Hydraulic fracturing of unconventionals and water resources

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Workshop on Risks of
Unconventional Shale Gas Development

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Short term1: stray gas contamination

- Thermogenic gas in the shallow subsurface doesn’t necessarily imply leak, it can be natural

Evaluation of Methane Sources in Groundwater in Northeastern Pennsylvania

by Lisa J. Molofsky[1] , John A. Connor[2] , Albert S. Wylie[3] , Tom Wagner[3] , and Shahla K. Farhat[2]

Abstract

Testing of 1701 water wells in northeastern Pennsylvania shows that methane is ubiquitous in groundwater, with higher concentrations observed in valleys vs. upland areas and in association with calcium-sodium-bicarbonate, sodium-bicarbonate, and sodium-chloride rich waters—indicating that, on a regional scale, methane concentrations are best correlated to topographic and hydrogeologic features, rather than shale-gas extraction. In addition, our assessment of isotopic and molecular analyses of hydrocarbon gases in the Dimock Township suggest that gases present in local water wells are most consistent with Middle and Upper Devonian gases sampled in the annular spaces of local gas wells, as opposed to Marcellus Production gas. Combined, these findings suggest that the methane concentrations in Susquehanna County water wells can be explained without the migration of Marcellus shale gas through fractures, an observation that has important implications for understanding the nature of risks associated with shale-gas extraction.

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Short term1: stray gas contamination

- Thermogenic gas in the shallow subsurface doesn’t necessarily imply leak, it can be natural: low in recharge areas, higher in discharge areas
- Need predrill / baseline data
- Need to understand when contamination occurred if recent: after drilling but before HF’ing?
- Considerable variability in methane concentration at a given sampling point
- Transport of methane vs. transport of brine components

Short term2: surface spills - WWTPs

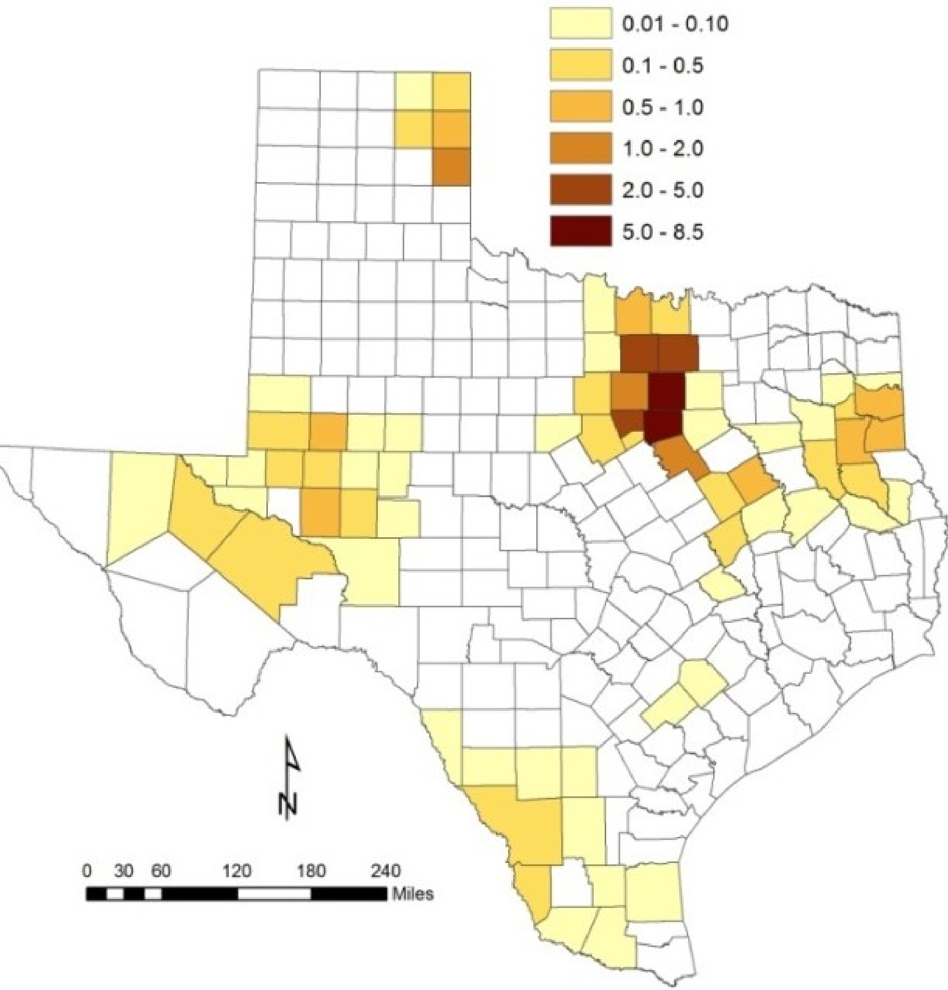
- Surface spills: training and enforcement issue
- Disposal in rivers: seems to be specific to Marcellus – dilution cannot be the solution
- NORMs: seems to be more acute in the Marcellus – scaling and precipitates are an issue; not when dissolved

Long term1: water availability

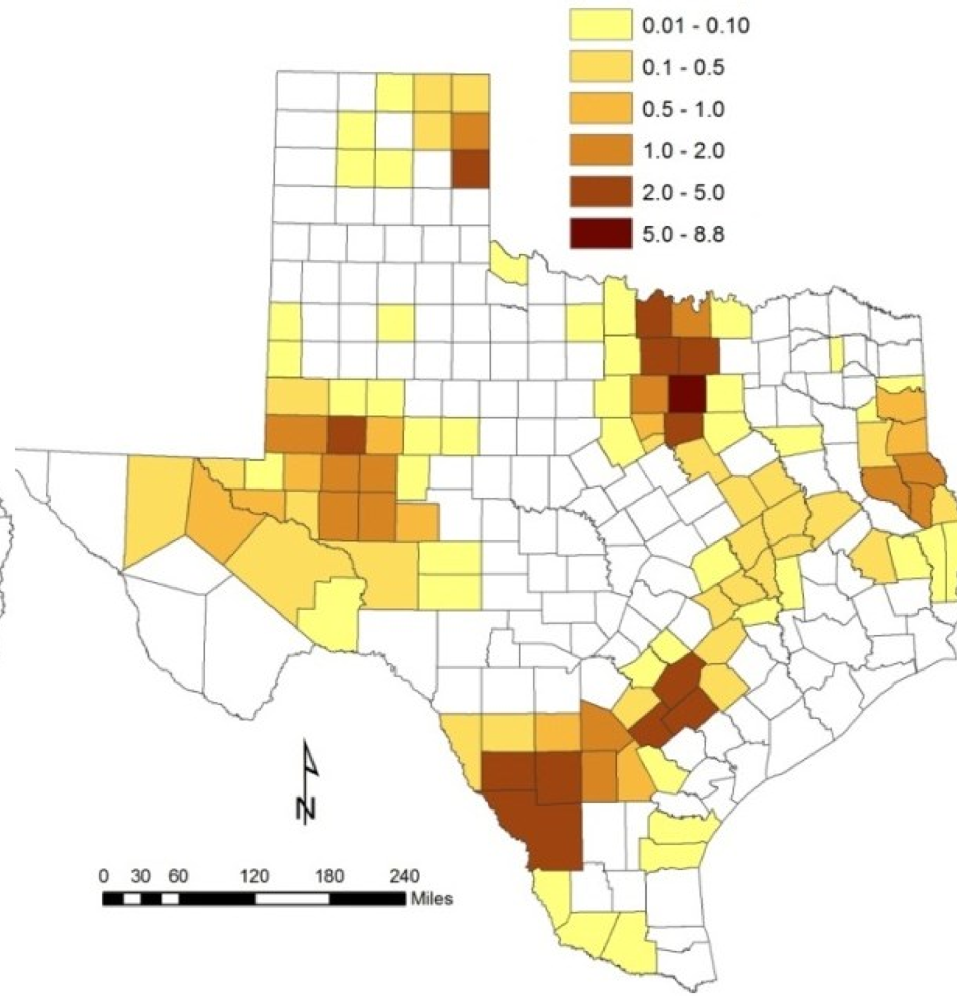
1 AF = 325,851 gallons

1kAF = 1.23×10^6 m^3

2008: 36 kAF



2011: 81.5 kAF



Source of raw data: IHS Enerdeq database

Long term1: water availability

- TX: ~100,000 AF vs. 15 million AF (~60% Ir.)
- CO: ~15,000 AF vs. 16 million AF (~85% Ir.)
- PA: ~21,000 AF; OK: ~14,000 AF; ND: 22,000 AF
- Water levels dropping but mostly because of drought and increased water use

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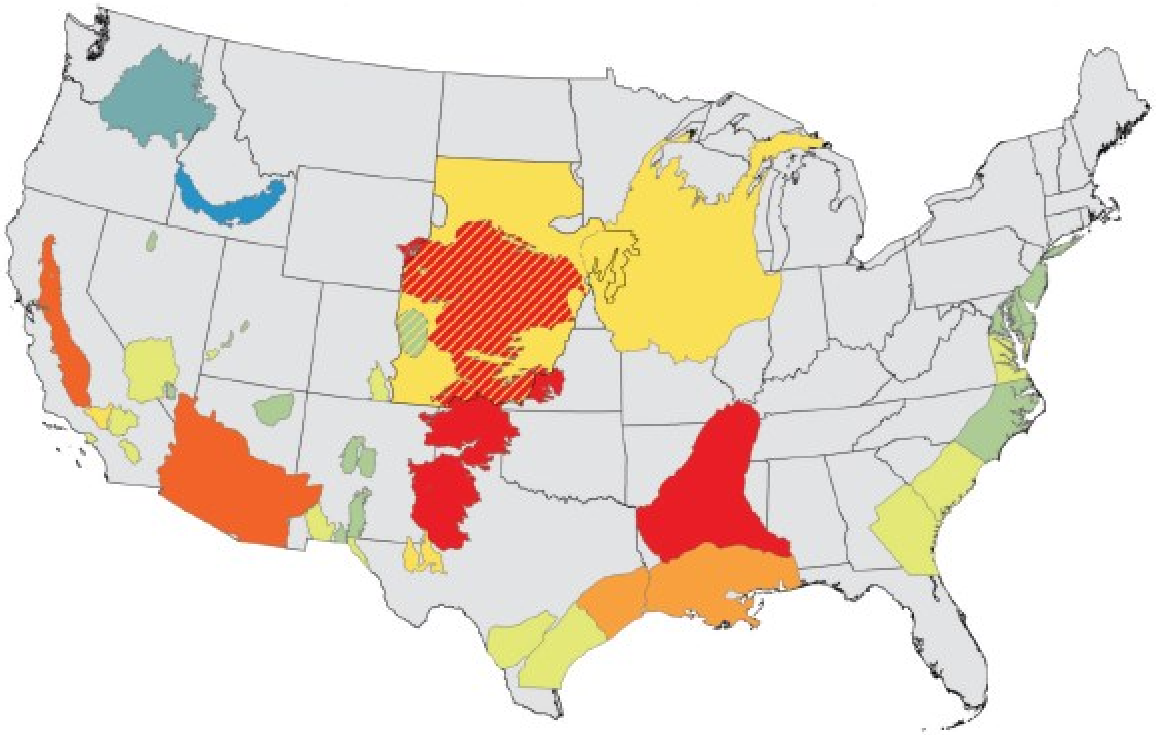
Groundwater Depletion in the United States (1900–2008)



Scientific Investigations Report 2013–5079

By Leonard F. Konikow

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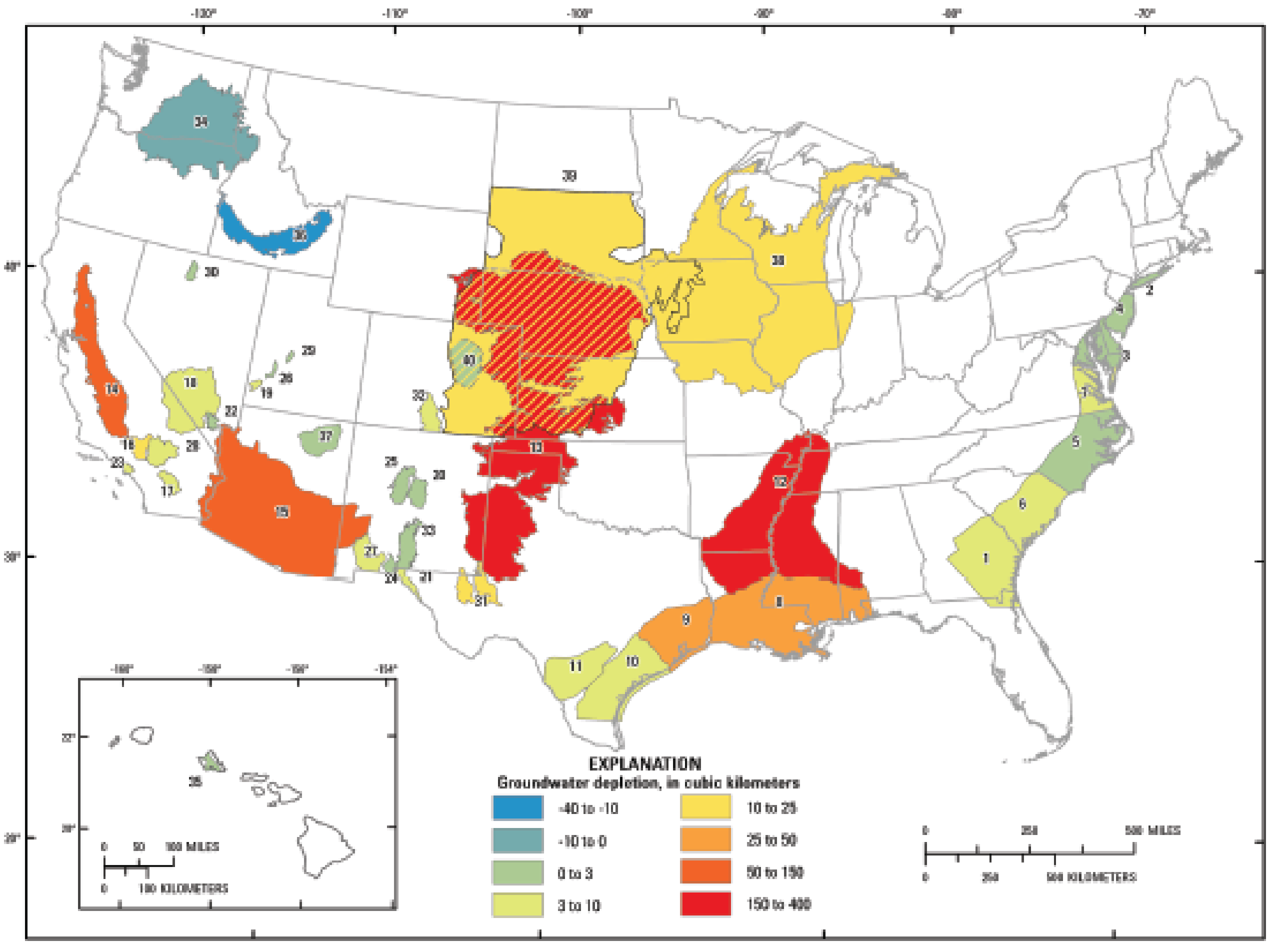
Long term1: water availability



Base from U.S. Geological Survey digital data, 1972, 1:2,000,000
Albers Equal-Area Conic Projection
Standard parallels 29° 30' N and 45° 30' N, central meridian 96° 00' W

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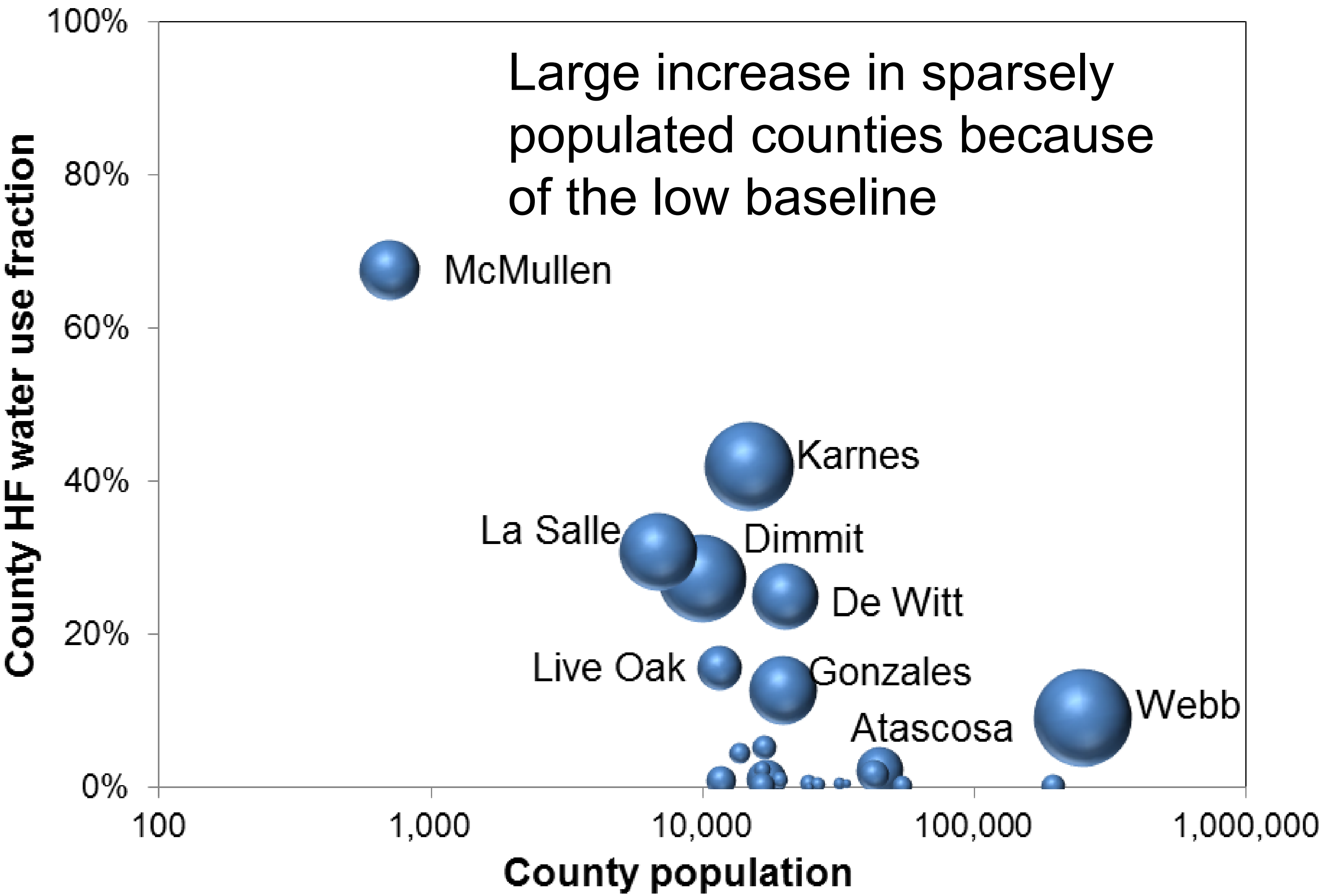
- GW: Down to the county level: need to differentiate between impact on aquifers and impact on shallow domestic wells

Long term1: water availability
Baseline water use



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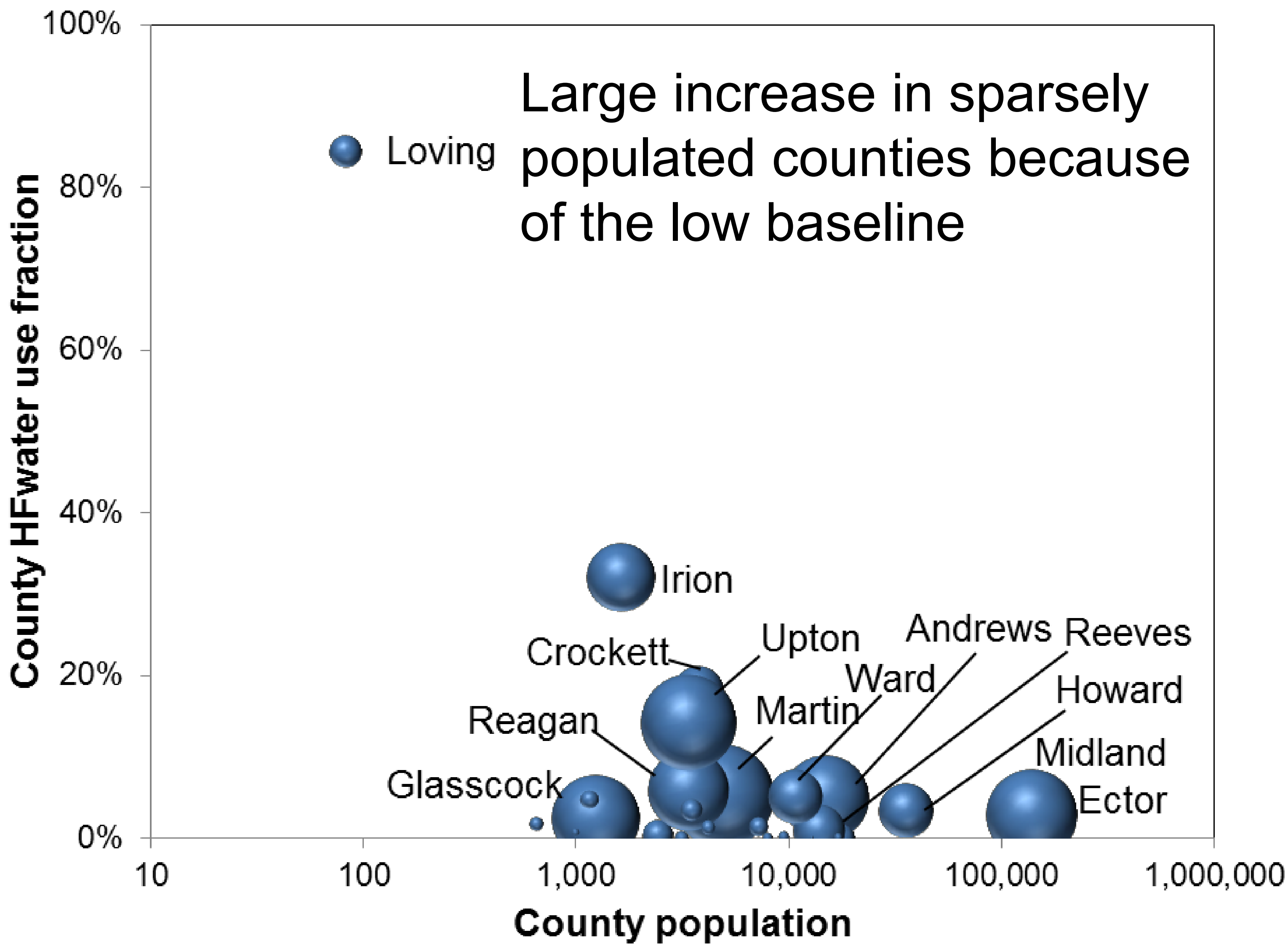

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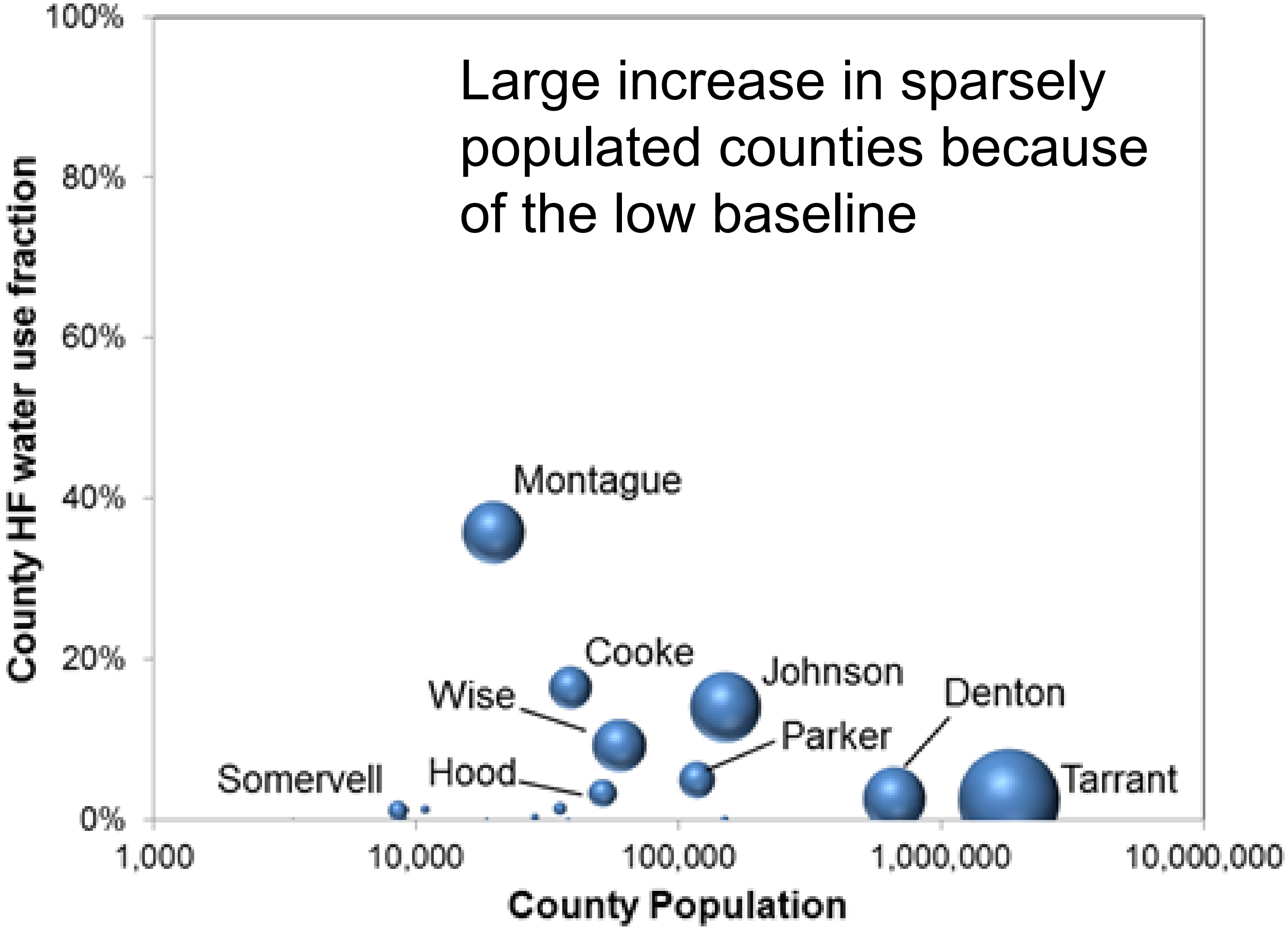

Large increase in sparsely populated counties because of the low baseline

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- PA: ~21,000 AF; OK: ~14,000 AF; ND: 22,000 AF
- GW: Water levels dropping but mostly because of drought and increased water use
- GW: Down to the county level: need to differentiate between impact on aquifers and impact on shallow domestic wells
- SW: more location than amount
- Ancillary water use for sand mining possibly outside of production areas

Long term2: natural pathways

- New fractures created by excess pore pressure cannot reach fresh water aquifers
- They can intersect natural faults
- Operators avoid faulted areas: hard to steer within the pay zone and sometimes unacceptable water cut

Long

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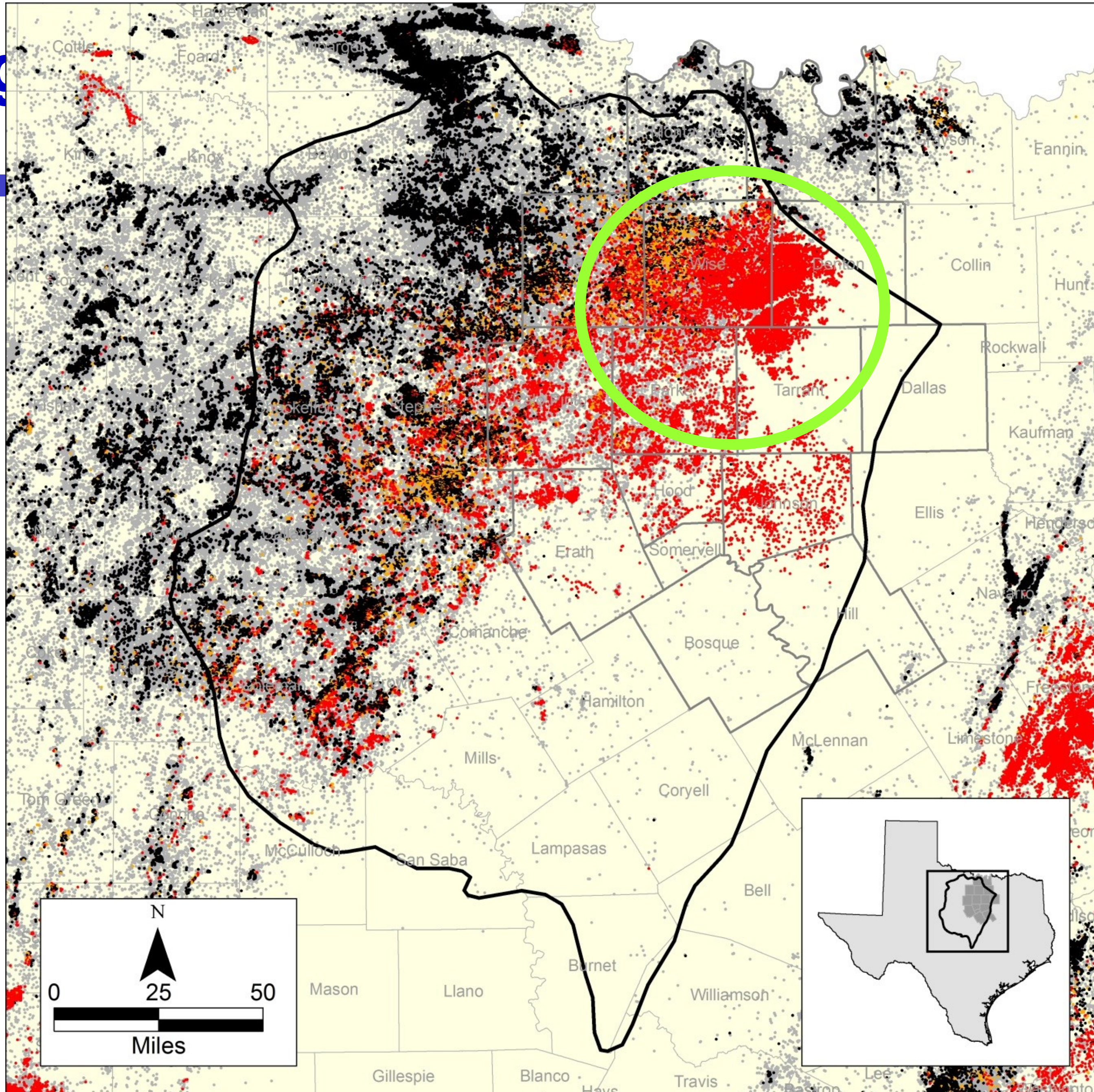
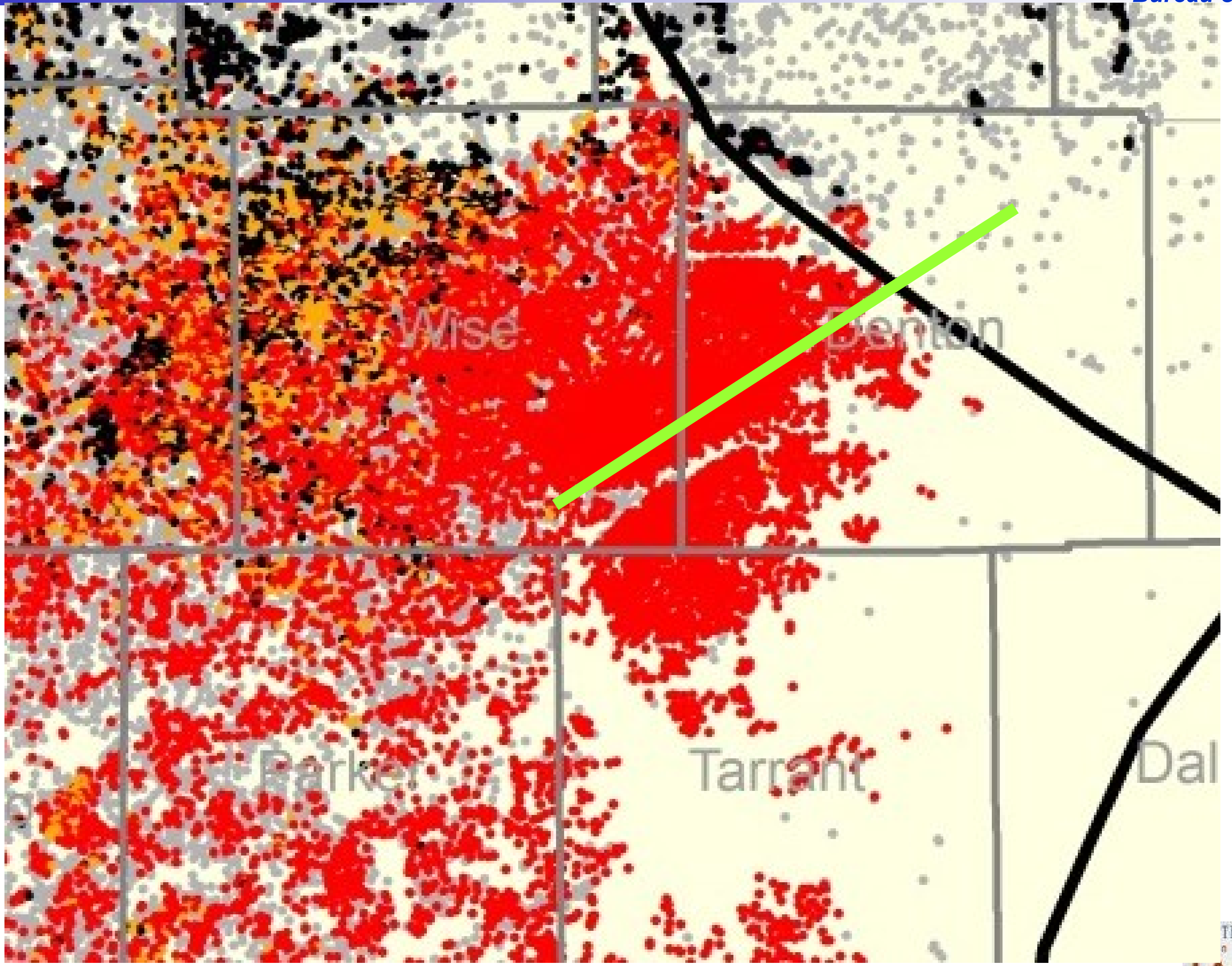


Long term2: natural pathways



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Long term2: natural pathways

- New fractures created by excess pore pressure cannot reach fresh water aquifers (e.g., Davies et al., 2012)
- They can intersect natural faults
- Operators avoid faulted areas: hard to steer within the pay zone and sometimes unacceptable water cut
- Not uncommon to have gas or brines migrate upward over geologic times. Problem is timing and rates.

Long term3: abandoned wells
Well depth vs. age (proxy for plugging quality) – Case of Texas

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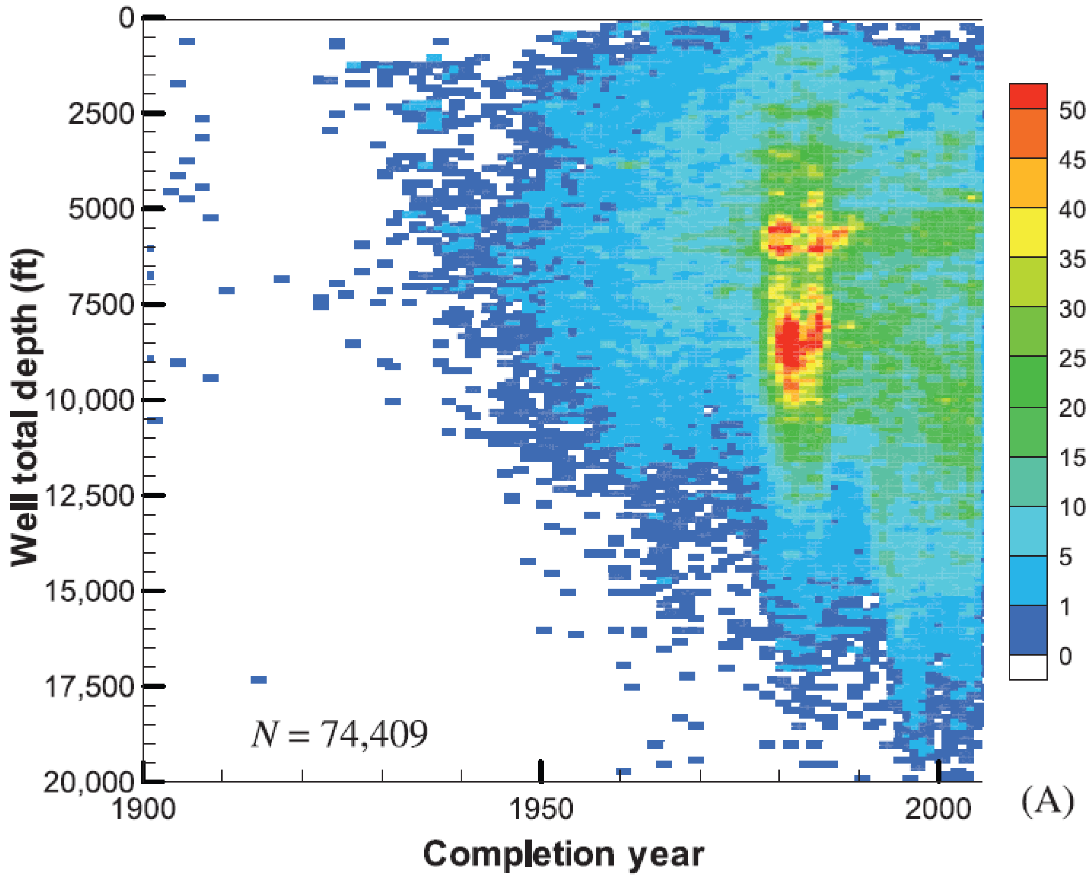
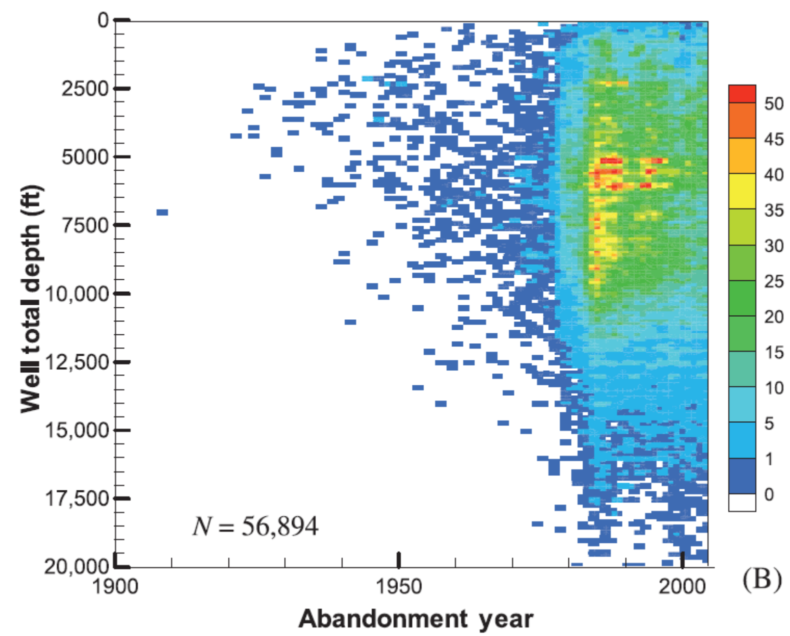


(A)

Figure 9. Time-depth density of oil and gas wells with available data in RRC districts 2, 3, and 4: (A) completion year and (B) abandonment year. The new regulatory requirements of the 1974 Safe Water Act clearly improved abandonment reporting and/or recording. Bins are 1 yr/100 ft (30 m). RRC = Texas Railroad Commission.



(B)

Nicot and Hovorka, 2009

Long term4: residual contaminants

- Buildup of NORM scales in rivers and improper disposal of solid waste
- Water quantity: water will move to the higher value products (oil, gas) despite lack of water rights
- Water quality: operational problems can be solved; geologic uncertainty can only be mitigated through careful planning