TAMEST Shale Task Force

Read the Report: tamest.org/shaletaskforce

TAMEST Shale Task Force Report:

Environmental and Community Impacts of Shale Development in Texas

Agenda:

- Introduction: Mary Beth Maddox, TAMEST
- Report Overview: Christine Economides, Task Force Chair
- Chapter Presentations:
  Seismicity; Land; Water; Air; Transportation;
  and Economic and Social Impacts
- Q&A

- Submit questions through GoToWebinar (in “Questions” field)
- Follow-up interviews are available; contact info will be emailed at end of webinar
- Briefing will be recorded and archived
- Website: TAMEST.org
- Social: #ShaleReport

About TAMEST

Mary Beth Maddox

Executive Director

The Academy of Medicine, Engineering and Science of Texas (TAMEST)

About TAMEST

- TAMEST is Texas' premier scientific organization, bringing together the state's best and brightest scientists and researchers.
- TAMEST membership includes all Texas-based members of the National Academies of Sciences, Engineering and Medicine and the state's Nobel Laureates.
- 18 research universities are affiliates of TAMEST.

About TAMEST

- TAMEST works to promote Texas as a destination for outstanding research, supports rising star researchers in the state and serves Texas as an intellectual resource.
- The TAMEST Board of Directors commissioned this National Academies-style study to help inform state policymakers and the public.
- The task force includes expert representation by academia, industry, an NGO and government.

Shale Task Force

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Report Overview

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Report Overview

Christine Ehlig-Economides, Ph.D. (NAE)

TAMEST Shale Task Force Chair

Professor and Hugh Roy and Lillie Cranz Cullen Distinguished University Chair

University of Houston

Statement of Task

- Evaluate the scientific basis of available body of information
- Communicate current state of knowledge
- Key steps:
  - Review methodologies and approaches
  - Identify gaps
  - Suggest improvements
  - Make recommendations

Task Force Membership

Christine Ehlig-Economides – Chair

Air

David Allen – Lead

Ramón Alvarez

Matthew Harrison

Land

Melinda Taylor – Lead

Joseph Fitzsimons

Tracy Hester

Water

Danny Reible – Lead

Denny Bullard

Michael Young

Seismicity

Brian Stump – Lead

Kris J. Nygaard

Craig Pearson

Transportation

John Barton – Lead

Cesar Quiroga

General

Amelie G. Ramirez

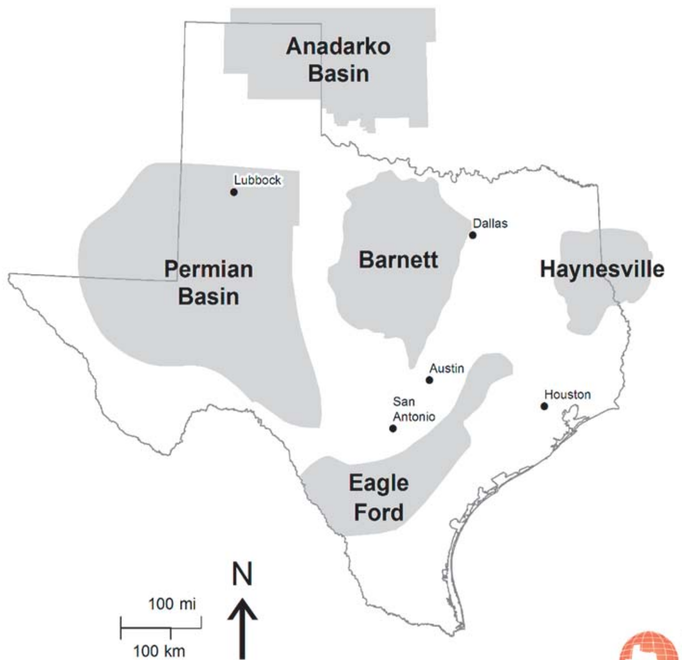
Economic/Social

Gene Theodori – Lead

Omar Garcia

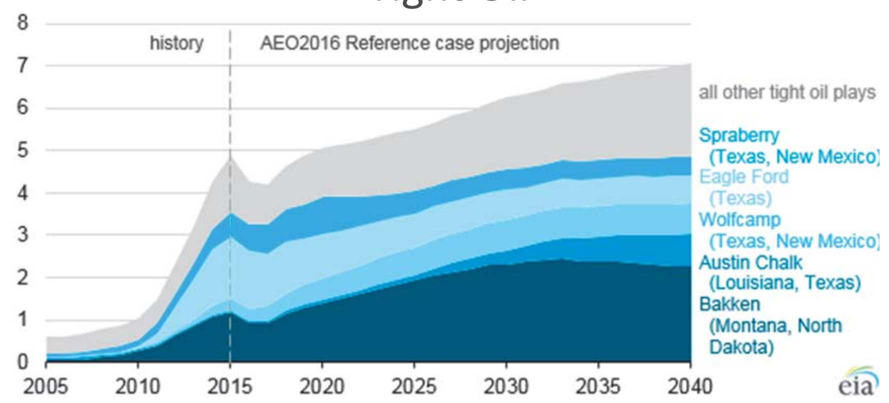
Urs Kreuter

The Texas Shale Experience

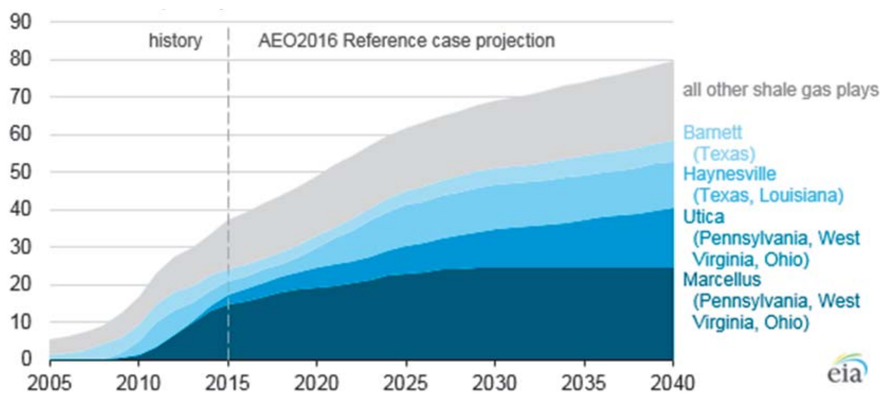


BUREAU OF ECONOMIC GEOLOGY

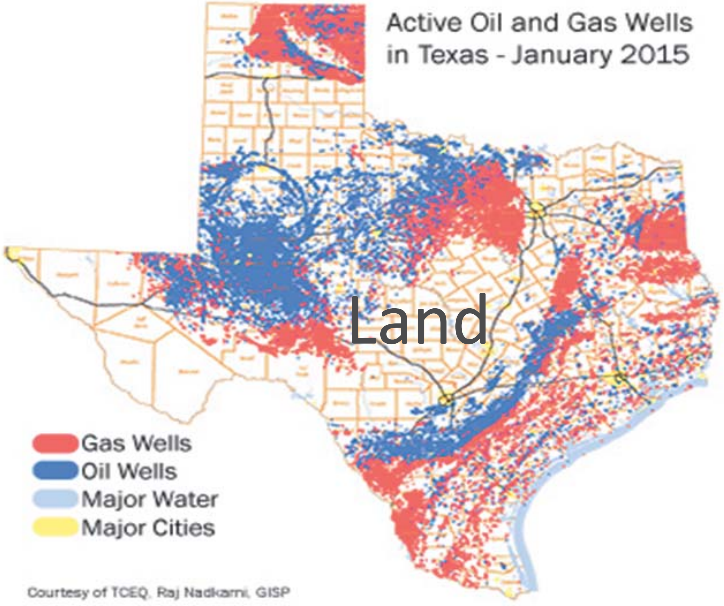
Tight Oil

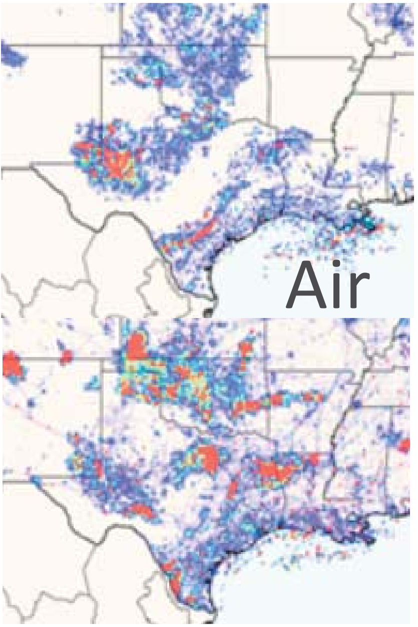


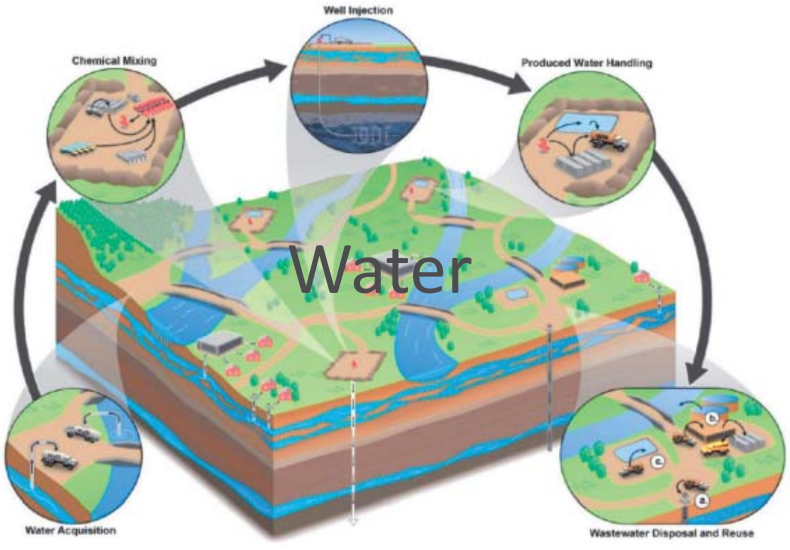
Natural Gas

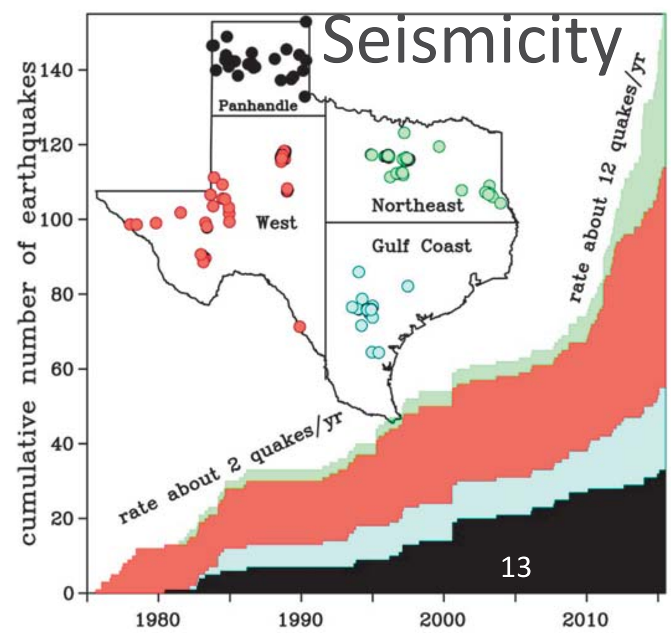


Environmental Impacts

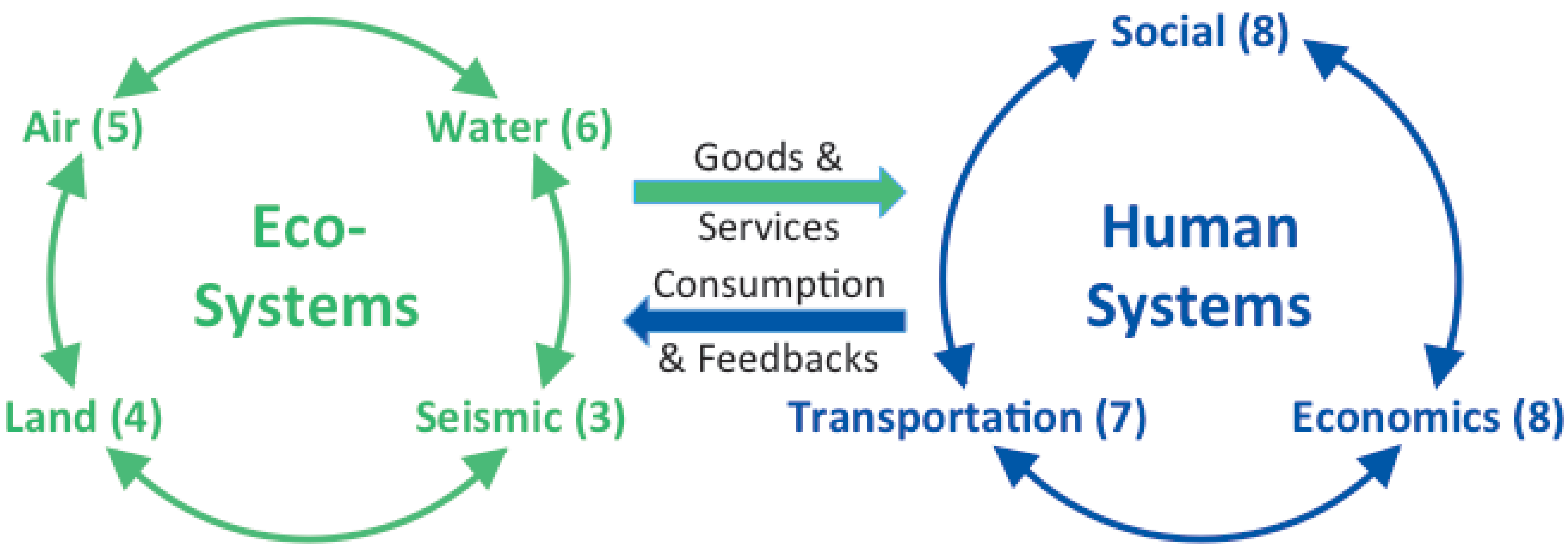








Way Forward



Transdisciplinary Connections, Trade-offs, and Decision Making

Geology and Earthquake Activity

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Geology and Earthquake Activity

Brian Stump, Ph.D.

Albritton Professor of Earth Sciences
Dedman College of Humanities and Sciences
Southern Methodist University

Geology and Earthquake Activity

TAMEST Shale Task Force

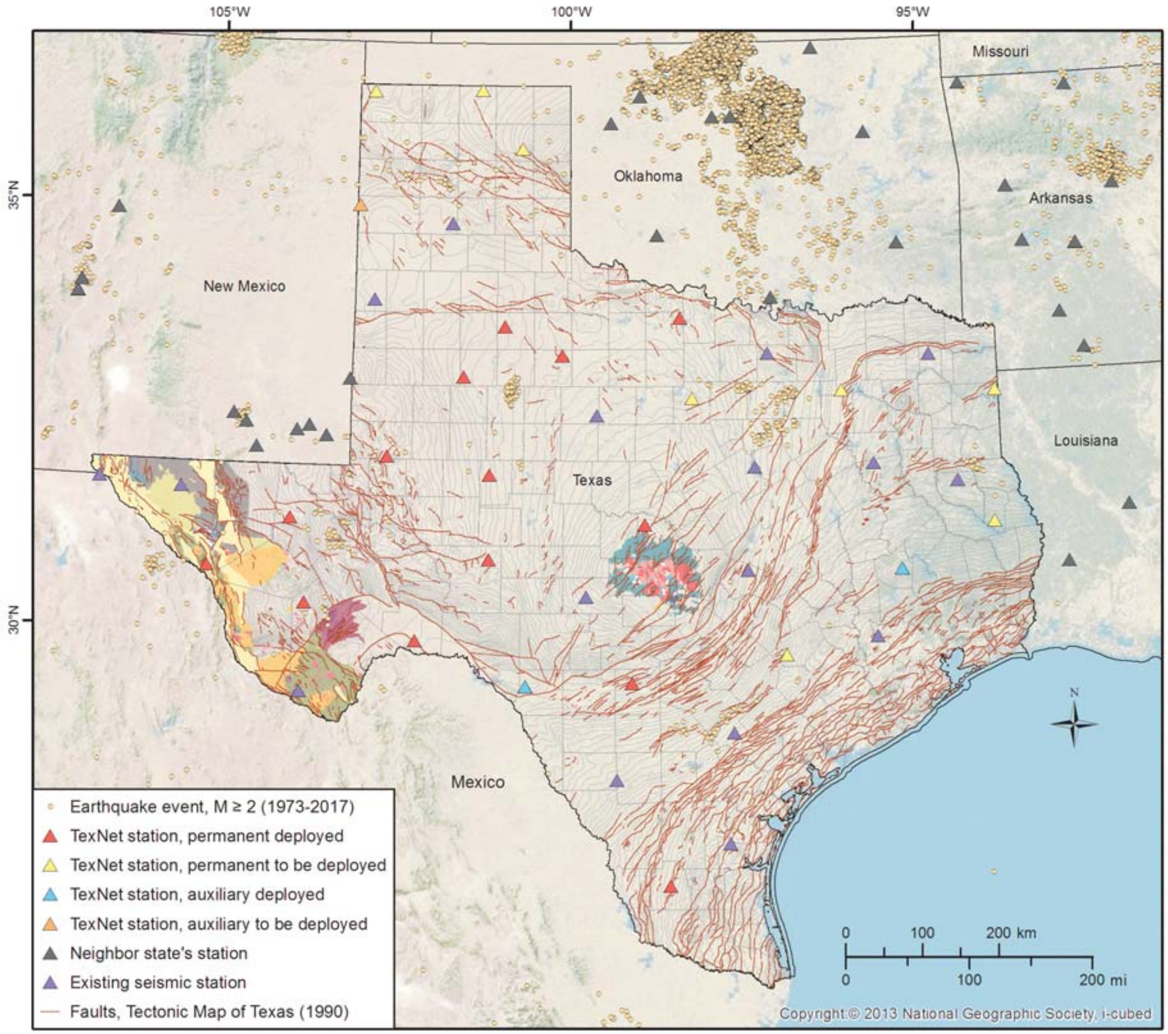
- **Geologic faults are ubiquitous across Texas; these faults are poorly and incompletely characterized, with the majority of known faults in the subsurface in Texas stable and not prone to generating earthquakes.**

- **Earthquakes have increased in Texas. Before 2008, Texas recorded about 2 earthquakes a year. Since then, there have been about 12-15 a year.**

- **Some of these earthquakes are linked to wastewater disposal from oil and gas development, not with hydraulic fracturing.**

- **Seismic monitoring stations in Texas are increasing from 18 to 43 with TexNet**.

- **Wastewater disposal wells near earthquake locations now must receive special approval from state regulators.**



Geologic faults are ubiquitous across Texas; these faults are poorly and incompletely characterized with the majority of known faults in the subsurface in Texas stable and not prone to generating earthquakes.

SOURCE: BEG, 2016 (after Ewing, 1991).

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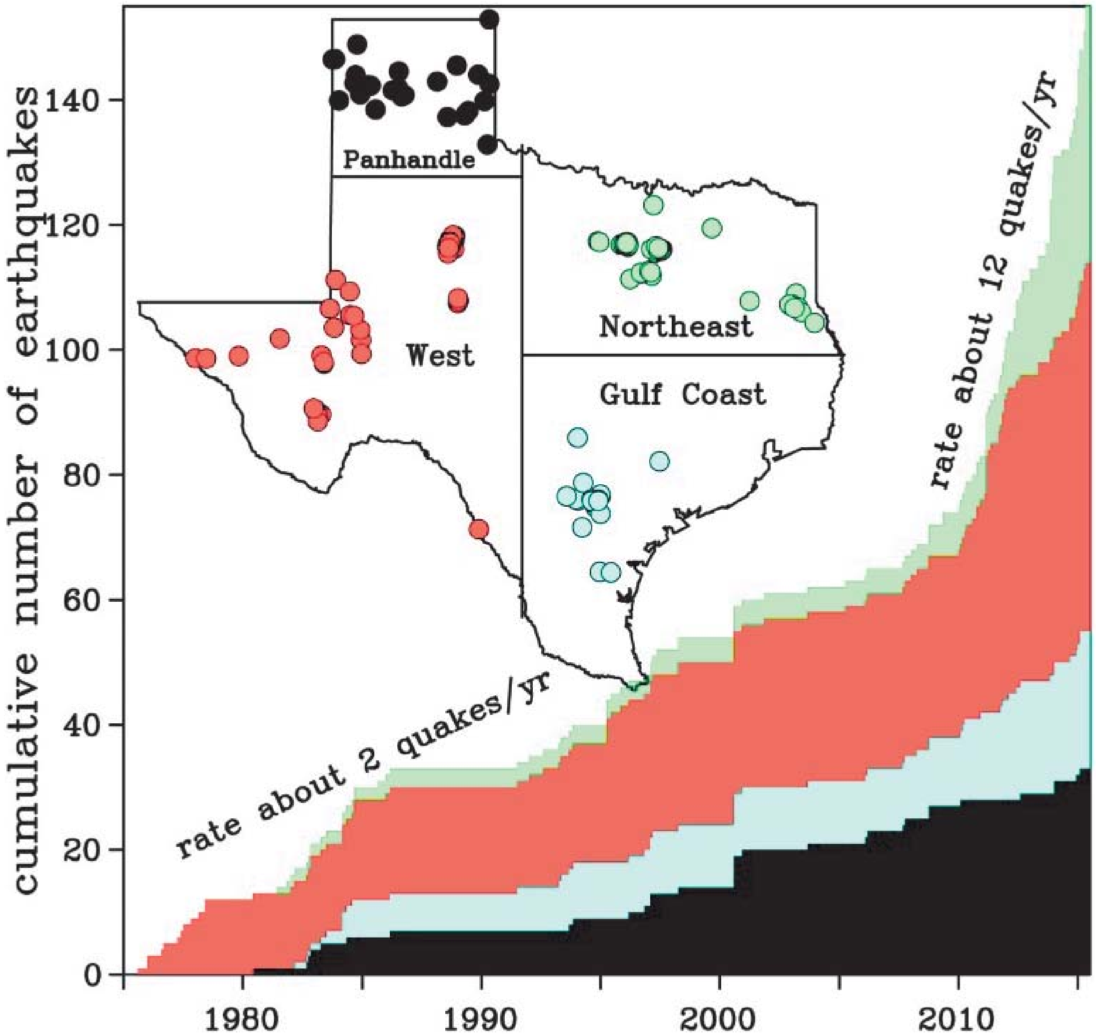
Texas Seismic Events since 1975 with Magnitude of 3.0 or Above



Earthquakes have increased in Texas. Before 2008, Texas recorded about 2 earthquakes a year. Since then, there have been about 12-15 a year.

SOURCE: Frohlich et al., 2016.

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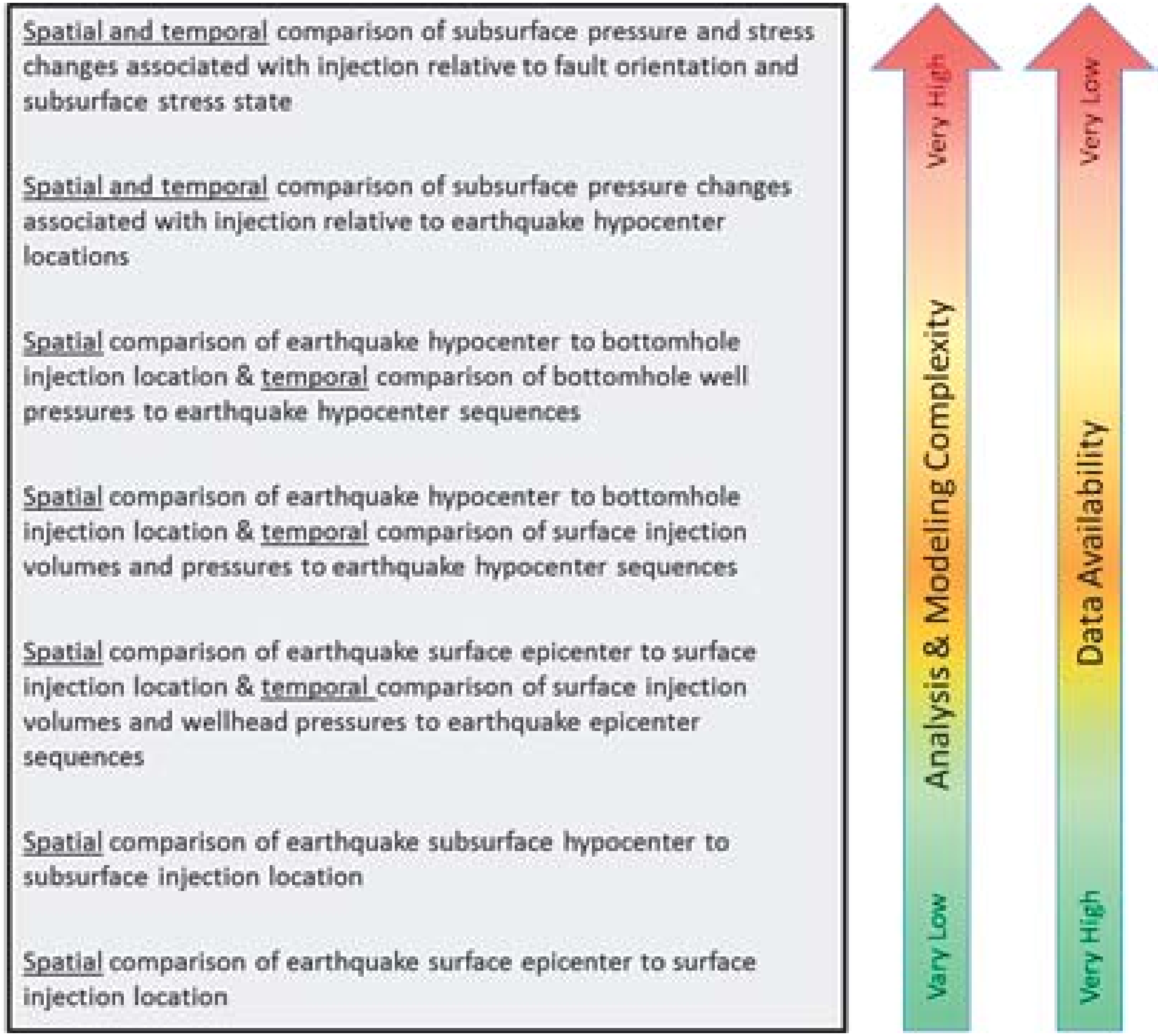
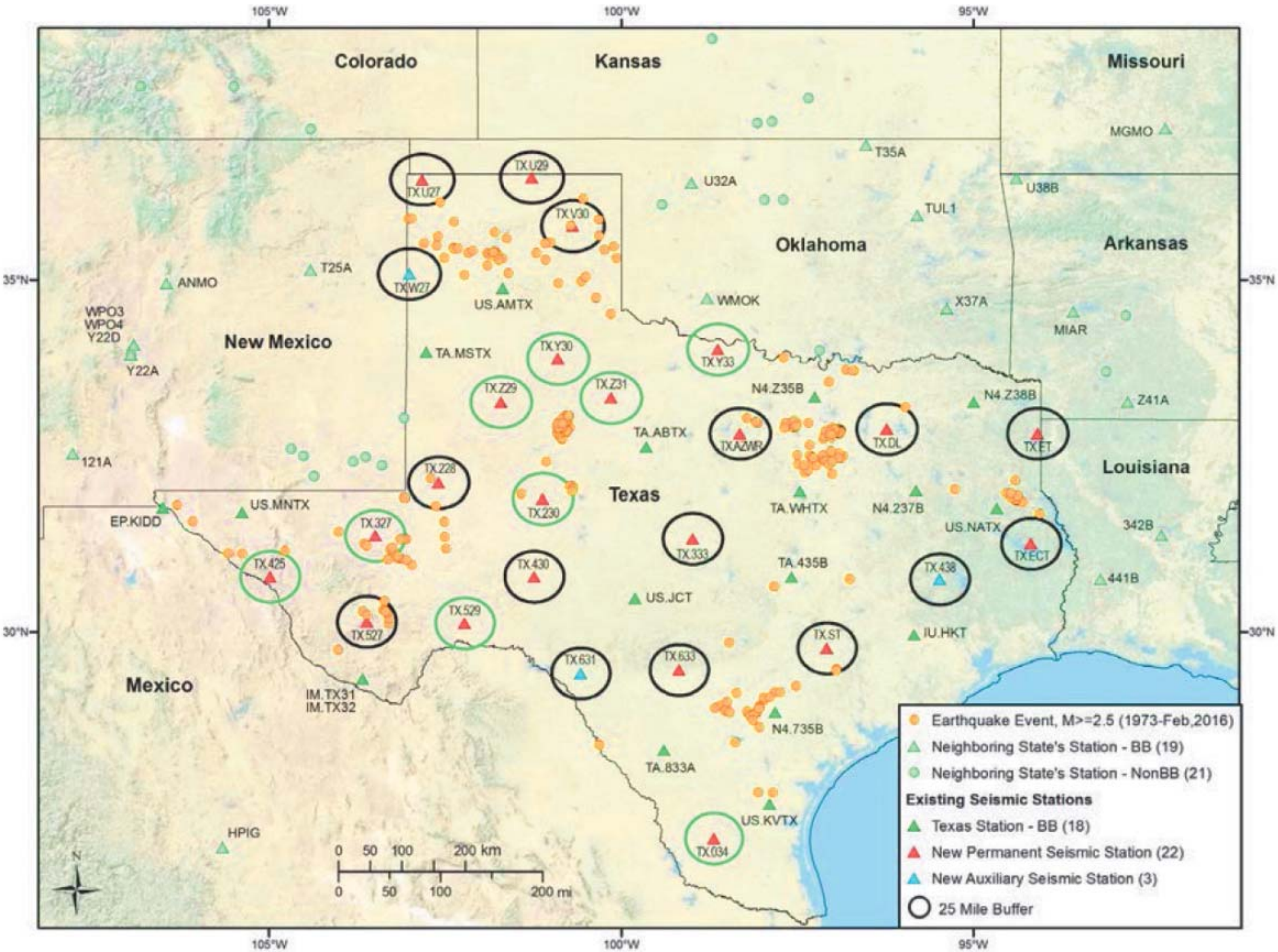


Some of these earthquakes are linked to wastewater disposal from oil and gas development, not with hydraulic fracturing.

SOURCE: Groundwater Protection Council and Interstate Oil and Gas Compact Commission, 2015.



Seismic monitoring stations in Texas are increasing from 18 to 43 with TexNet.

SOURCE: BEG, 2016.

Recommendations

- **Future geologic and seismological research initiatives should develop improved and transparent approaches that seek to balance concerns surrounding data handling and sharing, and that promote sharing of data.**

- **Development of a common data platform and standardized data formats could enable various entities collecting data to contribute to better data integration. It also could facilitate interdisciplinary collaboration directed toward mitigation and avoidance of induced seismicity.**

- **The TexNet goals address an integrated research portfolio that considers seismicity analysis, geologic characterization, fluid-flow modeling, and geomechanical analysis.**

Land Resources

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Land Resources

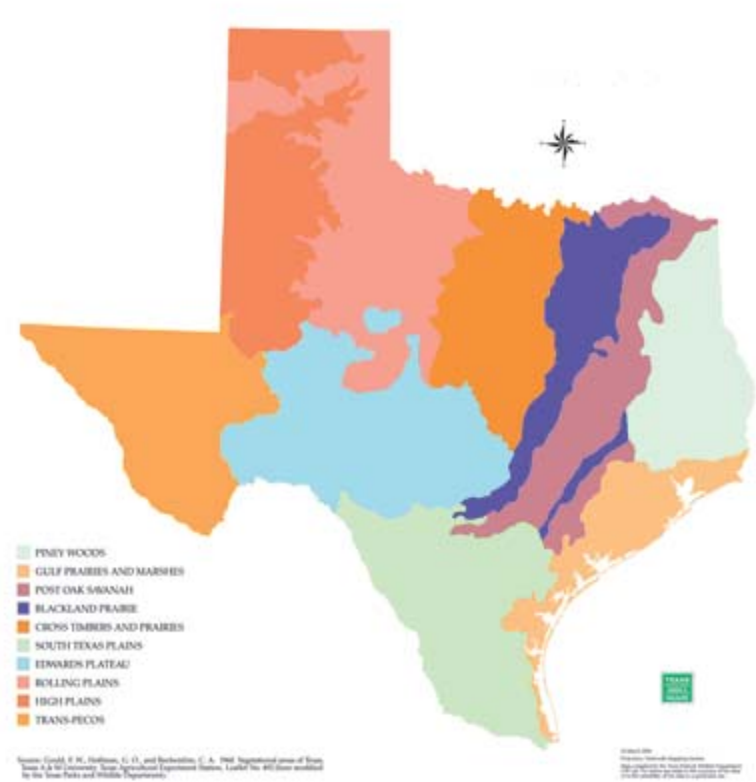
Melinda Taylor, Ph.D.

Senior Lecturer and Executive Director of the Kay Bailey Hutchison Center for Energy, Law, and Business

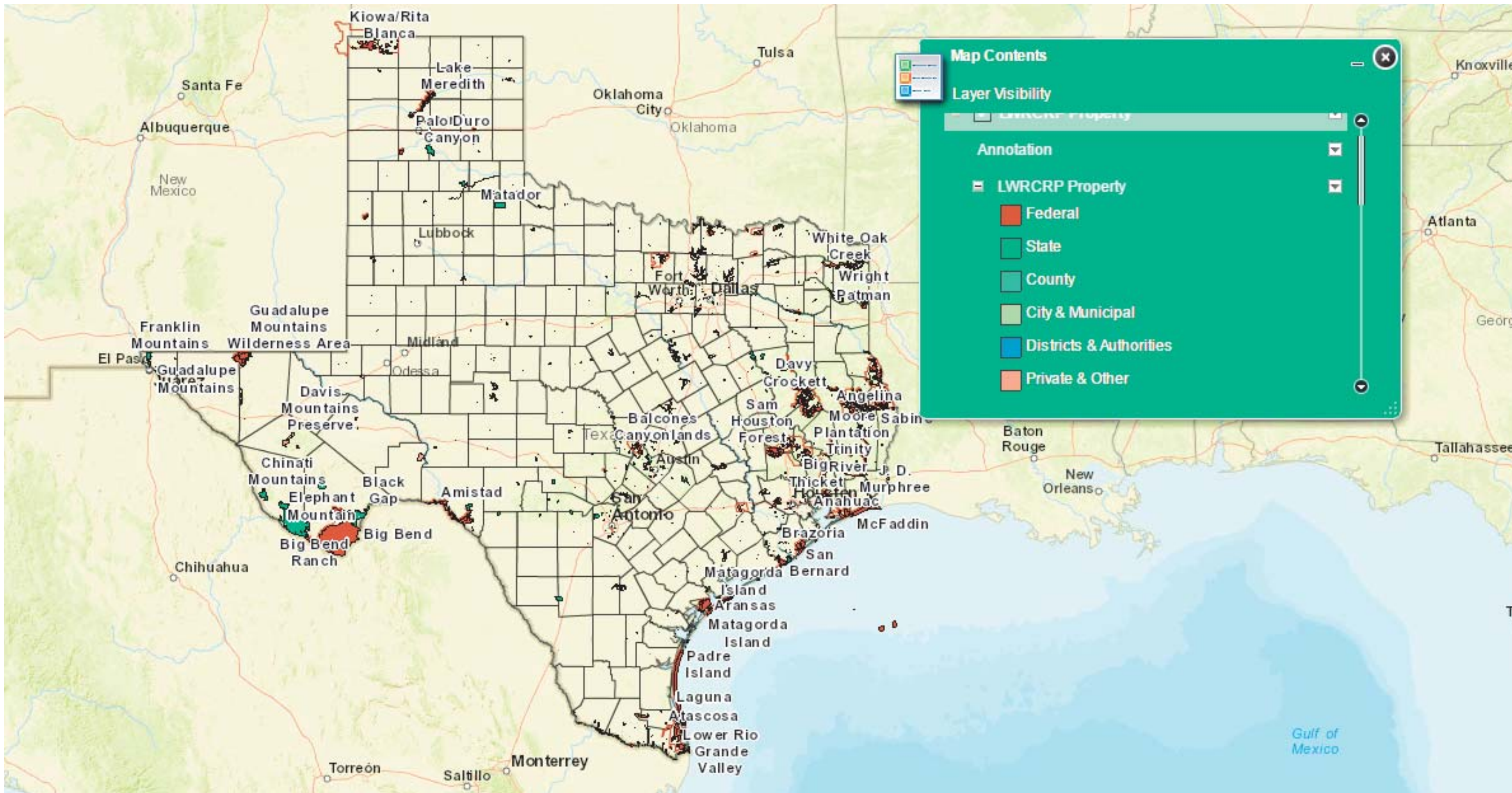
The University of Texas School of Law

Texas is Unique

- Large geographic area (266,807 square miles)
- Dramatic climatic variations from north to south and east to west
- Second highest number of species (6,273 plants and animals)
- 10 “ecoregions”

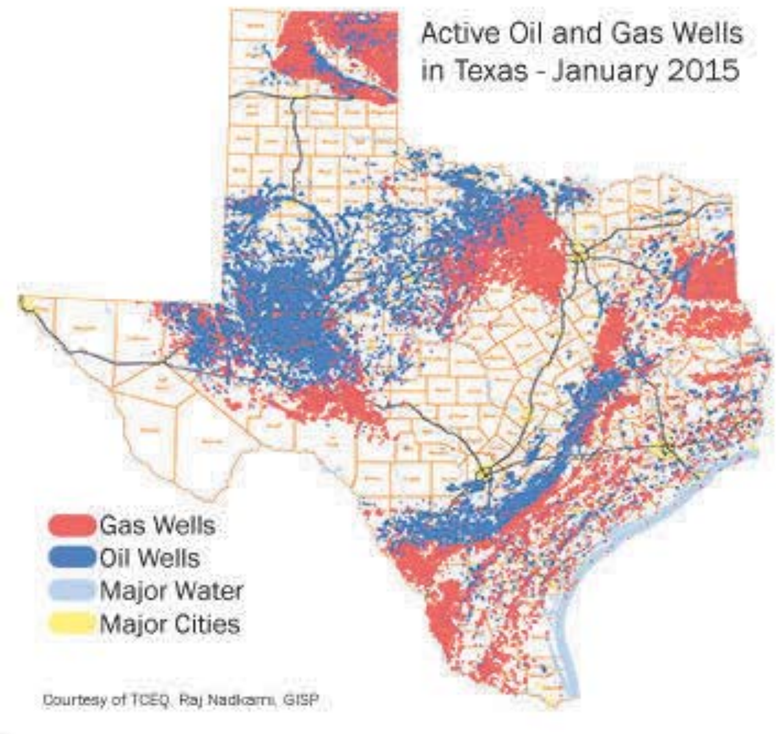


Texas has Little Public Land



Onshore Oil and Gas Production Occurs Mainly on Private Lands

- Few baseline studies have been conducted
- Significant increase in drilling since 2007
- Most counties in Texas have oil and gas wells
- Land impacts include: habitat fragmentation, soil erosion, vegetative changes, soil contamination, loss in property values



Impacts to Natural Resources of Texas: Fragmentation

- 1.5-3.1 hectares cleared for every well pad
- 26,000 well permits issued in 2014
- Pipelines, roads add to fragmentation
- Effects of fragmentation are not well understood
- Most comprehensive data exists for Dunes Sagebrush Lizard and Lesser Prairie Chicken

Impact to Landowners of Texas: Surface Damages

- With no mineral rights, surface owners have little leverage over producers
- Two year statute of limitation for damages (even if they were undetectable)
- Texas is the only major shale-producing state without a surface damage statute

Recommendations

- Baseline land and habitat conditions at the oil and gas play level should be characterized, and changes to wildlife populations and vegetation should be tracked over time.
- The effectiveness of voluntary programs to conserve at-risk species should be studied, along with options for incentives to conserve at-risk species and reduce effects on land resources by oil and gas development activities.
- Advantages and disadvantages of adopting a surface damages act to address the gaps in legal protection for landowners who do not own the minerals associated with their property should be evaluated.
- The existing, nonproprietary information about land impacts of shale development that is collected and evaluated by multiple state and federal agencies should be assembled and made available online to the public.

Air Quality

Read the Report: tamest.org/shaletaskforce

Air Quality

David Allen, Ph.D. (NAE)

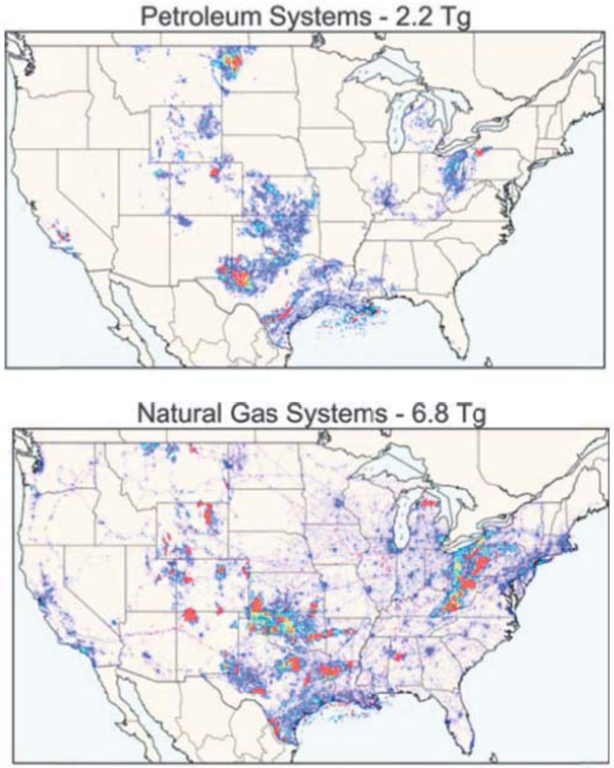
Melvin H. Gertz Regents Chair in Chemical Engineering

Cockrell School of Engineering

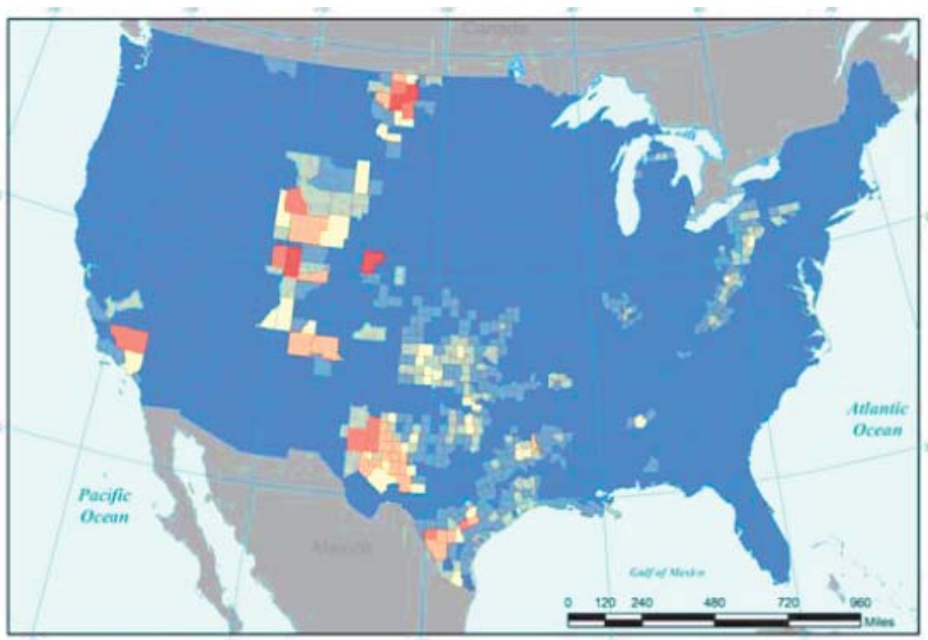
The University of Texas at Austin

The production of shale resources results in emissions of greenhouse gases, photochemical air pollutants, and air toxics.

Greenhouse gas (methane) upstream and processing emissions



Volatile organic compound upstream oil and gas emissions



Recent federal and state regulations have reduced emissions from multiple types of emission sources.

Examples: Federal

- New Source Performance Standards OOOO and OOOOa:
  - Requirements of reduced emission well completions for gas wells
  - Tanks with potential emissions of >6 tons/yr must have emission controls
  - Leak Detection and Repair Standards

Examples: State

- State permits can require emission controls beyond federal standards, particularly in regions that do not meet National Ambient Air Quality Standards

Emissions in many categories associated with shale resource production are dominated by a small sub-population of high-emitting sources.

Case study: two source categories for methane emissions

- ~50,000 wells (of the roughly 500,000 natural gas wells in the United States) vent during a process referred to as a liquid unloading, a small fraction (~3 to 5%) likely account for half of unloading emissions

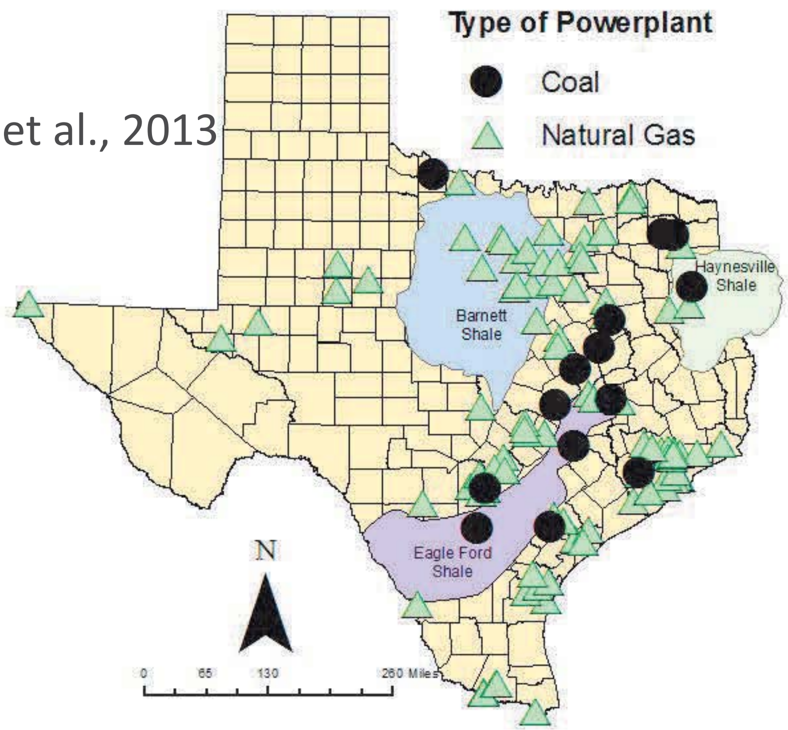
- Pneumatic controllers use pressurized natural gas to control the opening and closing of control valves, and are estimated to be the largest source of methane emissions in the petroleum and natural gas supply chains; ~20 percent of pneumatic controllers at natural gas sites account for 95 percent of pneumatic controller emissions

Development of inexpensive, robust, reliable, and accurate methods of rapidly finding high-emitting sources has the potential to reduce emissions.

Optical Gas Imaging Camera being used to scan a wellhead for leaks (Source: University of Texas)

Shale resource development both directly and indirectly impacts air quality. Indirect impacts include reductions in emissions associated with the substitution of natural gas for coal in electricity generation. Comprehensive assessments of both direct and indirect impacts to air quality from the production of shale resources are complex.

Pacsi, et al., 2013



- Electricity generation and emissions from natural gas power plants increase
- Electricity generation and emissions from coal power plants decrease
- Production and emissions in natural gas production regions increase
- Net: Decreases in emissions state-wide

There is limited information concerning exposures to air toxics emissions and their corresponding health impacts. Targeted research in this area should be conducted

Source: TCEQ

Eagle Mountain Lake site, operated by the TCEQ in the Barnett Shale, makes hourly measurements of dozens of hydrocarbons

Water Quantity and Quality

Read the Report: tamest.org/shaletaskforce

Water Quantity and Quality

Michael Young, Ph.D.

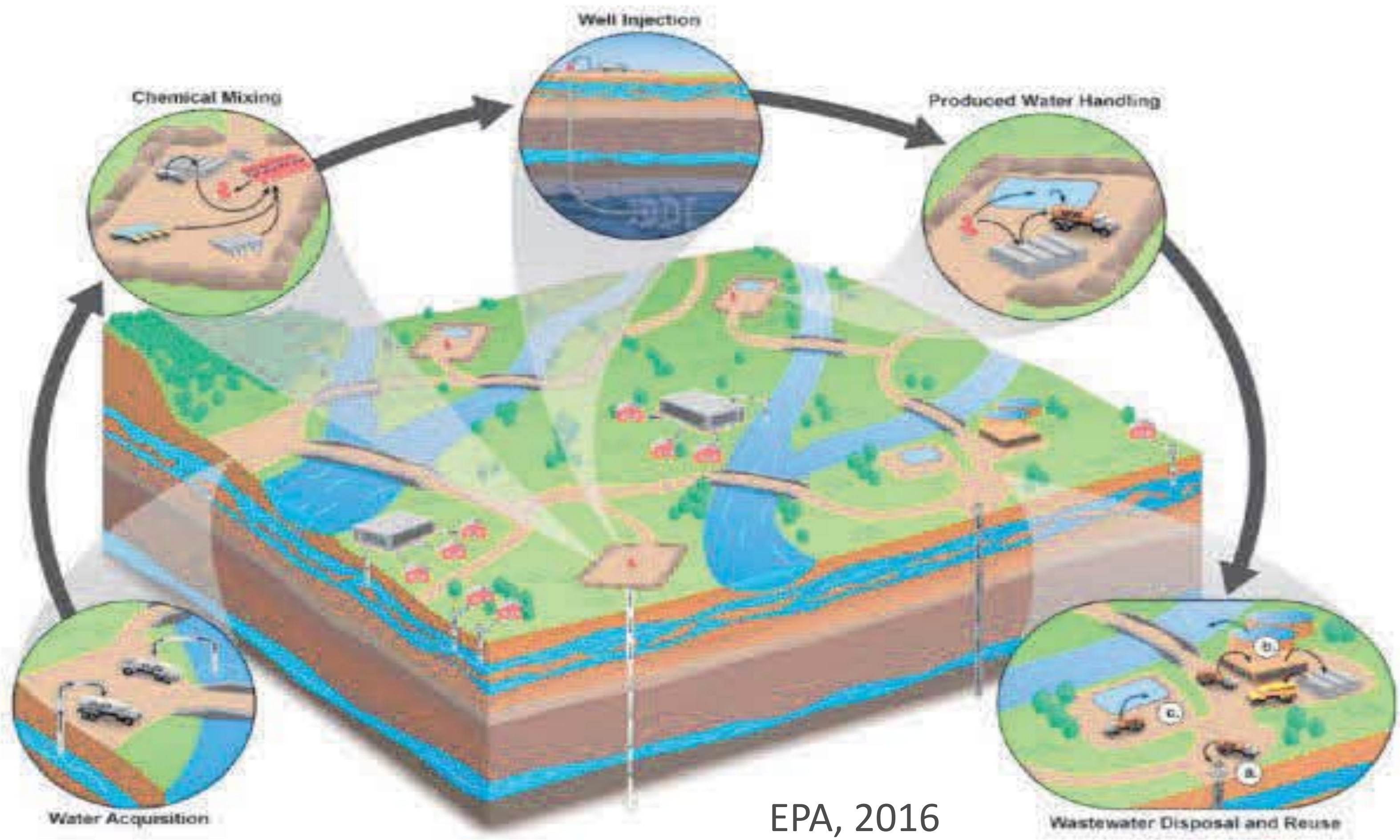
Senior Research Scientist and Associate Director for Environment Division

Bureau of Economic Geology

Jackson School of Geosciences

The University of Texas at Austin

Water Impacts of Shale Development is an Important Public Concern



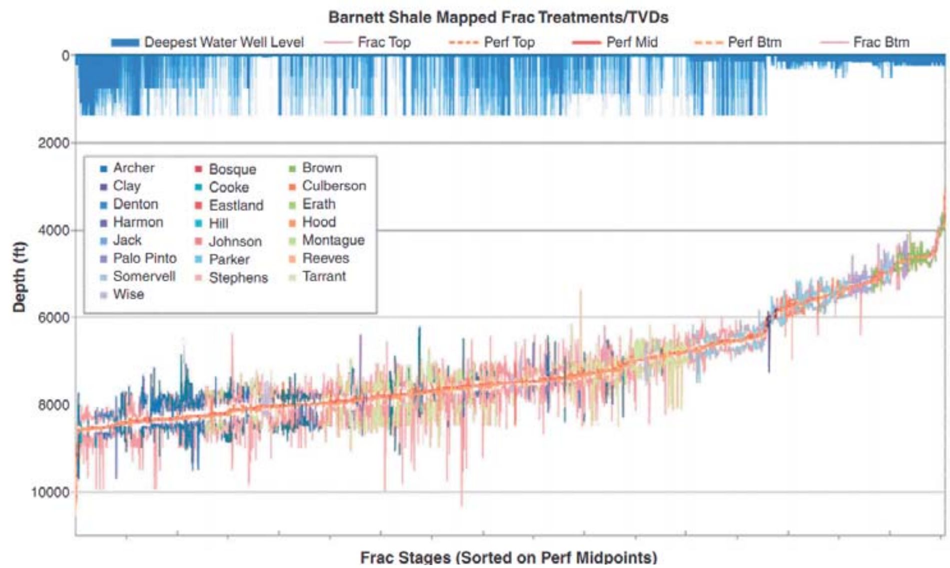
EPA, 2016

Water Use for Hydraulic Fracturing

- Life cycle water use for shale oil and gas is typically substantially less than life cycle water use for other forms of energy (e.g. coal, nuclear and biofuels)
- Statewide, total freshwater use for shale oil and gas is <1% of total statewide freshwater use. Future use likely to decrease as brackish and produced water use increases
- Locally, freshwater use can be significant, particularly in rural counties without large amounts municipal or agricultural freshwater use
- Use of brackish and produced water can substantially reduce the impact of shale development on freshwater resources

Hydraulic Fracturing is Unlikely to Directly Impact Drinking Water Resources

- Fracturing is typically far removed from drinking water aquifers
  - Image of mapped fractures in Barnet Shale



Fisher and Warpinski, 2012, SPE

- Indirect impacts due to spills and leaks of saline water at the surface more likely a cause for concern

Produced Water Quality is Poor

- Often triple the salinity of seawater in Texas
- Treatment for uses other than for hydraulic fracturing is costly and inefficient
- Impact of spills and leaks of this fluid perhaps greatest potential impact on land and water resources
- Greater handling of these fluids (e.g. reuse) may increase potential for spills and leaks


McBroom, 2013

- Spill reporting (particularly of saline waters) is less stringent and less accessible in Texas

Recommendations

- Use of water resources—other than freshwater—should be encouraged through operational changes, research and regulatory enhancements. Effectiveness of these efforts should be monitored.
- Brackish water resources should be better understood and, where appropriate, exploited for municipal, agricultural, and industrial uses.
- Spill and leak reporting and tracking should be improved to aid identification, and to correct recurring causes and improve best management practices.

Transportation

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Transportation

John A. Barton, P.E.

Associate Vice Chancellor

Texas A&M University System

Deputy Director & Chief Engineer, TxDOT (Retired)

Critical Reality

Current technologies for oil and gas development and production create a dramatic increase in heavy truck traffic volumes, especially in rural areas

- Number of truckloads per well: 1,000-1,500
- Number of ESALs per well: 5,000-15,000
  (ESAL: Equivalent single-axle load)

Most highway corridors, particularly secondary roads, were never designed to sustain heavy energy-related traffic, resulting in accelerated pavement, bridge and roadside deterioration

Relative Pavement Impact *per Truck*

Total Weight (lb)	Weight Ratio	EALF Ratio	Weight Ratio	EALF Ratio	Weight Ratio	EALF Ratio
	WRT 4,000 lb		WRT 35,000 lb		WRT 80,000 lb	
4,000	1	1				
10,000	2.5	23				
35,000	8.8	583	1	1		
80,000	20	18,009	2.3	31	1	1
84,000	21	22,210	2.4	38	1.05	1.2
90,000	22	28,511	2.6	49	1.1	1.6
100,000	25	42,753	2.9	73	1.25	2.4

Economic Impact

$1 billion per year on low volume highways

$2 billion per year including county roads & city streets

- No main highways or bridges included

Cost to industry if no pavement repair is done:

- $1.5-3.5 billion per year
  - Equipment damage
  - Lower operating speeds

Traffic Safety Impact

Dramatic increase in crash rates

Comparing crashes in rural areas involving CMVs in the Eagle Ford Shale and Permian Basin regions for the 4 year periods of 2006-2009 to 2010-2013:

- 52-61% increase in the total number of crashes
- 57-77% increase in the number of fatal, incapacitating, and non-incapacitating crashes
- 76-88% increase in the number of fatal crashes

Dramatic increase in crash-related costs

$50-$150 million per year

Major Takeaways

- Current technologies for oil and gas development and production from shale formations **require extremely large volumes of heavy truckloads**
- Most existing roadways and bridges were **not designed** to carry/accommodate energy sector truckloads
- Truck traffic associated with the development and production of oil and gas from shale formations has resulted in **severe traffic crash increases**
- Funding to address the impacts to the transportation infrastructure and traffic safety in energy sector areas is **very low relative to the magnitude of the impact**

Recommendations

The following strategies will improve preparedness of the state's transportation systems for oil and gas development and production in the future:

- Improve availability and quality of data related to ongoing and forecasted drilling activities
- Develop integrated, multimodal transportation infrastructure strategies and solutions
- Identify provisions for reliable, sustainable funding for proactively preparing the state's transportation infrastructure for future drilling activities

Economic and Social Impacts

Read the Report: tamest.org/shaletaskforce

Economic and Social Impacts

Omar Garcia

President and CEO

South Texas Energy & Economic Roundtable (STEER)

Findings – Economic Impacts

- **Shale energy development primarily contributes positively to local, regional, and state economies, but not all economic effects have been positive.**

- **Limited published data exist on the net economic benefits and costs of shale energy development to the institutions and residents in Texas counties and communities.**

Findings – Economic Impacts

- **Public school districts and universities across Texas benefit substantially from the taxes and royalty revenue paid by the oil and gas industry.**

- **Economic benefits associated with oil and gas development are unevenly distributed across public schools and universities.**

Findings – Social Impacts

- **Community leaders and residents in Texas tend to appreciate and welcome the economic and service-related benefits that accompany shale energy development, whereas they tend to dislike certain social and/or environmental effects that accompany it.**

- **Traffic-related issues—including increased truck traffic, traffic accidents, and traffic congestion—are of primary concern to leaders and residents in and around communities experiencing shale development.**

Findings – Social Impacts

- **The oil and gas industry is viewed as a relatively trustworthy source for information on shale development and hydraulic fracturing.**

- **The more negatively shale energy development is perceived—particularly with respect to the social and environmental consequences—the more likely local residents are to engage in behaviors opposing increased shale development.**

Findings – Social Impacts

- **Decisions regarding setback distances in Texas are established at the municipal level.**

- **Shale development has the potential to disproportionately affect certain segments of the population.**

Recommendations

Additional research is needed on:

- **the economic benefits and costs and associated equity issues—or "winners and losers"—in shale energy development.**
- **the underlying factors accompanying the formation of both positive and negative perceptions of shale development.**
- **the various factors that may be associated with behavior taken in response to or anticipation of shale development.**

Recommendations

Additional research is needed on:

- **potential environmental and health effects associated with varying setback distances**
- **the uneven distribution of benefits and costs associated with development.**

Q&A

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