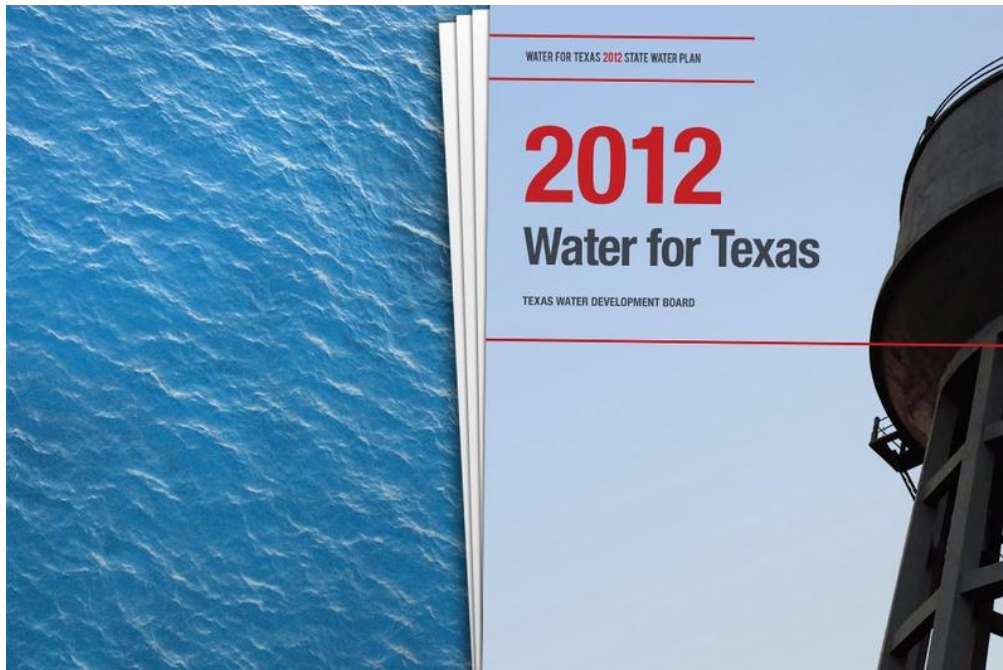


The 2012 Texas State Water Plan: *A Citizen's View*



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Project Overview

The Texas State Water Plan provides a comprehensive assessment of the state's current water resources and demands as well as projections for how these figures will change over the next 50 years. Additionally, the Plan details hundreds of strategies for increasing water supply that are designed to meet the state's growing water needs over that same timeframe. However, the majority of the data included in the Plan is not presented spatially, and thus is not easily interpreted in terms of its distribution across the state. For example, areas where demand or need is concentrated are not easily identifiable. Thus, the current project is an effort to create a link between data presented in the 2012 State Water Plan and its distribution across the state, making it more meaningful to the average Texan.

Background

As a part of its mission, the Texas Water Development Board (TWDB) is charged with "the conservation and responsible development of water for Texas".¹ The agency's primary planning tool for achieving this end is the State Water Plan, a report that has been produced nine times since 1961 and was most recently issued earlier this year. The Plan is developed using a "bottom-up" methodology whereby local stakeholders contribute to the development of regional water plans, and these 16 distinct regional plans are then combined to form the final State Water Plan.² The document that emerges is a 300-page summary of the state's current water circumstances, both in terms of needs and availability; the state's projected circumstances in terms of population growth, water needs and water availability; and the strategies and projects that are proposed to meet future needs.

Though the 2012 Texas State Water Plan presents a thorough and comprehensive analysis of water in Texas, individuals unfamiliar with water policy and planning cannot easily relate the information contained in the document to their own lives. This is largely due to the fact that, once aggregated to the state level, data contained in the plan lose any spatial connection to the regions that have generated them. Thus, though Plan graphs and figures demonstrate statewide trends in unmet needs, plan costs, and other variables over the next 50 years, plan consumers have no way of knowing to what extent their regions of Texas will be affected by these shifts unless they spend time sifting through their regions' water plans and analyzing the figures they contain.

Additionally, the length and level of detail contained in the Plan can be off-putting to the average citizen, particularly given the current dominance of graphics and short sound-bytes in media. The Plan contains dozens of figures, but few link Plan data to the state's geography other than to show the location of features such as aquifers or regional water planning groups. This project aims to address the spatial disconnect

¹ About Texas Water Development Board, accessed October 2, 2012, <http://www.twdb.texas.gov/about/>.

² State Water Planning, accessed November 20, 2012, <http://www.twdb.texas.gov/waterplanning/swp/index.asp>.

between State Water Plan data and Texas geography and to increase the Plan's accessibility to the average Texan by highlighting key data through the use of maps.

Methodology

Data for the current project were provided directly by the Texas Water Development Board (TWDB). Figures provided include demand, need, existing water supplies, supplies from implementation of water plan strategies, and water source type. TWDB data included 2010 figures as well as projections for each decade from 2020 through 2060 and were organized by water user group.³

Each Texas county contains numerous water user groups, so data were first aggregated at the county level, as this is the preferred geographic unit for the current project. Data were then organized alphabetically by county and then by decade to achieve the format required for use with ArcGIS's Time Slider window. Individual project variables were then calculated as described below, and the resulting data tables were joined to ArcGIS 10.1 along with Texas state and county boundary files.⁴ Data files for each variable were then joined to the Texas county boundary file one at a time, and maps for the variables were created. With the exception of the water source map, which is a stand-alone static map, all files were then animated using ArcGIS's Time Slider window to demonstrate projected changes in variables over the next 50 years. Finally, resulting images and maps were exported as .jpeg and .avi files for inclusion in this paper.

Water Source

TWDB data included 2010 water volumes measured in acre-feet according to source type: surface water, groundwater, or reuse. As water from reuse comprised only 3% of all water used in Texas in 2010, these volumes were eliminated in order to focus on primary water supply sources. Groundwater and surface water figures were summed to determine a total water volume, excepting reuse, for each county. The percentage of this total water volume generated by groundwater was then calculated, and these data form the basis of the *Water Source* map. The formula used to generate the *Water Source* variable by county is as follows:

$$\frac{\text{Groundwater Volume}}{\text{Total Water Volume}} \times 100 = \text{Percentage of water from groundwater sources}$$

³ The Texas Water Development Board defines a water user group as an "identified user or group of users for which water demands and water supplies have been identified and analyzed and plans developed to meet water needs. Water user groups are identified at the county level." – Texas Water Development Board, *Water for Texas: 2012 State Water Plan*, report (Austin, TX: Texas Water Development Board, 2012), 249.

⁴ Boundary files can be found through the Texas Natural Resource Information System at http://www.tnris.org/get-data?quicktabs_maps_data=1

Demand

Project data included actual demand volumes for the year 2010 as well as projected demand volumes by decade from 2020 through 2060. In order to demonstrate change over time in these figures, cumulative change in demand was calculated. Volumes for each decade were compared to 2010 figures, and the resulting calculations illustrate the degree to which demand is anticipated to change over the course of the study period. For each decade, the *Cumulative Change in Demand* variable was calculated by county as follows:

$$\frac{\text{Projected Demand Volume in Decade } X}{\text{Actual Demand Volume in Year 2010}} - 1 = \text{Change in demand relative to 2010}$$

Existing Supply

Project data also included existing supply volumes for 2010 as well as supply projections by decade from 2020 through 2060. To illustrate change in these volumes over time, the *Cumulative Change in Supply* variable was calculated using the same methodology employed in calculating cumulative demand change. The formula for calculating *Cumulative Change in Supply* by county is as follows:

$$\frac{\text{Projected Supply Volume in Decade } X}{\text{Existing Supply Volume in Year 2010}} - 1 = \text{Change in supply relative to 2010}$$

Needs

Project data included water need volumes for 2010 as well as projected water need volumes for each decade from 2020 through 2060. In order to place these volumes in a meaningful context, *Need* was calculated as a percentage of existing supply. Thus, the formula for calculating the *Need* variable by county is as follows:

$$\frac{\text{Projected Need Volume in Decade } X}{\text{Projected Existing Supply Volume in Decade } X} \times 100 = \text{Need as a percentage of supply}$$

Supply from Water Plan Strategies

TWDB data also included 2010 water volumes produced by implementation of water plan strategies as well as predicted volumes associated with future implementation of plan strategies. To make these volumes meaningful, *Supply from Water Plan Strategies* was calculated as a percentage of total projected supply. The formula for calculating the *Supply from Water Plan Strategies* variable by county is as follows:

$$\frac{\text{Projected Supply from Strategies}}{\text{Projected Existing Supply} + \text{Projected Supply from Strategies}} \times 100$$

= Percentage of future supply generated by water plan strategies

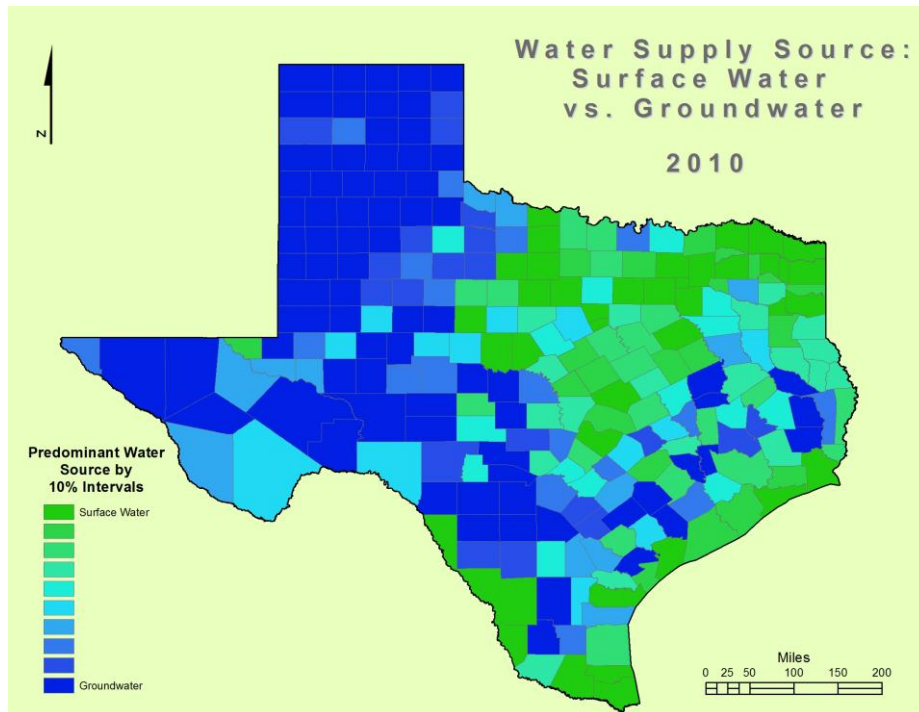
Results

Maps and animations generated using the methodologies described above follow. Each graphic links temporal data contained in the 2012 Texas State Water Plan to its spatial distribution across the state. This process enhances the data by placing it in context spatially, and in doing so makes it more meaningful to Texans.

Water Source

In 2010, 49.5 percent of the state's water supply came from surface water, 47.5 percent came from groundwater, and the remaining 3 percent came from water reuse. Though the state's water supply was roughly equally distributed between ground and surface water, supply sources are not evenly distributed across the state. West Texas and the Panhandle depend primarily on groundwater whereas the Gulf Coast, parts of the Rio Grande Valley, and the northeastern portion of the state depend primarily on surface water. Across the remainder of the state, most counties depend on a combination of source types, and there is more variation in source type within these regions.

Figure 1: Water Supply by Source Type



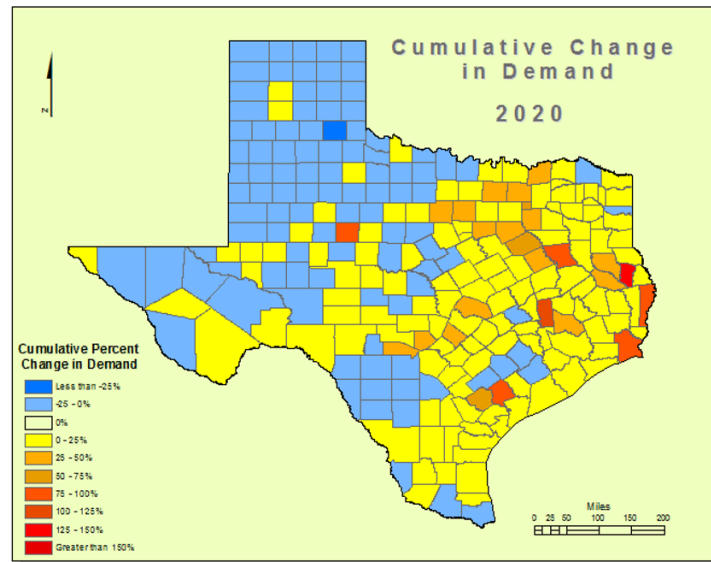
Demand

Between 2010 and 2060, Texas's population is projected to increase by 82 percent.⁵ Over the same time period, demand is only expected to grow by 22 percent. The slower rate of increase in demand for water relative to population growth is attributed primarily to two factors: reduced water demand for irrigation purposes and increased municipal conservation efforts.⁶

Over the coming decades, demand is projected to decline most dramatically in the Panhandle region of the state, an area typically dominated by agricultural land uses that necessitate widespread irrigation. Projected increases in demand, on the other hand, are concentrated around metropolitan areas such as the Dallas-Fort Worth Metroplex and the Central Texas region including Austin and San Antonio.

The following animation illustrates changes in the state's demand patterns over the next 50 years. Static maps of 2020 and 2060 cumulative change in demand are subsequently provided for purposes of comparison.

Figure 2: Cumulative Change in Demand Time Series Animation



⁵ Texas Water Development Board, *Water for Texas: 2012*, 129.

⁶ *Ibid.*, 128.

Figure 3: Cumulative Change in Demand – 2020

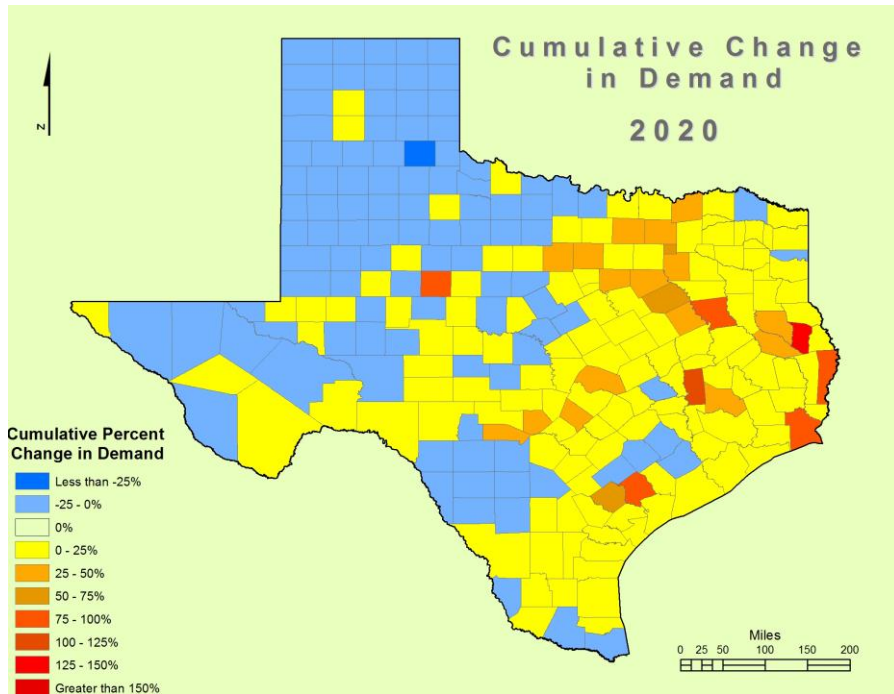
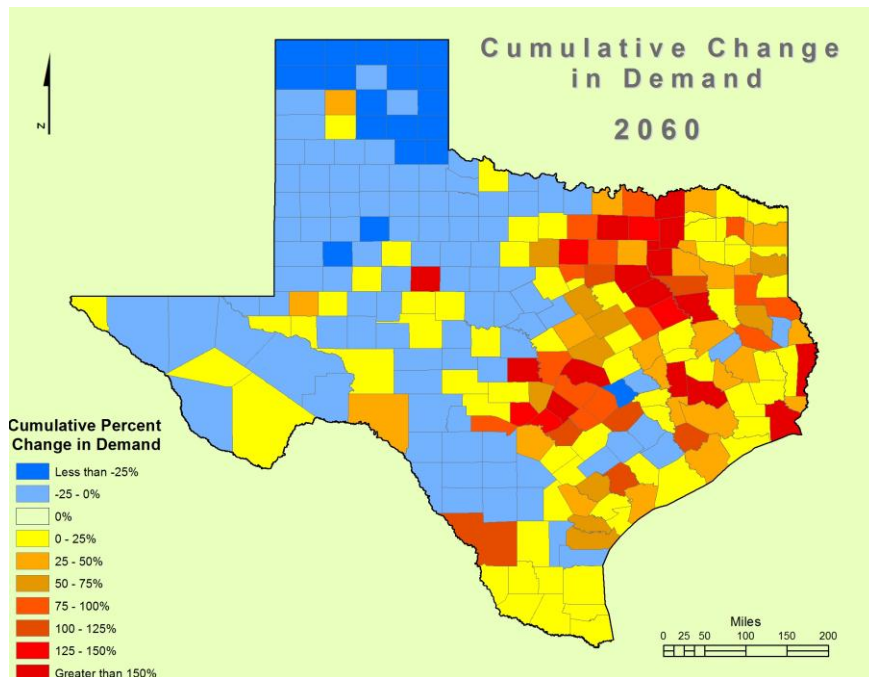


Figure 4: Cumulative Change in Demand – 2060



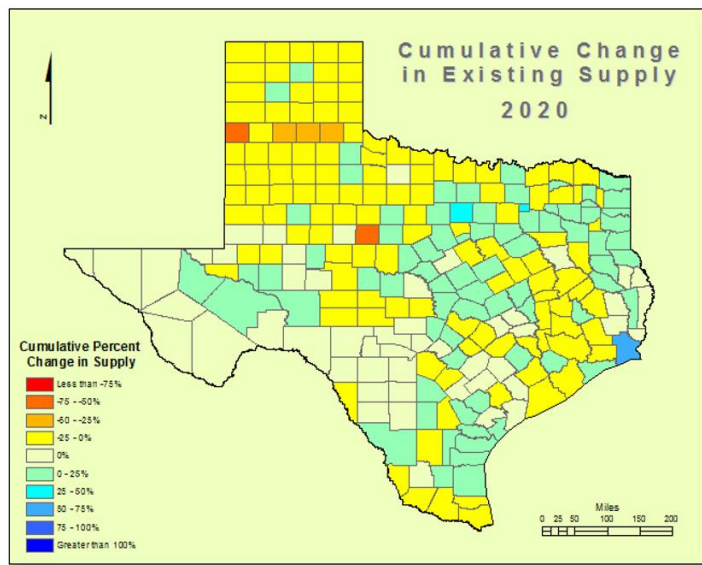
Existing Supply

Existing water supply is defined by TWDB as “the amount of water that can be produced with current permits, current contracts, and existing infrastructure during drought”⁷ and is distinct from the available water supply, which is the quantity of water that would be available if there were no legal constraints or limitations on infrastructure.

The state’s existing water supply is projected to decline by roughly 10 percent from 2010 to 2060. Supplies from groundwater are expected to drop by 30 percent, primarily due to gradual depletion of the Ogallala Aquifer and also to mandatory reduced pumping of the Gulf Coast Aquifer required to mitigate land subsidence along the coast. Surface water supplies, on the other hand, are expected to increase by 6 percent. This upward shift is due to changes in the methodology used to calculate existing surface water supplies with relation to available water supplies.⁸

The following animation and subsequent maps illustrate projected cumulative changes in the state’s existing water supply. Supplies are expected to decline most significantly in the Panhandle region of the state, an area that relies almost exclusively on the Ogallala Aquifer. The only significant rise in existing supply occurs in Jefferson County and is the result of an increase in the legally available amount of contracted water.⁹

Figure 5: Cumulative Change in Existing Supply Time Series Animation



⁷ Ibid., 157.

⁸ Ibid., 156.

⁹ *East Texas Regional Water Planning Area 2011 Update of the Regional Water Plan*, report (n.p.: East Texas Regional Water Planning Group, 2010), 4C-26.

Figure 6: Cumulative Change in Existing Supply – 2020

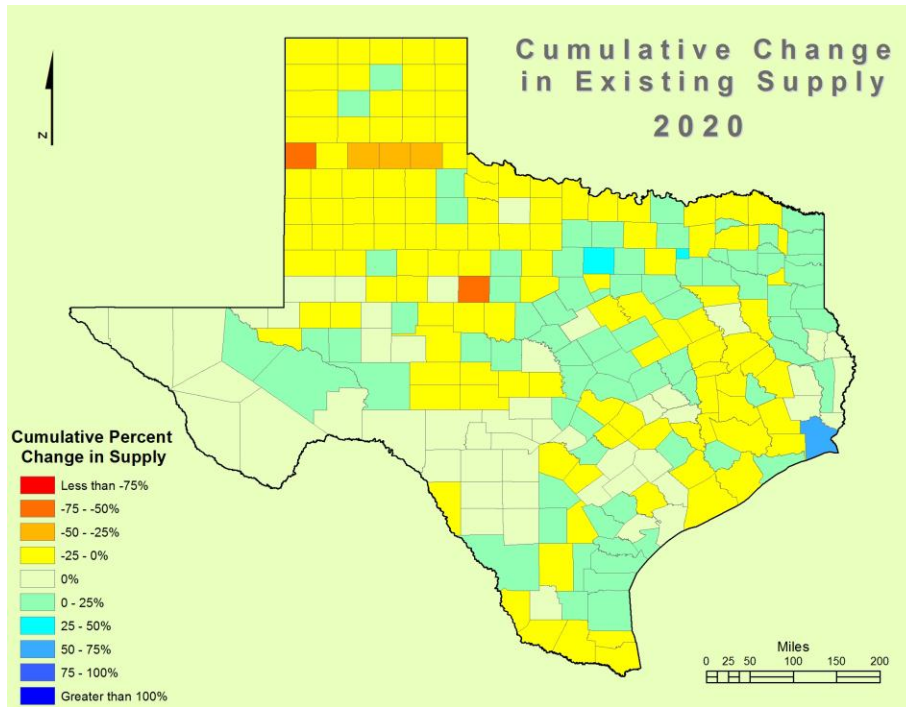
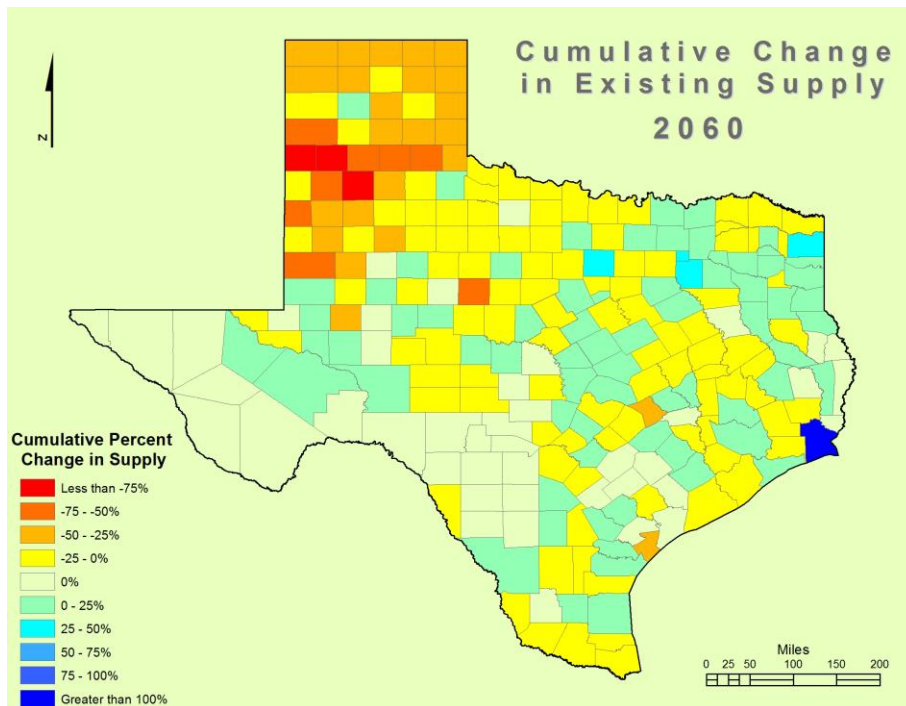


Figure 7: Cumulative Change in Existing Supply – 2060



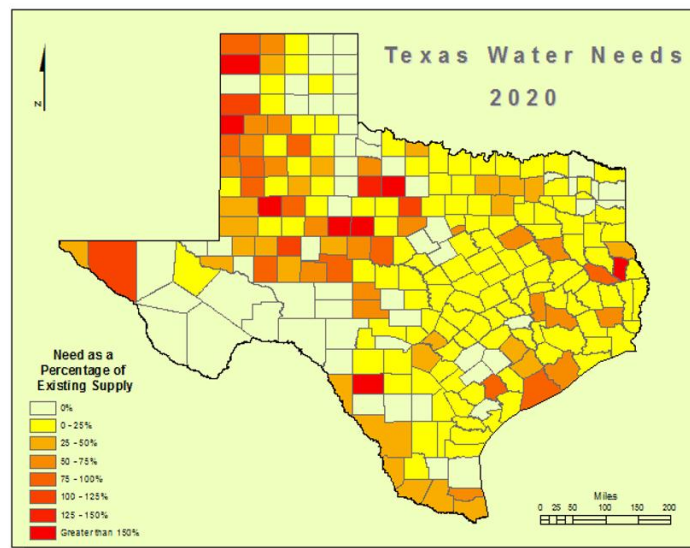
Needs

TWDB defines water needs as “projected water demands in excess of existing water supplies for a water user group or a wholesale water provider.”¹⁰ In other words, projected water needs are the state’s unmet demands in times of severe drought if no supply strategies from the State Water Plan are implemented.

The state’s water needs are estimated to increase by 130 percent over the next fifty years. Were the state to find itself in a severe drought at present, the municipal sector would account for roughly 9 percent of total needs and irrigation needs would account for an additional 86 percent of the total. By the year 2060, these numbers are anticipated to shift to 41 percent and 45 percent respectively. Thus, irrigation needs are expected to show a dramatic decline as a percentage of total needs whereas municipal needs are expected to sharply increase.¹¹

Over the next fifty years, needs increase markedly in the Panhandle region, along portions of the Rio Grande, and in many of the state’s largest metropolitan areas. In particular, the Dallas-Fort Worth Metroplex shows significant growth in water needs. The following animation and maps illustrate these projected changes over the coming decades.

Figure 8: Texas Water Needs Time Series Animation



¹⁰ Texas Water Development Board, *Water for Texas: 2012*, 248.

¹¹ *Ibid.*, 4.

Figure 9: Texas Water Needs – 2020

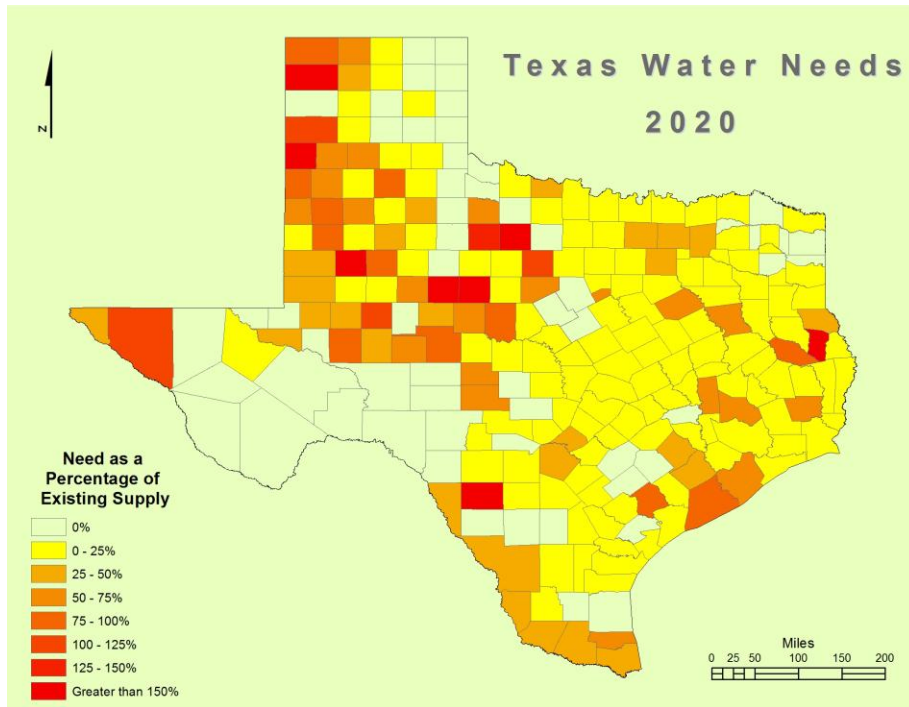
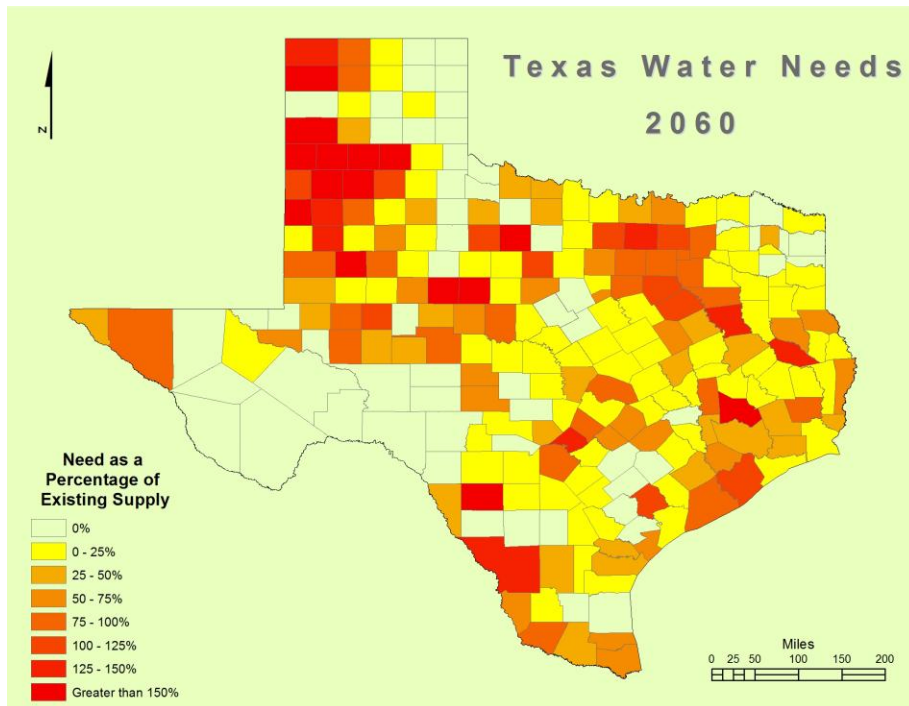


Figure 10: Texas Water Needs – 2060



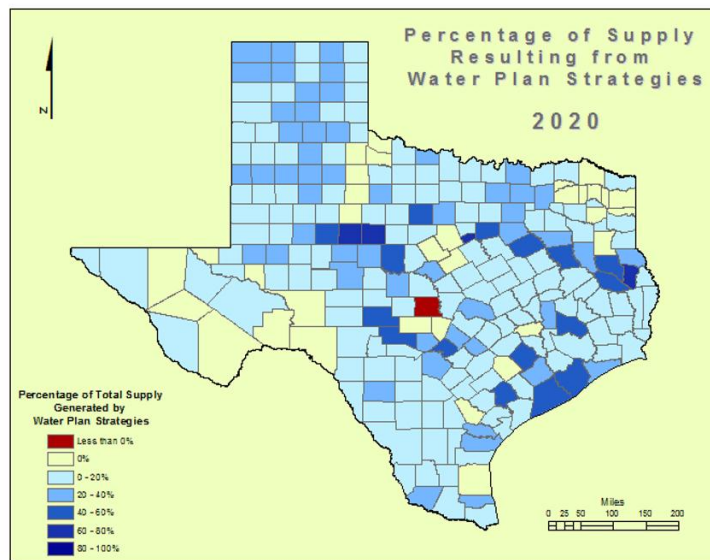
Strategy Supplies

If all recommended water strategies detailed in the State Water Plan are fully implemented, virtually all of the state's water needs will be met. Of the unmet needs that remain, over 98 percent occur within the irrigation sector.¹² These needs are anticipated to persist because the return on investment is not adequate to justify the significant expense of water management strategies.¹³

With few exceptions, supply from strategies is projected to increase across the state in the decades to come. The largest increases in these supplies are expected to occur in the Dallas-Fort Worth Metroplex, the Panhandle region, and in Central Texas. In three cases, supply from strategies is expected to decrease. In Llano County, supply is shown to decrease in 2020 and 2030 because additional water supply generated via increased efficiencies at a steam-electric plant will be transferred out to nearby counties.¹⁴ For Culberson (2040-2060) and Hudspeth (2050-2060) Counties, supply is shown to decrease because the region's water plan strategies include pumping water from aquifers underlying these counties and exporting it to El Paso.¹⁵

The following graphics illustrate projected changes to the state's water supply if all water management strategies included in the State Water Plan are implemented.

Figure 11: Percentage of Supply Resulting from Water Plan Strategies Time Series Animation



¹² Ibid., 5.

¹³ Ibid., 181.

¹⁴ Temple McKinnon (TWDB Regional Water Planning Team Lead), e-mail message to author, November 19, 2012.

¹⁵ LBG-Guyton Associates and Freese and Nichols, *Far West Texas Water Plan*, report (n.p.: Far West Texas Water Planning Group, 2011), ES 12-13.

Figure 12: Percentage of Supply Resulting from Water Plan Strategies – 2020

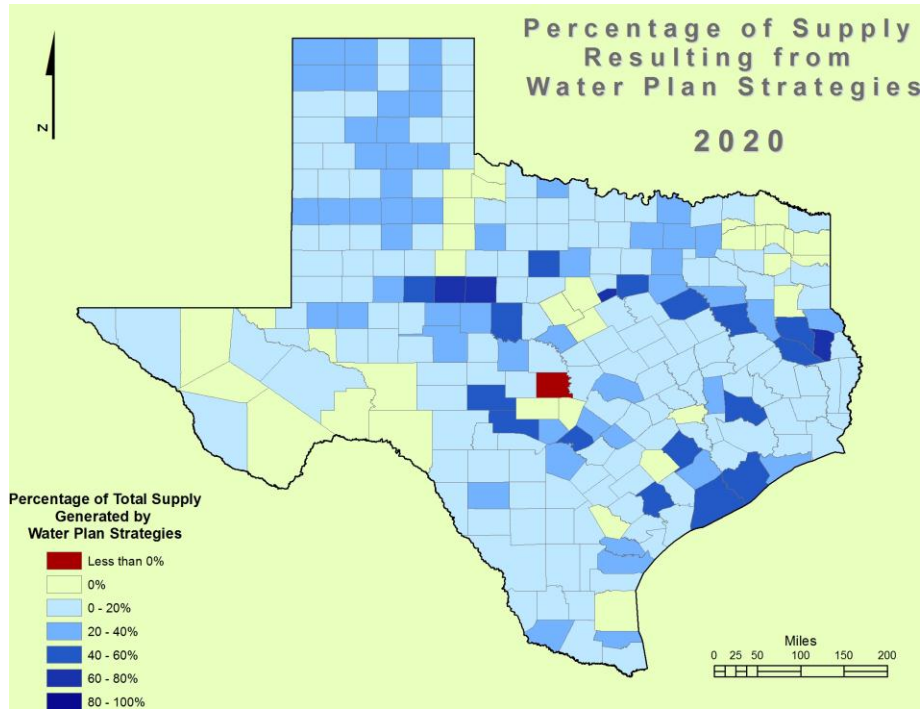
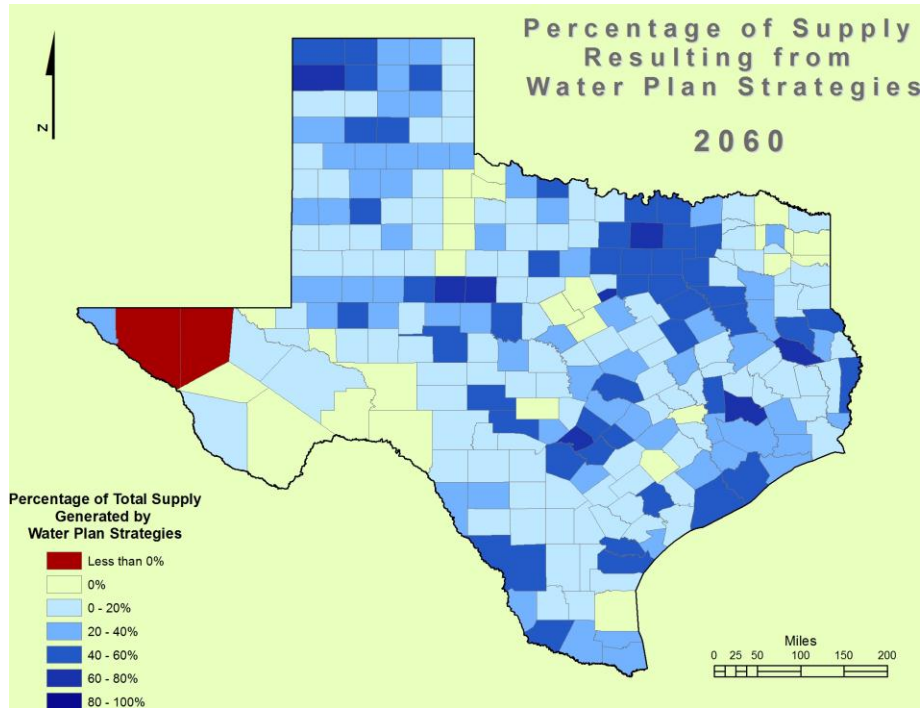


Figure 13: Percentage of Supply Resulting from Water Plan Strategies – 2060



Recommendations for Project Expansion

Given the wealth of data present in the 2012 Texas State Water Plan, there are numerous ways in which the current project can be expanded. Opportunities for further project development include, but are not limited to, maps reflecting the following information at the county level for the 2020 through 2060 timeframe:

- *Unmet Needs by Volume*
 - Quantities illustrated using a graduated color ramp would reflect volumes in acre-feet.
 - This map would provide a sense of which areas of the state will experience the highest and lowest levels of unmet needs should the state experience a drought similar to the drought of record.

- *Unmet Needs by Water Use Category*¹⁶
 - All counties would be coded according to their water use categories that are projected to experience unmet needs. Each category, or unique combination of categories, would then be represented by a different color using the categorical variable symbology option.
 - This map would indicate which water use categories will most commonly experience unmet needs and where across the state these unmet needs will occur.

- *Unmet Municipal Needs by Volume*
 - Quantities illustrated using a graduated color ramp would reflect volumes in gallons per capita.
 - Impacts to municipal water use are of concern to Texans as they affect homes and businesses alike. Demonstrating where impacts to these uses are projected to occur in a time of drought may provide residents with a greater sense of urgency regarding implementation of water plan strategies.

- *Needs by Water Use Category*
 - Counties would be coded using the same methodology described for the *Unmet Needs by Water Use Category* map.
 - This map would provide a sense of which water use categories will be most commonly impacted and where these impacts will occur if the State Water Plan is not implemented.

¹⁶ TWDB specifies six water use categories: municipal, manufacturing, mining, irrigation, steam-electric, and livestock. – Texas Water Development Board, *Water for Texas: 2012*, 227.

- *Percentage of Water Supply from Reuse*
 - Quantities illustrated using a graduated color ramp would indicate the percentage of water supply that is anticipated to be generated by water reuse.
 - Though water from reuse currently constitutes less than five percent of the state's total supply, it provides more than 10 percent of supply in 11 Texas counties, and these figures are expected to increase. This map would indicate where and to what extent water reuse will constitute a water supply source.

- *Proposed Number of Water Strategies per County*
 - Counties would be sorted according to the proposed number of water strategies for each. Counties would then be grouped by number of water strategies, and a maximum of ten equal interval groupings would be used. Each group would then be represented by a different color using the categorical variable symbology option.
 - This map would illustrate the number of strategies proposed for each county, thus highlighting areas of the state where extensive use of water plan strategies is required to meet future needs.

- *Supply Volume per Strategy*
 - Each supply strategy would be geocoded to its proposed location. The water supply volume associated with each strategy would be represented by a graduated symbol that also marks its location.
 - Supply strategies that do not have a specific geographic location, such as water conservation, would not be represented using this methodology. Instead, a pie chart showing percentage of strategy supply from geographically specific strategies and percentage of strategy supply from general, non-geographically specific strategies would be presented in conjunction with the map.
 - Inset maps would be used as needed if symbols overlap due to close geographic proximity of strategies.
 - This map gives a sense of the magnitude of proposed strategies as well as their distribution across the state.

- *Cost of Supply Strategies per Acre-Foot of Additional Supply*
 - Cost per acre-foot of additional supply per water strategy would first be calculated. These figures would then be represented by graduated symbols that also mark each strategy's location using the geocoding process completed for the *Supply Volume per Strategy* map.
 - Costs associated with non-geographically specific strategies would be represented using the same type of pie chart described for the *Supply Volume per Strategy* map.

- Inset maps would be used as needed if symbols overlap due to close geographic proximity of strategies.
- This map would indicate which water supply strategies are most costly in terms of volume of water produced as well as which strategies are most cost effective for increasing supplies.
- *Total Cost of Supply Strategies*
 - Quantities illustrated using a graduated color ramp would indicate the total cost of proposed supply strategies located in each county.
 - This map would reflect where funding for State Water Plan projects needs to be directed in order to ensure that the plan is implemented.
 - This map would not reflect costs that a specific county or municipality is anticipated to incur as a result of implementation of the State Water Plan. This point would need to be clearly made in order to ensure that information contained in the map is not misinterpreted.

Conclusion

The 2012 Texas State Water Plan – in conjunction with the 16 regional water plans that form its basis – provides a comprehensive assessment of Texas’ water supplies, needs, and demands over the next 50 years as well as descriptions of strategies for ensuring that the state is able to meet its water needs in time of drought. While these plans provide copious amounts of data, very little of it is spatially linked to the state, thus making it difficult to contextualize and interpret for most Texans. This project takes the step of linking some of the most salient data in the Plan to Texas counties. By doing so, it helps bridge the gap between an information-dense document and the Texans that it is ultimately meant to serve.

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