Smart and Connected Water Resource Management via Social Media and Community Engagement

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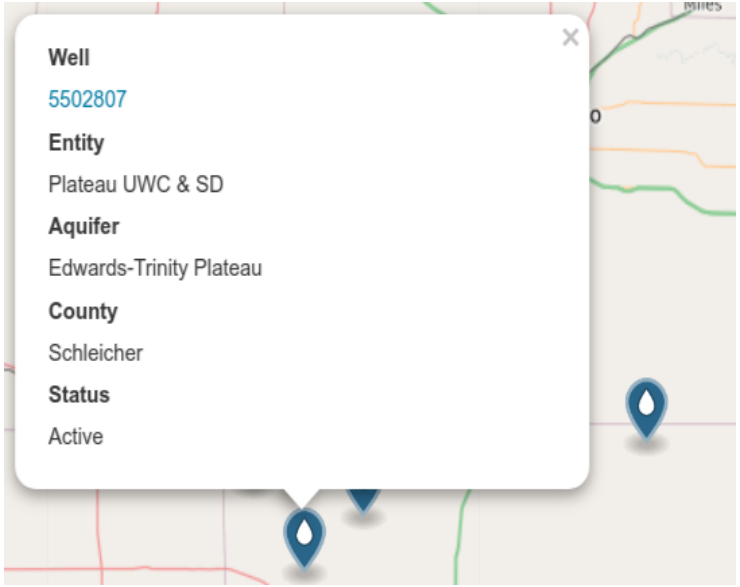
Outline

- Overview of Existing Platforms
- Motivations & Objectives & Approach
- Solution Design
- Methodology
- Demo

Existing Platform

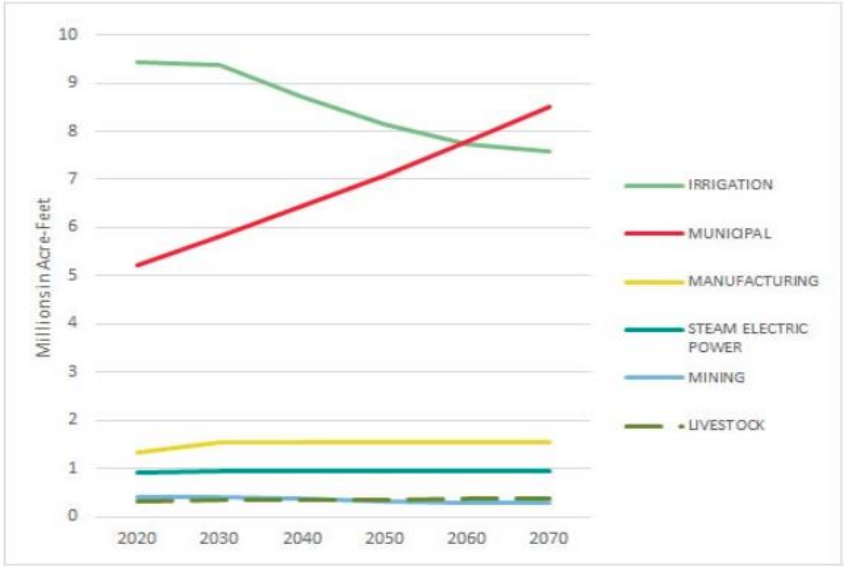
Water Data for Texas



Basic well water information

https://waterdatafortexas.org/groundwater

Texas Water Development Board

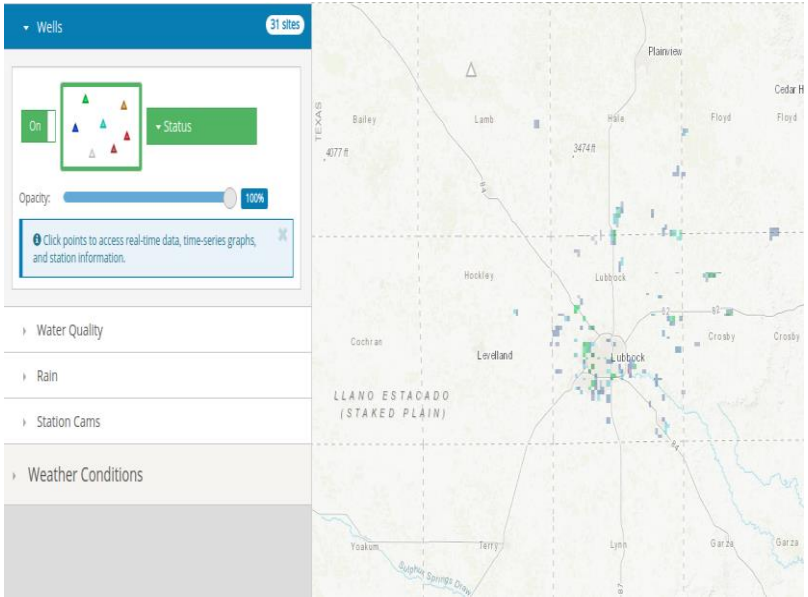


Water planning until year 2070

http://www.twdb.texas.gov/waterplanning/index.asp

Existing Platform

United States Geological Survey



Well distribution - NOT updated

https://txpub.usgs.gov/txwaterdashboard

United States Geological Survey – raw data

Station Number	Station name	Date/Time	below LSD
Bandera County			
295204099340201	AS-69-12-206 (Bandera County Edwards GW Well 1)	07/25 23:30 CDT	249.38
Bexar County			
292943098354404	AY-68-36-132 (Z DED)	07/25 23:00 CDT	194.10
293252098380801	AY-68-27-610 (Parkwood Park)	07/25 23:00 CDT	194.96
293516098325501	AY-68-28-211 (Shavano Park at Fawn Drive)	07/26 00:00 CDT	236.38
El Paso County			
315712106361803	MBOWN-238 - JL-49-04-476 (CWF-2C)	07/25 22:00 MDT	84.87
Fort Bend County			
294327095445201	JY-65-29-106 (Fort Bend Extensometer)	07/25 23:15 CDT	26.16
Galveston County			
292338095063601	KH-65-40-707 (Galveston)	07/26 00:00 CDT	93.12
Harris County			
293348095070604	LJ-65-32-428 (Clear Lake Deep Extensometer)	07/25 23:45 CDT	132.63
294338095270402	LJ-65-21-226 (Southwest Monitor No. 1)	07/25 23:30 CDT	228.65
294338095270403	LJ-65-21-230 (Southwest Piezometer No. 2)	07/25 23:30 CDT	253.90
294726095351101	LJ-65-12-725 (Addicks Piezometer No. 2)	07/25 23:00 CDT	12.33
294726095351102	LJ-65-12-726 (Addicks Monitor No. 1)	07/25 23:00 CDT	364.19
294726095351104	LJ-65-12-729 (Addicks Piezometer No. 1)	07/25 23:00 CDT	153.73
294728095200103	LJ-65-14-738 (Northeast Piezometer No. 4)	07/25 23:00 CDT	173.46
295449095084101	LJ-65-07-905 (Lake Houston Piezometer No. 2)	07/25 23:30 CDT	74.21
Lamb County			
341010102240801	RU-10-53-602	07/26 00:00 CDT	148.79
Medina County			
292618099165901	TD-69-38-601 (Seco Creek Well)	07/26 00:00 CDT	192.02
293202099063501	TD-69-32-703 (MED-1)	07/26 00:00 CDT	176.32

Only water raw data. Limited analytics.

https://waterdata.usgs.gov/tx/nwis/current/?type=gw&group_key=county_cd

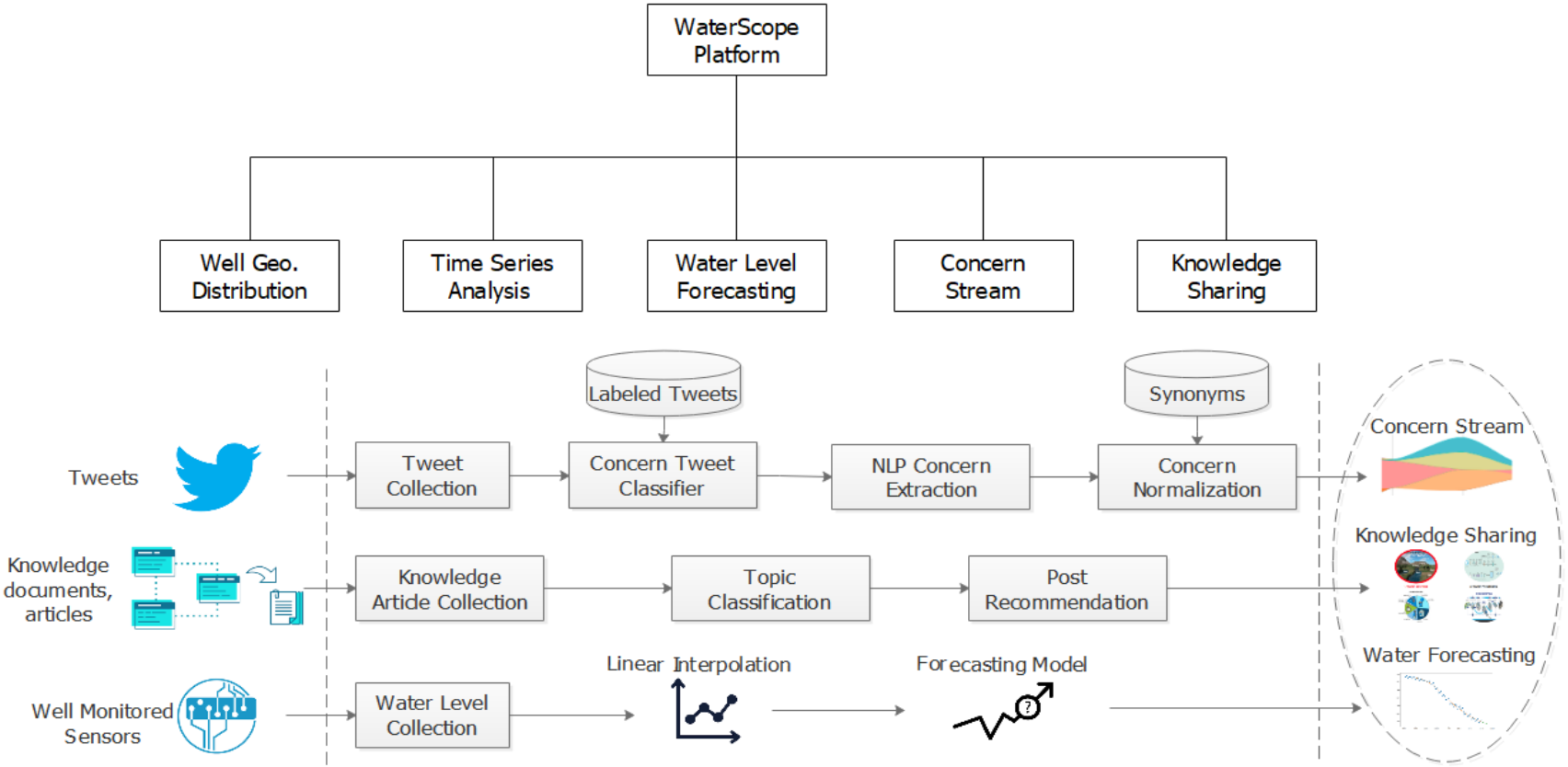
Limitation

- Most of the websites focus on a small part of specific water resource information
- No comprehensive water resource management website that could integrate information
- The information is delivered as one-way data reporting (administration boards to the public). No community engagement.

Project Motivation

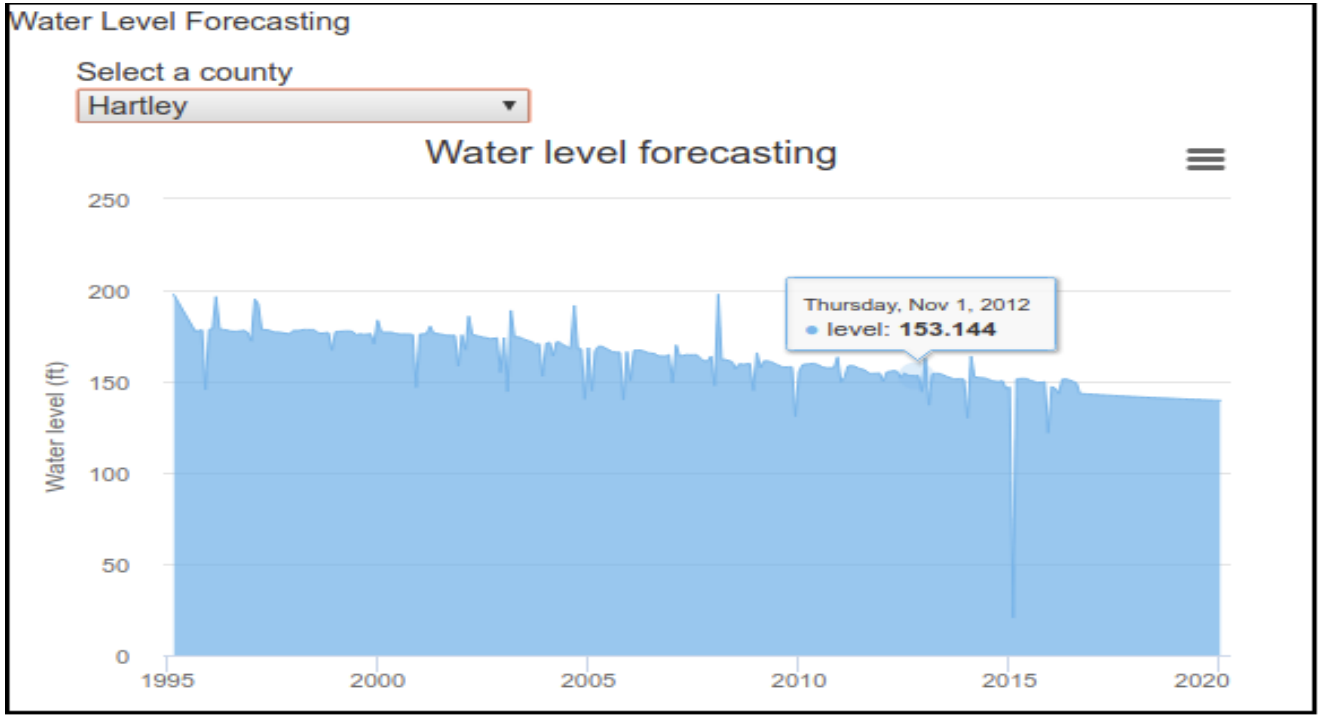
- Motivations
  - To provide a multi-source information sharing platform
  - To allow collaboration among different parties
  - To encourage community engagement in water resource management.
  - To improve water use efficiencies across the industries
- Approaches
  - Smart Platform
  - Information Integration
  - Connecting Communities
- Objectives
  - Design for everyone via unified view of water related information.
  - Advanced analytics support
  - Integrate concerns via social media
  - Community engagement via knowledge sharing and discussion board

Solution Design



Methodology

- Water Supply Forecasting (using LSTM).



Methodology

- Water Supply Forecasting.

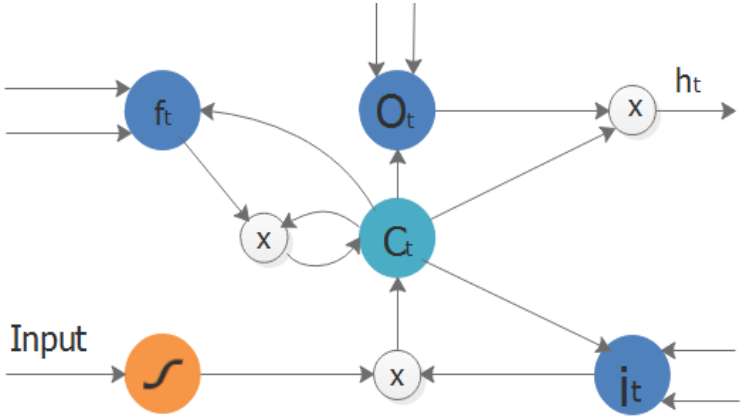
$$i_t = \sigma(W_{xi}x_t + W_{hi}h_{t-1} + W_{ci}c_{t-1} + b_i) \quad (1)$$

$$f_t = \sigma(W_{xf}x_t + W_{hf}h_{t-1} + W_{cf}c_{t-1} + b_f) \quad (2)$$

$$c_t = f_t c_{t-1} + i_t tanh(W_{xc}x_t + W_{hc}h_{t-1} + b_c) \quad (3)$$

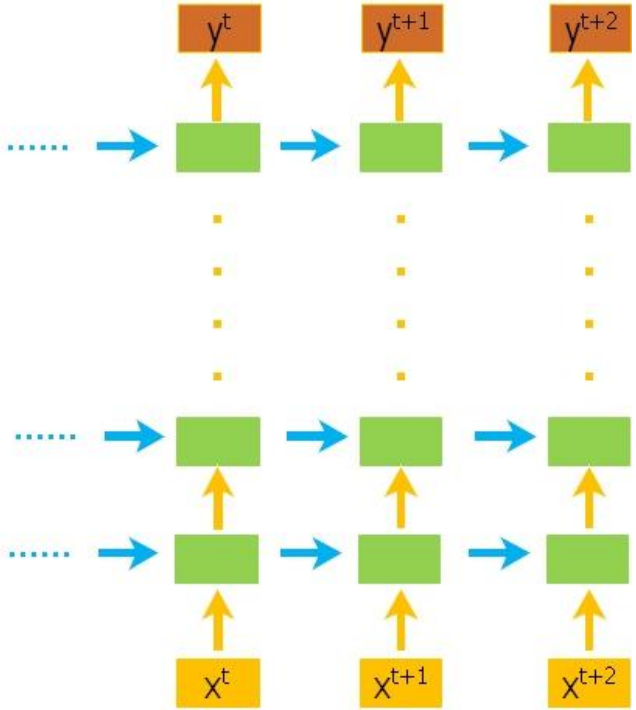
$$o_t = \sigma(W_{xo}x_t + W_{ho}h_{t-1} + W_{co}c_t + b_o) \quad (4)$$

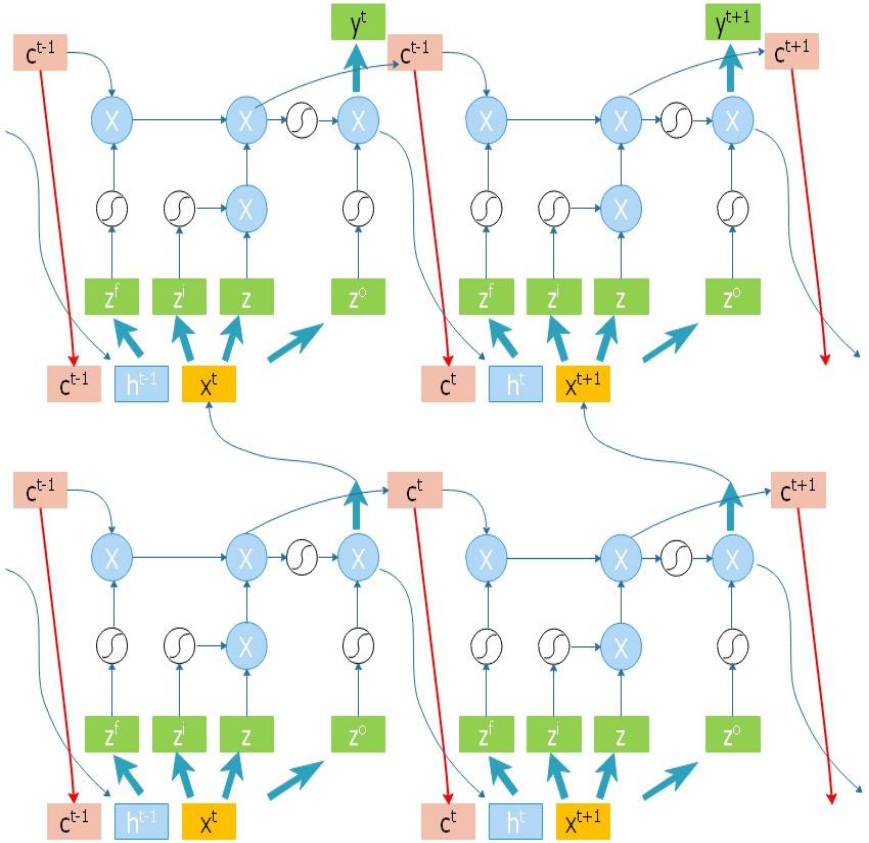
$$h_t = o_t tanh(c_t) \quad (5)$$



Methodology

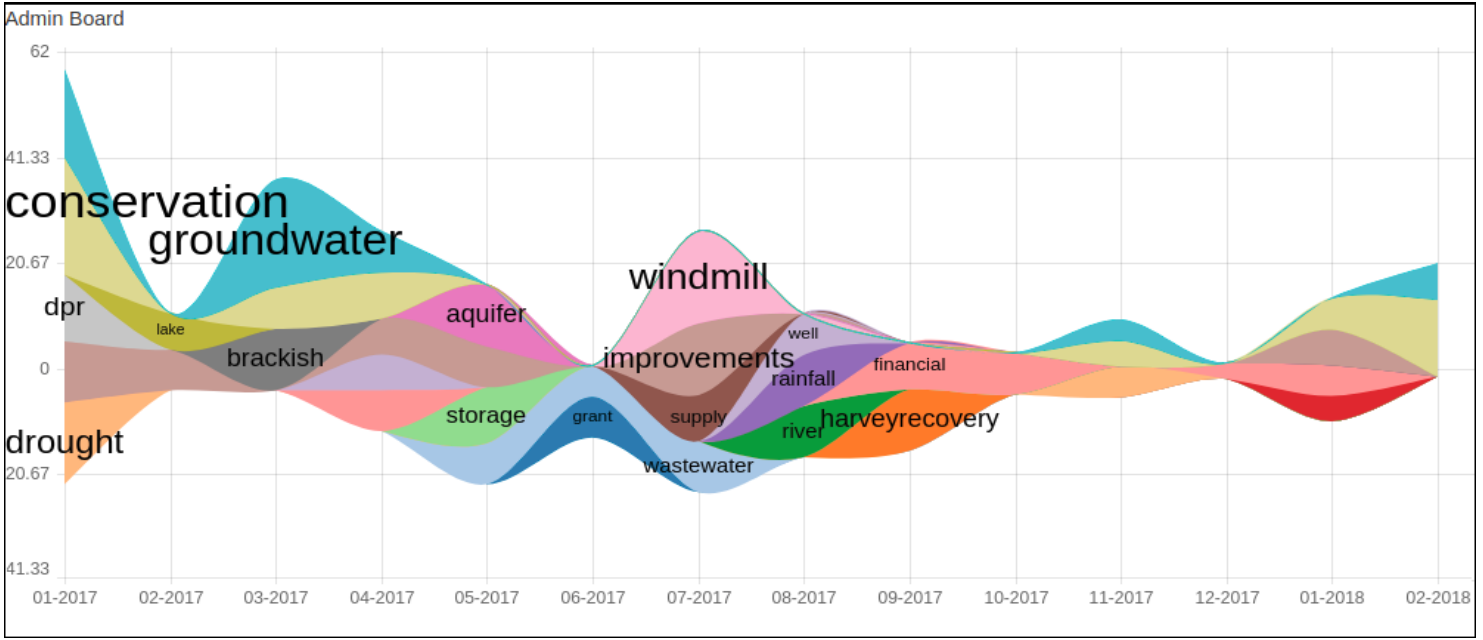
Water Supply forecasting with LSTM





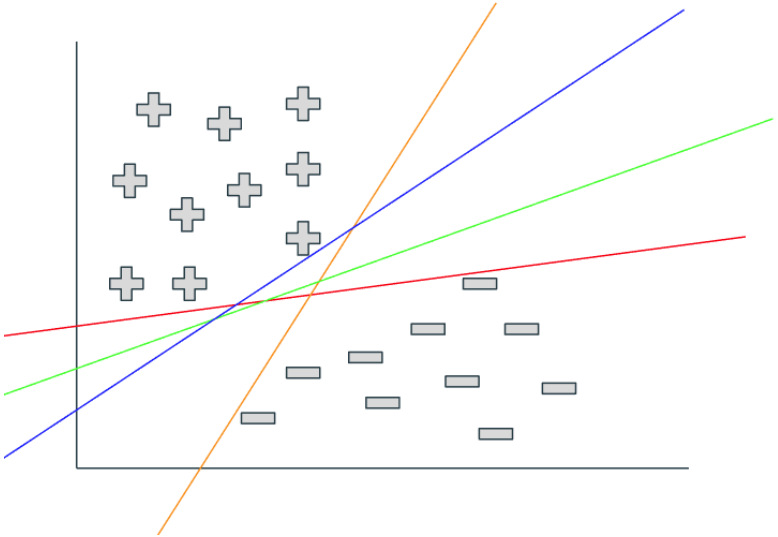
Methodology

- Social media data => SVM classifier + Natural Language Processing => Concern stream



Methodology

SVM classifier



which classifier is the best?

$$\min_{w,b} \frac{1}{2}||w||^2$$

$$\text{s.t.} \quad y_i(w^T x_i + b) \geq 1, \quad i = 1, \ldots, m$$

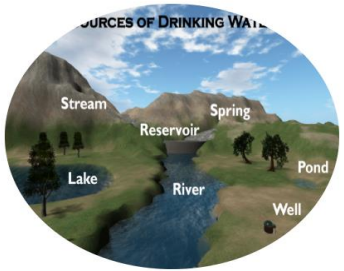
Constraint transformed: $g_i(w,b) = -y_i(w^T x_i + b) + 1 \leq 0$

Lagrangian: $\mathcal{L}(w,b,\alpha) = \frac{1}{2}||w||^2 - \sum_{i=1}^{m} \alpha_i(y_i(w^T x_i + b) - 1)$

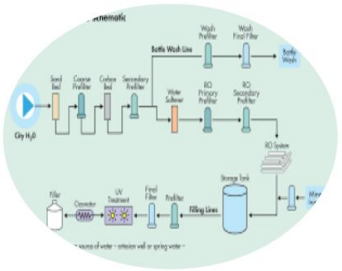
$$\begin{aligned}
\mathcal{L}(w,b,\alpha) &= \frac{1}{2}||w||^2 - \sum_{i=1}^{m} \alpha_i(y_i(w^T x_i + b) - 1) \\
&= \frac{1}{2} w^T w - \sum_{i=1}^{m} \alpha_i y_i w^T x_i - \sum_{i=1}^{m} \alpha_i y_i b + \sum_{i=1}^{m} \alpha_i \\
&= \frac{1}{2} \sum_{i,j=1}^{m} \alpha_i \alpha_j y_i y_j x_i^T x_j - \sum_{i,j=1}^{m} \alpha_i \alpha_j y_i y_j x_i^T x_j - \sum_{i=1}^{m} \alpha_i y_i b + \sum_{i=1}^{m} \alpha_i \\
&= \sum_{i=1}^{m} \alpha_i - \frac{1}{2} \sum_{i,j=1}^{m} y_i y_j \alpha_i \alpha_j x_i^T x_j
\end{aligned}$$

Methodology

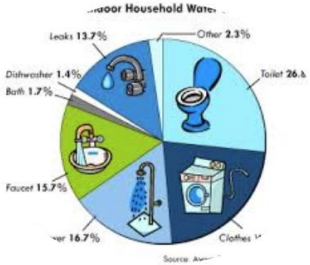
Topic modeling with LDA



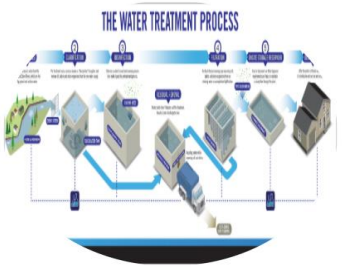
1. WATER SOURCES



2. WATER PROCESSING



3. WATER USAGE



4. WATER TREATMENT

Methodology

Topic modeling with LDA

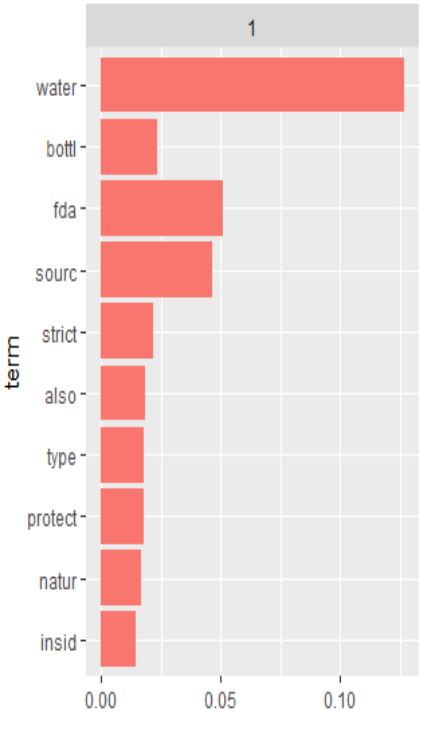
Bottled water, often called drinking water, is usually bottled at the source and sealed in safe drinking containers. There are many types of bottled water, held inside many types of unique shaped bottles. It seems the fancier the bottle, the more expensive the water inside. Let's take a look at the kinds of bottled water available:

- Spring **water**: this comes from an underground formation and must flow naturally to the earth's surface or through a sanitary borehole.
- **Purified** drinking **water**: this type of water has been processed to remove chlorine and a majority of dissolved solids, such as magnesium. The source is not required to be named unless it is untreated public source of water.
- **Naturally sparkling water**: this is naturally carbonated from a spring or artesian well.
- **Seltzer Water**: the FDA regulates this as a soft drink, which means rules are less strict than those for bottled water.
- **Mineral water**: typically, from a spring, this contains dissolved solids like calcium, magnesium, sodium, potassium, silica and bicarbonates.

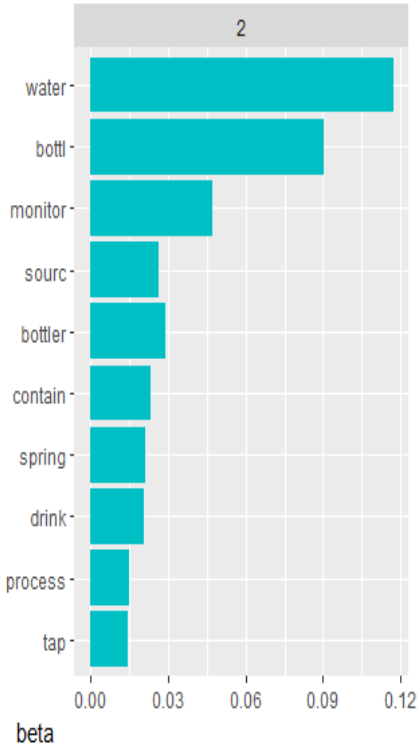
Bottled water, some say, is not always safer than tap water. Tap water, from city water systems, is monitored by the Environmental Protection Agency, while the FDA monitors water bottling activity. In fact, bottled water is one of the products most closely monitored by the FDA. The standards for these two agencies is a little different; for example, the EPS monitors for asbestos while the FDA does not. Water bottlers are also not very strictly required to monitor or disinfect for parasites. This is mainly because the FDA says that at the source the water is bottled from, it is unlikely to harbor parasites or contain these dangerous elements. However, water bottlers are given stricter standards for lead and chlorine.

But, there is more than just the FDA. Bottled water is actually monitored at three levels to ensure high quality and safety standards, the first being federal through the FDA. It is also regulated by the state and also by trade associations such as the International Water Bottlers Association (IBWA). While every water bottler has different techniques, here are some general guidelines of the steps to bottling water. Bottling water starts at the source. As mentioned above, there are several sources to find water: protected underground springs, wells and municipal supplies. The next step is to filter the water through multi-barrier sources which could included source protections, source monitoring, reverse osmosis, ultraviolet light, distillation, micron filtration and ozonation. Water bottlers may use one or more of those processes.

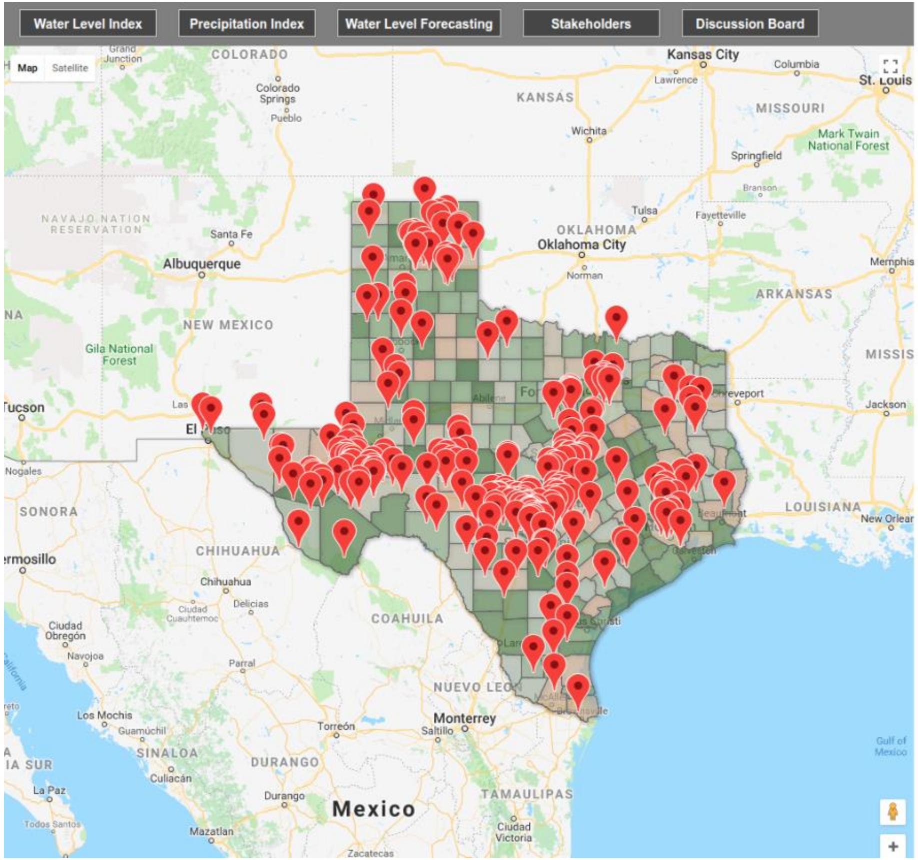
Water regulation



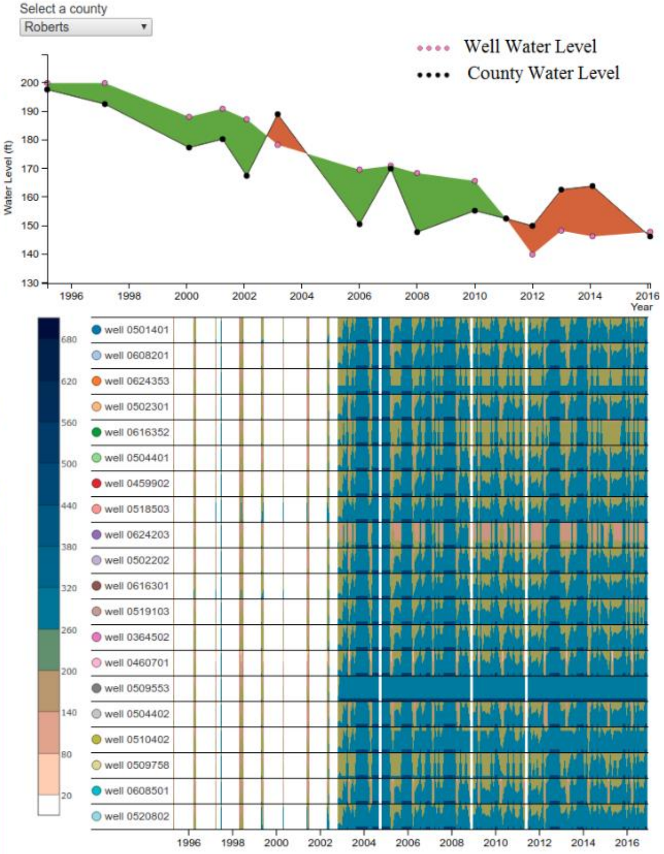
Water processing



Overview

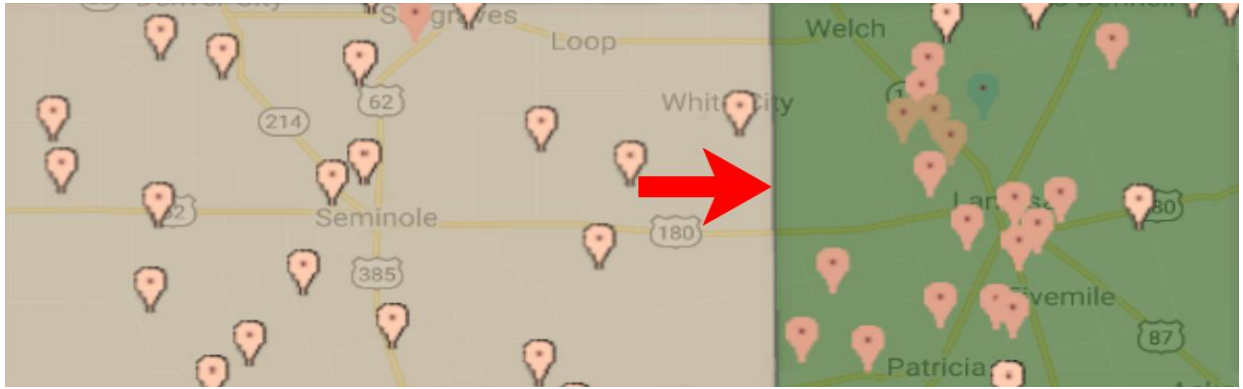


Water Level Index
Precipitation Index
Water Level Forecasting
Stakeholders
Discussion Board
Map
Satellite
COLORADO
KANSAS
MISSOURI
OKLAHOMA
Oklahoma City
ARKANSAS
NEW MEXICO
Albuquerque
LOUISIANA
SONORA
CHIHUAHUA
COAHUILA
NUEVO LEON
TAMAULIPAS
DURANGO
SINALOA
Mexico
Monterrey
Kansas City
St. Louis
Wichita
Tulsa
Santa Fe
Memphis
Tucson

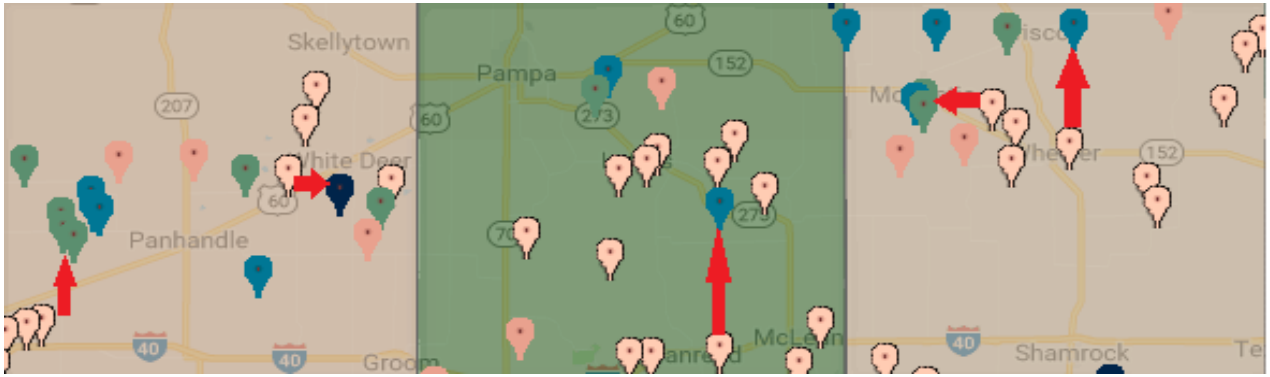


Select a county
Roberts
Well Water Level
County Water Level
Water Level (ft)
200
190
180
170
160
150
140
130
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Year
680
620
560
500
440
380
320
260
200
140
80
20
well 0501401
well 0608201
well 0624353
well 0502301
well 0616352
well 0504401
well 0459902
well 0518503
well 0624203
well 0502202
well 0616301
well 0519103
well 0364502
well 0460701
well 0509553
well 0504402
well 0510402
well 0509758
well 0608501
well 0520802

Demonstration 1 - Water Logistics



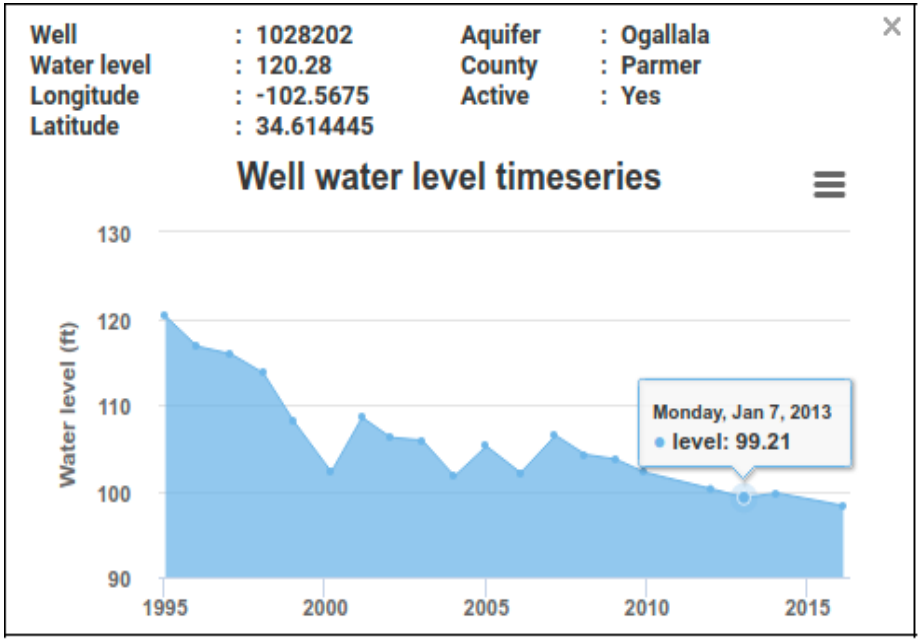
Between counties water logistics



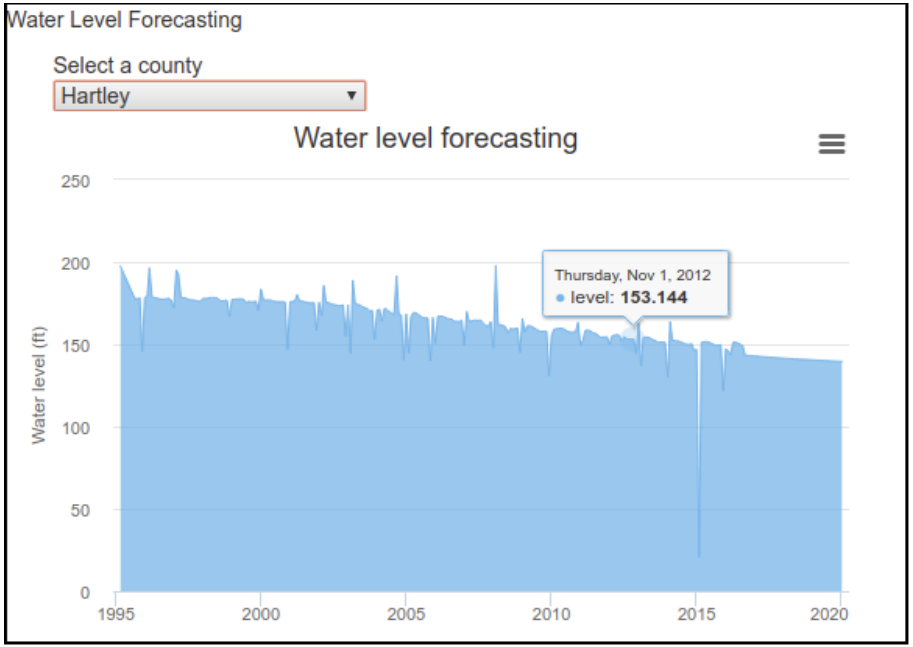
Between wells water logistics

Demonstration 2 - Water Trend and Forecast

Water trend with time series data



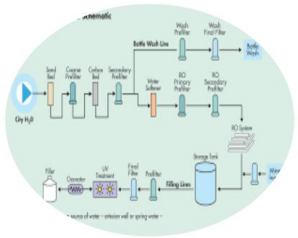
Water forecasting



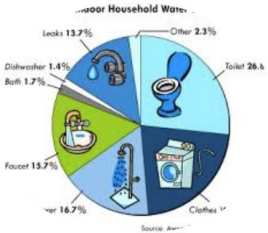
Demonstration 3 - Knowledge Sharing

Water related topics

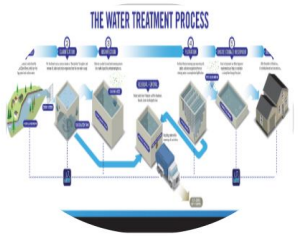
1. WATER SOURCES



2. WATER PROCESSING



3. WATER USAGE



4. WATER TREATMENT

Water related sub-topics

Water Processing

CATEGORY

Bottled water processing

Purified water

Recreational water

Bottled water processing

The Bottled Water Purification Process

A trip to the local grocery store and a walk down the beverage aisle will reveal dozens of varieties of bottled water. From big, two gallon jugs with spouts to mini bottles that can fit in a lunch box, there are kinds galore. But many may take for granted to process that takes place to get that water from the source, safely into the bottle and into our lives.

more...

(5)

Texas Water Development Board

Bottling Process & Tour

Welcome to our bottling plant!! While pictures don't really do it justice, we've assembled a few photos to give you an idea of how the whole thing works. We start with racks of empty bottles collected by our route managers. When they pick up your bottles at your home or office, they inspect each of them for cleanliness and put them into these blue racks. Once the racks arrive at the bottling line, the bottles are again inspected visually and the each bottle is sniffed for any foreign contaminants. Once a bottle passes these inspections, it is loaded onto the washer conveyor.

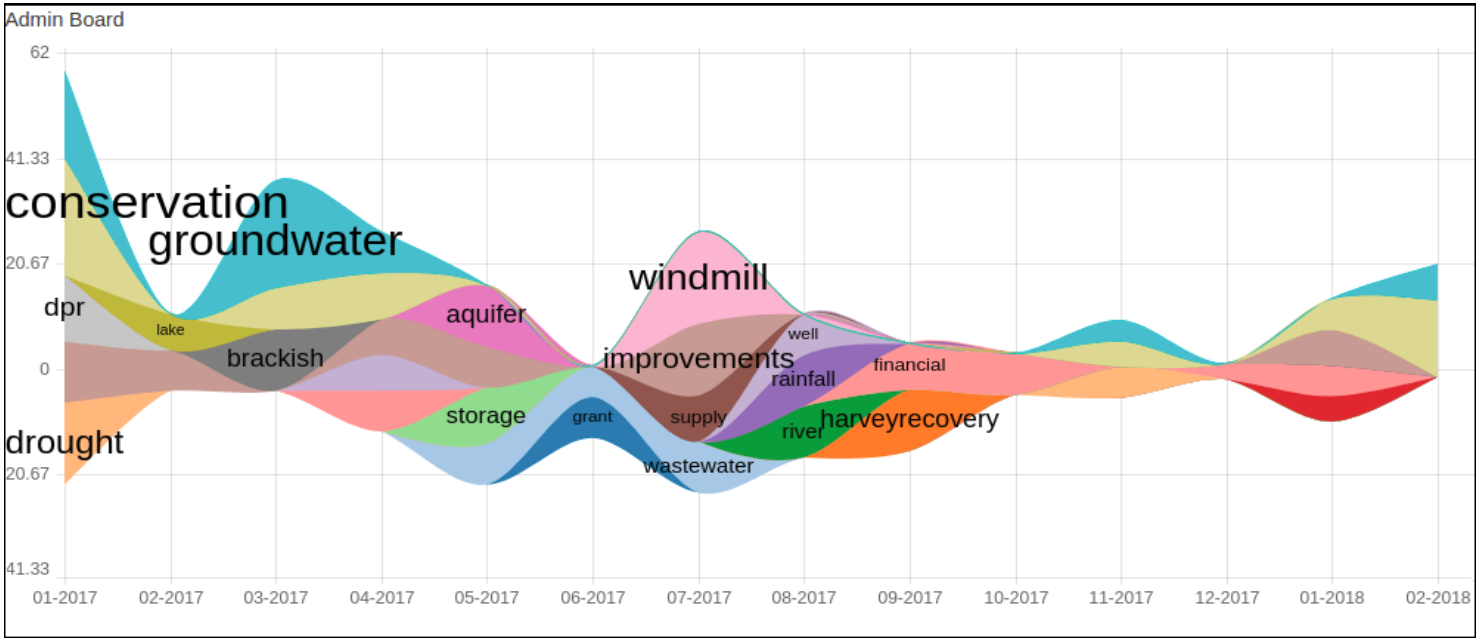
more...

(3)

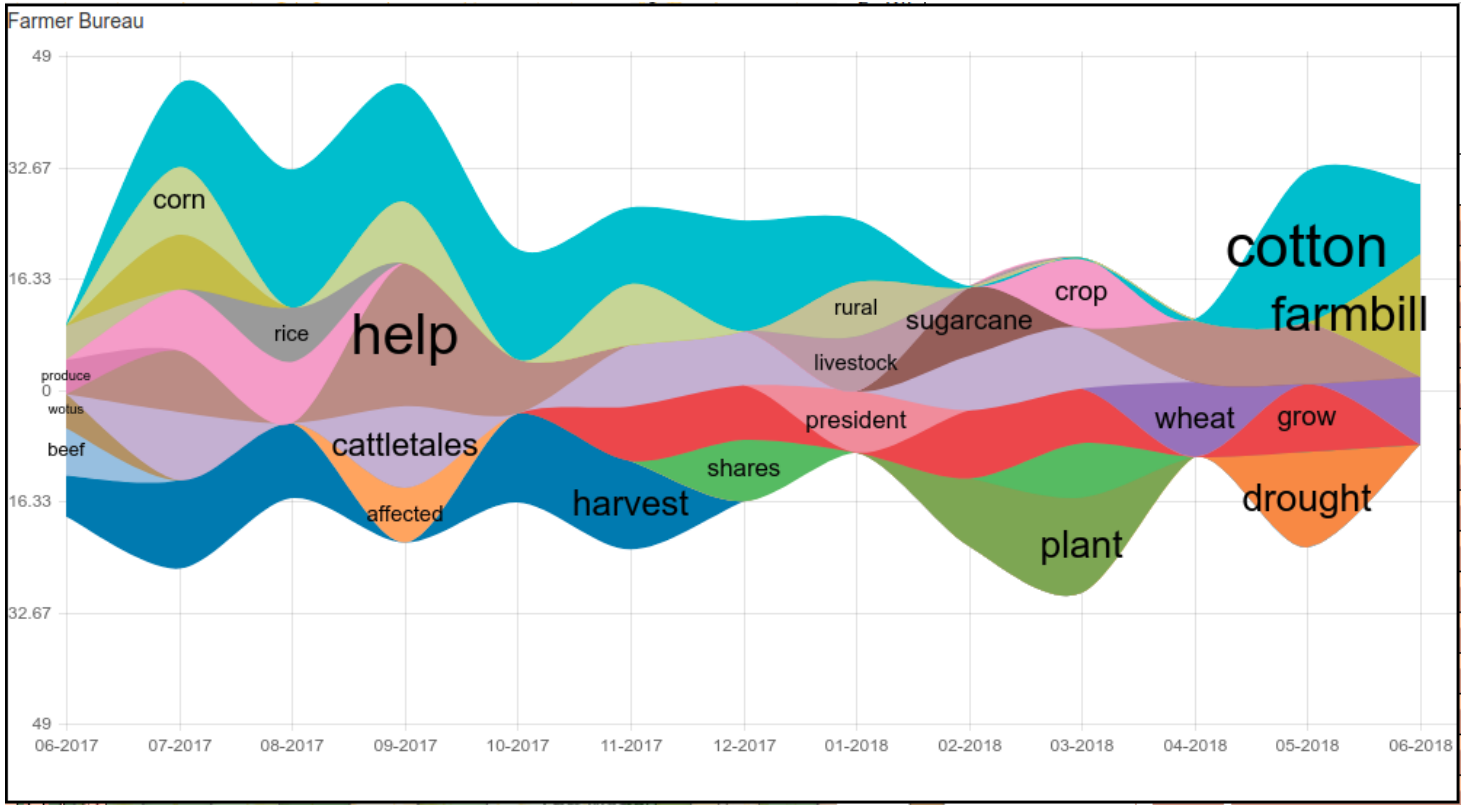
Texas Water Development Board

Demo 4 - Concerns from Texas Water Development Board

What are the HOTTEST concerns?



Demonstration 5 - Concerns from Farmer Bureau



Online Demo

http://myweb.ttu.edu/fjin/projects/west-tx-water/

Thank you

Q & A


감사합니다
Natick
Grazie
Danke
Ευχαριστίες
Dalu
Obrigado
Thank You
Köszönöm
Tack
Спасибо
Dank
Gracias
谢谢
Merci
Seé
ありがとう