The Effects of Fracking on the Bakken Shale Play

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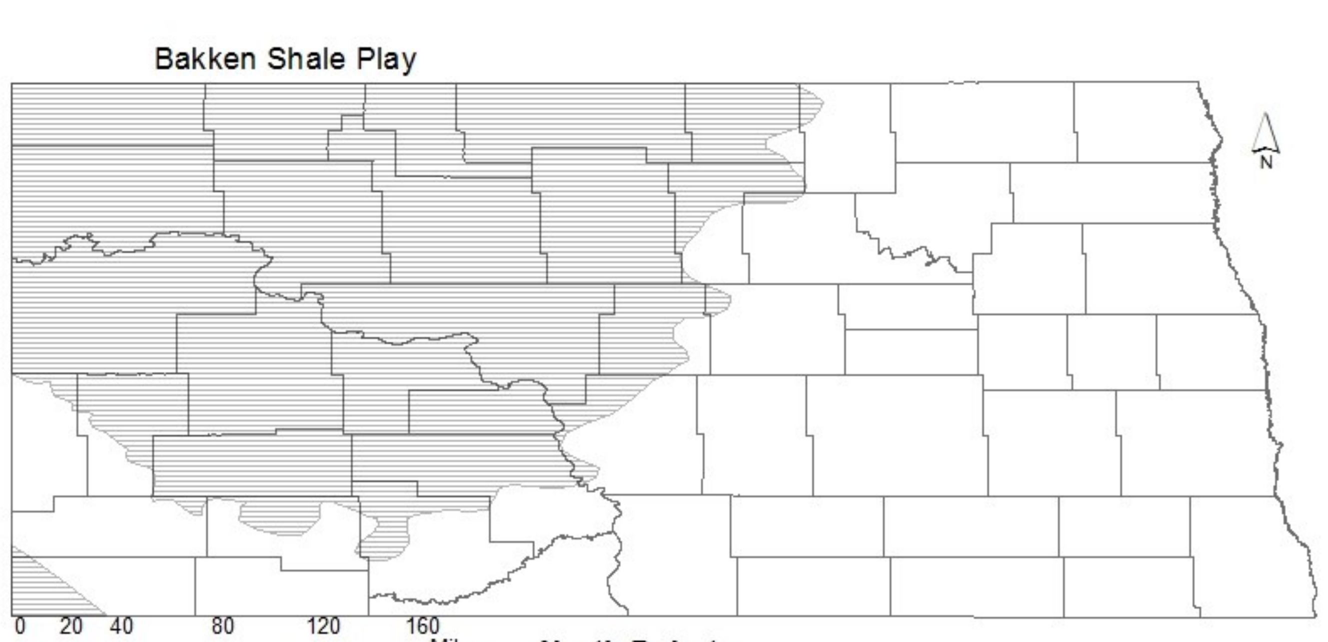
Introduction

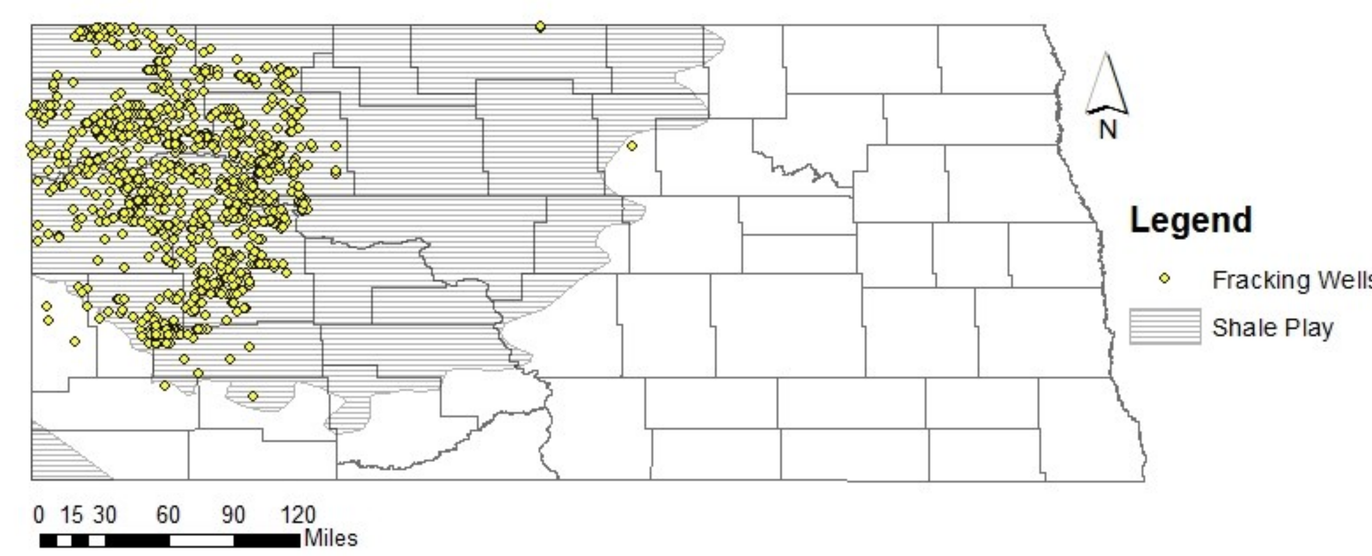
Hydraulic fracturing—known commonly as fracking—is a process used in natural gas extraction in which the earth is injected with high quantities of fluids at high pressures in order to stimulate the flow and aid in the extraction natural gas in deep lying reserves. This method of extraction has recently been reinvigorated by innovations in drilling and extraction technology and methods such as horizontal drilling and sophisticated pump systems. The technology has made retrieving oil from shale rock formations and tight sands with low permeability possible, allowing oil companies to tap into natural gas resources that were previously unavailable. Despite the ease and efficiency of natural gas extraction by fracking, the practice has several shortcomings. Namely, fracking activity is suspected to affect nearby geo-environmental systems.

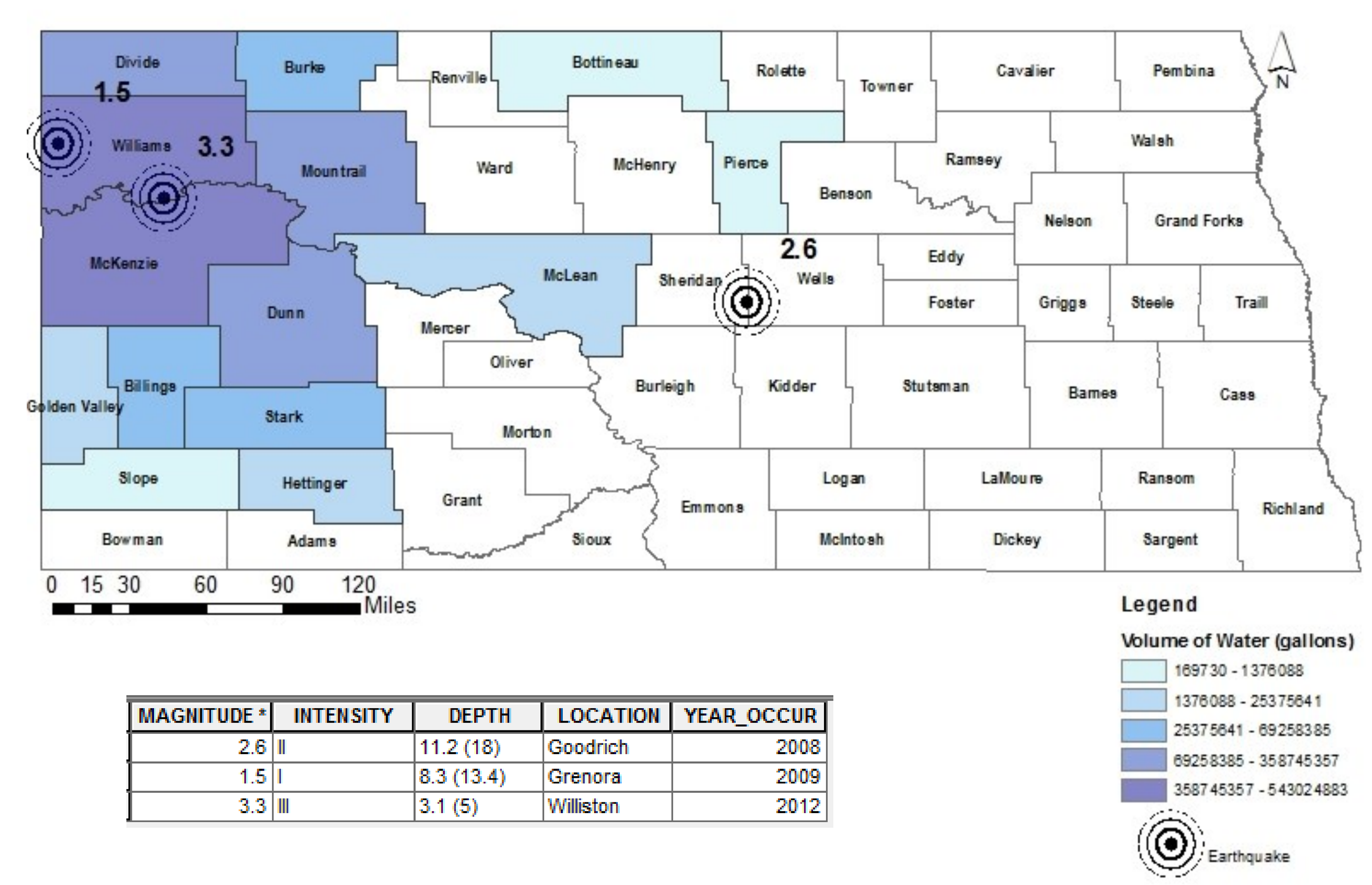
Fracking works by pumping thousands of gallons of solution at a time into horizontally drilled wells. This solution is pumped at high pressures in order to fracture either shale rock or densely packed sands encasing natural gas, allowing the gas to flow freely out of the tight shale or sand formations. Once the extraction is complete, the fluid pumped into the ground is extracted from the site and pumped back into the ground into a deep injection well. These deep injection wells are suspected of inducing earthquakes in nearby surrounding areas. Furthermore, the fracking fluids used to aid in extraction contain additives that are known carcinogens and other toxic compounds and in some cases even diesel fuel. Once injected back into the ground the fluid often permeates through the ground and can contaminate nearby groundwater systems.

This study serves as a preliminary risk assessment of North Dakota given a recent surge in fracking activity. The Bakken shale formation in the northwest corner of the state was identified as natural gas reserve in 1951, however it wasn't until 2008 when the USGS released a report indicating that the formation contained roughly 4 billion barrels (126000000 gallons) of natural gas that the region was considered ripe. Given the advances in drilling technology resulting in the development of fracking as a method of natural gas extraction, oil companies flocked to the area in order to tap into the recently discovered reserves. The increase in fracking activity is suspected to be correlated to recent earthquakes in the state. And while the effects on the nearby groundwater systems are yet to be seen, it is suspected that the nearby systems will also be negatively affected. This study aims to correlate the recent rise in fracking activity in the region to increased seismic activity in the state, and identify at risk aquifers based on well locations.

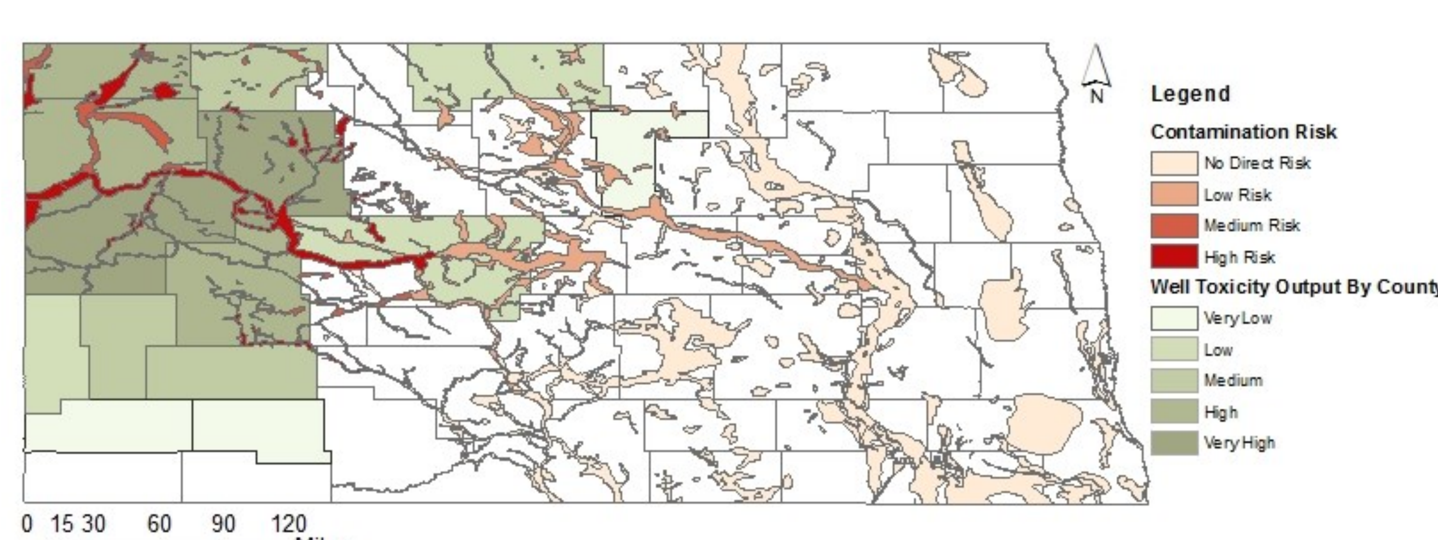


Maps





MAGNITUDE *	INTENSITY	DEPTH	LOCATION	YEAR_OCCUR
2.6	II	11.2 (18)	Goodrich	2008
1.5	I	8.3 (13.4)	Grenora	2009
3.3	III	3.1 (5)	Williston	2012



Procedure and Methods

The goal of this project was to correlate the increased fracking activity to seismic activity and map out aquifers that could be affected by the activity. The following information was required in order to assess the effects of the increased fracking activity in North Dakota: Well Information including location, volume of water used in production Water toxicity readings at the well, Earthquake Information including date, location, and magnitude, and locations of the states aquifers.

The earthquake data obtained from North Dakota GIS, included 11 earthquakes, between 1909 and 2012. Of the 11 earthquakes, 3 have occurred between 2008 and 2012—an alarming rate considering that there have only been 11 total quakes in the 103 year span. The well information obtained contained volume of water used per well. The volume of water indicated by the well data was used in order to determine if there is any correlation between the earthquakes recorded in the state since 2008—about a year after fracking began. The well data was assigned to the counties in which the wells presided. This was accomplished by spatially joining the county regions to the well data. Spatial joining works by taking the data from each point (well), such as the volume of water and toxicity, and summing all of the values that fall within a defined polygon (counties). After completing the spatial join, the counties now had values for volume of water and toxicity outputs. The volume of water per county was mapped and was overlain by the earthquake information obtained.

To assess the aquifers at risk by the recent surge in fracking activity, the toxicity from each county was summed from the well data, and again spatially joined. This time the join was between the aquifer and the toxicity per county. This spatial join assigned values of toxicity to the state's aquifer based on their location relative to counties with toxicity from the fracking wells. The index ranked aquifers from no direct risk—meaning that the aquifers do not intersect with counties that have little to toxicity from the wells—to high risk—suggesting that the aquifers directly intersect counties with high toxicity. The at risk aquifers were plotted and underlain by the toxicity by county.

Discussion and Conclusions

The analysis completed in this study shows a clear correlation between fracking activity and seismic activity and identified most aquifers in the shale play as at risk. Given the low quantity of earthquakes reported in the state the data may seem statistically insignificant, however the map speaks for itself. The earthquake activity falls directly on the shale play, and two of the three earthquakes have occurred in counties boasting the greatest volume of water used as a result of the number of wells in the region. Additionally, the toxicity index developed for the aquifers shows most of the aquifers at the heart of the fracking activity at high risk of contamination. It is worth noting that the assessment of the aquifers assumes that the volume of water being injected back into the ground is occurring at or near the well sites, and that it is able to escape into the nearby aquifers. From this analysis, it can be concluded that the northeast corner of the state including Divide, Williams, Mckenzie, Dunn, and Mountrail counties should continue to be monitored for seismicity and toxicity over the next few years as the fracking activity has only started and is the practice is growing rapidly.

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