

Marcellus Shale Development and the Susquehanna River: An Exploratory Analysis of Cross-Sector Attitudes on Natural Gas Hydraulic Fracturing

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Abstract

In this exploratory analysis, we survey Susquehanna River basin stakeholders regarding the environmental, social, and economic impacts of natural gas hydraulic fracturing in the Marcellus Region. Our survey involved collecting data based on four categories: economic opportunity, protection of health and safety, preserving communities, and achieving energy security. We separated responses on a cross-sector basis in order to differentiate between the nonprofit, government, and private sectors. Overall, responses by the three sectors are relatively similar. Of the 21 questions measured by a 5-point Likert-type scale (with 5 being the highest priority), 17 questions measure above 3 for all three sectors. With hydraulic fracturing in the Marcellus Region in the early stages of a typical energy “boom-bust” cycle, the results of this survey provide baseline data to compare with stakeholder attitudes at later stages of the cycle.

Keywords

hydraulic fracturing, Marcellus Shale, stakeholders, boom-bust cycles, sustainable development

This article provides an exploratory analysis of Susquehanna River Basin stakeholder attitudes as an initial step toward analyzing the environmental, social, and economic impact of Marcellus Shale natural gas development occurring in the Susquehanna River Basin (Figure 1). The importance of this analysis is underscored by American Rivers’ (an environmental nonprofit group) identification of the Susquehanna River as “America’s Most Endangered River.” According to American Rivers (2011), the primary cause of the “most endangered” status is the threat of contamination as part of the hydraulic fracturing or fracking process to extract natural gas from shale.

Hydraulic fracturing involves the injection of more than a million gallons of water, sand, and chemicals at high pressure down and across into horizontally drilled wells as far as 10,000 feet

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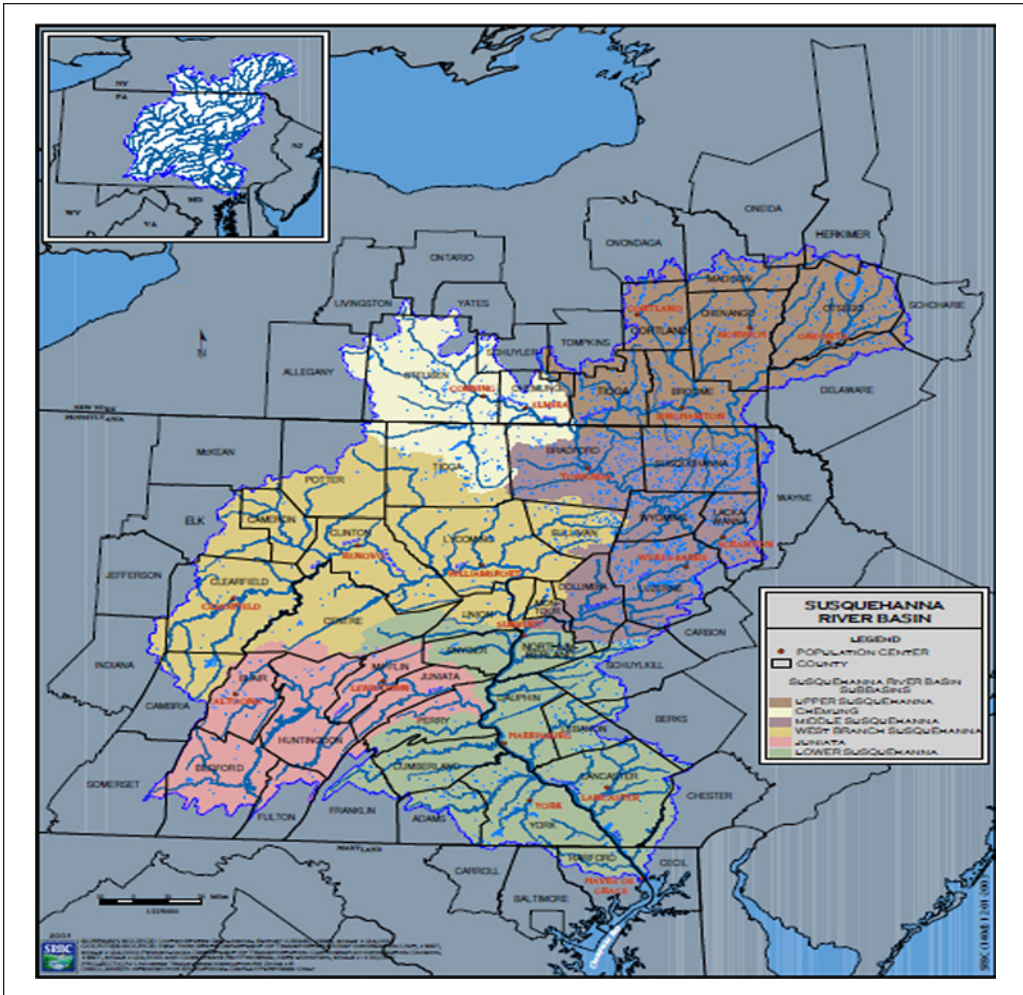


Figure 1. Susquehanna River Basin Commission.

below the surface (American Rivers, 2011). Between 2009 and 2011, Pennsylvania’s natural gas production more than quadrupled due to fracking in the Marcellus Shale region (Figure 2), resulting in Pennsylvania’s rapid ascendance to becoming a leading natural gas producing state. Pennsylvania natural gas production rose 69% in 2012 despite reduced drilling activity (Figure 3, U.S. Energy Information Administration, 2013). The rapid increase in shale gas production in the largely rural, economically underdeveloped Susquehanna River Basin has created environmental, social, and economic conditions associated with energy boomtowns (Freudenburg, 1981).

Jacquet (2009) explains this phenomenon:

By the late 1970s, a so-called “boomtown model” or “social disruption model” emerged as a prominent framework among researchers to describe the rapid growth that overwhelms local governments and permanently alters social relationships. The body of evidence tended to find a mix of positive and negative economic impacts to local residents, contrasted with highly negative social impacts. (p. 11)

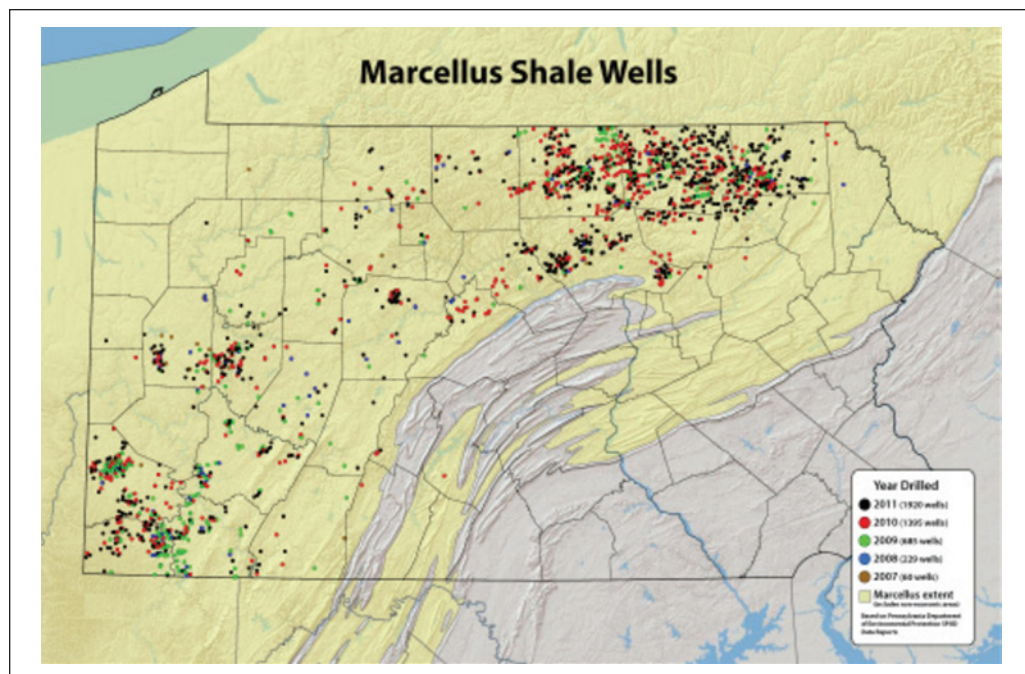


Figure 2. Distribution of Marcellus Shale wells.
Source. Adapted from Susquehanna River Basin Commission.

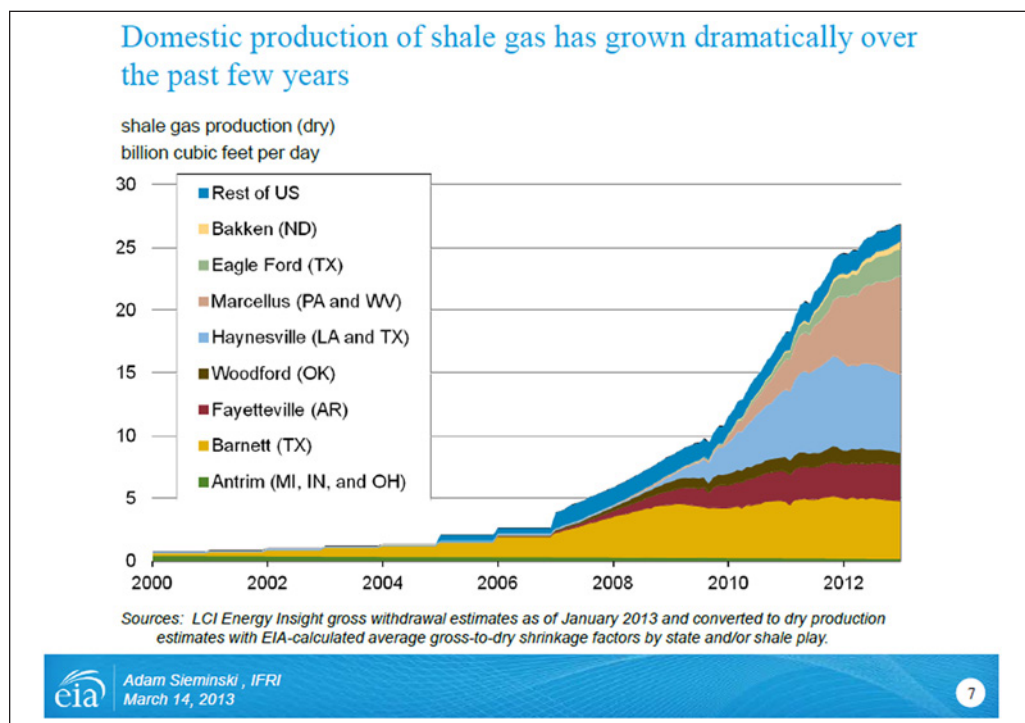


Figure 3. Domestic production of shale gas from 2000 to 2012.
Source. Adapted from U.S. Energy Information Administration (2013).

For stakeholders involved in the early stages of this boomtown phenomenon, the dilemma involves the potential for economic growth and job creation juxtaposed with potential long-term environmental and social consequences for the Susquehanna River ecosystem should environmental contamination occur. Shale gas production from Pennsylvania wells reached an all-time high during the first 6 months of 2013, according to Department of Environmental Protection data. Operators pulled more than 1.4 trillion cubic feet of gas, doubling the production reported during the same time last year (2012; "Shale gas production," 2013). However, as fracking requires millions of gallons of water for each well and the possibility of potentially dangerous spills, environmental concerns have increased also as the Susquehanna River provides drinking water for many communities and sustains a tourism industry vital to Pennsylvania's economy (Susquehanna River Heartland Coalition for Environmental Studies [SRHCES], 2011).

The primary objective of this exploratory analysis is to establish a baseline of stakeholder attitudes to enable comparisons with future attitudes as Marcellus Shale production increases. This exploratory analysis began in 2012 with approximately 25 interviews with stakeholders from industry, nonprofit organizations, and government. Following Heuer (2011), the cross-sector format for interviews was used to identify potential biases or ideologically driven points-of-view among and between the sectors regarding Marcellus Shale development in the Susquehanna River Basin. The interviews included firms involved in natural gas waste management, chambers of commerce and rotary clubs, tourism bureaus and firms, clergy, nonprofit organizations, consultants, and local, state, and federal governments. Apart from interviews with stakeholders directly involved in natural gas fracking, a consistent response from interviewees was a lack of information about the impact of Marcellus Shale development, along with a vague awareness that drilling activity was increasing (Heuer, 2012). Additionally, there were ongoing concerns about acid mine drainage and the economic deterioration resulting from the previous energy boom-bust cycle involving coal mining in the Susquehanna River Basin. This feedback, along with the relative absence of well-informed insights regarding Marcellus Shale development, prompted us to conduct a survey-based exploratory analysis on attitudes as the first stage of research involving Marcellus Shale development and the Susquehanna River Basin.

Hypothesis Development

We expect a boom-bust cycle involving natural gas fracking to occur in the Marcellus Shale region. The environmental, social, and economic impacts of the boom-bust cycle will be influenced by the involvement of stakeholders in the Susquehanna River ecosystem. Surveying attitudes at a cross-sector level may provide output useful in conducting future research and in informing regional decision makers about general concerns of stakeholders.

The SRHCES (2011, p. 14) characterized the status of Marcellus shale as "at an early development stage in which the biggest challenge facing us, then, is working through the social, economic, environmental, and political fractioning and panic that is occurring." The SRHCES (2011, p. 14) expects the next phase, the development phase, to be "the period where the most people will be required for production. The foundation for a community's future will be also laid during this period." Jacquet (2009) identifies housing as part of the future foundation formed during the development phase, as follows:

One of the housing policy challenges is that the demand for labor, and thus housing, is highest during the development phase of natural gas, which is when all the wells are being drilled and pipelines are being laid. Once this current phase ends (which could be 15 or more years within an individual community, depending upon how many rigs are active), the need for housing will decline dramatically as those workers leave. The challenge for local decision-makers is ensuring that sufficient housing exists during these "boom" years without creating a large housing surplus after the activity ends and

making sure that new infrastructure adds value to the community in the long run. To ensure that there isn't an excess of housing, communities must put careful thought and planning into the housing issue and look for opportunities to address both short- and long-term needs simultaneously.

As the development phase becomes full-fledged, there will be a need for policy makers to have stakeholder data to develop the environmental, social, and economic support mechanisms needed as Marcellus Shale development impacts the Susquehanna River ecosystem on an increasingly larger scale. The importance of stakeholder data is underscored by the political polarization regarding natural gas fracking, as well as uncertainty about how to address increasing demand for public services. The lingering environmental and social problems resulting from the coal industry decades after its demise unite stakeholders in the Susquehanna River Basin. Also, many citizens and organizations in the Susquehanna River Basin continue to struggle with long-term economic malaise due, in part, to the decline of the coal, furniture, and prefabricated housing industries. Meanwhile, political factions involving pro-industry and pro-environment groups continue to take vocal stances on shale gas development. This is exemplified by the Pennsylvania state legislature's support for natural gas development and the economic growth and job creation it may offer, in contrast to New York State, which maintains a moratorium on natural gas fracking while the environmental implications of natural gas fracking are evaluated (Socha, 2013). Thus, we assert that given an environment of uncertainty, a strong desire not to repeat past mistakes, and political polarization regarding fracking, there is a need for data on stakeholder attitudes; hence, our survey.

Method

In order to gain feedback on a balanced set of criteria, a community discussion guide from the Public Issues Forums of Centre County (Pennsylvania) titled, "The Marcellus Shale: What Does It Mean for Us?" (2012), was utilized. These public issues forums are designed to evaluate and to wrestle with the trade-offs and consequences inherent in different perspectives. The goal is to discover areas of common ground for moving forward.

The survey in this article utilized the four categories included in the public issues forum: economic opportunity for all, protection of health and safety, preserving communities, and achieving energy security. Using the public issues forum as a guide, 29 survey questions were designed to address a range of issues pertinent to each category along with a demographics section (see Table 1). The survey was pretested with a Pennsylvania wood products trade association due to its specialized knowledge about forest sustainability issues in the Marcellus Shale region and related environmental regulations.

The online survey was administered by using Survey Monkey during August and September 2012. The intent of the survey was to focus on stakeholders located within the Marcellus Shale Region and Susquehanna River Basin. Organizations and individuals meeting these criteria were identified through scanning local newspapers and websites of local and regional organizations, attending local conferences and meetings, and word of mouth. The range of organizations varied from local river guide businesses to global oil and gas companies. The vocations of individual respondents ranged from clergy to wastewater treatment executives. Of the 186 responses received, over 50% of the respondents live and/or work within 5 miles or less of the Susquehanna River.

Given the exploratory nature of this survey, a three-sector stakeholder approach involving the nonprofit, government, and private sectors was selected as the unit of analysis for collecting, organizing, and interpreting responses. The three-sector, or cross-sector, analysis approach builds on significant previous research in the stakeholder environmental management field (Googins & Rochlin, 2000; Selsky & Parker, 2005; Starik & Heuer, 2002; Westley & Vredenburg, 1991). We

Table 1. Demographic Information ($n = 186$).

	Frequency	Percent
1. Current employment ($n = 141$)		
Nonprofit sector—clergy	55	29.6
Government	23	12.4
Private sector	63	33.9
2. Distance live from Susquehanna River (home, $n = 186$), unit: mile		
<1	20	14.1
1-5	85	59.4
6-10	15	10.5
11-15	4	2.7
16-20	5	3
>20	14	10.3
3. Distance work is from Susquehanna River (work, $n = 186$), unit: mile		
Retired or unemployed	53	28.4
<1	27	14.5
1-5	67	36.1
6-10	14	7.7
11-15	7	3.5
16-20	4	2.1
>20	14	7.7
4. Property ownership status		
Home owner	113	60.8
Land owner	19	10.2
Renter	14	7.5
N/A	40	21.5
5. How often do you and/or your family personally visit the waterways in the Susquehanna River Basin? ($n = 186$)		
N/A	40	21.5
Never	7	3.8
More than twice a month	54	29
Once a month	40	21.5
1-2 times a year	45	24.2
6. If use of the Susquehanna River Ecosystem were to be limited, it would affect me how?		
Financially	24	13.4
Quality of life (recreation)	91	48.8
Existentially (access to clean water)	71	37.8
Total	186	
7. Does your residential and/or work location use water initially taken from the Susquehanna River?		
Yes	50	27.0
No	73	39.2
Uncertain	33	17.7
Missing	30	16.1
Total	186	
8. Based on current usage, the Susquehanna River Ecosystem will be available to future generations in a condition similar to today		
Yes	42	22.6
No	43	23.1
Uncertain	60	32.3
Missing	41	22.0
Total	186	
	Mean	Rank
9. Prioritize the four categories in this survey in terms of greatest concern (with 1 being the highest priority)		
Economic opportunity	2.64	3
Health and safety	1.5	1
Communities	2.62	2
Energy security	3.22	4

believe that the cross-sector approach offers a more generalized view of stakeholder attitudes to enable policy makers to understand the major areas of concern as they manage the boom-bust cycle. Also, collecting responses by sector may allow for potentially polarizing issues to be identified, as was the case with previous cross-sector research on the environment, which identified conflicts between the private sector and nonprofit groups (Gray, 1989; Pasquero, 1991; Selsky & Parker, 2005). Based on this previous research, we hypothesized significant differences among the sectors in this survey.

As indicated in Table 1, the demographic section is structured so that all responses can be interpreted based on the three sectors. To determine the relationship of stakeholders toward the Susquehanna River ecosystem, respondents were asked "If use of the Susquehanna River ecosystem were to be limited, it would affect me how?" Respondents were also asked whether their home or business utilized water from the Susquehanna River and how often they visited the waterways of the Susquehanna River. The demographics section also included a self-projective question as "Based on current usage, the Susquehanna River ecosystem will be available to future generations in a condition similar to today." Of the 186 respondents, the majority of current employed respondents were private sector ($n = 63$, 33.9%), with nonprofit second ($n = 55$, 29.6%), and government third ($n = 23$, 12.4%). The majority of respondents live within 1 to 5 miles of the Susquehanna River ($n = 85$, 59.4%). The majority of respondents also work within 1 to 5 miles of the Susquehanna River ($n = 67$, 36.1). Homeowners represented the major type of property ownership ($n = 113$, 60.8%). The majority of respondents and/or their family visit the waterways of Susquehanna River Basin more than twice monthly ($n = 54$, 29%).

The majority of respondents think it will affect their quality of life from a recreational perspective ($n = 91$, 48.8%), with respondents expressing concern about access to clean water ($n = 71$, 37.8%) if use of the Susquehanna River ecosystem were to be limited in the the second position. Financial impact due to limited use of the Susquehanna River ecosystem ranked third ($n = 24$, 13.4%). According to Items 7 and 8 in Table 1, approximately 27% ($n = 50$) of respondents have a residential or work location that intakes water, at least initially, from the Susquehanna River, while 39.2% ($n = 73$) do not. Nearly one third of respondents are uncertain about the future condition of the Susquehanna River ecosystem based on current usage ($n = 60$, 32.3%), and the second largest group does not believe the current condition of the Susquehanna will be available in the future ($n = 43$, 23.1%).

Interpreting the Results

Reliability and Validity

The validity of the constructs in the survey instrument, as shown in Table 3, was evaluated through both convergent validity and discriminant validity analyses. Convergent validity was assessed by examining factor loading values, composite reliability values, and the average variance extracted (AVE). Descriptive statistics and correlations (see Table 2) determine the degree to which the movement of the two variables is associated. The results indicated significant positive correlations between "Health & Safety" (HS), "Community" (CM), and "Energy Security" (ES). CM also has a positive correlation with ES.

The mean and standard deviation related to each construct variable provides the overall attitude orientation of respondents toward each variable. Based on ratings through use of a Likert-type 5-point scale, respondents provided the highest score on "Health & Safety" ($HS_{\text{mean}} = 3.62$) versus the lowest score on "Energy Security" ($ES_{\text{mean}} = 2.69$).

Table 3 lists the values for each construct. The factor loading values ranged from .3 to .99 as a result of applying a .3 cutoff value in support of higher reliability for this exploratory research. The composite factor reliability (*CFR*) of each construct ranges from .67 to .83. Most of the *AVE*

Table 2. Descriptive Statistics and Correlations.

Construct variable	Item's average	M	SD	Correlations (n = 186)			
				1	2	3	4
1. Economic Opportunity (EO)	EO1	2.66	3.36	0.68	(0.73)		
	EO2	2.67					
	EO3	3.64					
	EO4	4.04					
	EO5	3.90					
2. Health & Safety (HS)	HS1	3.42	3.62	1.36	-0.03	(0.68)	
	HS2	3.76					
	HS3	4.63					
	HS4	4.48					
	HS5	3.32					
	HS6	4.12					
3. Community (CM)	CM1	3.34	3.36	1.51	0.02	0.77**	(0.64)
	CM2	3.97					
	CM3	3.41					
	CM4	4.67					
4. Energy Security (ES)	ES1	3.47	2.69	1.40	-0.06	0.68**	0.78**
	ES2	2.74					(0.64)
	ES3	2.85					
	ES4	3.61					
	ES5	3.55					

Note. The boldfaced diagonal values are the square root of the average variance extracted for each construct.

*p < .05. **p < .01.

Table 3. Measurement Items and Reliability.

Construct/indicator		Standardized factor loading	Construct reliability (Cronbach's α)	Composite factor reliability (CFR)	Average variance extracted values (AVE)
Economic Opportunity (EO)	EO2	.83	.42	.82	.54
	EO3	.69			
	EO4	.74			
	EO5	.66			
	EO5	.66			
Health & Safety (HS)	HS1	.57	.76	.83	.46
	HS2	.30			
	HS3	.65			
	HS4	.65			
	HS5	.58			
	HS6	.99			
	HS7	.55			
Community (CM)	CM1	.69	.67	.68	.42
	CM2	.59			
	CM3	.65			
Energy Security (ES)	ES1	.50	.72	.67	.41
	ES4	.73			
	ES5	.67			

values for each of the constructs range from .42 to .54. All these results indicate an acceptable level of convergent validity for these measurement constructs (Bagozzi & Yi, 1988; Fornell & Larcker, 1981; Hair, Anderson, Tatham, & Black, 1998). We also tested discriminant validity by examining the square roots of the AVE for each construct and comparing them within the correlations between the constructs (see Table 2). A construct is considered to be distinctive from other constructs if the square root of the AVE from it is greater than its correlations with other latent

constructs (Fornell & Larcker, 1981). The assessments of discriminant validity for the constructs were acceptable only for the variable “Economic Opportunity.”

According to data from the survey, respondents rank “Health & Safety” as the first priority, “Community” second, “Economic Opportunity” third, and “Energy Security” fourth (see Table 1). Given the focus on determining stakeholder attitudes based on responses from the three sectors, the following hypotheses are presented.

Economic Opportunity

We conducted an analysis of variance (ANOVA) between groups to explore if there are significant differences among organization groups (nonprofit, government, and private) based on these four constructs. For the first hypothesis, we tested for differences in attitude among the nonprofit, government, and private sectors on their attitude on questions related to economic opportunity.

H₀: No statistically significant relationship exists among the nonprofit, government, and private sector on economic opportunity.

H₁: A statistically significant relationship exists among the nonprofit, government, and private sector on economic opportunity.

According to ANOVA analysis results (see Table 4), respondents feel consistently related to the perspective of “Economic Opportunity.” There are no significant differences between these three groups, and we accepted the null hypothesis. First, respondents from the private sector scored highest ($EO_{1-Private} = 2.86$) in streamlining government regulations to expedite natural development in Pennsylvania in support of future competitiveness. Respondents from government scored lowest ($EO_{1-Government} = 2.22$). Second, related to providing incentives to local business development that will support the gas industry, both nonprofit ($EO_{2-Nonprofit} = 2.78$) and private sector organizations ($EO_{2-Private} = 2.75$) scored higher than government ($EO_{2-Government} = 2.48$). Third, nonprofit organizations scored highest ($EO_{3-Nonprofit} = 3.65$) on expanding education and training opportunities in gas-related occupations to enable local residents to take advantage of the new jobs created. Fourth, government scored highest on Q4 ($EO_{4-Government} = 4.22$) in creating longer term economic benefit by taxing gas production, and Q5, local communities receive gas industry funding to improve the quality of life in their communities ($EO_{5-Government} = 4.17$). Among the five questions on the economic opportunity construct, respondents overall ranked Q4 as the highest priority, Q3 and Q5, second and third, respectively.

Health and Safety

H₀: No statistically significant relationship exists among the nonprofit, government, and private sectors on health and safety.

H₁: A statistically significant relationship exists among the nonprofit, government, and private sectors on health and safety.

According to ANOVA analysis results (see Table 5), respondents feel consistently related with respect to “Health & Safety.” There are no significant differences between these three groups, and we accepted the null hypothesis. First, respondents from government have the highest scores related to slowing down or halting new development while more is learned from existing Marcellus wells capable of impacting the Susquehanna River ecosystem ($HS_{1-Government} = 3.76$). Second, government respondents have the highest scores related to educating/informing stakeholders of the general public of the safeguards already implemented in gas production to protect the Susquehanna River ecosystem ($HS_{2-Government} = 3.81$). Third, nonprofit respondents scored

Table 4. Economic Opportunity.

Question description (n = 186, missing = 45)	Rank of priority 1: highest; 5: lowest	3			ANOVA significance p value
		Nonprofit (n = 55)	Government (n = 23)	Private (n = 63)	
Q1: Streamlining government regulations and oversight in order to expedite natural gas development and enable Pennsylvania to be competitive with other gas-producing states	4	2.76 (1.63)	2.22 (1.53)	2.86 (1.33)	.21
Q2: Providing incentives to develop and expand local businesses that support the gas industry (e.g., hotels, restaurants, financial services)	5	2.78 (1.26)	2.48 (1.24)	2.75 (1.18)	.59
Q3: Expanding education and training in gas-related occupations to enable local residents to take advantage of the new jobs created	2	3.65 (1.28)	3.57 (1.38)	3.62 (1.11)	.96
Q4: Creating longer-term economic benefit by taxing gas production and earmarking it specifically for rebuilding local infrastructure adversely affected by the gas production	1	3.95 (1.28)	4.22 (1.24)	3.84 (1.19)	.46
Q5: Recognizing that good stewardship means the gas industry funds local communities in the way the communities want, to improve the quality of life	3	3.82 (1.19)	4.17 (1.23)	3.81 (1.18)	.42
(Select 1 to 5, with 5 as the highest priority)					

*p < .05. **p < .01.

Table 5. Health and Safety.

Question description (n=186, missing =56)	Rank of priority 1: highest; 7: lowest	1		2		3		ANOVA significance p value
		Nonprofit (n = 53)	Government (n = 21)	Private (n = 56)	Total			
Q1: Slowing down or halting new development while we learn more from existing Marcellus wells capable of impacting the Susquehanna River ecosystem	3	3.36 (1.48)	3.76 (1.48)	3.21 (1.62)	3.36 (1.54)	.38		
Q2: Regularly educating/informing stakeholders of the general public of the safeguards already implemented in gas production, which protect the Susquehanna River ecosystem	5	3.74 (1.24)	3.81 (0.93)	3.58 (1.05)	3.68 (1.11)	.66		
Q3: Regularly monitoring and testing the treated wastewater for the chemicals used in gas production to ensure those chemicals are not released into the Susquehanna River ecosystem	1	4.68 (0.61)	4.48 (0.87)	4.51 (0.71)	4.57 (0.70)	.96		
Q4: Requiring gas companies to filter out the chemicals use during gas production and properly dispose of them	2	4.51 (0.78)	4.43 (1.08)	4.50 (0.87)	4.49 (0.87)	.93		
Q5: Creating county councils to coordinate efforts, share and review data, and recommend improvements to preserve the Susquehanna River ecosystem	7	3.42 (1.34)	3.14 (1.53)	3.52 (1.11)	3.30 (1.27)	.66		
Q6: Ensuring emergency response preparedness, including training of first responders, wherever drilling occurs in or near the Susquehanna River ecosystem	6	4.04 (0.98)	4.24 (0.94)	4.07 (0.88)	4.09 (0.93)	.70		
Q7: Ensuring a transparent process for monitoring, investigating, and treating cases of environmental contamination in or near the Susquehanna River ecosystem	4	4.38 (0.95)	4.62 (0.59)	4.31 (0.87)	4.39 (0.86)	.39		
(Select 1 to 5, with 5 as the highest priority)								

*p< .05. **p< .01.

highest on monitoring and testing the treated wastewater for the chemicals used in gas production to ensure that those chemicals are not released into the Susquehanna River ecosystem ($HS_{3-Nonprofit} = 4.68$). Fourth, respondents of the nonprofit sector scored highest in requiring gas companies to filter out the chemicals used during gas production with proper disposal ($HS_{4-Nonprofit} = 4.51$). Fifth, respondents of private sector organizations have the highest scores related to creating county councils to coordinate efforts, share and review data, and recommend improvements to preserve the Susquehanna River ecosystem ($HS_{5-Private} = 3.52$), while respondents of government have the lowest scores ($HS_{5-Government} = 3.14$). Sixth, respondents of government have the highest scores on ensuring emergency response preparedness, including training of first responders, wherever drilling occurs in or near the Susquehanna River ecosystem ($HS_{6-Government} = 4.24$). Seventh, respondents of government have the highest score on ensuring a transparent process for monitoring, investigating, and treating cases of environmental contamination in or near the Susquehanna River ecosystem ($HS_{7-Government} = 4.62$). Respondents of nonprofit organizations have the lowest score ($HS_{6-Nonprofit} = 4.04$) on the training of first responders, while respondents of private sector organizations have the lowest scores ($HS_{7-Private} = 4.31$) on ensuring a transparent process for dealing with environmental contamination on the Susquehanna River ecosystem.

Community

H₀: No statistically significant relationship exists among the nonprofit, government, and private sectors in the community.

H₁: A statistically significant relationship exists among the nonprofit, government, and private sectors in the community.

According to ANOVA analysis results (see Table 6), respondents feel consistently related with respect to "Community." There are no significant differences between these three groups, and we accepted the null hypothesis. Respondents of government have the highest scores in each category. Respondents of the private sector have the lowest scores within each category.

Energy Security

H₀: No statistically significant relationship exists among the nonprofit, government, and private sectors on energy security.

H₁: A statistically significant relationship exists among the nonprofit, government, and private sectors on energy security.

According to ANOVA analysis results (see Table 7), respondents consistently related regarding the community. There are no significant differences between these three groups, and we accepted the null hypothesis. As was the case with "Community," government respondents scored highest on each question. Respondents of private sector organizations have the lowest scores on Q1, tracking the development of renewable energy sources, while nonprofits have the lowest score on all remaining questions.

Discussion

Overall, responses by the three sectors of stakeholders to the four sections of questions are relatively similar. Given the early stage of Marcellus Shale development, it is particularly noteworthy that of the 21 questions measured by the 5-point Likert-type scale (with 5 being the highest priority), the average total score of 17 questions measured above 3 for all three sectors. "Health & Safety" ranked highest with four of the seven questions in the category ranking above 4 for all

Table 6. Community.

Community question description (n = 186, missing = 63)	Rank of priority 1: highest; 4: lowest	ANOVA			ANOVA significance p value
		1 Nonprofit (n = 49)	2 Government (n = 21)	3 Private (n = 53)	
Q1: Finding equitable ways to specifically tax industry and landowners who benefit from local gas drilling to pay for specific needs identified by the local government	2	3.51 (1.28)	3.90 (1.18)	3.51 (1.40)	3.58 (1.31) .46
Q2: Helping local governments strengthen their capacity to plan for, and respond to, Marcellus shale development in the Susquehanna River ecosystem	3	4.00 (1.10)	4.10 (1.09)	3.89 (0.93)	3.97 (1.02) .71
Q3: Requiring gas industry human resources management and local community groups to regularly meet to address the gas employees' and local residents' needs to improve the quality of life during gas production	4	3.51 (1.04)	3.67 (0.91)	3.28 (1.03)	3.44 (1.02) .28
Q4: Requiring gas companies to leave the site as good as, or better than, they found it (water quality, runoff, wildlife habitat, forest and farmland quality)	1	4.66 (0.69)	4.71 (0.56)	4.57 (0.67)	4.63 (0.66) .62
(Select 1 to 5, with 5 as the highest priority)					

*p< .05. **p< .01.

Table 7. Energy Security.

Question description (n = 186, missing = 66)	Rank of priority 1: highest; 5: lowest	ANOVA			ANOVA significance p value
		1 Nonprofit (n = 48)	2 Government (n = 21)	3 Private (n = 51)	
Q1: Directing federal and state government investment to track the development of renewable energy sources	1	3.33 (1.28)	3.76 (1.18)	3.20 (1.10)	.19
Q2: Subsidizing the access of gas-producing communities to locally produced gas	4	2.77 (1.18)	2.95 (1.20)	2.82 (1.14)	.83
Q3: Prohibiting the export of U.S. natural gas to other countries	5	2.67 (1.55)	2.86 (1.53)	2.80 (1.47)	.86
Q4: Mandating local, state, and federal governments to require energy conservation measures in all government-operated buildings	3	3.40 (1.28)	3.90 (1.09)	3.55 (1.21)	.30
Q5: Government funding of peer review Life Cycle Analysis of different energy sources to include educating/informing the general public of the results, in order to make known the true costs of energy resources on health, economy, and natural environment, especially the Susquehanna River ecosystem (Select 1 to 5, with 5 as the highest priority)	2	3.35 (1.47)	3.86 (1.53)	3.57 (1.27)	.38

*p< .05. **p< .01.

three sectors that indicate public's primary concern. Overall, as indicated in the question (Table 1), respondents prioritized the four categories as follows: Health & Safety ($M = 1.5$; rank = 1); Communities ($M = 2.62$; rank = 2); Economic Opportunity ($M = 2.64$; rank = 3); Energy Security ($M = 3.22$; rank = 4). These measures, coupled with the results of no significant statistical difference among the three sectors for all of the hypotheses, are interesting, given that economic opportunity and jobs have been promoted as a positive outcome of Marcellus Shale development.

There are potential leading indicators of shifting stakeholder attitudes suggesting a growing awareness of the shale gas issue. Governor Corbett strongly supported the natural gas industry in the 2010 Pennsylvania gubernatorial race, which he won. However, in the November 2012 statewide elections, an Attorney General and Auditor General were elected, both of whom pledged stricter oversight over shale gas drilling than the status quo. The Republican challenger for Attorney General received more than \$180,000 from the drilling industry in the unsuccessful effort (Finnerty, 2013). Although no statistical relationship is claimed, the concern for health and safety in our exploratory survey and analysis is consistent with the shift in statewide electoral preferences. As the boom-bust cycle progresses, our future survey efforts in the Susquehanna River Basins will seek to identify changing stakeholder attitudes regarding the environmental, social, and economic impact of shale gas fracking.

Limitations

As an exploratory analysis, this study involves the limitation of relying on organizations as a means of targeting respondents. This approach was utilized because of the lack of awareness about Marcellus Shale fracking, which was identified during initial interviews. Given the apparent lack of awareness about Marcellus Shale fracking and the rural nature of the Marcellus Shale region, achieving a significant sampling of individuals from three sectors was unlikely without contacting organizations. Also, the use of the term *ecosystem* in Question 8 of the demographics section (Table 1) may explain partially why 32.3% of respondents indicated "uncertain" and 22% did not answer this question about preserving the Susquehanna River ecosystem for future generations. While "ecosystem" expressed the intention of the question, which was to determine attitudes about the future condition of the natural environment and not just the availability of water, the "uncertain" and missing responses could be the result of respondents not understanding the meaning of "ecosystem." We did not report results for clergy: but instead included their responses by how clergy identified themselves as working in the nonprofit sector, government, or private sector. Of the 33 clergy respondents, 28 identified themselves as nonprofit, none in government, and 5 in the private sector. In Question 30 on the survey, 53 of the 186 respondents entered "retired" or "unemployed" when asked how many miles they worked from the Susquehanna River. Thus, this response only included 133 responses. Overall, the ANOVA does not achieve the .7 standard utilized in social science research; however, we believe the results achieved to be acceptable for an exploratory analysis.

While extensive efforts were made to contact a representative sample of organizations, we did not evaluate the extent to which respondents were evenly distributed throughout the Marcellus Shale region. However, we do know that 86% of the respondents lived or worked within 20 miles of the Susquehanna River, an important factor given the geographic focus of this analysis on the Susquehanna River Basin in the Marcellus Shale Region. The geographic distribution of respondents will be evaluated in future studies.

Additionally, this analysis referenced "boomtown conditions" in citing the need for decision makers to understand stakeholder attitudes. However, the initial boomtown research conducted during the 1970s and 1980s focused on resource extraction in the Western states, which may not be directly comparable to boomtown circumstances in the Marcellus Shale region.

Regarding this comparability issue, Jacquet (2009) notes that

the Marcellus Shale region undoubtedly differs in many critical respects from the community experiences that form the Boomtown Model, as well as contemporary examples, especially in the areas of population size and distribution, transportation, history, and sheer size of the potential resource. However, there are also a large number of key similarities as the equipment, workforces, organization, and process used in the extraction of the natural gas remain nearly identical across the industry, and many communities in the Marcellus Shale region are sufficiently small and rural in that nearby large scale development would likely produce a number of similar effects as have been documented in other areas. (p. 6)

Finally, another limitation of this study is the possible lack of participation in the survey by non-resident landowners in the Marcellus Shale region. Kelsey, Metcalf, and Salcedo (2012) surveyed 11 counties accounting for 79% of all Pennsylvania Marcellus wells through 2011 and concluded that nearly 40% of the land area in these 11 counties is owned by nonresidents (including the Commonwealth of Pennsylvania). Given that 86% of respondents lived or worked within 20 miles of the Susquehanna River, it is unlikely that the attitudes of nonresident landowners were represented significantly in our results.

Conclusion

Because Marcellus Shale development is still in the early stages of development and the economic gain versus environmental and social impacts are not yet clear, stakeholder attitudes supporting health and safety issues, as well as uncertainty about preserving the Susquehanna River Basin for future generations, suggest concern among stakeholders about the environmental impact of natural gas fracking. Respondents ($n = 186$) indicated a great deal of uncertainty about this question, as 23.1% indicated no; 22.6%, yes; 32.3%, uncertain; and 22% did not respond (see Table 1).

There are several high-profile efforts underway that could influence stakeholder attitudes toward Marcellus Shale development and the Susquehanna River. Geisinger Health System, a major health care provider and medical research organization in the Marcellus Shale region, has undertaken a study of the effects of Marcellus Shale drilling on Pennsylvanians' physical health and social well-being. The first results of the analysis may be realized within a year, while others will unfold over 5, 10, or 20 years of study (Socha, 2013). Another high-profile issue involves limiting the traditional power of local municipalities to make zoning decisions regarding industrial siting. Pennsylvania Act 13, the omnibus law dealing with Marcellus Shale drilling, reduced the local zoning decision making. The zoning provision has been appealed to the Pennsylvania Supreme Court after a lower court overturned the zoning provision (Pronko, 2012). Finally, environmental interests continue to advocate for the Susquehanna River to be designated as "impaired" in order to direct resources toward more intensive study (Dandes, 2013).

While there appears to be consensus now among interviewees of this study that acid mine drainage from abandoned coal mines violates the concept of sustainable development (Tregidga, Kearins, & Milne, 2013) the fact is that it has been occurring for decades and the negative environmental and social impacts are understood and nearly impossible to overlook. However, based on the results of this survey, there is less certainty about the long-term impact of shale gas practices on the Susquehanna River Basin. The purpose of this ongoing study, which will involve surveys on a periodic basis, is to provide greater certainty about stakeholder attitudes before the next bust cycle arrives and it is too late for appropriate action. The results of the 2012 Pennsylvania statewide elections suggest greater awareness and concern about health and safety concerns regarding natural gas fracking than in 2010 when Governor Tom Corbett, a strong natural gas supporter, was elected. However, the uncertainty among the private, nonprofit, and government sector respondents about the preservation of the Susquehanna River ecosystem for future

generations suggests doubts among stakeholders about sustainable Marcellus Shale development in the Susquehanna River ecosystem (Starik & Kanashiro, 2013). The support of respondents in all three sectors for health and safety as the strongest preference among the four survey categories suggests that stakeholders desire a sustainably developed Susquehanna River ecosystem even though they may not fully understand the implications of Marcellus Shale fracking at this early stage of development.

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