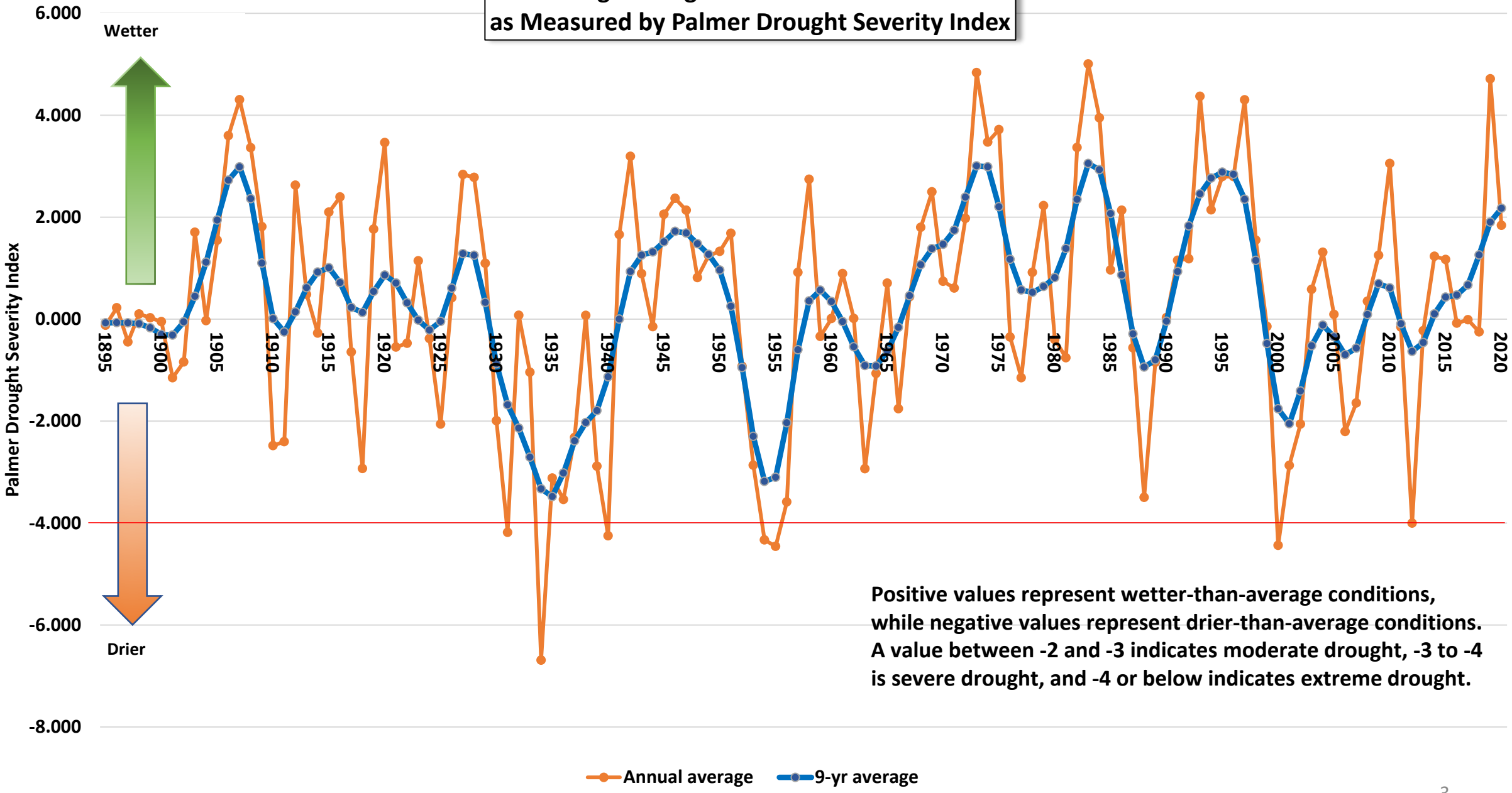
Public Service Commission of South Carolina

Drought

"**Drought is the most economically expensive recurring natural disaster to strike North America in modern time.**" (Celine Herweijer, et al, 2007)

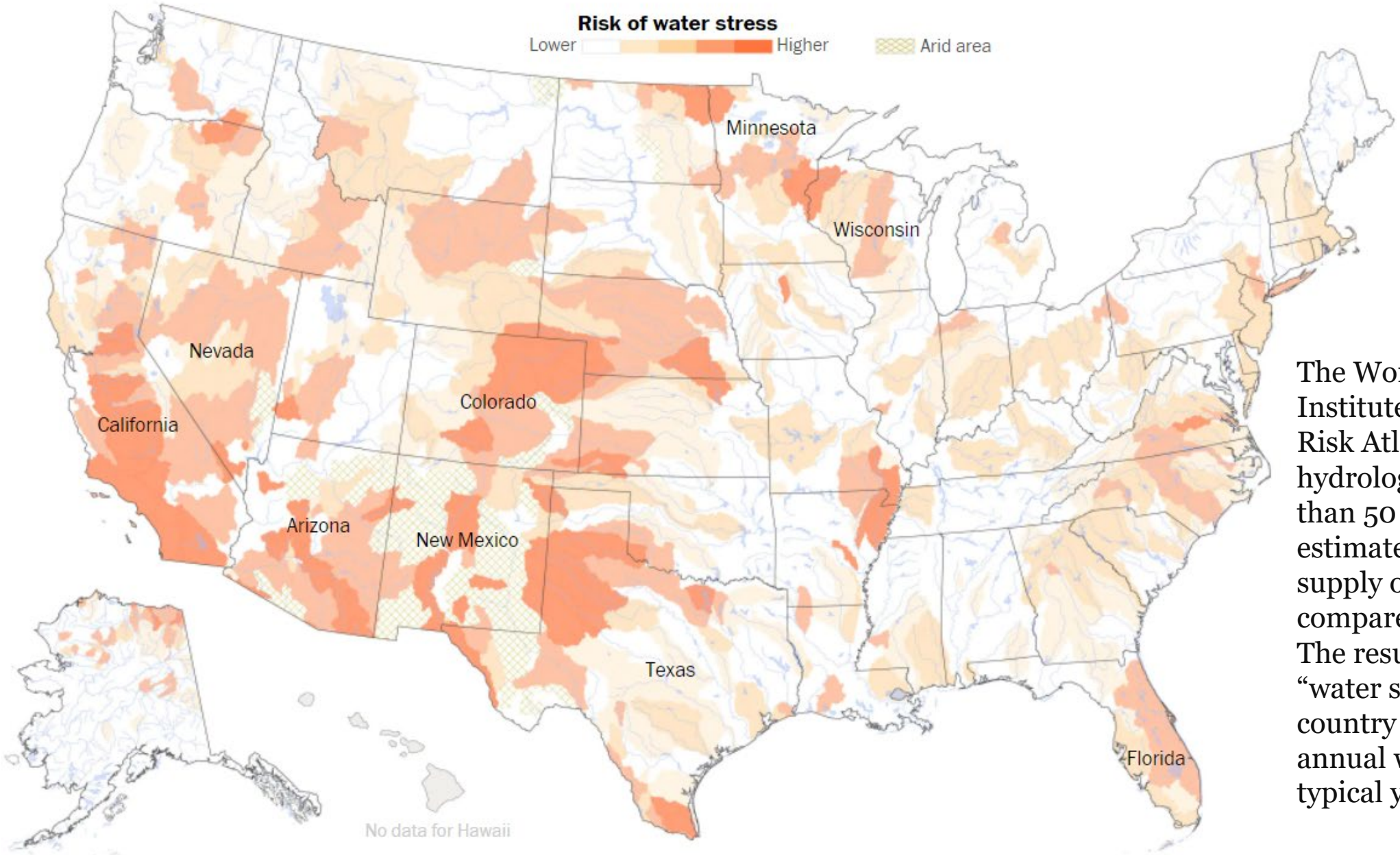
"**Droughts represent some of the most disruptive natural disasters in North America, and the impacts of historical…and more recent…events have been well documented.**" (Benjamin I. Cook, et al., 2015)

Average Drought Conditions in the U.S. as Measured by Palmer Drought Severity Index



Positive values represent wetter-than-average conditions, while negative values represent drier-than-average conditions. A value between -2 and -3 indicates moderate drought, -3 to -4 is severe drought, and -4 or below indicates extreme drought.

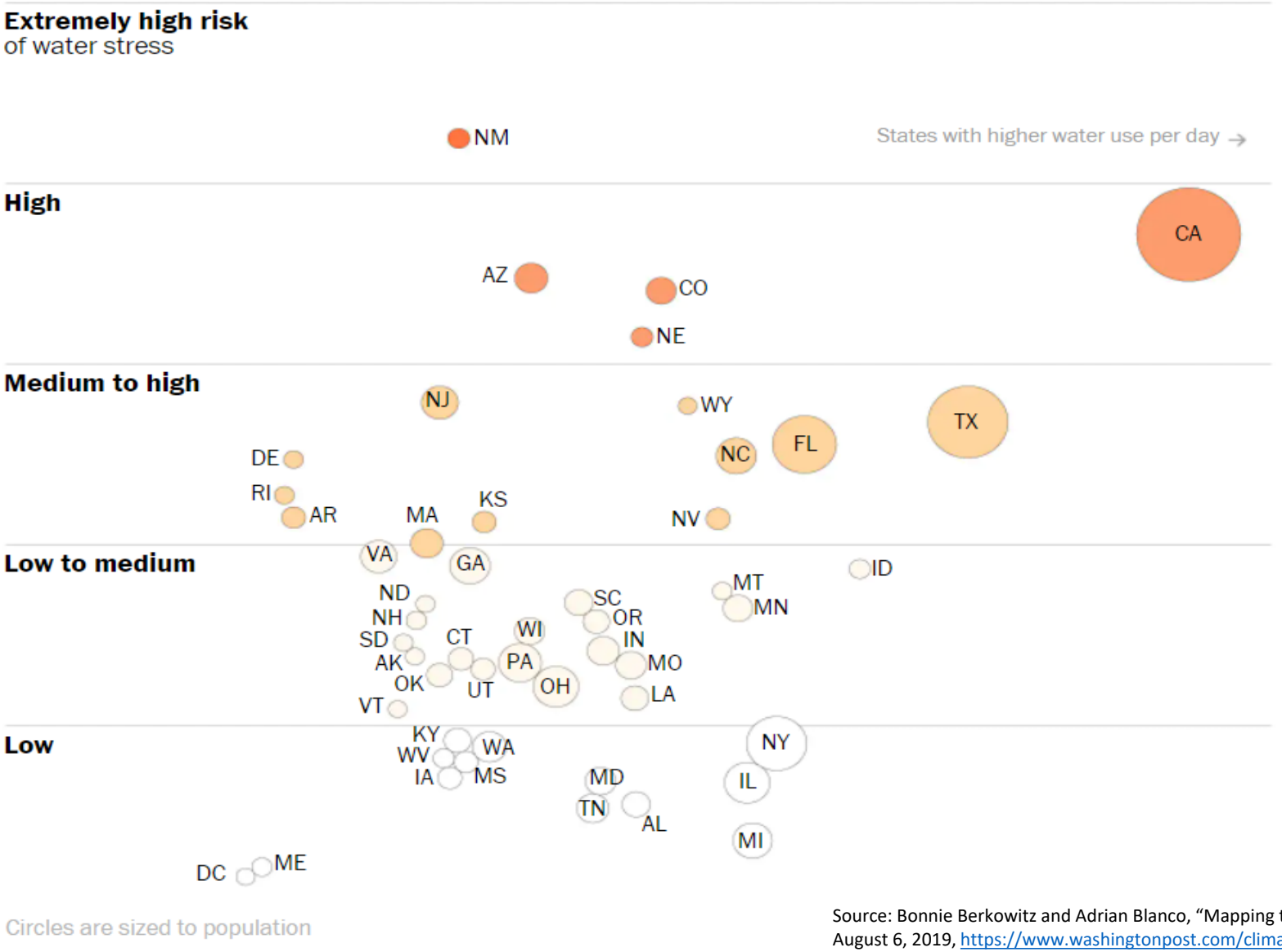
Source: "Climate Change Indicators," EPA, https://www.epa.gov/climate-indicators/climate-change-indicators-drought#ref7.



The World Resource Institute's Aqueduct Water Risk Atlas researchers used hydrological models and more than 50 years of data **to** estimate the typical water supply of 189 countries compared to their demand. The result was a scale of "water stress" — how close a country comes to draining its annual water stores in a typical year.

Source: Bonnie Berkowitz and Adrian Blanco, "Mapping the Strain on Our Water," Washington Post, August 6, 2019, https://www.washingtonpost.com/climate-environment/2019/08/06/mapping-strain-our-water/.

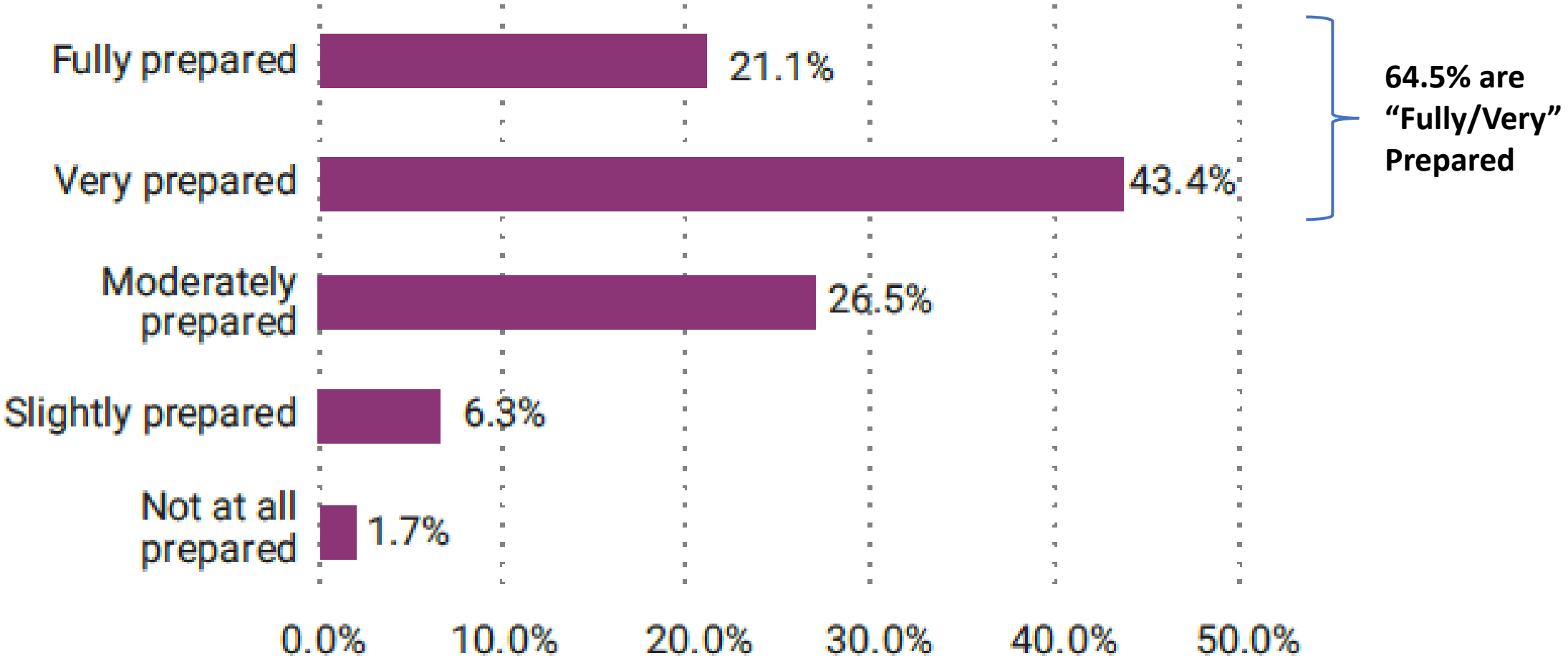
Risk of Water Stress by State



The United States ranked 71st of 189 countries, and low-medium on the stress scale, which means that we are pulling less than 20 percent of our available water.

Source: Bonnie Berkowitz and Adrian Blanco, "Mapping the Strain on Our Water," Washington Post, August 6, 2019, https://www.washingtonpost.com/climate-environment/2019/08/06/mapping-strain-our-water/.

Utility Ability to Meet L-T Water Supply Needs



Current Climate Models

- **Some climate models through 2099 show GHGs increasing through 2050 and decreasing gradually afterward.**
- **Model results on projected changes in precipitation and surface water show progressive drying in the sub-tropical latitudes, especially over southern North America and the Mediterranean region of the Northern Hemisphere.**
  - **Models indicate a transition to a more arid climate in the U.S. Southwest – "the 21st Century Drought."**
- **"As many large-scale droughts tend to be, it is a spatially complex pattern that can change rapidly from year to year."**

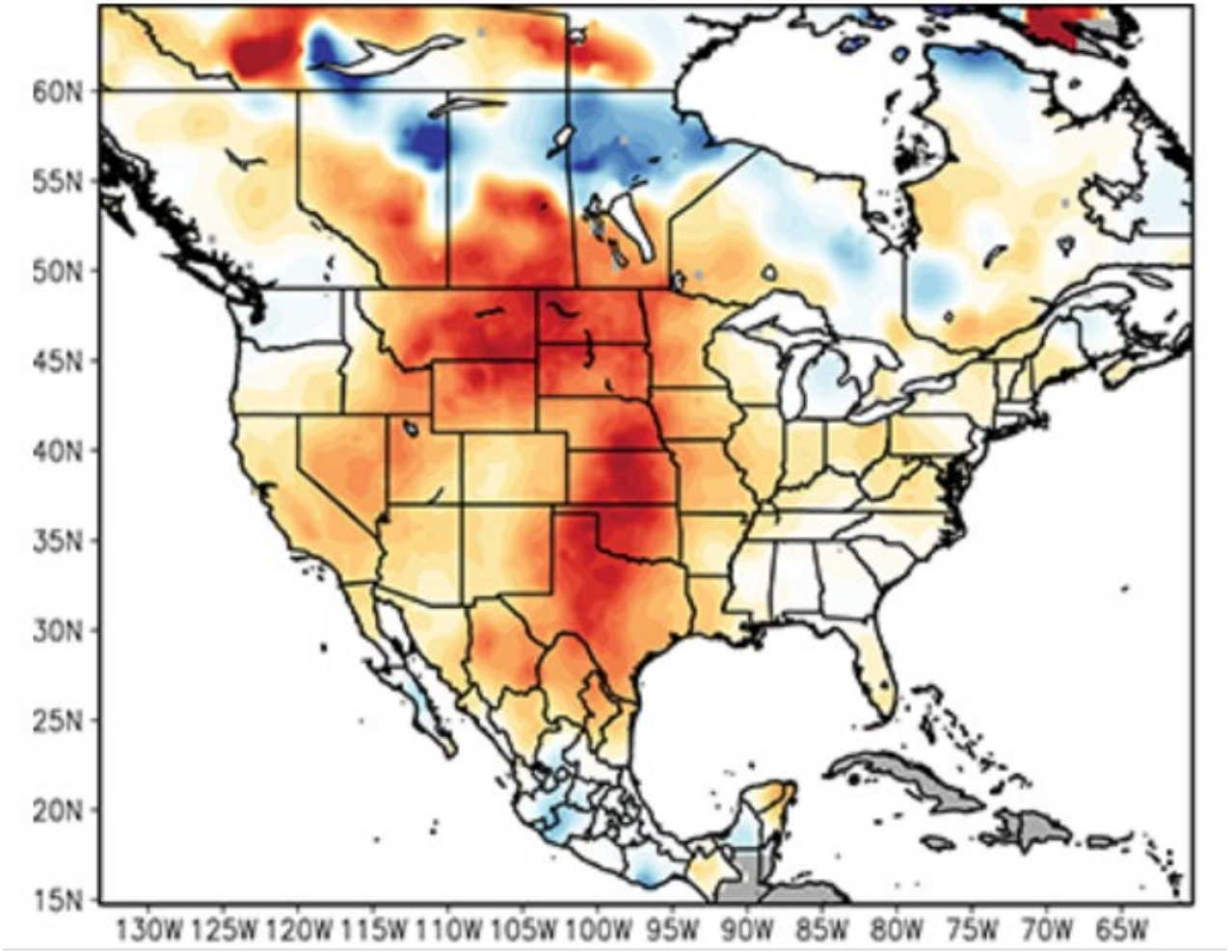
Source: Edward R. Cook, et.al., "Megadroughts in North America: Placing IPCC Projections of Hydroclimatic Change in a 2 Long-Term Paleoclimate Context," Journal of Quaternary Science, December 2009, pp. 48-61.

21st Century Drought: How Does It Compare?

- **Researchers tallied for each year the number of grid points of summer PDSI that exceeded a drought threshold of PDSI<-1.0 (incipient or more severe drought) and expressed them as a percentage of the total number of grid points to produce a Drought Area Index (DAI).**
  - **2002: DAI = 59%**
  - **1934 (Dust Bowl): DAI = 77%**
  - **1954 (Great Plains/Southwest Drought): DAI = 62%**
- **Conclusion: The 21st Century Drought "is not unprecedented."**
- **"There is abundant evidence now that some droughts in North America prior to the 20th century were remarkably more severe compared to anything we have experienced since that time."**

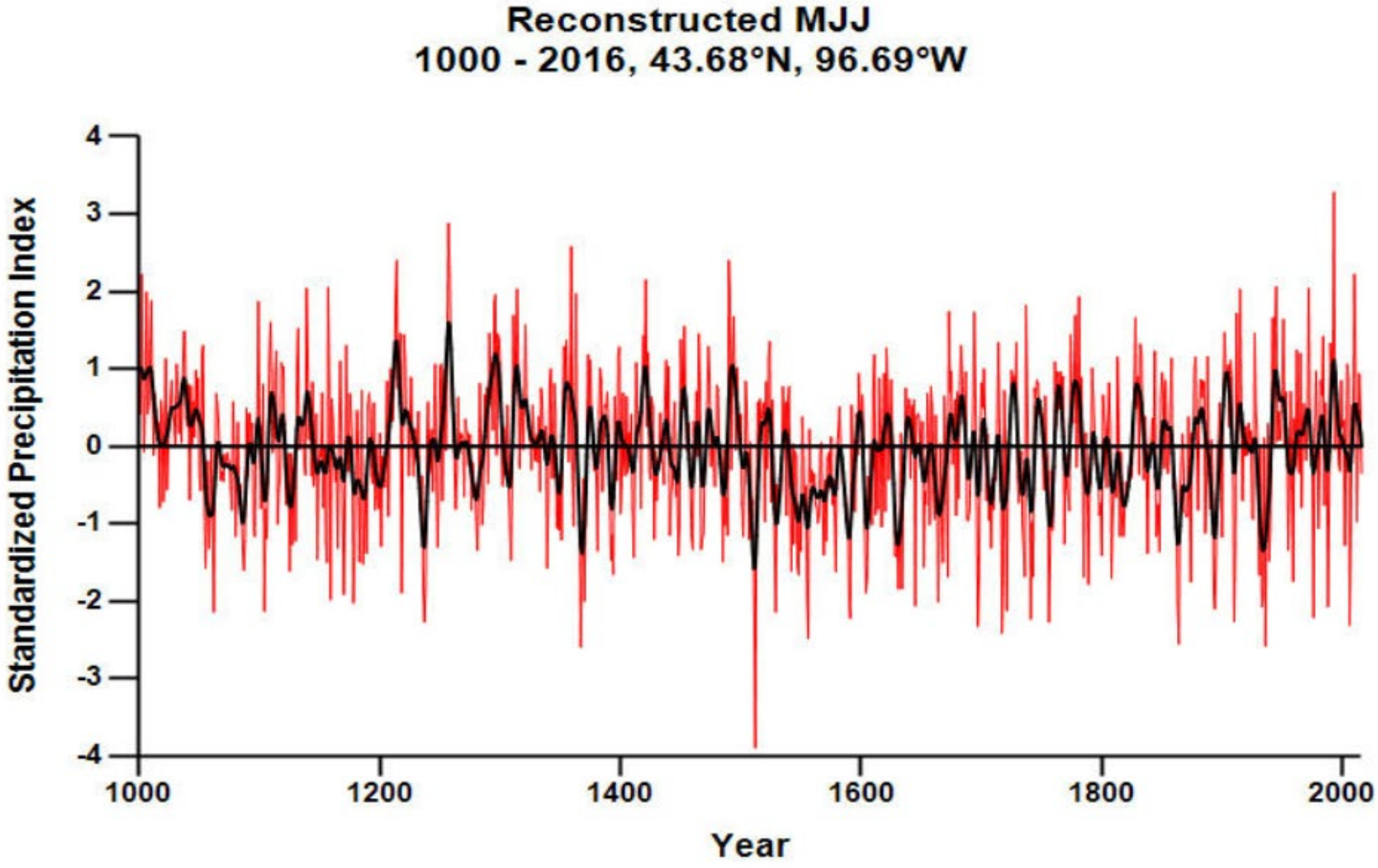
Source: Edward R. Cook, et.al., "Megadroughts in North America: Placing IPCC Projections of Hydroclimatic Change in a 2 Long-Term Paleoclimate Context," Journal of Quaternary Science, December 2009, pp. 48-61.

North American Drought Atlas



Pre-19th Century: If Trees Could Talk…

Reconstructed May-June-July Precipitation for 1000 to 2016 in South Dakota Using Tree Rings



Tree ring-reconstructed warm season precipitation for the closest NASDA grid point to USGS Earth Resources Observation and Science (EROS) Center in South Dakota (red line). The time series spans AD 1000-2016 with a 10-year smoothing function (black line) applied to emphasize decadal variability.

Source: "Tree Ring Time Series Precipitation Data, U.S. Geological Survey, https://www.usgs.gov/media/images/tree-ring-time-series-precipitation-data.

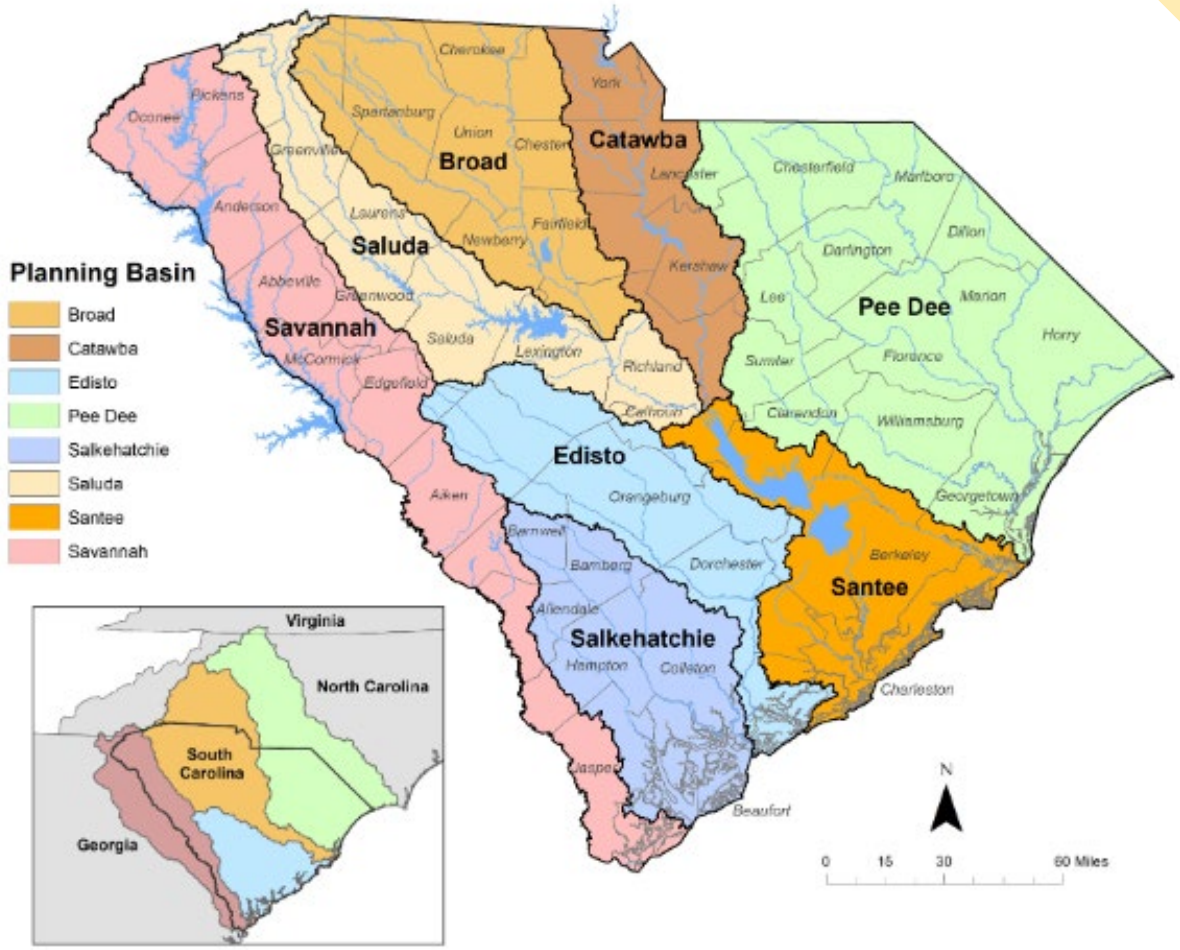
Megadroughts

- **Recent development of a grid of summer Palmer Drought Severity Index (PDSI) values across much of North America reconstructed from tree-ring data provide much insight into historical and more recent droughts.**
- **Researchers have been able to compare more famous recent droughts with reconstructed droughts over the past 1,000 years.**
- **"What becomes apparent is that the famous droughts of the instrumental era are dwarfed by the successive occurrence of multi-decade-long 'megadroughts' in the period of elevated aridity between the eleventh and fourteenth centuries A.D."**
- **1,000 year-long gridded reconstruction of North American droughts reveals "unequivocal evidence" of successive megadroughts similar in severity to more famous modern droughts, but the historical megadroughts were exceptional in their duration.**

(Source: Celine Herweijer, et al, "Gridded Network Of Tree-ring Data", American Meteorological Society, Vol 20, 1353-1376**)**

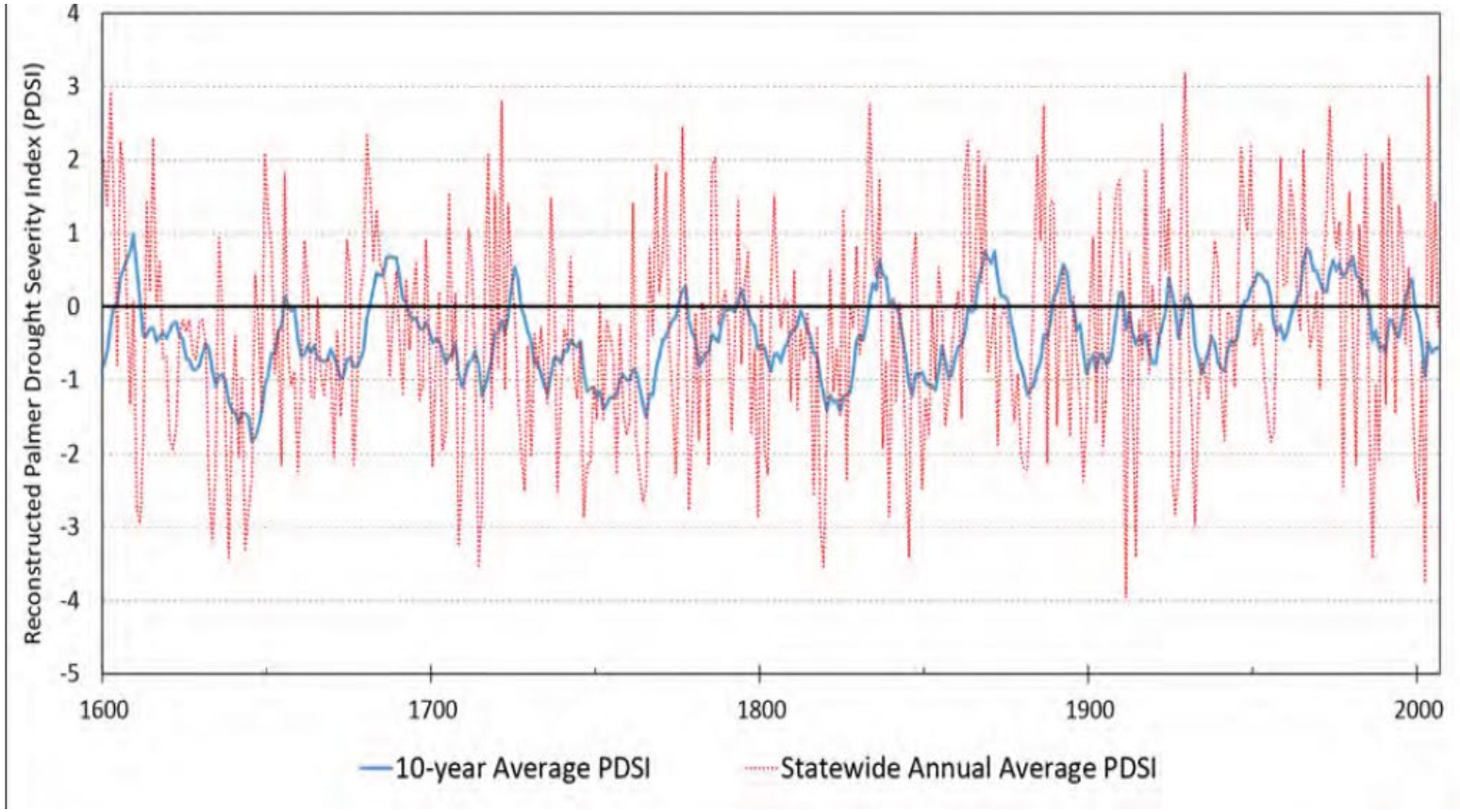
Current Water Resource Planning Approach

- Typically, utilities manage water based on observations of the recent past, typically the past 50-100 years.
- Example: Current water basin modeling in S.C. uses data from 1925 to 2019, 94 years of data.
  - Planning horizon for most recent (2019) S.C. water plan is 50 years for each of 8 water basins.



Dendroclimatology and South Carolina Droughts

Dendroclimatology—the science of analyzing tree ring growth to characterize past climate conditions—suggests the droughts experienced in South Carolina during the instrumental period of record (approximately the last 100 years) may have been *less severe and of shorter duration* than droughts which occurred in the previous four to five centuries.



Source: South Carolina State Water Planning Framework, South Carolina Department of Natural Resources, October 2019, p. 11.

What Planning Horizon Should We Use?

"…Utilities may need to recalibrate their definition of averages and extremes, as they look deeper into the scientific record to reveal how hydrological flows have varied over thousands of years."

Source: The Ripple Effect: Water Risk in the Municipal Bond Market – Sharlene Leurig, PriceWaterHouse Coopers for Ceres Water Asset Management.

Top 10 Issues Facing Water Sector (2017-2021)

2021	Change	2020	2019	2018	2017
Renewal and replacement of aging water and wastewater	↔	Renewal and replacement of aging water and wastewater	Renewal and replacement of aging water and wastewater	Renewal and replacement of aging water and wastewater	Renewal and replacement of aging water and wastewater
Financing for capital improvements	↔	Financing for capital improvements	Financing for capital improvements	Financing for capital improvements	Financing for capital improvements
Long-term water supply availability	↔	Long-term water supply availability	Long-term water supply availability	Public understanding of the value of water systems and services	Long-term water supply availability
Emergency preparedness	↑	Public understanding of the value of water systems and services	Public understanding of the value of water systems and services	Long-term water supply availability	Public understanding of the value of water systems and services
Public understanding of the value of water systems and services	↓	Watershed/source water protection	Watershed/source water protection	Public understanding of the value of water resources	Public understanding of the value of water resources
Watershed/source water protection	↓	Public understanding of the value of water resources	Public understanding of the value of water resources	Watershed/source water protection	Watershed/source water protection
Public understanding of the value of water resources	↓	Aging workforce/ anticipated retirements	Groundwater management and overuse	Aging workforce/ anticipated retirements	Emergency preparedness
Aging workforce/ anticipated retirements	↓	Emergency preparedness	Aging workforce/ anticipated retirements	Public acceptance of future W/WW rate increases	Cost recovery (pricing water to accurately reflect the cost of service)
Compliance with current regulations	↔	Compliance with current regulations	Emergency preparedness	Emergency preparedness	Public acceptance of future W/WW rate increases
Groundwater management and overuse	↔	Groundwater management and overuse	Cost recovery (pricing water to accurately reflect the cost of service)	Governing Board acceptance of future W/WW rate increases	Water conservation/ water use efficiency

W/WW—water/wastewater

American Water Works Association

Question

- **How should water utility managers plan for the future to ensure long-term water supply availability?**