Water Sources for Hydraulic Fracturing

Reducing the oil and gas industry's need for fresh water

Hydraulic Fracturing and Water Demand

Hydraulically fracturing a modern well can require millions of gallons of water for the initial fracturing process. This is a potential problem in arid regions with competing demands for fresh water (i.e. high water stress), such as Colorado and West Texas (see map). Today, advanced technologies allow the use of saline or brackish water (including groundwater and recycled oilfield water) for hydraulic fracturing, decreasing the demand for fresh water.

Using Brackish Groundwater

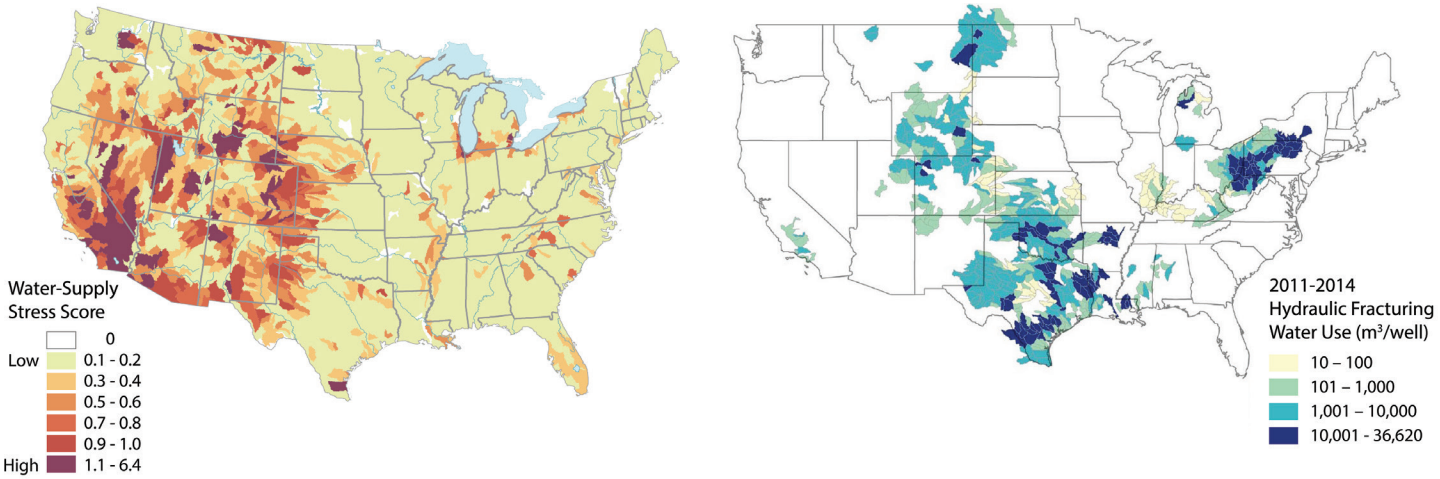
Roughly 14% of all the water used in the United States is too salty to drink. Most of this is seawater used for cooling at coastal power plants. Much of the rest is brackish (slightly salty[1]) groundwater, used in the oil and gas industry for hydraulic fracturing, for water injection to improve oil recovery, and in refineries.[2]

Using Produced Water

Oil and natural gas co-exist underground with varying amounts of water, so in some cases significant amounts of water may be extracted, or "produced", along with the oil and/or gas – nationally an average of 10 barrels of water are produced for each barrel of oil.[6] This produced water is often naturally salty, contains residual oil, and, for hydraulically fractured wells, may contain "flowback" water and chemicals from the original hydraulic fracturing fluid. Most produced water cannot be safely released into the surface environment, so over 90% is disposed of in deep underground injection wells.[6] Storing, treating, and re-using this water for hydraulic fracturing and other oilfield operations can help reduce the need for both disposal wells and fresh water.

Regional variations in the amount and composition of produced water, as well as differences in state regulations, affect the use of produced water in hydraulic fracturing and other oilfield applications such as waterflooding (injecting water into oil formations to help push out more oil):

- In the Bakken area of North Dakota only about 5% of the wells drilled in 2014 used produced water in their fracturing fluid. This is partly due to state regulations that prohibit storage of salty produced water in open-air pits,[7] and partly because the extreme salinity of produced water in this area makes treatment and reuse difficult and expensive.[8]



Left: Water stress in the United States[3] - in brown areas of the map, total water demand for all uses ranges from 40-80 percent of available supply.[4] Right: Hydraulic fracturing water use per well across the country.[5] Image credits: Left: Copyright, Union of Concerned Scientists, used with permission; Right: U.S. Geological Survey.

- The Marcellus shale in the northern Appalachians produces very little water compared to other major oil- and gas-producing regions.[9] Almost all of the produced water is reused in hydraulic fracturing operations, but the small amount of water produced compared to the amount used means that produced water can provide only a small fraction of the water needed for hydraulic fracturing in this area.[10]

- In Texas, reusing produced water is less attractive because the state has large amounts of brackish groundwater. It is cheaper to extract and use this groundwater than to store, transport, and treat produced water for reuse in hydraulic fracturing operations. Underground disposal of produced water is also relatively easy and inexpensive, and water ownership issues have discouraged transfer of produced water between operators.[11] As a result, companies in Texas are more likely to dispose of produced water than to treat, transport, and reuse it.

- The Eagle Ford shale in semi-arid South Texas has been a significant source of both oil and gas in the hydraulic fracturing boom. In this area, water needs for hydraulic fracturing are high, but less than 5% of this need is met by reusing produced and flowback water.[12] In 2013, hydraulic fracturing in the Eagle Ford was responsible for roughly 16% of total water consumption in the area. Much of this water was initially drawn from fresh groundwater supplies: between 2009 and 2013, one area saw groundwater levels drop by up to 200 feet due largely to extraction of fresh groundwater for hydraulic fracturing. Some operators here have switched to using abundant, non-potable brackish groundwater for hydraulic fracturing.[12]

Disclosing the Composition of Hydraulic Fracturing Fluids

FracFocus, an online chemical disclosure registry lists the chemicals used in hydraulic fracturing operations for over 124,000 wells (although some proprietary ingredients are undefined).[13] The registry is searchable by location, operator, or chemical.

In semi-arid West Texas, companies have long used brackish groundwater and reused produced water for both conventional and hydraulically fractured wells.[14] The abundance of brackish groundwater in Texas has also given rise to large-scale desalination operations to produce fresh water for industrial and municipal use.[15,16]

Alternative Hydraulic Fracturing Fluids

A variety of alternative fluids are being developed for hydraulic fracturing:

- To decrease environmental impacts caused by leaks and spills, less harmful additives are being developed and fewer additives are now added.

- To decrease water use, alternatives include fluids foamed with nitrogen or carbon dioxide, which can be used in low-pressure oilfields,[17] and high-pressure carbon dioxide. Some of these alternatives require specialized equipment and may be more expensive than standard hydraulic fracturing fluids.

References & More Resources

For a complete listing of references, see the "References" section of the full publication, *Petroleum and the Environment*, or visit the online version at: www.americangeosciences.org/critical-issues/petroleum-environment

American Water Works Association (2013). Water and Hydraulic Fracturing. http://www.awwa.org/portals/0/files/legreg/documents/awwafrackingreport.pdf

Gallegos, T.J. et al. (2015). Hydraulic fracturing water use variability in the United States and potential environmental implications. Water Resources Research, 51(7), 5839-5845. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2015WR017278

U.S. Department of Energy – The Energy-Water Nexus: Challenges and Opportunities. https://energy.gov/under-secretary-science-and-energy/downloads/water-energy-nexus-challenges-and-opportunities