Water Use In the Eagle Ford Shale Play: A Systems Dynamics Approach

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Project Overview

• Objectives of Study:
  – Assess localized water use impacts from Eagle Ford shale play
  – Utilize a Systems Dynamics approach
    • The approach requires input from many different stakeholders
  – Output: policy recommendations and potential goals for policymakers

• Accessing data only made publicly available
  – FracFocus

• Timeline of Study
  – Approximately 5 months
Federal vs. State vs. more localized

- Federal Level
  - Different shale plays have different attributes that are not uniform across the nation

- State Level Water Usage (TWDB State Water Plan, 2012)
  - Mining (includes O&G development) uses approximately 1.6% of the water used in the state
  - Use from mining expected to decrease by 2060
  - Shale play development significantly different in each region of Texas

- Local Level?
Water Use Difficult to Track

Nicot, 2013
State of the Eagle Ford Area: GROWTH

• Tremendous growth since 2008

• Texas experiencing drought conditions through this extreme growth period
Wells and County Locations

- Gonzalez
- Dimmit
- DeWitt
Region L: Water Use

- Complexity of users
- Groundwater is a major source of water in region
- Mining a small amount compared to irrigation and municipal in region
- These numbers not always correct, as we have seen

<table>
<thead>
<tr>
<th>REGION L (acre-feet)</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
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</thead>
<tbody>
<tr>
<td>MUNICIPAL</td>
<td>395,996</td>
<td>451,111</td>
<td>503,375</td>
<td>547,136</td>
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<tr>
<td>MANUFACTURING</td>
<td>119,310</td>
<td>132,836</td>
<td>144,801</td>
<td>156,692</td>
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<tr>
<td>MINING</td>
<td>14,524</td>
<td>15,704</td>
<td>16,454</td>
<td>17,212</td>
</tr>
<tr>
<td>STEAM ELECTRIC</td>
<td>46,560</td>
<td>104,781</td>
<td>110,537</td>
<td>116,068</td>
</tr>
<tr>
<td>LIVESTOCK</td>
<td>25,954</td>
<td>25,954</td>
<td>25,954</td>
<td>25,954</td>
</tr>
<tr>
<td>IRRIGATION</td>
<td>379,026</td>
<td>361,187</td>
<td>344,777</td>
<td>329,395</td>
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<tr>
<td>REGION L TOTAL</td>
<td>981,370</td>
<td>1,091,573</td>
<td>1,145,898</td>
<td>1,192,457</td>
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</tbody>
</table>

Source: TWDB, 2010
Region L: Water Stresses

U.S. Drought Monitor

Texas

July 16, 2013
Valid 7 a.m. EST

Drought Conditions (Percent Area)

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>D1-D4</th>
<th>D1-D4</th>
<th>D2-D4</th>
<th>D3-D4</th>
<th>D4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>0.30</td>
<td>99.70</td>
<td>64.38</td>
<td>70.99</td>
<td>33.43</td>
<td>12.07</td>
</tr>
<tr>
<td>Last Week (07/09/2013)</td>
<td>0.58</td>
<td>99.42</td>
<td>61.60</td>
<td>75.22</td>
<td>34.70</td>
<td>12.20</td>
</tr>
<tr>
<td>3 Months Ago (04/09/2013)</td>
<td>1.29</td>
<td>98.71</td>
<td>61.31</td>
<td>72.30</td>
<td>34.82</td>
<td>12.19</td>
</tr>
<tr>
<td>Start of Calendar Year (01/01/2013)</td>
<td>3.04</td>
<td>96.96</td>
<td>87.00</td>
<td>65.39</td>
<td>35.03</td>
<td>11.96</td>
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<tr>
<td>Start of Water Year (09/25/2012)</td>
<td>9.13</td>
<td>90.87</td>
<td>78.73</td>
<td>57.41</td>
<td>24.91</td>
<td>5.18</td>
</tr>
<tr>
<td>One Year Ago (07/07/2012)</td>
<td>4.49</td>
<td>95.51</td>
<td>77.23</td>
<td>39.41</td>
<td>9.08</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu

Released Thursday, July 18, 2013
Richard Heim, National Climatic Data Center/NOAA

- Drought
- Unmet irrigation needs
- Increasing needs for more water through 2060 projections
- Increasing population
- County Level Water Usage
  - Reliance on GMA’s & GCD’s to implement some regulation on GW usage in region
    - Evergreen GCD
    - Wintergarden GCD
Eagle Ford Task Force Report (RRC, 2013)
- Movement of industry from slickwater fracs (use more water) to gel fracs (use less water) since 2007
- Average: 850 gallons of water/ft of fracture
- About 5 million gallons of water per well (or about 15 acre-feet)
- Carrizo-Wilcox Aquifer covers 80% of EF region – will most likely be able to handle load
- “Water Market” created in EF between landowners and O&G industry
- Produced water is a future source for hydraulic fracturing operations

UT study (Nicot, 2012)
- Potential O&G water use to have large local impacts
- Data set for EF less certain than other shale plays
- Est. 90% of water initially injected in EF is GW
- Est. 20% of water used is brackish
- Est. 0% recycling/reuse water
- Fresh water use in TX will decrease & strong increase in use of brackish
• Ceres Study (Freyman, 2013)
  – Over 51% of TX wells in FracFocus database were in high water stress areas
• Texas House Natural Resources Committee Interim Report (2013)
  – Projected O&G demand for water in EF is ~ 5.5 – 6.7% of total water demand in that region
  – EF had over 3,000 permits issued, where ½ of those were drilled using ~6.1 million gal/well

– Over next 20 yrs. ~25,000 new wells will be drilled in EF
– Differences between EF northern and southern sections
  • Difficult to predict and manage GW availability
– Wintergarden GCD – impact to water supply should be assessed by local scale
  • 1/3 of avg. annual recharge in Carrizo-Wilcox Aquifer required to develop EF
  • Recharge rates slower than pumping rates in historical past of aquifer
Major Assumptions for this Study

- Most water use quantities reported on FracFocus are for entire life cycle of well
  - Hydraulic fracturing makes a large component of that amount
- Water is consumed, not just withdrawn
- Most wells in region are horizontal, not vertical
Stakeholder Input:
– Oil and Gas Industry
– Policymakers and advisors (both state and federal)
– Local and other public representatives
– Water users, planners, and regulators
– Academia
– Environmental Entities
– Landowners
Methods: Trends

- “Trend” method – 5% off the top and the bottom of the data to create an average without outliers
- FracFocus
  - DeWitt, Dimmit, and Gonzales county analyses
- SkyTruth
  - 27 county analysis of average water trends for Eagle Ford
- Sky Truth vs. FracFocus
  - Difference between these two on a large scale not significant when assessing just average water use trends from the FracFocus header data
  - *Note: More in-depth analysis will be needed to if assessing beyond average trends*
Challenges to Research

• Talking to industry – variable input
• Collaboration
• Accessing information
  – Quality control of data & data validation
• FracFocus database:
  – Prior to June 2013, database validity checks not as strong as current version implements
  – Voluntary input in 2011, 2012, and part of 2013 within Texas
• Data consistency lacking due to structural database changes, voluntary submission, and ease of database maneuverability to gather research in a timely manner
Eagle Ford Region Findings

• Approximately 5 million gallons of water used per a well in region

• Although increasing average trend of water use can be seen, this is most likely due to large growth in region

• Major companies in region have variable average water use trends
County Findings

• DeWitt
  – Average use: 3.4 million gallons per well
  – Since 2011, no foreseeable trend of water use with current data

• Dimmit (most activity of the three counties)
  – Average use: 5.6 million gallons per well
  – Increases over time, could be due to other factors

• Gonzales (least activity of the three counties)
  – Average use: 3.8 million gallons per well
  – Since 2011, no foreseeable trend
Visible Trends & Other Considerations

• Most operators source the water themselves (not the service companies)
  – Usually means groundwater wells
• Disconnect between what water planners are planning for and actual mining use
  – Need to further assess
• A relatively slow industry trend towards brackish water use in area
  – Brackish water use highly variable by company

• Other things to consider in further analysis:
  – Population growth from EF eco. development
  – Changing water use demands of O&G because of recycling/reuse, market fluxes, and other factors (scenarios)
  – Other water stresses and competition (i.e. irrigation in region and GW recharge)
Policy Recommendations

- Promote tracking of sources of water used for O&G operations
- Promote transparency and ease of access to information
- Promote water plans that:
  - Account for O&G operations during drought planning, especially for water stressed localities
  - Considered scenarios of changes of water demand by O&G industry over projection time periods
  - Although mining is a small portion on a large scale, localized affects should be assessed in water stressed regions
- Promote O&G industry to have effective water management plans for every well site
  - Plans that include an assessment of water use in that area
- Promote policymakers and regulators to have more inclusive definitions in regulations and laws
Questions?

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Shale Play Development

Lower 48 states shale plays

Source: Energy Information Administration based on data from various published studies. Updated: May 9, 2011
Texas Overview

• State & Local Regulators:
  – Texas Railroad Commission
  – Texas Commission on Environmental Quality
  – Groundwater Management Areas
  – Groundwater Conservation Districts

• Recent regulations:
  – RRC: Hydraulic Fracturing Disclosure Rule - O&G required to submit to Fracfocus.org (since Feb. 2013)
  – RRC: Amendment to recycling/reuse rules to make these technologies easier to utilize
Major Aquifers in Region

Edwards (Balcones Fault Zone) Aquifer

Carrizo-Wilcox Aquifer

TWDB, 2013
### Water Use for Counties in 2010

<table>
<thead>
<tr>
<th>County</th>
<th>MUNICIPAL</th>
<th>MANUFACTURING</th>
<th>MINING</th>
<th>LIVESTOCK</th>
<th>IRRIGATION</th>
<th><strong>Total</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DIMMIT COUNTY</strong></td>
<td>834,504,411</td>
<td></td>
<td>326,828,553</td>
<td>179,869,752</td>
<td>3,457,604,961</td>
<td>4,798,807,677</td>
</tr>
<tr>
<td><strong>GONZALES COUNTY</strong></td>
<td>1,338,595,908</td>
<td>782,042,400</td>
<td>9,123,828</td>
<td>1,776,865,503</td>
<td>424,909,704</td>
<td>4,331,537,343</td>
</tr>
</tbody>
</table>

*Note: Data represents the water usage for specific purposes in 2010 for each county.*