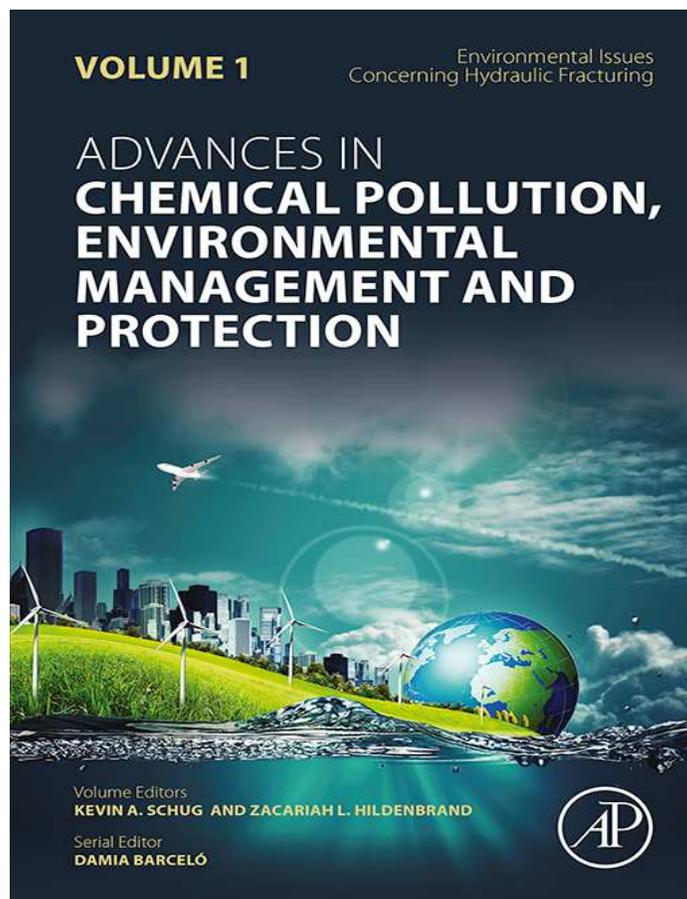


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# Societal Implications of Unconventional Oil and Gas Development

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## Abstract

The increase in unconventional drilling (UD) for oil and natural gas extraction—also known as fracking—in the United States has prompted a national debate with supporters and opponents who strongly defend each position. There are many important social, environmental, human health, and economic outcomes related to the practice of UD that have been the center of a debate about the practice. The purpose of this chapter is to explore the positive and negative effects of “fracking” on society at large using a social scientific framework. The first section outlines the process of UD and examines the health consequences of UD, the second section focuses on the consequences for the

land and environment through interrelated policies, and the third section focuses on understanding the role of power and inequality on communities and individuals.

**Keywords:** Fracking, Hydraulic fracturing, Societal effects, Power, Society

Natural gas is one of the principal sources of energy for many residential users throughout the world<sup>1</sup> and is becoming increasingly more common in the United States. Oil and natural gas extraction is an industrial process; as such it can have various social, environmental, human health, and economic outcomes. This process arrived at urban and rural areas that were well established before the discovery of what was hidden deep beneath them: shale deposits of unconventional oil and gas reserves. This chapter explores the multifaceted effects that unconventional oil and gas production has on our society.

Since reliance on natural gas is increasing, its presence in urban and rural areas has become ubiquitous. In the Barnett Shale of Texas, which covers the densely populated area East of Dallas including the city of Fort Worth, nearly 20,000 gas wells have been drilled between 2006 and the first quarter of 2017.<sup>2</sup> In Texas, the setback between production wells and any building including homes, schools, playgrounds, and churches is only 200 ft. This short distance puts residents at risk for toxic air emissions, water contamination, explosions, and others.<sup>3</sup> The United States Environmental Protection Agency (US EPA) compiled a report titled “Study of Hydraulic Fracturing for oil and gas and Its Potential Impact on Drinking Water Resources,” where it was estimated that almost 10 million people live within 1 mile of a fracked well.<sup>4</sup> This number will continue to grow as unconventional drilling (UD) exploration expands operations.

Unconventional oil and gas [O&G] development is an articulated series of processes that are used to extract oil and natural gas reserves deep from impermeable rock formations (predominantly shales) that are otherwise inaccessible. In the early 2000s, energy companies began combining horizontal (directional) drilling with hydraulic fracturing [HF] to tap these reserves.<sup>5</sup> Although HF was developed before 2007, it was not a common practice due to the lack of financial incentives to extract natural gas. By 2010, however, natural gas earnings soared to 20% of domestic gas production, causing a national boom<sup>6</sup> with more and more “fracked” production wells being developed. The most common term for this practice is *fracking*, which is short for HF, even though that is only one part of the process. The term *fracking* has been said by industry professionals to have been adopted by media and environmental groups purposely to give it a negative connotation, creating an association with something offensive. However, a recent study stated that it does not induce a negative bias toward the process despite

its similarity with a profane word.<sup>7</sup> Other socially relevant terms include high-volume, horizontal hydraulic fracturing, hydrofracking, UD, fracking, horizontal drilling, unconventional oil and gas development, and unconventional oil and natural gas extraction. For the purposes of this chapter, the authors will use the terms fracking and unconventional oil and gas development [UD] to refer to the processes of HF and acidization alike, since the effect on society is not distinguished between the two techniques.

Drilling a well can take a few weeks; UD is split into three phases: drilling, stimulation, and production. The drilling phase encompasses the use of drilling muds to reach 1–2 miles deep (or deeper in some cases), and the setup of protective casing of steel and/or cement. The stimulation phase can involve HF and shale acidization (hydrochloric and/or hydrofluoric acids) to dissolve the production strata to acquire the previously sequestered hydrocarbons. Fluids that contain chemical additives and proppants (e.g., sand) are pumped under high pressure to fracture the shale, creating cracks that allow oils and gas to flow. Chemicals commonly used in this process will be discussed in the next section. The production phase involves the gathering of oil and natural gas [O&G], which can require the burning of residual hydrocarbons gases in the case of unconventional oil wells. With the initial gathering of hydrocarbons come flowback fluids, which contain heavy metals, radioactive materials, and other toxins. The production phase also involves the management of waste (flowback), either through storage in waste pits, the recycling through membrane separation technologies, or the subsurface disposal in underground injection wells.<sup>8</sup> The process of HF is very complex and industrial, posing a challenge for those who live near it. All the stages outlined have potential to cause an adverse impact on human health, which we discuss in the next section.



## 1. HYDRAULIC FRACTURING AND HUMAN HEALTH

Empirical evidence suggests that the consequences of air pollution in human health caused by UD are a real public health concern. Residents living near UD wells have reported odors, upper respiratory, neurological, and dermatological symptoms, which are consistent with documented health effects connected to petroleum hydrocarbons exposure.<sup>9–12a</sup> It is difficult to attribute these conditions specifically to UD, and this is exacerbated by the fact that studies that seek to understand the link between UD and human health cannot account for lifestyle, frequency and duration of exposure, or the time it can take for illnesses such as cancer to develop.<sup>9–12a</sup>

Our knowledge of which chemicals are used and in what quantities are often shrouded in mystery. According to an EPA report of voluntary chemical disclosure statements by industry members, the top three additives to fracking fluid were methanol, hydrochloric acid, and hydro-treated light petroleum distillates.<sup>12b</sup> Many chemicals, however, are not disclosed to the public, government, or scientific agencies for the sake of preserving “proprietary” or “trade secret” information. This further complicates our understanding of how UD can potentially harm humans and contaminate air and water. To date, “over 1,000 substances have been identified in fracturing fluids or hydraulic-fracturing wastewater, including solvents, heavy metals, aromatic hydrocarbons, and naturally-occurring radioactive materials, but the exact composition of fracturing fluids remains unknown because chemicals and their concentrations may be classified as confidential business information” (Ref. 13, p. 90). Collectively, these chemical additives comprise a high-articulated milieu that contains various classes of compounds such as anticorrosive agents, biocides, friction reducers, cross-linkers, and solvents. Nonetheless, the lack of access to pertinent information regarding these chemical additives means that researchers are limited to some known and some suspected toxic chemicals of estimated or unknown concentrations. However, researchers have provided enough evidence to indicate that a deeper understanding of the negative health outcomes to populations living near UD is imperative. See Chapter “[Hydraulic Fracturing Chemical Disclosure: Can the Public Know What’s Going Into Oil and Natural Gas Wells?](#)” by Horwitt.

## 1.1 Water Contamination

The US Environmental Protection Agency estimated that roughly 8.6 million people were served by a drinking water source located 1 mile from an unconventional well between the years 2000 and 2013. The same report also stated that UD has contaminated drinking, groundwater, and waterways such as creeks and rivers in several states.<sup>4</sup> The report detailed water contamination and problems in three specific communities: Dimock, PA; Parker County, TX; and Pavillion, WY. The peer-reviewed scientific report, which provides ample evidence of systemic water contamination, does not offer suggestions for policy changes.

One of the factors that make UD a controversial topic is that many decision makers that handle the fate of many communities have turned scientific evidence into questionable information. UD water contamination is an intricate topic that must be viewed as a technical, social, and political issue.

For example, President Donald Trump has proposed plans to deregulate fracking asserting that it is a method of acquiring clean energy. Trump, who vowed to eliminate the EPA, appointed Scott Pruitt as EPA Administrator; he has connections with the O&G industry and has sued the EPA, which he now oversees, over President Obama's Clean Power Plan.<sup>4</sup>

Human exposure to organic solvents can result from inhalation, ingestion, and dermal absorption. Pollutants such as formaldehyde, benzene, toluene, ethylbenzene, and xylene (BTEX) are emitted or produced from HF during all phases of drilling and extraction oil and/or natural gas.<sup>14–23</sup> Benzene is of particular interest because it has been associated with several adverse health outcomes including pediatric cancer and intrauterine growth restriction. In addition, maternal exposure to ambient levels of benzene recently has been associated with an increase in birth prevalence of neural tube defects.<sup>24</sup> Independent researchers<sup>19</sup> recently analyzed groundwater samples from the Cline Shale region in western Texas before, during, and after drilling activity, where they observed significant variations in the detection of exogenous chemical compounds that correlated with the expansion of UD over time. Their study was limited by the lack of chemical disclosure information that was publicly available; however, the detection of various alcohol species, BTEX constituents, and the extreme fluctuation of total organic carbon corresponded with the pertinent chemical additives listed in a 2011 Congressional report on hydraulic fracturing.<sup>25</sup>

Kassotis et al.<sup>26</sup> reported that in Garfield, CO, a heavily drilled area, the water tested showed higher levels of estrogenic, antiestrogenic, and/or antiandrogenic activities, which are endocrine-disrupting chemicals that may have negative health impacts in humans and animals such as increased cancer occurrence, impaired gonadal development, and decreased fertility years or decades after exposure. Coman<sup>27</sup> provided evidence of the public concerns over groundwater, with more than 1000 cases of contamination from fracking documented in Colorado, New Mexico, Alabama, Ohio, and Pennsylvania. Furthermore, Ferrar et al.<sup>28</sup> performed a longitudinal study in the Marcellus Shale with community members living near UD activities, where they discovered that the perceived health effects increased over time, especially mental health issues such as stress. They also found increases in impacts on the dermal, digestive, upper respiratory, and central nervous systems.

## 1.2 Water Disposal and Seismic Activities

One of the major concerns associated to UD is the disposal of wastewater, as it contains high levels of salinity, chemical additives, and naturally occurring

radioactive material, which has been found in both downstream surface waters and river sediments even after the treatment of produced waste.<sup>29</sup> Hydraulic fracturing waste fluid is sometimes pumped back into the ground though the use of underground injection wells. In Bakersfield, California reports that oil production wastewater was injected into freshwater aquifers, designated for human consumption and irrigation, posed a problem of potential contamination and usage in that area.<sup>30a</sup>

Additionally, increases in induced seismicity and anthropogenic earthquakes have been attributed to this method of disposal.<sup>30b</sup> For example, seismic activities ensued in places like Youngstown, OH for the first time in record, which dates to 1776. After only 1 year of utilizing the first injection well, 109 earthquakes were recorded in Youngstown.<sup>30c</sup> Cases in other areas of the United States have been recorded and attributed to the location and time of injection wells. In the town of Azle, Texas a series of earthquakes were attributed to injection wells.<sup>31</sup>

There is also evidence that pressurization by HF into a fault yields episodic seismicity that can persist for months. Researchers observed that in Alberta, Canada, UD reactivated existing faults, triggering a series of small earthquakes. This is significant because geographical locations will respond to seismic activities in different ways and therefore the shale composition and fault sensitivities need to be considered in both UD and injection wells.<sup>32</sup>

### 1.3 Water Usage

Aside from the impact on water quality and disposal of wastewater, water usage is of concern. Drilling a single well requires millions of gallons of water, which can greatly impact areas where drought is a natural occurrence, such as Texas.<sup>33,34</sup> Water is critical for communities, but it is also a key part of the UD process. In California, O&G development must compete with agricultural irrigation for water. Although water used for UD does not seem significant compared to agricultural use, oil extraction is most common in regions that often deal with water scarcity, where any extra usage is a cause of stress.<sup>35</sup>

The interplay between water resource management and UD is best exemplified in Kern County, California. One of the most prolific agricultural areas of the state, the Kern River basin, where tangerines, grapes, and almonds are common crops is also an oilfield where Chevron is the largest producer. Chevron started selling their wastewater “at cost” to the local municipality that distributes it to over 90 farms within 7 miles from Kern county. The consequences of consuming produce and seeds that have been



**Fig. 1** Cattle grazing by a gas well. Barnett Shale, TX. *Photographer: Jeff Williams.*

watered with oil production waste are unknown. Tests have not shown elevated amounts of heavy metals and radioactivity due to UD, but the lack of studies in regard to human health and long term build up on the soil cast doubts and uncertainty<sup>36</sup> (Fig. 1).

#### **1.4 Air Contamination and Climate Change**

Studies on the effects of UD indicate that air pollutants such as hydrogen sulfide, nitrogen oxides, and volatile organic compounds (e.g., benzene and formaldehyde) are released during all phases of UD.<sup>16</sup> Similar findings are widely available in the literature (e.g., Refs. 15,17,19–22). The consequences of intensified toxic gases in the atmosphere are manifested through events such as extreme weather that may cause floods, heat waves, hurricanes, droughts, and biodiversity changes. These incidents cause health consequences that are not as visible as the destruction/damage of structures; for example, the aftermath of floods that have yielded increased reports of diarrhea and respiratory illnesses.<sup>37</sup>

Payne et al.<sup>22</sup> found discernible, yet sporadic plumes of methane near compressor stations, making residents that live within 1 mile from these stations vulnerable to methane exposure, which is the most abundant constituent of natural gas. Despite the challenge to measure methane accurately, their study provided significant insight into the need for further investigations of natural gas infrastructures that could lead to environmental regulation and improved safety. While methane is naturally occurring, it is

one of the main contributors of climate change since anthropogenic sources emit more than twice the amount of natural sources.<sup>38</sup> The significance of methane is clear: “Methane contributes substantially to the greenhouse gas footprint of shale gas on shorter time scales, dominating it on a 20-year time horizon. The footprint for shale gas is greater than that for conventional gas or oil when viewed on any time horizon, but particularly so over 20 years. Compared to coal, the footprint of shale gas is at least 20% greater and perhaps more than twice as great on the 20-year horizon and is comparable when compared over 100 years” (Ref. 39, p. 679).

McKenzie et al.<sup>20</sup> findings’ in Colorado regarding the potential hazards of air pollution caused by UD showed that health effects resulting from air emissions are most likely to occur in residents living nearest to the well pads. They found exposure to BTEX chemicals, all of which have neurological and/or respiratory effects. “We also calculated higher cancer risks for residents living nearer to wells as compared to residents residing further from wells. Benzene is the major contributor to lifetime excess cancer risk for both scenarios” (p. 83). Furthermore, Hildenbrand et al.<sup>19</sup> found that specific components on various pad sites were emitting BTEX into the atmosphere, and the emissions were attributed to mechanical inefficiencies since they were not found to be occurring systematically.

## 1.5 Other Health Effects

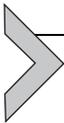
Noise pollution related to UD has also been found to be a concern to human health. Despite the noise being temporary or intermittent for the most part, depending on the drilling phase, it is considered as a possible risk factor for stress and adverse cardiovascular outcomes.<sup>40</sup> Light pollution has also been a concern for residents and wildlife. In the Bakken Shale in North Dakota, the second largest oil producer in the United States, the oilfield flares can be seen from the space station.<sup>41</sup>

Every stage of the UD process can have a negative impact on human health, which merits a deeper consideration of UD policies and alternative energy sources. The next sections identify examples of how legislative action has been taken to safeguard O&G companies from the laws traditionally in place to protect citizens. Such laws are in place to prevent water pollution, to provide individuals with knowledge of hazardous chemical exposures, and to protect individual land rights. O&G companies have invested large sums of money to put in place their operations, which are extremely costly considering its industrial nature, and their aim to maximize profits is



**Fig. 2** Flaring a well. Eagle Ford Shale, TX. *Photographer: Jeff Williams.*

understandable. However, there needs to be a consideration for individuals, communities, and the public at large—of whom a majority are against the fracking process (Fig. 2).



## **2. LEGISLATION AND RIGHTS**

### **2.1 Taxpayer Cost**

Urban planning is a topic that affects communities but generally receives little attention. Rahm et al.<sup>42a</sup> found a significant increase in crashes and fatalities, showing that communities are struggling to meet heavy demands that O&G activities placed onto their transportation system. That includes increased traffic and congestion, deteriorating roads, and maintenance costs, which are expenses incurred by local taxpayers rather than the O&G companies. A study published in 2014 noted that the heavy trucks hauling equipment to and from gas extraction sites cause damage to Pennsylvania roadways. The state costs associated with each UD production well are between \$5000 and \$23,000 for uncompensated roadway reconstruction.<sup>42b</sup> This may seem like a small amount of money until you add up the 7788 fracking wells located in Pennsylvania.<sup>42c</sup> Jemielita et al.<sup>43</sup> found an increase in hospitalization, with an emphasis on cardiac and neurological conditions, among citizens living in close vicinity of drilling sites. Their findings were determined by density of wells and proximity and they concluded that “health care utilization should be factored into the value (costs and benefits) of hydraulic fracturing over time” (p. 16).

Taxpayers must also pay to plug leaking wells, which can compromise groundwater, surface water, and air quality. “Postmineral extraction cleanup costs are substantial, including restoration of damaged or contaminated streams and soil, improper handling of wastewater disposal, and improper disposal of radioactive material and hazardous waste” (Ref. 44, p. 784). The estimated number of abandoned O&G wells in the United States is roughly 2.3 million. Due to the lack of industry reporting abandoned wells and varying state regulations, it is not possible to have a precise number, but based on the number of new wells drilled in recent years, it is possible to estimate this number will grow significantly in the United States. States require that owners pay to plug their wells; however, decades can go by before a well is inactive, making ownership hard to trace. Pennsylvania, like most other states, has an Orphan and Abandoned well fund, and O&G companies have stated that it is not fair to impose the cost on them. Further, plugging inactive wells adds financial burden to the companies; lack of state and federal incentives to report and properly plug wells makes it easier to abandon the wells instead.<sup>45,46</sup> Since the Appalachian basin is the oldest in the United States, it is likely to have the highest amount of abandoned wells, which leak methane into the atmosphere and can contaminate water.<sup>47a</sup>

## 2.2 Environmental Regulations

The US Environmental Protection Agency’s Clean Water Act (CWA) of 1972, and the Safe Drinking Water Act (SDWA) of 1974, places the responsibility of regulating and monitoring waterways and drinking water that provide for more than 25 people into the hands of the EPA, leaving out millions of residents who use water from private wells.<sup>47b</sup> The CWA manages permits for companies who wish to discharge wastewater into US waterways. Through this process, the CWA ensures that any wastewater is free from hazardous pollutants. The SDWA ensures that drinking water is free of contaminants that exist in the environment such as animal waste, human waste, or chemicals from manufacturing. Traditionally, this type of regulation and monitoring has been in place for industrial operators to ensure that pollutants do not contaminate drinking water and/or are discharged into waterways.

In 2005 Congress voted on the Energy Policy Act of 2005, also known as the “Halliburton loophole,” to provide exemptions for the O&G industry so that the CWA and the SDWA could no longer regulate runoff and the underground injection processes related to fracking.<sup>47c</sup> The Vice President

at the time, Dick Cheney, was a former Halliburton executive and chaired then President Bush's Energy Policy Task Force, which made the recommendation to exempt fracking from federal regulation.<sup>48</sup> This means that the EPA no longer has the means to regulate the types of fluids used in the process of fracking, except where diesel fuel is used.

The EPA is also restricted in its ability to enforce practices that ensure safe drinking water in and around fracking wells. For example, in a case in Parker County, TX, the Lipsky family reported effervescent water in their home to the EPA, which coincided with two unconventional wells drilling near their home. The EPA found that both wells contaminated the nearby homes, including Lipsky's, and issued an imminent endangerment order for Range Resources to immediately halt all gas production from the recently drilled wells. Range Resources and the Texas Railroad Commission (TRRC) conducted separate investigations, both finding that the source of the gas could not be traced back to the wells and that the gas was naturally occurring. In that case, the EPA did not have power to override state regulations. Independent and academic researchers tested Lipsky's water, all concluding the gases were not naturally occurring.<sup>49</sup> Cases like this abound, putting communities and families in a lengthy battle between local and federal investigations while suffering financial, physical, and mental health hazards imposed by UD development.

### 2.3 Restricting Public Speech

Because the industry's responsibility to waterways is largely unregulated, individuals can be harmed by the UD process without their knowledge. Ground and surface water resources can become contaminated, individuals can be exposed to poor air quality around the well site (which in some cases is directly adjacent to neighborhoods), and/or O&G laborers can be harmed at the well site. Until 2016, there was a provision in a Pennsylvania state law that prevented physicians from talking about the potential harmful effects of fracking with their patients or even other health professionals. The Pennsylvania law stated that the gas companies practicing fracking must list and identify each of the chemicals used in fracking fluids to any health professional who would like to know. Those health professionals, however, were required to sign a nondisclosure agreement, stating that they will not share this information with anyone, which scared doctors and prevented many from seeking such information.<sup>50</sup> Patients were allowed to be notified of the chemicals only if it directly impacted their health care during the

doctor visit or in the case of an emergency. O&G companies such as Halliburton and Exxon presented the confidentiality agreement as a way to protect trade secrets, but doctors and patients received it as intimidation.

The Pennsylvania Supreme Court overturned much of the law including the so-called physician gag order in September 2016. Other states, however, have had similar laws proposed to limit the disclosure of the toxic chemicals used in the fracking process. In 2014, North Carolina proposed legislation that would make it a felony to disclose the contents of fracking fluid to the public. The only exception would have been for emergency responders and physicians seeing patients in emergency situations.<sup>51a</sup> Similar to the Pennsylvania law that was struck down by a judge, health care workers would have to sign a confidentiality agreement not to disclose chemicals involved in the health crisis. The bill would have even restricted first responders and health care workers from talking about fracking chemicals with their colleagues and at their annual conferences. This bill represented the strictest call for secrecy of chemicals used in UD because of its call for jail time for the “violation of trade secrets”.<sup>51b</sup>

In addition to this type of legislation regarding the release of chemical compositions to the public, individuals receiving settlements for damages incurred by fracking have been asked to sign nondisclosure agreements. In one fracking settlement in Pennsylvania, a 7-year-old and a 10-year-old minor were put on a lifelong ban from discussing their case publicly or privately.<sup>51c</sup> In southern New York in a town called Sanford, on the border of the Marcellus Shale formation, the city council imposed a gag order on residents for nearly a year pertaining to any discussion of fracking at their city meetings.<sup>51d</sup> Residents sued, claiming that the gag order violated residents' first amendment rights and restricted their rights to dissent to the effects of the fracking operations in their town.

If the public, government agencies, and researchers do not know what chemicals are used throughout the UD process (and in what quantity), then they do not know what chemicals to test for in the air and water to detect contamination. This can negatively impact public health in several different ways. With a gag order, the effects of exposure to these chemicals cannot be studied and public health campaigns cannot be enacted to notify the public of what symptoms to look for in relation to health. Similarly, if community members are not allowed to voice their opposition or concerns around fracking at city meetings, their voices are not heard and their needs are not addressed. In the Marcellus Shale, environmental public health experts or organizations were not included in advisory bodies overseeing UD

activities despite “the well-publicized public concerns about the potential health impacts of Marcellus Shale activities, which have been forcefully described by the public in numerous hearings” (Ref. 10, p. 485).

In the face of opposition, O&G companies command the wealth and legislative power to advance their agenda, while individual community members, whether they agree with fracking or not, must adhere to the rules and laws in place that protect the industry. There are cases where public opinion, however, has been powerful enough to advance their own agenda of disclosure. In Wyoming, environmental activists successfully sued Halliburton, the nation’s second largest O&G service company, to relax its disclosure laws and make it harder for other companies to withhold chemical lists from the public.<sup>52</sup> Additionally, the Obama administration in 2015 announced federal measures that require gas companies to disclose the chemicals used in the extraction process on federal and tribal lands.<sup>53</sup> These new measures were challenged in court by representatives of the natural gas industry, and in March 2017, President Trump reported that he would be rolling back the Obama-era requirements of chemical disclosure as part of an executive order to reduce restrictions on industry.<sup>54</sup> By restricting the knowledge of the chemicals used, little research can be done on the effects to human health and studies on the effects of these chemicals on the public cannot be undertaken. This restriction places individuals in society at a disadvantage while advantaging the gas companies, who hold the power to influence the legislative process.

## 2.4 Land Rights

While some landowners welcome fracking to their land, others fear the possibility of air, soil, and water contamination if their land is to be used for surface activities. Gas companies use lobbying and legislation to circumvent individual opposition by using existing state and local laws that allow for gas companies to drill under a property even if the individual landowner does not consent. For example, when a company wants to extract oil or natural gas through UD on private property, they must negotiate with the landowner for the right to extract hydrocarbons under their land and to pay them a percentage of the fair market value of the extracted hydrocarbons. Federal law guarantees individual landowners a royalty rate of no less than 12.5% of profits made from the sale of the O&G. This rate has not been increased since the 1920s, and many argue that it is too low considering the record-breaking profits being made by O&G companies in the past decade. Some individual

states have written their own laws to increase the percent of royalties paid out to individuals. Pennsylvania has kept its royalty payout consistent with the federal minimum, but Texas charges a 25% royalty rate for drilling on public lands, some western states charge 16.7% (Wyoming, Utah, Montana, Colorado), and New Mexico and North Dakota charge a royalty rate of 18.8%.<sup>55</sup>

If there is a landowner within 200–400 ft. who decides not to lease his/her property for the mineral rights, the gas company can still legally obtain the oil and/or natural gas and they do not have to compensate the non-compliant or “hold-out” owner. This is done under the “rule of capture” laws in place. As long as the gas company does not trespass on the owner’s property (i.e., the well pad is placed on a neighbor’s property) and all rules and laws are followed, they can extract underground without the landowners’ permission. The “hold-out” owner is not entitled to any royalties if the rule of capture is used because it is difficult to prove whether and in what proportions the gas came from under their property. Setback distances vary from state to state; these restrictions include safe distances to drill near to schools, residential property, and hospitals. In a 2008 ruling, the Texas Supreme Court ruled that a family that had its natural gas drained from under the land by an adjacent fracking was not entitled to the profits under the “rule of capture” provisions of state law.<sup>56</sup> This ruling overturned a multimillion dollar judgment awarded to the family by a lower court. The rule of capture provision is seen as a protection from drillers from trespass claims of landowners. As long as the O&G company follows the state laws, they do not have to pay royalties to landowners who do not sign leases with them. This practice clearly privileges gas companies over individual landowners.

A second practice that also favors O&G operators is the concept of “forced pooling.” Using this concept, as long as an O&G company gets leasing agreements for a certain percentage of the acreage, they have the ability to capture the gas under the land.<sup>57</sup> Under these circumstances, all landowners, whether they entered into a gas lease or not, are entitled to royalties on the extracted gas.<sup>57</sup> Additionally, pooling laws that exist in over 40 states allow the majority to decide whether a neighborhood gets drilled or not, causing feud among neighbors.<sup>58</sup>

If O&G companies obtain land rights through leases, rule of capture, or forced pooling, they sometimes do not pay their fair share. There have been a number of lawsuits brought against companies for “cheating” residents out of royalty payments. For example, if the royalty payment is 12.5% on the

profit of the sale, companies will first take out administrative, processing, marketing, or other fees out of the profit before taking the 12.5%.<sup>59</sup> Companies may also create a subsidiary and sell the gas to themselves for a lower price, calculate royalty payments on this low price, and then sell the gas at the higher price later from the subsidiary. These practices are not legal under some lease contracts. In 2003 the state of Alabama was awarded \$103 million from Exxon and the state of West Virginia was awarded \$404 million in punitive damages in 2007. However, in states like Pennsylvania, it is much harder to take the O&G companies to court for such matters (Fig. 3).

O&G companies have also lobbied to be granted the right to declare eminent domain for hydrocarbon extraction. Under the Fifth Amendment of the US Constitution, the government has the power and right to take private land for public use if the landowners are given “just compensation.”<sup>60a</sup> Eminent domain has traditionally been used for public work projects such as highways, power lines, or schools. In most cases, only the government or an agent of the government has the authority to declare eminent domain to secure land for a project. In recent years, however, state and local government have provided eminent domain powers to O&G companies for UD and pipelines. In 2005, the Connecticut Supreme Court made a decision that made it easier for local governments to grant eminent domain authority to private companies for economic development. This was done under a reinterpretation of the language of “public use” to mean something



**Fig. 3** Drilling a well, Barnett Shale, TX. *Photographer: Jeff Williams.*

more broad—public purpose.<sup>13</sup> With this precedent, gas companies have the power to take private land to conduct their UD operations. This represents another example of how those with economic and political power are able to meet their needs over the needs of individual landowners.

Individuals have the right to take gas companies to court, but often lack the economic or political resources for long drawn out disputes over land rights.<sup>60b</sup> This is the case for many individuals because UD production and disposal wells are more likely to be located in poor communities, communities of color, and communities with larger than average numbers of vulnerable populations (such as children and the elderly). A recent geospatial analysis of the impact of exposure to pollution due to unconventional gas wells along the Marcellus Shale region (Ohio, Pennsylvania, and West Virginia) found that poor populations were disproportionately affected. This means that gas wells were more likely to be found in clusters of vulnerable populations (the elderly, the poor, and the children) compared to other rural and urban areas that had smaller proportions of vulnerable populations.<sup>60c</sup> There is a current debate as to whether inequalities in environmental exposure are race related or income related or an interaction between race and income,<sup>60d</sup> while others argue that income seems to be the common denominator.<sup>60e</sup> In the United States, industrial operations in general, which pose the greatest risks to human health through toxic environmental pollution, tend to be concentrated in localities with the most economically vulnerable populations.<sup>61a</sup>

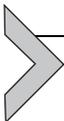
## 2.5 Public Protest

One way that individuals and community groups can shape the stewardship of the UD process is through public protests, marches, or demonstrations that put a public face to the dissent of the process. Perhaps the most famous protests of O&G companies in recent years are the Native American groups that continue to protest the Dakota Access Pipeline. Less well known are ongoing antifracking protests in the nation's capital as well as a number of states with current or proposed fracking operations including Maryland, Florida, Texas, and Colorado. When it becomes clear that there are individuals who protest fracking in their communities and disrupt gas sites, the gas companies lobby to create legislation to make it illegal to protest under certain circumstances. As evidence of this, there were a total of 18 states that proposed antiprotesting bills during the 2017 state legislative sessions.<sup>61b</sup> All the bills attempted to penalize protesting in various ways. Minnesota,

Washington State, South Dakota, Indiana, Florida, Mississippi, and Iowa have all proposed bills to increase fines and jail sentences for protestors obstructing traffic. Colorado and Oklahoma proposed bills that would increase fines and penalties for protesters who tamper with or trespass on rail-ways and pipelines, signaling the bills as a warning to future pipeline protesters. Indiana has proposed a bill to allow police to use “any means necessary”<sup>62a</sup> to clear protestors from highways leaving the term to dangerous interpretation. Additionally, the new term “economic terrorism”<sup>62b</sup> has emerged in legislation from Washington and North Carolina. Both states proposed bills that would fine protesters for economic disruption, which has been characterized as economic terrorism.

Definitions of economic disruption would be left open to interpretation, but would include any effects that protesting has on businesses, people, and state economics. Minnesota proposed a similar bill that would charge protesters for the policing costs. Furthermore, Michigan, Colorado, and Arizona introduced similar bills that would allow individuals to sue other individuals who protest them or who choose to mass picket them. While the proposed antiprotester bills are not directly targeted toward gas companies and UD specifically, some of the harshest ones occur where individuals have been openly protesting fracking.<sup>62c</sup>

Another way that individuals can protest UD in their neighborhoods is to work with city councils to take a stand on allowing fracking in their communities. Denton, TX was the first in the state to adhere to its resident’s concerns about fracking and create a ban in the town. The measure to ban fracking in the city passed with 59% of the vote with the mayor’s support, who vowed to fight for their right to ban the practice in their city.<sup>63a</sup> The ban held for 7 months before the Texas state legislature and the governor signed into law HB 40 which states that O&G regulation can only take place at the state level.<sup>63b</sup> Under HB 40, the state makes all decisions about where UD takes place. This takes power away from individual communities such as Denton that are likely to be affected by UD.



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### 3. POWER RELATIONS

Proponents of UD argue for its benefits, which include securing energy independence, economic growth, lower fuel costs, and a cleaner environmental footprint through natural gas, which enables a shift away from carbon-intensive, coal-based electricity.<sup>64</sup> Furthermore, natural gas is promoted as a symbol of national pride and a patriotic path to energy

independence that is scientifically sound<sup>65a</sup> and to be used as a “bridge fuel” toward the development and use of renewable energy. However, UD is linked to air and water pollution in communities and areas around UD wells, and these genuine threats to public health have been well established.<sup>65b</sup> Individuals and groups that oppose UD cite these environmental concerns, whereas communities affected by UD also complain of additional issues such as truck traffic, drilling noises, and unattractive well sites. Both proponents and detractors of UD make arguments based on their own perspective, but the wider societal implications are played out in the distribution of wealth and power in society. A recent Gallup poll indicates that only 36% of Americans support fracking and 51% directly oppose it.<sup>65c</sup>

One way to understand the current tensions between O&G industry and individuals in communities is to look at it using a Conflict Perspective. In general, a conflict perspective views the social world consisting of groups vying for control (or power) over scarce resources. Power relations dictate who can access a resource and how.<sup>65d</sup> In traditional conflict theory, the bourgeoisie, or capitalists, own the raw resources and the means of production, or factories and other equipment that produce consumer goods from the raw materials. These goods are then sold for profit, which the capitalists own. The proletariat, or working class, only own their labor, which they sell to the bourgeoisie. They earn nothing from their labor other than wages.

Applying this to the O&G industry, the raw resources of production, hydrocarbons, are extracted via UD to be sold for profit. Oil company shareholders and executives are the bourgeoisie who own and control the gas production process and the profits that come from it. Industry workers and those living near UD sites make up the proletariat as they have little say over the production process or what happens to the profits that are derived from that process, even if a mineral lease is signed. They have only their labor and in some cases their land rights to sell and have little to no input into the UD process, despite the potential dangers that exist to their environment and individual health. From a conflict perspective, we refer to this as the “relations of production,” or the business–customer dynamics that partially drive corporate and consumer culture. Oil company shareholders and executives want to maximize profits from the means of production and one way to do so is to ignore the negative consequences of UD. Those living near UD sites want to reduce health risk exposure and may seek to prevent drilling from occurring in their communities.

The fact that the desires of O&G companies prevail over public opinion on the potential dangers of the UD process speaks to the social power of the

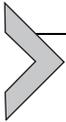
industry. This power is derived from the laws that protect the UD process. But power is also found in how society supports the “rights” of the O&G sector and other large industries over the need to protect public and environmental health from industrial production processes. This is done directly through lobbying efforts by O&G companies, through politicians or political appointees who come from the O&G industry, and is indirectly maintained by a populace that wants access to inexpensive sources of energy.

Public relations and advertising also play a large role in shaping the image of the O&G industry, normalizing its impact on natural resources and communities. Citizens and the O&G companies contend for the same land and water, but both share the desire for financial benefits, which motivates landowners to lease their property for UD purposes. O&G companies provide homeowners with their expertise in exchange for access to land and water.<sup>66</sup> The expertise is delivered through publications like *Energy in Depth*, a public relations venue created by the Independent Petroleum Association of America (IPAA) in 2009: “Modern technology and scientific rigor are cited as key in the success and environmental cleanliness of natural gas development and are used as imagery to legitimize unconventional shale gas development” (Ref. 65a, p. 296). IPAA also runs the Groundwater Protection Council, one of the organizations that manage FracFocus, a website that serves as a national HF chemical registry for O&G companies who wish to volunteer full or partial chemical information to the public.

The extraction of hydrocarbons through UD continues growing around residential and urban areas. Legislative channels are the most evident ways in which O&G companies can operate despite evidence of environmental contamination and negative health outcomes. The profits earned through the sale of oil and natural gas are partially reinvested into legislative and communication efforts that help create a more favorable business environment in which to operate.<sup>65a,67,68</sup> In 2015, the United States provided \$4.7 billion in tax subsidies for the O&G industry.<sup>69</sup> In the presidential election of 2012, O&G companies contributed around \$75 million to federal candidates and spent more than \$140 million lobbying.<sup>70</sup>

Favorable environmental regulations, laws that support unsustainable business practices, and gag orders that prevent wider discussion and research of the health problems associated with UD, are all ways in which the cultural hegemony of capitalism comes to dominate the health and lives of American citizens. For example, in a high-profile case that spurred public outrage in 2014, the Speaker of the Texas House of Representatives and his wife, along with Secretary of State Rex Tillerson (then CEO of Exxon Mobil), sued to

block a 15-story water tower to be built to assist with water needs for a nearby UD production well. Tillerson testified that the proposed project, planned to be adjacent to his 83-acre ranch, would be a noise nuisance and traffic hazard.<sup>71</sup> Tillerson argued that it would interfere with the quality of his life.<sup>72</sup> However, when arguing for less regulation for UD and promoting drilling (near other people's residences), Mr. Tillerson said "This type of dysfunctional regulation is holding back the American economic recovery, growth, and global competitiveness."<sup>71</sup> Tillerson won the lawsuit and protected his estate and lifestyle, unlike citizens who fought for the same rights but do not hold similar political or financial power. It is worth noting that at the time of the lawsuit, Exxon Mobil was the largest producer of natural gas in the United States through its subsidiary company, XTO. In wealthier communities, the location of fracking wells is often fought in court. An executive for Range Resources, a Pennsylvania gas company, was cited as saying that their company avoids putting gas wells near wealthy neighborhoods out of fear that they would have the financial resources to challenge the well placements.<sup>3</sup> This deliberate display of inequality demonstrates whose voice dominates and who makes the rules.



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#### **4. CONCLUSION**

This survey of the literature pertaining to unconventional oil and gas development has demonstrated the wide array of effects UD has had on our society since its arrival. A recent study of how fracking portrayals in the mainstream media demonstrates that American news outlets are mostly focused on water pollution when reporting about UD.<sup>73</sup> The focus on water pollution could be due to the lack of knowledge regarding this complex industrial practice, which involves proprietary chemicals and technologies, as well as convoluted policies. Although water is extremely important, UD needs to be examined from other aspects to fully understand its full spectrum of impacts on society. For example, the lack of focus on air pollution excludes considerations about UD and climate change. Climate change is caused by anthropogenic sources and mitigation of climate change by decreasing the use of fossil fuels should have an improvement in human health. This knowledge is extensively established in the scientific literature across disciplines,<sup>74</sup> and that could be considered one of the main impacts of UD on our global society. UD is banned in countries like France, South Africa, and Bulgaria, but it is a thriving industry in the United States despite strong public opposition. When combined, the lack of experts addressing

public concerns, the costs to taxpayers, and the lack of transparency from O&G companies, the negative effects on society have become intensified.

This text was designed to illustrate that UD's impact on society includes, but is not limited to, issues related to health, environment, seismic activities, legislation, taxes, land rights, public speech, research, and power. The public should be informed about all the possible ramifications of living near industrial activities and should have a voice, particularly with respect to forthcoming legislative changes/amendments to O&G regulation. When faced with an industry that has a poor record of environmental stewardship, most citizens know they cannot compete fairly for a chance to decide the fate of their communities (e.g., HB40 in Texas). If one favors, condones, or opposes this practice, it is clear that it will continue to grow and create its own rules despite documented negative public opinion, public health outcomes, and climate change effects.

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