Stanford | Water in the West

Research Brief

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Hydraulic Fracturing Near Domestic Wells

Introduction

Between 2000 and 2015, natural gas production from hydraulically fractured wells increased tenfold in the United States. Hydraulic fracturing, or "fracking," a process that injects fluid through a drilled well to break up hydrocarbon-bearing rock, has been a windfall technology which has led to an increase in oil and gas production and a dramatic decrease in the price of natural gas. The rapid rise of hydraulic fracturing has raised public health and safety concerns. Some states and localities have banned hydraulic fracturing because of concerns over potential groundwater contamination.

The U.S. Environmental Protection Agency (EPA) affirmed that proximity of hydraulically fractured wells to domestic water resources creates "a greater potential for activities in the hydraulic fracturing water cycle to impact those resources."[1] In 2016, the EPA evaluated the proximity of hydraulically fractured wells to public water supplies, but did not include private groundwater wells due to lack of publicly available and consistent groundwater well data across the country. Private groundwater wells provide drinking water to 45 million U.S. citizens, about 14% of the population, and, unlike public water utilities, owners are not required to monitor quality regularly under the Safe Drinking Water Act.

To understand contamination risks that hydraulic fracturing may pose to drinking-water wells, it is important to characterize the proximity of hydraulic fracturing operations to private- and public-supply groundwater wells. Furthermore, because some of the potential contamination mechanisms identified in hydraulic fracturing ("unconventional" oil and gas

1 https://www.epa.gov/hfstudy

Photo Courtesy of Scott Jasechko

About the Researchers

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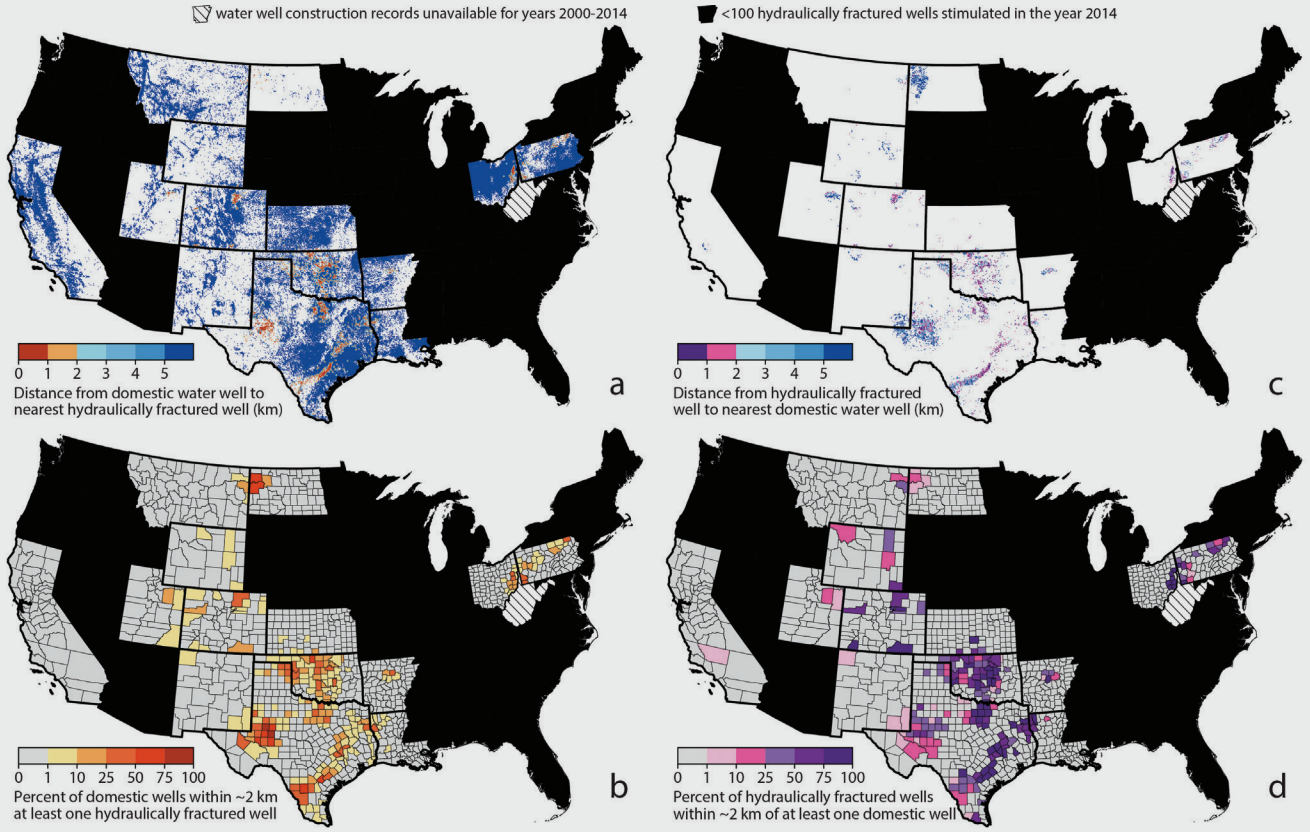
Figure 1.



Horizontal proximity among domestic groundwater wells (2000-2014) and the nearest hydraulic fracturing well stimulated in 2014. (a) Domestic water well proximity to nearest hydraulically fractured well; (b) county-level percent of domestic wells near (←2 km) hydraulically fractured well(s); (c) Hydraulically fractured well proximity to domestic water wells. (d) County-level proportions of hydraulically fractured wells near (←2 km) domestic water well(s). Only counties with n→10 records are shown in panels b-d.

Jasechko and Perrone 2017

production) are identified also in conventional oil and gas production, it is important to characterize the proximity of oil and gas wells more broadly to private- and public-supply groundwater wells. In a recent study, researchers identified hotspots where (1) domestic water wells are within close proximity to wells that had hydraulic fracturing fluids injected into them in 2014, and (2) domestic water wells are within close proximity to oil and gas wells that were producing in 2014.

Using data from FracFocus[2], the researchers identify 15 states with more than 100 hydraulically fractured wells in 2014. The year 2014 is the most recent year that actively producing oil and gas well data from FracTracker was available, allowing comparison across hydraulic fracturing and oil and gas hotspots. Of the 15 states, 14 states had publicly available groundwater well construction information: Arkansas, California, Colorado, Montana, Louisiana, Nebraska, New Mexico, North Dakota, Ohio, Oklahoma, Pennsylvania, Texas, Utah, and Wyoming.

2 https://fracfocus.org/

Key Findings

Many domestic groundwater wells constructed between 2000 and 2014 are within 2 km (~1.2 miles) of one or more wells that had hydraulic fracturing fluids injected into them in 2014. In 11 counties, the majority of domestic water wells are located nearby at least one. The exact numbers may differ from those reported where data gaps exist, however, it is clear that a considerable portion of domestic groundwater wells in the 14 states analyzed are located in close proximity to hydraulically fractured wells.

Most oil and gas wells actively producing in 2014 are within 2 km of at least one domestic water well in 315 counties in the 14 states that were analyzed. Significantly more counties in the study had domestic groundwater wells near at least one active oil and gas well than those that had domestic groundwater wells near at least one well that had hydraulic fracturing fluids injected into it in the same year.

The two main findings highlight that (1) hydraulic fracturing takes place in close proximity to domestic groundwater wells in many cases, and (2) there were significantly more oil and gas wells—conventional and unconventional—producing in 2014 than those that were hydraulically fractured during 2014, and these oil and gas wells are often in close proximity to domestic groundwater wells, too.

Broader Impacts

Quantifying and communicating risks of hydraulic fracturing to groundwater resources is challenging due to lack of consistently-catalogued information. More information is needed on the following topics:

- frequency and severity of spills and leaks linked to hydraulic fracturing
- integrity of active and decommissioned oil and gas wells
- groundwater quality prior to versus following the initiation of a hydraulic fracturing operation
- environmental profile, including toxicity, of chemicals used for oil and gas production

Mounting a nation-wide assessment of hydraulic fracturing fluid spill frequencies and severities would require substantial resources. The maps from this analysis provide hotpots of areas where resources could be focused.

While physical proximity of groundwater wells and hydraulically fractured wells does not imply well water contamination alone, the risks should be studied in order to quantify them and inform our water and energy policies.

Photo Courtesy of Scott Jasechko

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The study focused on 14 states and time period of 2000-2014, which is an example limited in both size and scope. A study of other regions during different time parameters could yield different results. While the depths for injection by hydraulic fracturing are often more than 1000 m below that of nearby domestic water wells, in some areas, hydraulically fractured wells exist at depths similar to nearby groundwater wells. Further data and study is needed to understand how hydraulic fracturing may affect groundwater quality. National standards for groundwater well construction data and oil and gas well data would promote further analyses.

Because many of the potential contamination mechanisms identified for hydraulic fracturing are also identified for oil and gas production more broadly, it is important to consider risks to groundwater quality from oil and gas production along with hydraulic fracturing.

Points for Policy Makers

- Addressing the existing data gaps can help quantify the risk posed by hydraulic fracturing to domestic groundwater quality. Increasing water quality monitoring prior to, during, and after the construction of hydraulically fractured wells can improve our understanding of how hydraulic fracturing may affect groundwater resources.
- Better water quality monitoring efforts may help protect private well water quality. Unlike domestic groundwater wells operated through public utilities, private domestic groundwater wells are not required to perform routine water quality tests under the Safe Drinking Water Act. Similarly, the federal government does not require routine ambient groundwater monitoring in the aquifers adjacent to oil and gas wells.
- Increasing water quality monitoring efforts may prove futile until we have more information about the chemicals used in hydraulic fracturing operations and their toxicity. Chemical additives are likely used by hydraulic fracturing operations that cannot be detected by common and relatively inexpensive water quality tests. The public has raised concerns about undisclosed chemicals used in some hydraulic fracturing operations; filling in these current and considerable chemical toxicity data gaps may help alleviate some of those concerns.
- As more shale oil and gas reservoirs become economically and technologically feasible to access with hydraulically fractured wells, understanding the frequency that groundwater resources are contaminated will be critical to allocating resources for safeguarding groundwater and addressing public concerns.

This research brief is based on the paper "Hydraulic fracturing near domestic water wells" by Scott Jasechko and Debra Perrone published in *Proceedings of the National Academy of Sciences*, which examines the proximity of groundwater wells built between 2000-2014—both public and private—to oil and gas wells that were hydraulically fractured in 2014 and to oil and gas wells that were producing in 2014.

About Water in the West

Water in the West, a joint program of the Stanford Woods Institute for the Environment and the Bill Lane Center for the American West, marshals the resources of one of the world's preeminent research universities to answer one of the most urgent questions about the American West's future—how can the region continue to thrive despite growing water scarcity? Through Water in the West, Stanford University's world-class faculty, researchers and students are working to address the West's growing water crisis and to create new solutions that move the region toward a more sustainable water future. Learn more: waterinthewest.stanford.edu

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