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DROUGHT PLANNING IN TEXAS

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Goals

For over a century, weather events have become more extreme, turning normal fluctuations into long-term climate trends. Extreme heat, wildfires, drought, inland and coastal flooding threaten different regions in the U.S. in different ways, but all are increasing. Texas is one of the largest U.S. states by area, population, agricultural production and energy consumption. It is situated in south central U.S. with a largest coast facing the Gulf of Mexico. Because Texas is so large, it has varying climatic conditions across the state. In general, the eastern part of the state receives more precipitation compared to the western portion. However, the state as a whole is susceptible to drought and has experienced several major droughts since recorded drought history. The following report will be brief overview of how major drought events have affected the state and how the state uses these past drought events to plan for future drought conditions using drought contingency plans.

Additionally, this report briefly describes how drought and extreme heat impact the power sector. The power sector in Texas is unique from the rest of the United States. While the electric grid in other states are interconnected, Texas is completely separated from other states. This means that when Texas power generators can't meet demand, the state does not have the ability to import electricity from surround states.

Introduction

Texas is one of the states most exposed to extreme heat, drought and wildfire (Schiller, 2015). If you like myself born in the late 1980's, then during our life time Texas has experienced drought conditions for over half of our lifetime. The figure below illustrates the states that are most threated by drought conditions. The lighter colors represent states that are least threaten by drought and the darker colors represent states that are more threatened by drought conditions. Several states such as Nevada, Montana, Iowa and Arkansas are shown to be more threatened, nevertheless Texas's D rating shows that the state will face drought conditions in years to come.

Furthermore, figure 2 illustrates the states that a least prepared to deal with the climatic changes that the states are expected to endure based on the climate change models. The preparedness map shows that Texas is one of the most unprepared US states able to deal with the climate changes that it will face. A possible recent example was shown during Hurricane Harvey and other recent storms. These natural disasters were considered 100-year storms have been more frequent. Failing to prepare today will only increase response and recovery costs tomorrow. The floods that ravaged Houston left behind billions of dollars in damage. Similar to these storms, droughts cost billions of dollars and are becoming more frequent, requiring proper planning in order to mitigate its impacts.

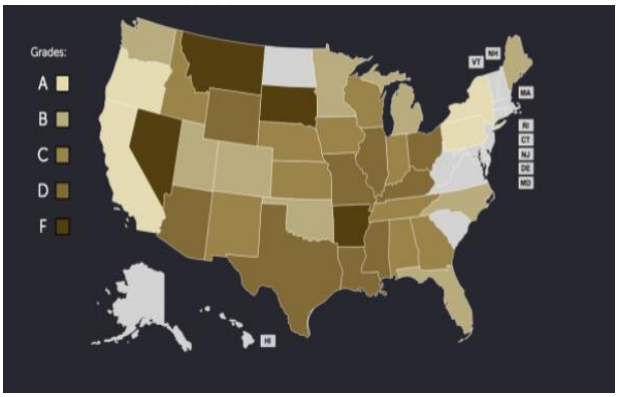

Figure 1 States Threatened by Drought

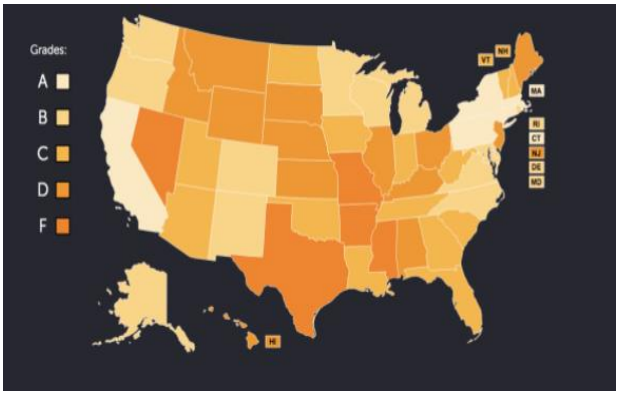

Figure 2: State Preparedness

Drought Severity

Before further discussing droughts and drought planning, it is important to understand the levels of drought and how they are represented on maps/graphs. The chart below is used nationwide to indicate graphically the levels of drought conditions. Illustrated in bright yellow, category D0 drought is the least intense condition and it represents abnormally dry conditions that an area may be facing. Abnormally dry conditions suggest that an area is about to go into a drought or that it is slowly on the path to recovery from a more intense drought event.

The drought intensity increases as the category goes from D0 to D1, this is a moderate drought. Moderate drought indicates that there may be some measurable damage or impacts associated with the lack of rainfall and the temperature. Clear indication of a moderate drought includes some damage to crops and water resources are low providing evidence that a shortage may likely occur. It is requested during this time that the water supply entity suggest voluntary water use reductions to its connections.

The third level of ongoing drought (D2) causes water shortages and crop losses are more evident, mandatory water restrictions are likely to be imposed. The type of restrictions and water reduction targets vary from water supply entities. Extreme drought and exceptional drought conditions are referred to D3 and D4, respectively. The impacts of a drought increase in conjunction with the drought category and affect agricultural productivity and water availability. Similarly, as a drought condition intensify so do the water restrictions.

Category	Description	Possible Impacts
D0	Abnormally Dry	Going into drought: ▪ short-term dryness slowing planting, growth of crops or pastures Coming out of drought: ▪ some lingering water deficits ▪ pastures or crops not fully recovered
D1	Moderate Drought	▪ Some damage to crops, pastures ▪ Streams, reservoirs, or wells low, some water shortages developing or imminent ▪ Voluntary water-use restrictions requested
D2	Severe Drought	▪ Crop or pasture losses likely ▪ Water shortages common ▪ Water restrictions imposed
D3	Extreme Drought	▪ Major crop/pasture losses ▪ Widespread water shortages or restrictions
D4	Exceptional Drought	▪ Exceptional and widespread crop/pasture losses ▪ Shortages of water in reservoirs, streams, and wells creating water emergencies

Figure 3: Drought Severity Levels

Current Conditions: Texas

Below in Figure 4, the drought map of Texas that I used during the oral presentation of this report in class. During this time scattered portion of the state showed abnormal dryness occurring mainly in the east and west portion of the state. Abnormal dry conditions were affecting approximately 9,177,000 people (36% of the population) in state. Areas such as Bowie and Cass Morris County were experiencing moderate drought conditions. Small portions of the state in Jim Hogg County were considered to be under severe drought conditions, but this only affect about 2,000 (less than .1% of the state's population) (Tinker, 2017). Figure 5 shows the percentage of Texas that is affect by each drought condition.

Much of the state was covered by some type of drought condition up until 2015 in which conditions drastically improved during the summer-fall of 2015, as illustrated in figure 5. This graph also brings forth that severe drought conditions covered between 30% to 60% of the state from 2013 to 2015. Extreme drought conditions covered approximately 25% of the state during this time and exceptional drought conditions while small did persist.

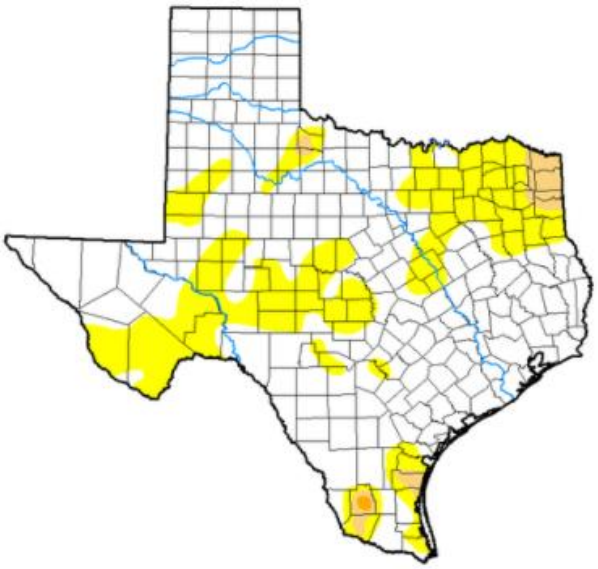

Figure 4: Texas Drought Map

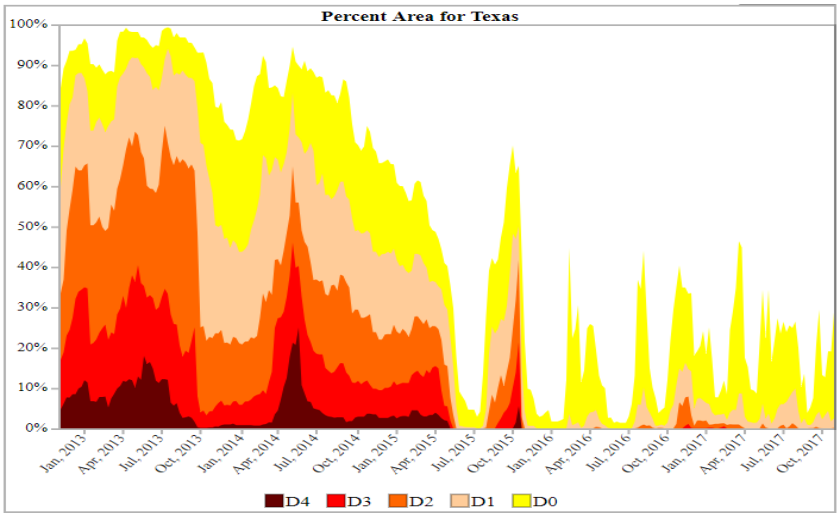

Figure 5: Percent Area for Texas

As this written less than a week after the presentation, changes in the drought conditions for Texas are already evidently increasing. As you can see from figure 6 below abnormal dryness across the east and west part of the state have spread to the center of the state. Additionally areas that were previoulsy covered in the bright yellow representing abnormal dryness have become beige representing moderate drought conditions. If drought condtions continue intensify at this rate, it wont be long before severe drought (orange) conditions cover more of the state. Abnormal dryness or drought are currently affecting approximately 13,502,000 people in Texas,

which is about 51% of the state's population (Tinker, 2017).

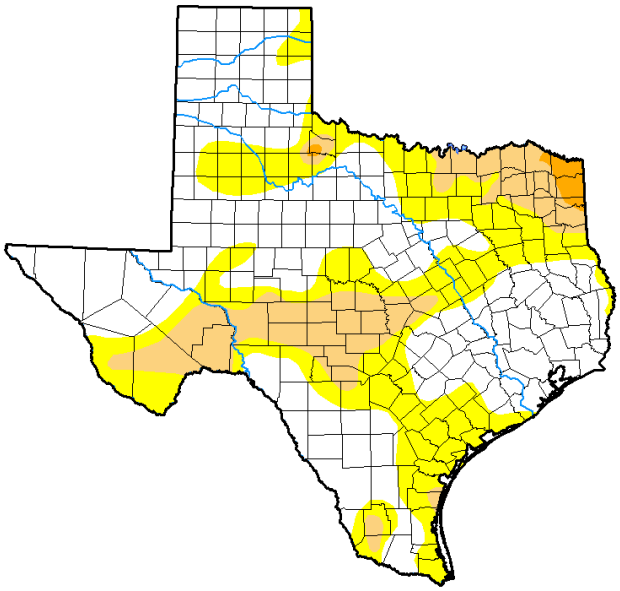

Figure 6: Updated Texas Drought Map 11/14/2017

Current Conditions: Utah

Althought my research focuses on Texas, I wanted to include a bit comparing Utah to Texas because they were a part of our learning experience in this class and in my research I learned even more about Utah and its drought conditions. Salt Lake City Utah is the 5th drought riskiest metro area in the country (Places, 2017). Similar to Texas, during the past three years most of Utah has experienced abnormally dry to extreme drought conditions.

However, we can see fom the illustrations below that although the droughts in Utah have not been as severe as those in Texas in the past 3 years, it has covered a greater portion of the state. Heavy summer rainfall, which increases reservoir levels for the fall and winter months, have helped mitigate drought conditions. Despite this abnormal dryness or drought are currently affecting approximately 1,117,000 people in Utah, which is about 39% of Utah's population (Stebbins, 2015).

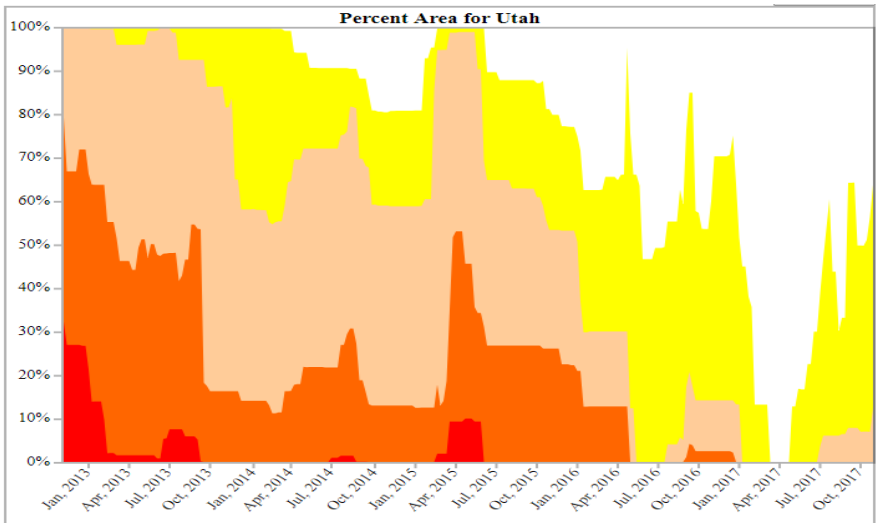

Figure 7: Percent Area for Utah

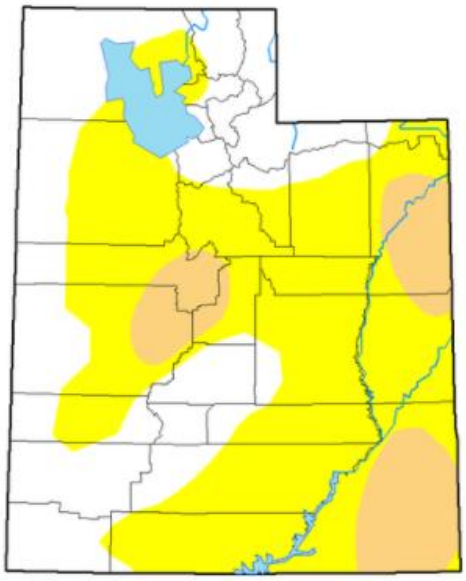

Figure 8: Current Utah Drought Map

Regional Water Planning Areas

Since 1957, the Texas Water Development Board (TWDB) has been charged with preparing a comprehensive and flexible long-term plan for the development, conservation, and management of the State's water resources. The current state water plan was produced by the TWDB and based on approved regional water plans. The purpose of the regional water planning is to provide for the orderly development, management, and conservation of water resources and preparation for and response to drought conditions in order that sufficient water will be available at a reasonable cost to ensure public health, safety, and welfare; further economic development; and protect the agricultural and natural resources of that particular region (2016 Approved Regional Water Plans, 2017). The TWDB divided the state into 16 planning regions and appointed members to the regional planning groups. The 16 regions are labeled and referred by

letters A-P, Austin fall within region K also known as the Lower Colorado, these regions are illustrated in figure 9.

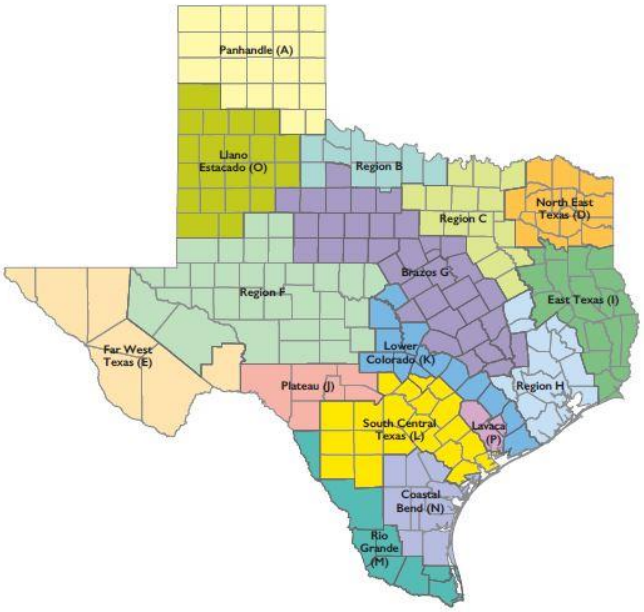

Figure 9: Texas Regional Water Planning

One of the best tools in drought preparedness is an understanding of the drought of record (DOR), or the worst drought to occur for a particular area. Regional planning focuses on the hydrological drought or the drought with the largest shortfalls on surface and/or subsurface water supply. The frequency and severity of hydrological drought is often defined on a watershed or river basin scale.

Drought of Record

Historically, for much of Texas planning the drought of record occurred from 1950 to 1957. During the 1950s drought, many wells, springs, streams, and rivers went dry and some cities had to rely on water trucked in from other areas to meet drinking water demands. By the end of 1956, 244 of the 254 Texas counties were classified as disaster areas by President Eisenhower (Timeline of Droughts in Texas, n.d.). This historic drought forced so many Texans to move that it permanently transformed Texas from a rural to a more urban state. The drought ended in 1957 with downpours that resulted in major flooding, several were killed, and hundreds of homes were destroyed (HENRY, A History of Drought and Extreme Weather in Texas, 2011).

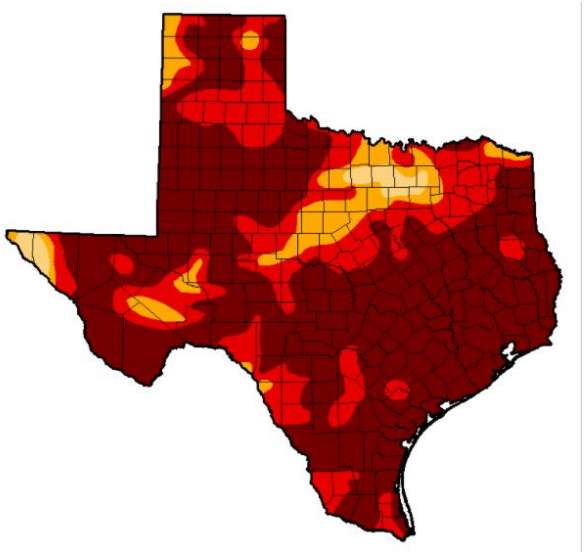

Figure 10: Texas 2011 Drought Map

Many of the planning regions are switching their drought of record from the 1950's drought to the driest year in Texas climate recorded history, the recent 2011 drought. This drought began in late 2010, Rainfall averaged eleven inches, making it the driest year in Texas history. Agricultural losses are estimated at more than $5.2 billion. The map of Texas above is a drought map of Texas from the 2011. While some areas faced severe to extreme drought conditions, over 70% of Texas was facing exceptional drought conditions.

Planning region A (Panhandle area) used the 2011 drought as their drought for the most recent approved 2016 Regional Water Plan to the Texas Water Development Board. Lake Meredith which is located within this region recorded the lowest historical inflow at approximately 6,300 acre-feet. The figure below indicates that Lake Meredith was considered a dead pool between 2011 and 2015 (Drought in Texas, 2015).

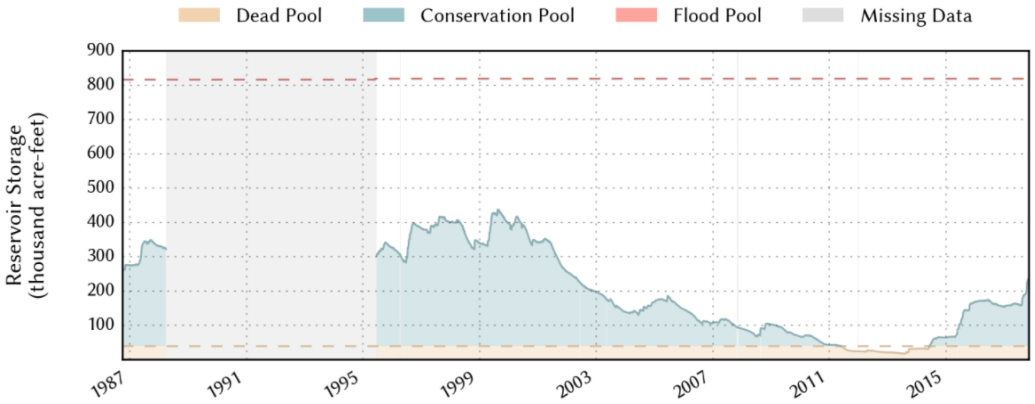

Figure 11: Lake Meredith Reservoir Level

Drought Contingency Planning

After the 2011 drought TCEQ required all wholesale and retail public water suppliers serving 3,300 connections or more, and irrigation districts to submit drought contingency plans (DCP). A drought contingency plan is a combination of strategies that are update every 5 years for temporary supply and demand management responses to water shortages. The philosophy of drought contingency planning is that: While often unpreventable, short-term water shortages can be anticipated. The potential risks and impacts of drought can be evaluated in advance and Response measures can be determined with defined implementation to minimize the impacts of drought (Texas Commission on Environmental Quality, 2017).

Below is an example of the Public Water Supply watch list which is a database containing public water systems that are experiencing drought-related water supply problems and have mandated water restrictions using trigger points contained in their Drought Contingency Plans. Initial responses to drought (or stage 1 responses) are usually voluntary water reduction (labeled in yellow) while stage 2 and beyond often call for mandatory reductions/ water restrictions (marked in orange).

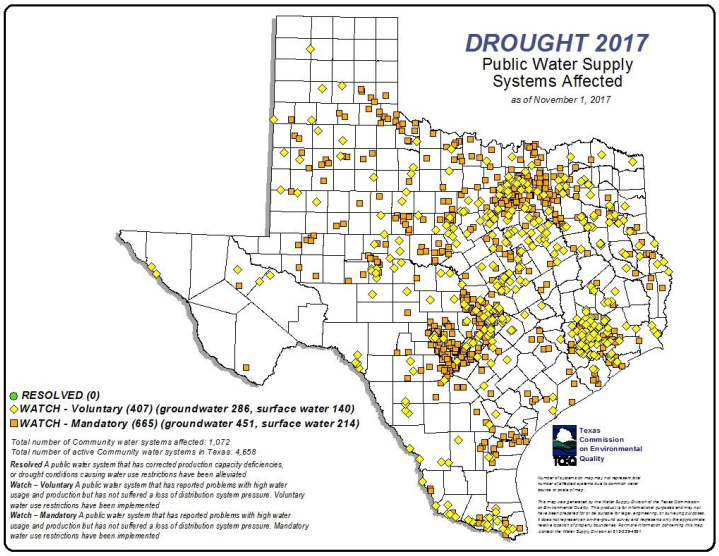

Figure 12: Public Water Supply Watch List

While the approach to planning may be different between entities all DCPs should include targets for water use reductions, drought response stages, triggers to begin and end each stage, supply management measures, demand management measures and descriptions of drought indicators. However, no drought plans are alike, which makes it difficult to organize and structure them for research. Current research in this area is underway to analyze these drought contingency plans in order to summarize and provide an overview of how Texas will respond to the next drought and where progress can be made.

Drought Impacts on Power

Texas is not only one of the most water intensive states, but it is also the one of the most energy intensive. Power plants require water for their cooling towers which they receive from nearby lakes or rivers. Approximately 5-7% of Texas's the total water demand goes towards steam-electric generation. During the 2011 drought demand for electricity was at an all-time high because of the heat, and the water needed to cool the coal, nuclear and gas power plants was in short supply (Faeth, 2013). In some places, there was too little water available and in others the available water was too hot to provide thermal cooling. Because of this in the summer of 2011, Texans were warned of potential rolling blackouts. This scatterplot shows that that not only was there below average rainfall, but the average temperatures were also above normal in 2011, which is lead to power plants having water scarcity issues.

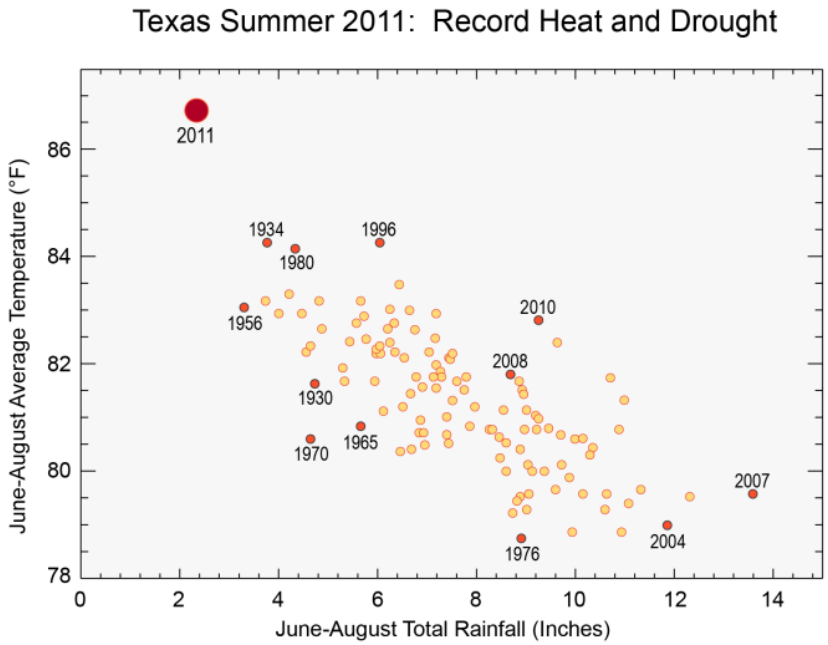

Figure 13: Texas Summer 2011 Scatter Plot

This map I made on ArcOnline shows the severity of drought conditions between June & September of 2011 across Texas. Overlaid are the 16 regional water planning areas, the dots are the states coal, gas and nuclear power plants. From this map you can notice that most power plants except for the those in regions C&D were in areas facing at least exceptional drought conditions.

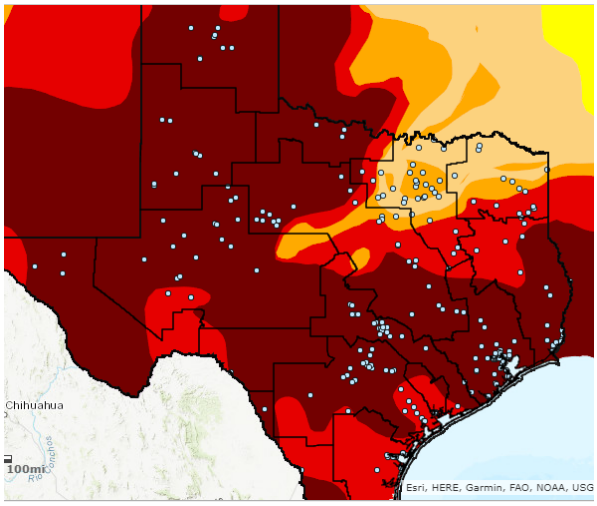

Figure 14: Power Plants During 2011 Drought

In the end, ERCOT met demand without blackouts (HENRY, ERCOT: So, About that Chance of Rolling Blackouts…, 2012). To keep its power plants operating, the state was forced to take water away from farmers and ranchers who held senior water rights. A key factor in keeping the power flowing during the drought was that Texas had been aggressively developing wind power. Texas generates more power from the wind than any other state. During the summer of 2011, about 10 percent of the electricity Texans needed came from wind, as much as 18 percent on some days. If the contribution from wind had come from coal plants instead, blackouts probably could not have been avoided.

Conclusion

In the future, climate change will exacerbate the issues in this region so average temperatures are expected to rise and increase surface water evaporation (Wilder, 2014). For drought contingency plans, it may be wise to implement more mandatory water restrictions in earlier stages of drought conditions. This would help conserve necessary water before drought conditions get worse. Implementing restrictions early would also bring a greater awareness of the water issues Texas may be facing, helping people adjust water consumption behavior.

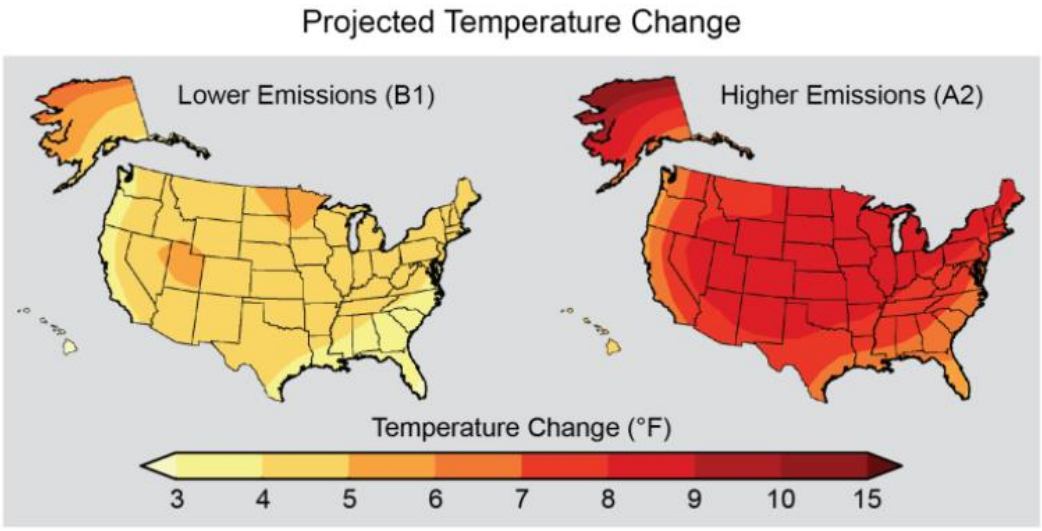

Figure 15: Projected Temperature Change

Future water planning efforts will require new sources of water supply. Texas gets more than 70% of its drinking water from surface water supplies. In general groundwater is less impacted by climate change and dry conditions than surface water. Regions will need to focus utilizing groundwater supplies before and during critical drought conditions. Additionally, although power plants only use a 7% of the total water demand. During critical times that water can be better used for drinking water. Furthermore, if plants used water reuse or brackish water they wouldn't have trouble cooing their towers during times of extreme heat conditions.

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