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Place-based perceptions of the impacts of fracking along the Marcellus Shale

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ABSTRACT

We examined community perspectives and experiences with fracking in Doddridge County, West Virginia, USA as part of a larger assessment to investigate the potential health impacts associated with fracking in neighboring Maryland, USA. In November 2013, we held two focus groups with community residents who had been impacted by fracking operations and conducted field observations in the impacted areas. Employing grounded theory, we conducted qualitative analysis to explore emergent themes related to direct and indirect health impacts of fracking. Three components of experience were identified, including (a) meanings of place and identity, (b) transforming relationships, and (c) perceptions of environmental and health impacts. Our findings indicate that fracking contributes to a disruption in residents' sense of place and social identity, generating widespread social stress. Although community residents acknowledged the potential for economic growth brought about by fracking, rapid transformations in meanings of place and social identity influenced residents' perceptions of environmental and health impacts. Our findings suggest that in order to have a more complete understanding of the health impacts of fracking, future work must consider the complex linkages between social disruption, environmental impacts, and health outcomes through critical engagements with communities undergoing energy development.

1. Introduction

Discovering new sources of energy along with independence from foreign oil has become increasingly important as the demand for fossil fuels continues to rapidly increase. Recent innovations in extractive technologies have made it possible to develop previously inaccessible natural gas and oil reserves. Unconventional natural gas development and production, or fracking, the horizontal drilling of a rock layer and the injection of a pressurized mixture of water, sand, and other chemicals to release gas and oil, is one such new technique employed to extract natural gas or oil reserves dispersed within shale formations. These methods have allowed for the rapid expansion of oil and natural gas development throughout the United States, Europe, Asia, and Australia, and are predicted to make the United States a key exporter of natural gas in the near future (Boersma et al., 2015).

One of the largest shale formations in the United States, Marcellus Shale, is abundant in gas resources and is found deep beneath the surface of the Northern Appalachian regions of Pennsylvania, Ohio, West Virginia, New York, and Western Maryland (Fig. 1). Although fracking has been established in the Western United States, in states like Colorado and Texas, it has only recently been implemented in states like West Virginia and Pennsylvania. However, despite shale production beginning in 2005, Marcellus Shale is currently the largest producing shale gas basin in the United States, accounting for almost 40% of US shale gas production. Production in the Marcellus Shale has increased dramatically, from 2 billion cubic feet per day in 2010 to its current level of 16.5 billion cubic feet per day (U.S. Energy Information Administration, 2015).

The process of extracting gas from shale formations is complex and involves several phases. Negotiating mineral rights with landowners, clearing land for well pads, construction of road and infrastructure including pipelines and compressor stations,

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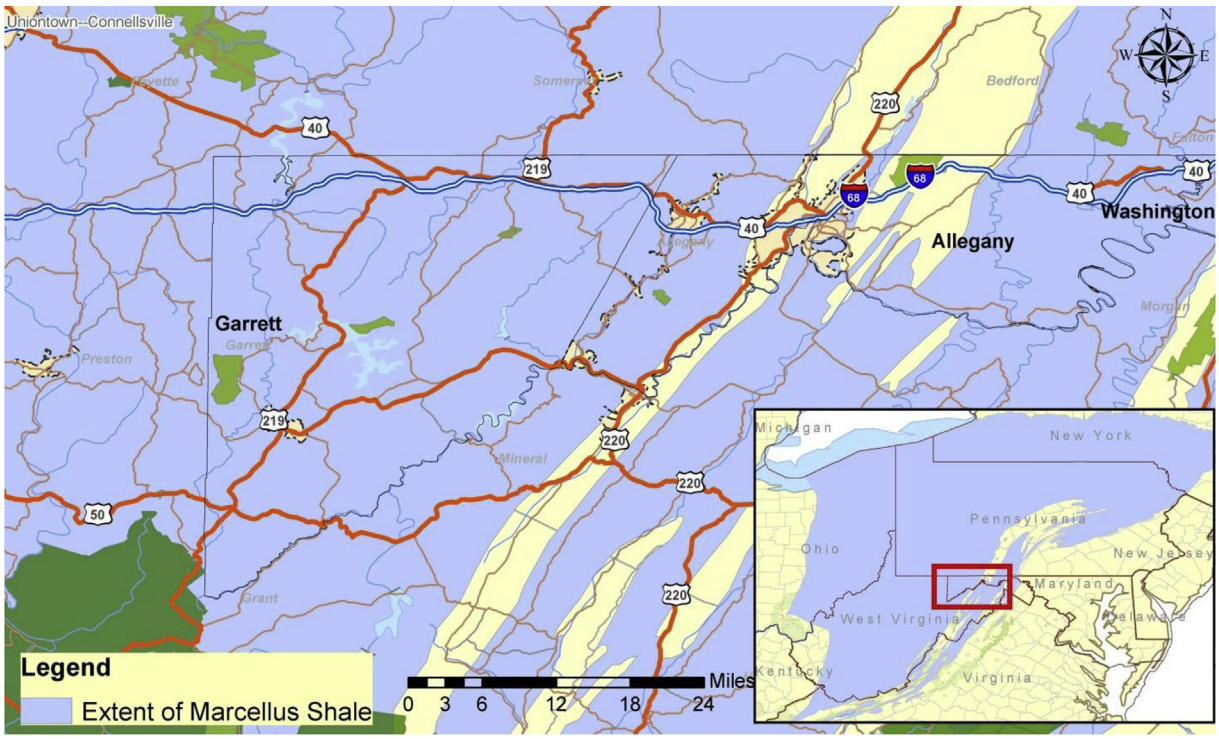

Fig. 1. Extent of the Marcellus shale in Western Maryland.

transporting and processing extracted gas as well as water and wastewater, and the influx of transient workers and populations into established communities are also important aspects of fracking. These stages of development may have significant environmental, health, and social effects for communities undergoing fracking (Ferrar et al., 2013; Jacquet, 2014).

Because fracking is relatively new and has expanded rapidly, there is a lack of substantive population-based studies of the public health effects of fracking operations. However, current research indicates that there is significant potential for adverse direct and indirect health outcomes as a result of fracking. A growing body of work has identified several key environmental, physical, and social stressors associated with fracking as well as the exposure pathways by which the health of communities may be impacted (Adgate et al., 2014; Shonkoff et al., 2014; Ziemkiewicz et al., 2014). Air pollutants, reported in various phases of fracking, have been a cause of concern since they are known respiratory, skin, and neurological toxicants; can cause drowsiness and headaches; and can lead to blood disorders, reproductive and fetal conditions, and cancer (McKenzie et al., 2012). Contamination of surface and groundwater has also been noted as a serious concern because of the large amounts of water used and generated through the fracking process (Environmental Protection Agency, 2015; Rahm and Riha, 2014). Although few studies have attempted to link chemicals used in fracking to direct health effects, these fluids are known to cause cancer and other mutations, disrupt endocrine functioning and normal immune responses, and damage neurological, cardiovascular, and kidney functioning (Colborn et al., 2011). Stressors emanating from the physical environment as a result of the fracking process such as noise and light pollution and accidents and injuries also have raised alarm among communities and researchers (Ferrar et al., 2013). Noise and light pollution can increase stress among residents living near fracking sites and may have serious impacts on workers; occupational hazards and traffic and industrial accidents can increase mortality related to fracking operations (Boudet et al., 2014).

Finally, social stressors related to rapid community change as a result of fracking—industrialization, uneven economic benefits, diminishing social cohesion, and increases in crime and substance abuse—have been noted as potentially contributing to health effects attributable to psychosocial stress (Brasier et al., 2011; Shandro et al., 2011; Stedman et al., 2012). Some of this literature has examined nonspecific health symptoms reported by residents living near fracking sites including upper respiratory tract issues, nosebleeds, eye irritation, headaches, vomiting, diarrhea, and skin rashes (Saberi et al., 2014; Werner et al., 2015). Others have focused on residential risk perceptions where fear of uncertainty around fracking and lack of trust surrounding government and industry regulations has led to increased levels of stress and anxiety (Willow, 2014). This scholarship indicates that fracking represents a significant dilemma for communities, who often welcome the potential economic growth but are also concerned about socio-environmental risks (Ladd, 2014).

In 2011, former Maryland governor Martin O'Malley issued an executive order establishing the Marcellus Shale Safe Drilling Initiative, the purpose of which was to assist state policymakers and regulators in determining whether and how gas production from the Marcellus Shale formations in Maryland can be accomplished without unacceptable risks to public health, safety, the environment, and natural resources (O'Malley and McDonough, 2011). As part of this initiative, the State of Maryland contracted us to conduct an assessment of the potential public health impacts associated with drilling in the Marcellus Shale in Western Maryland, especially those that would be concentrated in and unique to communities living and working near fracking sites. We employed a health impact assessment (HIA) methodology to conduct a study of potential public health impacts of fracking. A HIA is a process that utilizes a variety of data and analytic methods to determine a broad

range of potential health impacts, including those that may result from social, economic, and environmental changes, of a proposed project, plan, or policy before it is implemented (Witter et al., 2013). Our HIA included a comprehensive description of risks and potential public health responses to fracking using a baseline assessment of current regional population health, an assessment of potential public health impacts, and possible adaptive and public health mitigation strategies. The final HIA report and supporting documents are available on the project website (Maryland Institute for Applied Environmental Health, 2014).

In this paper, we report on qualitative data collected at the beginning of the HIA using focus groups and observational data. A necessary initial step in any HIA is the scoping process where the plan for the HIA is outlined and potential health risks and benefits are identified in consultation with a wide range of stakeholders. Through input from multiple stakeholders in Western Maryland, we conducted focus groups with residents from nearby West Virginia, where drilling operations were already underway, to examine how community residents perceive and experience fracking to better understand the potential health impacts for Western Maryland residents.

1.1. Western Maryland and West Virginia in context

Potential fracking operations in Maryland are predicted to occur in Allegany and Garrett counties, the westernmost counties in the state, nestled in the foothills of the Appalachian Mountains. Although West Virginia figures prominently in the social science and health literature on Appalachia, Western Maryland often has been overlooked. The limited scholarship on Western Maryland has noted that Allegany and Garrett counties are more similar to neighboring West Virginia and other states that encompass the Northern Sub region of Appalachia than to the rest of the state of Maryland due to closely-aligned economic and cultural histories (Hanna, 1995). Coal mining and oil and gas development greatly influenced regional settlement patterns and still have considerable environmental and economic impacts on the area (Bell and York, 2010). Much of the region is in economic and population decline after being major coal, oil, and gas production centers in the past century (Thorne et al., 2004). Tables 1 and 2 show current geographical, sociodemographic, and health outcome data for Allegany, Garrett, and Doddridge counties and for the states of Maryland and West Virginia. All three counties are rural and have populations that are older and racially homogenous and experience high rates of poverty. The health profile of Allegany and Garrett County residents is also comparable to that of Doddridge County residents.

Scholarship on Appalachia indicates that place-based identity is complex and diverse, resulting from a shared sense of regional geography, history, political economy, and culture. The Appalachian mountain range defines the region geographically, extending from Southern Alabama into Canada, encompassing nearly 400 counties in 13 different states (Mencken, 1997). Although rooted in place-based meanings related to physical and metaphorical homeplace of mountains, Appalachia also extends to a shared social identity rooted in regional politics, economic history, and social struggles (Cooper et al., 2011). Recent work has focused on how modern Appalachian identity rejects “hillbilly” and “culture of poverty” stereotypes as those in the region redefine themselves in the face of global capitalism (Fisher and Smith, 2012). Communities throughout the region are forming broader alliances and social movements to advocate for social and health justice in response to years of political, economic, and cultural marginalization (Taylor, 2009).

1.2. Place-based approaches to fracking

Although fracking is a global phenomenon, experiences with fracking are localized and often tied to individual and collective sense of place (Jacquet and Stedman, 2014). Scholars have long documented the deep and substantial connections between people and environments, and in particular psychosocial conceptions and meanings of place, individual and collective attachment to particular places, and the formation of identities strongly linked with place (Low and Altman, 1992; Proshansky et al., 1983). Although public health literature, for the most part, has focused on distinguishing between contextual or compositional effects of place, evidence indicates that people and places are mutually-reinforcing reciprocal systems and that personal and collective identities are situated and shaped by both social relations and place (Cummins et al., 2007). Proshansky and colleagues argue that the “subjective sense of self is defined and expressed not simply by one's relationship to other people, but also by one's relationships to the various physical settings that define and structure day-to-day life”

Table 1
Demographic profile.

	State of Maryland	Garrett County, MD	Allegany County, MD	State of West Virginia	Doddridge County, WV
Total population (Est. 2014)[a]	5,976,407	29,679	72,952	1,850,326	8391
Total land area (mi^2)[a]	9707.24	647.10	424.16	24,038.21	319.72
Pop. density (per mi^2)[a]	594.8	46.5	177.0	77.1	25.7
Pop. growth rate (% change. April 2010–July 2014)[a]	3.5%	−1.4%	−2.8%	−0.1%	1.7%
Demographics					
Pop. Id as non-hispanic white[a]	52.6%	96.6%	87.4%	92.5%	95.8%
Median age[b]	38	43.4	41.2	41.5	43.2
Economics					
Median household income[a]	$73,538	$45.206	$39,293	$41,043	$34,043
Poverty (% pop.)[a]	10.1%	15.9%	18.6%	18.3%	18.1%
Employment					
Civilian labor force (% pop. >16 yrs)[a]	68.8%	61.2%	52.9%	54.5%	46.7%
Leading employment by sector (% of pop. > 16yrs employed)[a]	Healthcare, Government, Professional	Healthcare, Construction, Retail	Administrative, Sales, Production	Healthcare, Retail, Education	Healthcare, Retail, Oil & Gas Industry

Sources:
[a] United States Census Bureau (2015a).
[b] United States Census Bureau (2015b).

Table 2
Regional health profiles.

	Maryland State	Garrett County, MD	Allegany County, MD	West Virginia State	Doddridge County, WV
Life expectancy (years at birth)[d]	78.8	78.0	77.2	75.4	76.1
Mortality (Age-adjusted per 100,000 population)[a]					
All cause mortality rate	797.5	808.0	885.3	938.7	915.2
Malignant neoplasms	189.6	172.8	191.7	212.0	199.5
Diseases of the heart	273.7	351.5	314.2	325.9	317.4
Chronic lower respiratory diseases	36.6	50.4	53.8	61.2	63.5
Accidents	25.8	39.6	31.8	57.7	57.0
Intentional self-harm	8.8	10.7	11.7	14.6	13.3*
Morbidity					
Diabetes prevalence (Age-adjusted rate per 100 adults)[c]	9.2	12.3	12.1	11.2	12.2
Disability (% pop. <65 yrs)[e]	7.0%	9.4%	13.5%	14.2%	11.5%
Quality of life (Avg. in past 30 days)[b]					
Poor physical health days	3.0	3.6	4.5	4.9	3.7
Poor mental health days	3.2	3.7	3.8	4.4	3.8
Health behaviors (% pop > 18 yrs)[b]					
Adult obesity	28%	31%	28%	33%	33%
Adult smoking	15%	20%	23%	26%	14%
Excessive drinking	15%	17%	16%	10%	10%
Health access					
Without Health Insurance (% pop. <65yrs)[f]	8.9%	12.8%	11.0%	10.4%	18.4%

Sources:
[a] Centers for Disease Control and Prevention (2015a).
[b] Robert Wood Johnson Foundation (2015).
[c] Centers for Disease Control and Prevention (2015b).
[d] Social Science Research Council (2015).
[e] United States Census Bureau (2015b).
[f] United States Census Bureau (2015a).

(1983, 58). These routine experiences and understandings contribute to how people come to construct complex meanings to their social and physical environments, especially in attributing social, cultural, and environmental values to place (Manzo, 2005). They also influence emotional ties and attachment to place (Korpela, 1989). Social and environmental changes to place, therefore, can have critical consequences for people's sense of self and their meanings and attachment to place (Fried, 2000; Siegrist, 2000).

Recently, literature on place meaning, place attachment, and place-based identity has found that disruptions to cultural attributes and social identities as a result of environmental degradation result in considerable psychosocial stress (Albrecht et al., 2007; Crighton et al., 2003; Kondo et al., 2014; Van Haaften and Van de Vijver, 1996). An emerging literature on the psychological and social impacts of fracking suggests that similar levels of stress may be occurring along the Marcellus Shale. For instance, Perry (2012), through long-term ethnographic work in Bradford County, Pennsylvania, uses “collective trauma” to describe community experiences of acute social disruption and stress ranging from altered connections with place and ruptures in sense of belonging and identity. In Eastern Ohio, researchers found that local residents who oppose fracking used narratives of disempowerment and vulnerability to document drastic alterations to their sense of place and identity which compounded their sense of health and environmental risk (Willow et al., 2014). Given the complex nature and relative novelty of fracking, we contribute to the literature by examining how changing relationships of place and social identity can result in multiple stressors that have a significant effect on people's perceptions of health and environmental impacts.

2. Methods

2.1. Data collection

We used methods traditionally employed in HIAs, utilizing the scoping process to understand community concerns related to natural gas exploration and development (Korfmacher et al., 2013; Witter et al., 2013). As part of the scoping phase, we conducted focus groups in November 2013 among Doddridge County, West Virginia residents to gain insight into how individuals living in communities where fracking is underway are being impacted. Focus groups allow individuals to use others' ideas as prompts to stimulate their own perspectives allowing for a deeper exploration of challenges, issues, and concerns about fracking (Kreuger, 1988; Lobdell et al., 2005). We determined that because of participants' shared history as landowners impacted by fracking, the focus group method was appropriate for a deeper exploration of community perspectives. The study was approved by the University of Maryland Institutional Review Board.

Flyers, email blasts, and an announcement on the project website were used to recruit study participants. Our aim was to understand the perspectives of residents who were engaged and impacted by fracking, rather than to seek a representative sample of the public (Marshall, 1996). Thirteen individuals, composed of ten women and three men, participated in two focus groups lasting 90 minutes each. Both focus groups were conducted in West Union, West Virginia in two private rooms in a local cafe, with staggered start times to accommodate all participants. All participants were 18 years or older, residents impacted by fracking, and signed consent forms agreeing to participate in the focus group. All focus group participants were non-Hispanic whites, reflecting the racially homogenous demographics of the county. Table 3 summarizes two key characteristics of participants, related to residency and land ownership rights, that featured prominently in the study.

A limitation of this study is that we were not able to recruit representative numbers of residents impacted by fracking at the county or state level. We also recognize that the individuals who chose to participate may have been likely to be the most concerned members of the community. Finally, although the vast majority of our sample consisted of women, who have been documented to be

more involved and vocal about environmental injustices (Xiao and McCright, 2013), we did not observe gender differences in perspectives related to fracking or suppression of pro-fracking sentiments that might have been voiced from either male or female participants.

The first and last author, both experienced moderators, led each focus group. Each session was audio-recorded and transcribed verbatim. Focus group questions explored participants' perspectives and experiences with fracking; the factors which structured these perspectives and experiences; narratives, metaphors, and judgments employed by participants to justify and support particular perspectives; and participant priorities for public health research related to fracking. Four of the authors also participated in a multi-day trip in November 2013 to local fracking sites and residences and recorded observations through photos and notes. These observations were discussed extensively among all authors in subsequent team meetings and were crucial in shaping analysis.

2.2. Data analysis

Focus group transcripts were compared with the original voice recordings for completeness and accuracy. The first and second authors coded the transcripts using a thematic approach to data analysis in Atlas ti 7.0, and initial broad coding were guided by major themes from the interview guides, but new codes and themes were developed on the basis of the data (Huberman and Miles, 2002). Following the constant comparative method, data coding and analysis occurred simultaneously in an iterative process of inductive reasoning (Glaser and Strauss, 1967). Excerpts and analytical memos were reviewed to identify common themes and differing views. Data was analyzed a second time to further detail the initial broad codes into sub-themes using grounded theory to develop fine codes (Strauss and Corbin, 1990). The definitions of these emerging fine codes were discussed and refined among the first two authors. After finalizing the coding scheme, printed reports of each fine code were discussed among all team members and used to write a detailed analytical report.

3. Results

3.1. Meanings of place and identity

Narratives about land, geography, and the history of place figured prominently in how participants framed their experiences and perspectives of fracking. Many participants described themselves as “newcomers” or non-natives to the area who were attracted to the quiet of the West Virginia hills as a place to peacefully raise a family or retire. They came for the peace, quiet, and pristine environment—the very qualities that they felt were critically compromised when fracking commenced.

For instance, a woman who had moved to the area from Baltimore told us, “When my husband and I moved here, our intent was to retire and disappear into the hollows so to speak.” Similarly, an older woman, another newcomer explained her family's move, “We retired here because it was clean and beautiful. Most people who've grown up here love it because it is clean and beautiful but now it's being turned into an industrial wasteland.” A man, also a newcomer, who had bought property in the area with his wife so that she could find relief for her health conditions stated, “I've been here about three years. I came to get away. My wife has a chronic illness, liver disease, and a whole lot of other things. Found the place, the furthest away from pollution. That's what brought us here but now we're trying like hell to get out.”

“Natives” or long-term residents, those who have lived in the area their entire lives and are able to trace their lineage back multiple generations, also described the same sense of loss and distress over the transformation of their land and their sense of place. One long-time resident, who was struggling to maintain her property as fracking operations commenced, explained, “I love where I live. I just love the area and I'm distressed. I'm grieving, grieving the loss of [my] environment. Grieving home when [I'm] still at home. It has been overwhelming. Lost the road. Living with the dust. Pipe yard within a 100 yards of my home that has since been converted to have a heavy equipment yard. Wood pallets. Trucks all hours. Gas well. Industrialized bottom line …”

Many individuals expressed that they couldn't afford to leave or lacked the desire to leave, which also compounded their distress. A newcomer who debated leaving said, “I wish we and a lot of other people could afford to get out.” Another newcomer told us, “It's like I moved out here because I wanted to have some place for my grandkids to be able to go. It's like, where do you go from here? We're fighting back the best we can, and we've had our hands tied, and we're spent. I mean, we're not rich people. This was supposed to be my house fund, but we've had to pay the lawyer.”

3.2. Transforming relationships

Discussions of the impact of fracking also significantly centered on the topic of split estates and mineral rights. Split estates, the separation of surface (above ground portion of land) and mineral (sub-surface) rights, is fairly common in the Appalachian region and throughout the Western United States as a result of several land grant and homesteading acts which were designed to encourage Western migration in the early twentieth century, while allowing

Table 3
Sample characteristics and representative quotes references.

Dimension	Context	Quote
Long term residents	Residents who could trace their lineage back for multiple generations with connections to the land.	*“My family has lived in West Virginia for a long time, my ancestors came here from Maryland like several of the rest of you - but a little bit earlier - 1799 they arrived at Falls Creek”.*
Newcomers	Residents who moved to Doddridge were seen as “newcomers” regardless of how many decades they had been in the county.	*“I'm a newcomer, like some of the people here in the sense that I bought the land in 1975, and moved in 1977, which means in another 30 or 40 years I might be considered local.”*
Mineral owners	Residents who retained control of their subsurface property and were perceived to have more control over interactions with the gas industry.	*“I'm 64 years old and my grandfather purchased the property that we called a home place. He owned 100% of the mineral rights and the surface.”*
Surface owners	Residents who did not own rights to subsurface property and had to allow companies “reasonable access” to the underground gas and minerals. Some had sold their rights, others had purchased land without mineral rights, and still others inherited property from ancestors who had ceded mineral rights.	*“I don't own my rights. No one around me owns our rights.”* *“I'm a surface owner, you're taking away my right to exist on my land. “*

the federal government to retain access to any future mineral discoveries (Collins and Nkansah, 2013). Under common law, mineral rights trump surface rights, and surface owners have to allow the necessary use of surface property for mineral access (Ryder and Hall, 2014). In West Virginia, legislation allows surface owners to be compensated for surface damages caused by horizontal drilling and property taxes on surface lands altered by fracking operations (Collins and Nkansah, 2013). Split estates have emerged as paramount issues in West Virginia because of rapid increases in natural gas drilling and fracturing technology.

Many participants discussed experiences in which gas development operations occurred on their property without their consent because oil and gas rights took precedence over the their rights as surface owners. However, participants also pointed to the substantial differences between the drilling of the past and fracking. To them, the older methods were less invasive and less dangerous. As a newer technology used only by a few large and powerful energy companies, the fracking process increased concern because of the uncertainty related to the use of more chemicals, deeper faults, and heavy machinery. As a long-term resident and surface-owner explained, his relationship with gas companies evolved over time:

> These leases originally were beautiful symbiotic relationships. They would come in to punch some vertical wells and people got a little bit of money. They got free gas. They didn't destroy your property. It was a little pad. I've got two of them on my property. The guy comes once a week on a little four wheel and checks it, doesn't bother a thing. A beautiful symbiotic relationship. Now these leases are no longer symbiotic. Now these leases are being used to devastate and destroy our property while the gas companies get all the benefits.

Another long-term resident and surface-owner further explained how fracking changed the nature of social relationships:

> A conventional well goes down 2000 feet vertically. What happens on your property, if it gets contaminated, it's you. When you drill a Marcellus, and you're going out a mile or more, you are impacting others and that's the difference. It takes a quarter million to drill a well; your little mom-and-pop drilling companies can't afford it. Their kids went to school with our kids. They had a vested interest in the community. When Marcellus came into the county, they saw the writing on the wall. They couldn't compete with the Exons, the AEPs, the multi-billion dollar, and multi-national companies that wanted to come.

Additionally, participants perceived that fracking increased tensions between surface and mineral owners. Individuals who maintained their mineral rights claimed that they (or their ancestors) were "smart enough" to hold on to their rights. Mineral owners today recognize that they have the power to choose whether to get involved with fracking operations on their property. A mineral rights owner defended his support of the industry, acknowledging that sometimes the industry takes advantage of individuals but that "there are people who are benefitting." He explained his advantageous position was due to generations of his family retaining their mineral rights, "Whether it's just luck or not, my grandfather a hundred years ago decided he wasn't going to let go of the mineral rights. It wasn't any choice that I made. I could have sold and I can sell right now, but I'm not going to sell."

However, most participants were surface owners who had far fewer options. As one surface owner explained, under current regulations, whoever purchases the mineral rights has the right to "reasonable access" to underground minerals on her land. She continued, "A hundred years ago 'reasonable access' was bringing a horse-drawn rig and drilling while today, it means that surface owners can have a well pad set up in their yard without warning." Another woman who had purchased land in the 1970's knew she didn't own the mineral rights, but pointed out that this was decades before fracking technology made large-scale drilling a possibility. She discussed her fears, "They could come to me tomorrow and say they're going to start a Marcellus crop and I would have no say because I don't own the minerals." This scenario was reported by an older man whose family had given up their mineral rights generations ago. He described how blindsided he and his wife felt when drilling operations commenced on their property, "That's how we found out—survey flags in our field. We contacted the company … they came into our house and said, 'We'll have our pit made at the end of the week. We're putting a well there. If you don't like it, sue us.'" Fig. 2 shows a road and storage pond that was constructed on a surface owner's property.

Meanwhile, residents living near fracking operations are left with rising insurance costs and plummeting property values. A surface owner complained, "I have catastrophic homeowners now; I dropped it because it went up a thousand dollars year after year. I'm a single individual with a kid in college. I can't pay $2000 a year for homeowner's insurance!" Other surface owners were more concerned with property values. Another surface owner said, "They need to compensate people for the value of the property. These are people's life savings. I invested everything we had, and I was happy to live here, but now I'm just trying to get my money out of it. It's been on the market for over two years now. No one will touch it!" A prevailing sentiment among surface owners was summed up by a frustrated participant, "We've got no rights. No rights at all."

Many surface owners felt that there was little they could do to fight back. Those who did seek legal recourse recounted facing well-funded corporate lawyers and evasive courtroom techniques. Without legal protection, these landowners felt powerless and resigned to their fate. While acknowledging that she and her husband were wealthy enough to move if they needed to, a long-term resident described how there were larger issues at play and how her community was powerless, "The major problem in West Virginia is we don't have a say so. Landowners who have owned their property for hundreds of years never had to fight about being poisoned on their own property, but now somebody can come in and say, 'We're on your land, this is what we're doing, sorry but we've got the right.'"

Fig. 2. Road and storage pond constructed on surface owner's property.

Participants described the role that poverty plays in structuring interactions between companies and Doddridge residents. One participant, a tax preparer and mineral rights owner, told us, "The amount of money that a lot of people here in the county live on would appall some of you. As for the economic part of it, our county until this started to happen five or six years ago was doomed for failure. I mean we had no activity, we had no businesses …" Such dire economic circumstances made fracking appealing for many, as a long-term resident explained, "I get up every morning and I smile, because I prayed for something like this to happen for our county and for this region."

Others spoke of both benefits and disadvantages of fracking. One participant said that she felt that all the benefits went to non-local, transient workers, while locals, like her son, are forced to take on lower paying jobs. She explained that the majority of the workers weren't local, "They travel, they follow the industry, they're out of state, and those paychecks are going home." However, she expressed her deep conflict with fracking by saying that without the industry, her son would need to leave West Virginia to find work, but by working for the oil and gas companies, he'd be working in dangerous conditions, "I'm not so against the industry all together. He knows the dangers. You know what? Just like everyone else in West Virginia, he needs a job."

A few participants, however, saw the appeals of an economic boom as "propaganda." Participants described fracking companies as "predatory" because they were aware of how poorer residents could be swayed with the promise of extra income. One concerned surface owner described an encounter with an executive at an industry presentation in the neighboring township, "One of the things he said that couldn't be more condescending was that he wanted people going to the mailbox to get a 'little check' instead of just their bills." Others opposed what they saw as predatory employment practices. An elderly man, retired from years in the oil industry, explained that the dangerous working conditions within fracking operations was not worth any amount of compensation, "Some laborers appear to be relatively well off, but they're not really that well off considering how they're treated. They work exceedingly long hours, and often under very dangerous circumstances, they're exempt from safety rules almost completely." He concluded that "from a very high level, it's all controlled by financial interests."

Participants described the "corrupt" relationship between state and local governments and big energy companies as further contributing to their distress. Many participants expressed concern that the money being offered by rich companies was potentially corrupting government officials, who continued to pass "pro-wells legislation." A surface owner described an instance where well-pad construction started before proper permits could be procured, saying "That tells me that they spend millions of dollars in labor and construction and they have not even been given the permit, and that implies to me that there is an understanding that this is a done deal." As a newer resident, she described herself as someone who was not a "radical activist" but "pretty conservative and very pro-business" but started turning to local activist groups for answers because of the failures of the local government.

Participants also saw evidence of this "pro-wells" bias in the lack of government regulation and enforcement. A long-term resident had witnessed workers cleaning up fracking fluid without adequate safety equipment at a spill near her property. She tried to contact the proper authorities but could not reach them, "The West Virginia Department of Environmental Protection (DEP)—their oil and gas division had tremendous influence from the industry, and they only have 14 to 16 inspectors and that is intentional." Participants felt this lack of oversight made enforcement nearly impossible. Another woman told us that she observed a truck accident where wastewater was leaking into a local creek, but when she followed up with authorities, there was a lack of response, "They never tested it … they asked for all of my pictures and I sent them the e-mail from DEP that said it wasn't necessary to test the creek water. This is every day. This happens every day." These experiences led her to turn to grassroots activism that focused on calls for better industry regulation, "We know what is supposed to be, but in West Virginia they think that is perfectly okay to have a station next door and not have the oversight."

3.3. Perceptions of environmental and health impacts

During the focus groups and observational activities to fracking sites and residences, residents expressed concern about environmental changes brought about by fracking operations such as increased traffic, land erosion and mudslides, wastewater, chemical runoff, and changes in air and water quality (Fig. 3). They told us that these concerns contributed to increasing levels of stress and growing sense of uncertainty about the future. Many participants repeatedly made connections between contaminated environments and poor health, reflecting what researchers have described as the interconnectedness of Appalachian health, identity, and place (Behringer and Friedell, 2006).

Few participants experienced health concerns themselves but spoke of neighbors, co-workers, and others who had symptoms such as nosebleeds, sore throats, skin rashes, chemically induced asthma, and headaches. Participants who directly experienced symptoms or expressed concern about symptoms were those living in close proximity to fracking operations—compressor stations, well pads, and increased truck traffic. A participant who lived so close to a well pad that she had been "breathing condensate" described, "I'm very sensitive to anything right now. Itching all over. I had burning skin. I have headaches. I have pains that is in all different parts of my body." An older woman who lived meters from an active drill site told us she worried about contamination of her well water as well as poor air quality, "I've been breathing this crap for two years. The condensation tank was a nightmare, but I've just gotten really ill, really bad sore throats, really bad rashes." In addition to her own health problems, she reported that her grandson, who periodically stays at her house,

Fig. 3. Increased truck traffic related to fracking.

had come back from the pediatrician with an unconfirmed diagnosis of asthma:

> I took him to the doctor who said he had a bad sore throat but no traces of bacterial infection. So the doctor asked, "How long has he had asthma?" I tell her, "He doesn't have asthma." She goes, "Are you sure?" and I say again, "Yeah, he's never been diagnosed with asthma!" When they checked, he almost had pneumonia in his right lung and that was when we started turning the gas on in the house so that could have had something to do with that too. So now we're taking him to an ENT doctor and they had to treat him with two doses of antibiotics, just for the lung. So I ask, "Does he have asthma or not?" They say, "We're not going to say he doesn't!" The doctors won't get involved in this. They're not even allowed to discuss it with people.

The most mentioned health effect was psychosocial stress. Participants frequently expressed that stress was a result of increased uncertainty, anxiety, anger, and fear related to living with fracking. The uncertainty of the future, when combined with the powerlessness residents feel against big companies, created stress across the entire community. An older man who was native to the area told us:

> I have sensitivity to a lot of things because I have cancer. My body is a little bit traumatized, so I have to be careful about what I do. You don't smoke. You don't drink. You don't put stuff into your body because you want to take care of your body, you want to live, and you want to be the healthiest you can. But when you lie in your house and you can't go outside and breathe fresh air because somebody else has the right to come on your property and poison it and you've got nowhere to go, it is a feeling of helplessness. Sometimes it is overwhelming, you just want to give up.

Likewise, the surface owner who had relocated to the region for his wife's health described how the stress of protracted legal battles impacted his ailing wife:

> My wife with her autoimmune disease, the worst thing for her is stress. When she gets stressed, she gets sick. She starts hurting all over because the fibromyalgia kicks in, the arthritis kicks in … So I try to downplay it all for her. The stress level on her, and every time this happens, she gets sick. This has happened multiple times. When this guy showed up, she was off the wall for a week or two … She was crying. She was absolutely distraught that they were going to put this industrial park in our yard. She said she'd chain herself to the tree and have news media out here and they'd have to cut down the tree over her dead body. She was dead serious.

4. Discussion

The current study examined community perspectives and experiences with fracking in Doddridge County, West Virginia using qualitative data. Participants were not selected randomly and their viewpoints may not reflect the perspectives of community residents. Our study focused specifically on one county in West Virginia and local experiences of fracking. While these findings cannot be generalized to other communities, including those in Western Maryland, they can be helpful in understanding the role of place and psychosocial stress in understanding the potential health impacts of fracking in other communities facing similar issues.

Participants reported deep distress over the transformation of the physical and natural environment, which led to conflicted meanings of place and compromised social identities as landowners and West Virginians. Although residents did not experience a complete loss of property or forcible removal from their land, they conveyed feelings of extreme anxiety, fear, and stress due to occupying an "outsider" position while living and experiencing the rapid transformation and destruction of their home and overall physical environment. These rapid changes, as a result of fracking, negatively impacted participants' sense of belonging and attachment to place. Many also expressed an unwillingness or inability to leave their homes and the region despite these social and environmental disruptions as a result of fracking, which only deepened their stress.

These findings corroborate a handful of studies of impacted communities along the Marcellus Shale which suggest that participants' lived experiences of fracking contribute to a heightened sense of fragmented individual and collective identities and increasing loss of control over lives and personal property (Perry, 2012; Poole and Hudgins, 2013; Willow, 2014). However, our findings indicate that Doddridge residents, despite their extensive experience with localized gas drilling, view fracking as significantly different. They described longing for a past where they felt that relations with neighbors and gas companies were not as detrimental and where meanings of place were still held intact. Uncertainty about potential environmental and social impacts, along with the accelerated pace of industrial land development and influx of a large "non-local" labor force may be impacting the ways in which fracking is perceived and experienced as far more disruptive to participants' sense of place.

The issue over mineral rights was also a key factor influencing participants' perceptions and experiences of fracking. The tension between mineral rights and surface owners was perceived to be intensified by fracking. Mineral rights owners generally supported fracking operations because they benefitted from it, whereas surface owners expressed feeling powerless because of what they perceived to be the failures of government and other entities (including health professionals) to protect their lives, livelihood, and environment from the "greed" of gas companies. This lack of power or agency was discussed as being part of the history of energy extraction in West Virginia, where government agencies and elected officials were seen as complicit in the destruction of land and personal property. However, surface owners again felt that there was a significant difference in the scale of fracking operations which exacerbated their mistrust in institutions designed to protect their welfare. Although all participants understood how fracking could bring about substantial economic growth, most did not perceive these benefits to be worth the cost of environmental degradation, safe working conditions, and social fragmentation. They felt strongly that government and elected leaders did not share these same values as evidenced by what they reported to be a "pro-wells" bias. Our findings contribute to research that documents increasing mistrust and community stress that results from perceived or actual lack of governmental regulation and enforcement related to fracking (Smith and Ferguson, 2013; Willow et al., 2014). Findings also support growing evidence of residents turning to informal networks and grassroots activism for more information and to advocate for their own rights in the face of fracking (Simonelli, 2014).

Furthermore, the nascent literature on split estate policy in energy development has documented the impact of ownership on

environmental, social, and economic inequalities (Anderson, 2013; Fitzgerald, 2013; Rahm, 2011). Collins and Nkansah (2013), for instance, found that over 40% of fracking gas wells were located on split estates in West Virginia and that surface owners reported more problems with the fracking process—land damage, polluted water, and storage of fracking fluids—than those with mineral rights. Our study indicates that surface owners may be at disproportionate risk for environmental, physical, and social stressors because they often are unable to stop the development of their property or sell their property should they wish to move away. Split estate issues are serious concerns for residents of Western Maryland as well as those living in West Virginia (Maryland Institute for Applied Environmental Health, 2014). Our work also suggests that issues of equity brought about by split estates may intensify disruptions to sense of place and identity.

Government, planning, and regulatory bodies can make better efforts to mitigate these stressors stemming from split estate conditions that can lead to long term community-level problems. Others have shown that perceptions of fairness and equity in the planning and siting process strongly influence perceived environmental and social risks in energy development (McComas et al., 2011; Sjöberg and Drottz-Sjöberg, 2001; Wolsink, 2007). Development of fracking should include institutional capacity building, a process in which knowledge resources, relational resources, and mobilization capacity are increased through collaboration with communities and various other stakeholders, ultimately leading to more sustainable policy and planning recommendations (Breukers and Wolsink, 2007). Once fracking operations have commenced, existing surface owner legislation and enforcement to protect surface owners against damages caused by fracking activities should be strengthened. In New Mexico, for instance, the drilling operator has to give a 30 day notice before commencing operations, enter into a written agreement that lays out rights and obligations regarding proposed surface activities with the surface owner, and compensate the surface owner for damages (N.M. Stat. Ann. §§ 70-12-1 to 70-12-10). In addition, collaborative strategies at the local level between communities, government experts, and conservation groups aimed at monitoring and ensuring that setback regulations (i.e. distance between fracking operations and occupied dwellings) are properly implemented may also alleviate stressors and bring about a sense of spatial equality for surface owners (Maryland Institute for Applied Environmental Health, 2014; Ryder and Hall, 2014).

Finally, this study found that participants perceived individual and social stress as contributing to the health impacts of fracking. Participants who lived near fracking sites reported nonspecific health symptoms, and others attributed community members' physical ailments such as nosebleeds and skin rashes as directly related to fracking operations. Almost all participants expressed that they suffered from health impacts such as fear, anxiety, and stress brought about by the uncertainty related to fracking. These psychosocial health impacts are heavily influenced by disruptions in people's sense of place, similar to those observed elsewhere (Wester-Herber, 2004; Willow, 2014). Our findings indicate that rapid environmental change brought about by fracking is impacting the physical, mental, and emotional health of individuals in this area. More thorough investigations of the multidimensional nature of individual and social stress related to fracking are needed, especially those which attend to the centrality of place in people's perceptions of health and environmental impacts.

5. Conclusion

On April 2015, the Maryland Congress passed legislation that included a moratorium on fracking until October 2017 and plans for further research of health and economic impacts. The emergent themes described in this study provide several important insights for future planning and research agendas related to fracking in Maryland. Baseline monitoring and longitudinal studies are essential for understanding and responding to short-term and long-term environmental health impacts of fracking. Community health research investigating the complex relations between environmental and social stress should be also prioritized, especially those that identify and measure the impact of place and community disruption on psychosocial risks. Research examining the full spectrum of stress can aid health providers, community leaders, and policymakers in the design and implementation of locally-appropriate services and programs for those impacted or potentially impacted by fracking. Social and psychological context, especially in relation to disruptions to place meaning, attachment, and identity, also has great potential to inform current and future work in environmental risk analysis and health impact assessments. Additionally, a greater focus on the impact of split estates on environmental and health outcomes is critically needed to better understand issues that may be disproportionately affecting surface owners. Finally, inclusive partnerships with communities throughout the process of fracking development should be strongly considered as they can bring about not only increased institutional capacity, but also potentially alleviate psychosocial stress and disruption to place-relationships.

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