INTERCONNECTIONS IN RESOURCE

Development: Controversies Surrounding the Marcellus Shale in New York

Burrell Montz*
East Carolina University

Katie Wilmer
Sean Walsh-Haehle
Naomi Lazarus
Yenal Kucuker
Michael Herr
Binghamton University

ABSTRACT

Recent energy company activity in the Marcellus shale region of the United States has led to numerous controversies. The economic benefits of natural gas development appear to be quite large, but how they will be distributed among both the public and private sectors remains unknown. There is also much uncertainty surrounding potential environmental impacts. Impacts from new roads, water quantity and quality, increased truck traffic, as well as chemicals used in the production process make this a dynamic and complex topic, each with direct and indirect environmental effects. This complexity is exacerbated by issues associated with institutional capacity at local and state levels, as well as interorganizational conflicts. This research evaluates the elements of this resource controversy as they are playing out in New York State focusing on the different and often conflicting goals and aspirations of various stakeholders. Among the themes that emerge from this evaluation is the fact that the varying spatial and temporal scales at which different players view the issues are at the root of much of the controversy, as is the uncertainty associated with both positive and negative economic and environmental impacts of gas development. These, then, lead to concerns about the ability of all stakeholders to contribute equally to the debate. This case study illustrates the importance of bridging gaps in knowledge, particularly with respect to various aspects of the drilling and production process to reduce uncertainties in potential impacts, and of the need to disentangle agency responsibilities. *Keywords: Marcellus shale, resource management, environmental impact, New York.*

Introduction

The Marcellus Shale formation in the eastern United States has the greatest potential for natural gas development when compared to all other similar shale deposits in the country (Arthur, Bohm and Layne 2008). This shale's potential was previously limited by its depth and extremely low permeability. However, recent technological advancements, particularly in

horizontal drilling and hydraulic fracturing, have made drilling for natural gas in the Marcellus Shale more economically viable. As a result, there has been a push by gas companies to develop this rich deposit, in part because it is located near high population centers associated with high energy consumption. At the same time, the region encompassed by the Marcellus shale is not accustomed to such resource development. This has created some contentious situations and is reflective of what LaChappelle, McCool and Patterson (2003, 474) have termed the "wicked problems and messy situations" that may characterize current resource management dilemmas.

This article reviews the elements of this resource controversy as they are playing out in New York State. These elements include environmental and economic impacts and institutional frameworks that overlap and sometimes conflict. The impacts are felt at the individual and group levels and in both the public and private sectors and are integrally related, which compounds the uncertainties surrounding the distribution of costs and benefits of resource development. Thus, such a review can further our understanding of the major factors contributing to the controversy in an effort to reduce the uncertainties under which various interests are working in other resource management issues.

The Societal Aspects of Resources

Natural resource development often sparks controversy. It had long been assumed, based on standard economic models, that the development of natural resources within an area would lead to economic development. This, however, has been questioned. At a national level, some countries that are rich in resources have not experienced the anticipated economic benefits (Sachs and Warner 2001). In addition, the distribution of the benefits that do accrue has led to competition among groups (Ward 2003). These lead to the "wicked problems and messy situations" referred to above. These problems and situations are characterized by, among other things, multiple and competing goals, little scientific agreement, limited time and resources, and inequalities in access to power and information (LaChappelle, McCool and Patterson 2003). Individually, these problems are difficult to overcome; together, as they relate to one another, at different spatial and temporal scales, and to different individuals and groups, the difficulties are compounded. Ascher (2001, 729) has suggested that these complexities involving a "multiplicity of interconnected relationships and levels" may lead to simplification that is neither warranted nor helpful in resolving the issues at hand. In fact, oversimplification of a factor can fuel controversy if others see it to be more complex.

Part of the problem stems from what cognitive psychologists have called decision frames (Tversky and Kahneman 1987). Although decision frames and related cognitive framing effects can have different definitions (Druckman 2001), Tversky and Kahneman's definition is used, in which a decision frame is the decision-maker's conception of the contingencies and outcomes associated with different decisions. In turn, one's conception is influenced by a decision-maker's understanding of the problem or issue as well as the scale at which the issue is viewed. In an analysis of different conceptions of place surrounding the controversy related to a proposal to drill for oil in the Alaska National Wildlife Refuge (ANWR), support was found for an argu-

ment made by Cheng, Kruger and Daniels. (2003) that the scale at which one views an issue can explain some of the controversy (Montz et al. 2006). These two studies were addressing spatial scale, but the temporal scale at which individuals and groups view resource management issues, particularly the more immediate economic gains compared to potential long term costs, is also important.

The importance of differences in framing was evaluated in a case study of a water controversy which incorporates the interactions among individuals, local communities, politics, and science (Lee and Roth 2006). The authors identified differences in spatial and temporal scales, in perceptions of the utility and applicability of scientific measurements, and in the construction of data that explained much of the debate. This gap between scientific knowledge and public experience has been seen elsewhere (White and Hall 2006) and calls into question the ability of all stakeholders to contribute to discussions on equal footing. As will be seen later, similar differences exist in New York where hydraulic fracturing is very new to landowners but not to the oil and gas industry. Thus the water issue addressed by Lee and Roth (2006), the ANWR drilling controversy, and numerous other natural resource development arguments reflect differences in cognitive framing, especially with respect to how temporal and spatial scales differ among players, as well as the influence of scientific uncertainty.

The Setting

The Resource

The Marcellus is a black shale, rich in organic matter. It is Devonian, having been deposited between 350 and 415 million years ago (Arthur, Bohm and Layne 2008). The spatial extent is approximately 95,000 square miles covering large parts of Pennsylvania, West Virginia, Ohio, and New York as well as smaller parts of Maryland, Virginia, and Kentucky (Figure 1), with depths varying between 4,000 and 8,500 feet (Figure 2). The deeper areas are generally to the east while the shale gets shallower to the west. The thickness of the shale varies between a minimum of approximately 50 feet thick and a maximum of 300 feet thick. Uplift since the time of deposition has caused the Marcellus shale to become highly fractured (Arthur, Bohm and Layne 2008). These fractures are primarily vertical in nature, and often contain natural gas, although most of the gas is trapped in pores within the rock.

Previously, the depth of the shale and its naturally low permeability have presented the greatest obstacles to natural gas production. Two relatively recent advancements in drilling technology have been economically successful in similar shale formations, particularly the Barnett Shale formation in central Texas. A combination of horizontal drilling and hydraulic fracturing has been shown to make production of the Marcellus shale economically viable. This process consists of drilling a vertical well bore until the desired strata are reached, at which point, the well bore is curved from vertical to horizontal by turning the drill bit 90 degrees over a 600 foot radius arc (Figure 3). Horizontal drilling has numerous advantages over vertical drilling in the Marcellus Shale. First, because this shale is not especially thick, a horizontal wellbore can reach the desired strata in the typical vertical fashion, and then extend horizontally to maintain contact with the strata for another 2,000 to 6,000 feet (Arthur, Bohm and Layne 2008). Second,

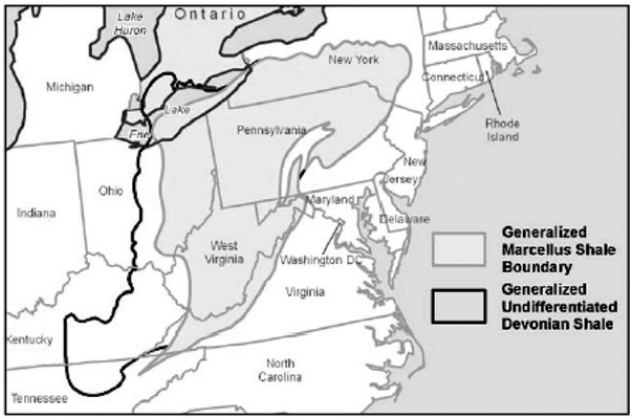

Figure 1. Geographic Extent of the Marcellus Shale (Arthur, Bohm and Layne 2008)

the Marcellus Shale contains many vertically oriented fractures that contain natural gas. A horizontal wellbore is significantly more likely to intersect them than is a vertical well. A third advantage of horizontal drilling is that multiple wells can be drilled from the same well pad because the horizontal wellbores can branch out in different directions, like the spokes on a wheel, without significantly interfering with one another in terms of gas collection. This allows companies to consolidate infrastructure, which can have both positive and negative environmental impacts. Fewer well pads will need to be established, requiring fewer roads and collection pipes, and thus less surface disruption, but the ones that are created will be larger and will create concentrated environmental impacts. Cost is the primary drawback of horizontal drilling as opposed to vertical drilling. While a typical vertical well could cost as much as $800,000 to drill, a horizontal well can cost more than $2.5 million, excluding the costs of creating the well pad and infrastructure (Arthur, Bohm and Layne 2008).

Technological advancements in hydraulic fracturing have also made gas production in the Marcellus Shale more economically viable. Because shale formations have especially poor permeability due to their fine-grained composition, gas is trapped in joints or pores and cannot flow easily throughout the strata. This was a limiting factor in deposits like the Marcellus Shale until hydraulic fracturing made production feasible. Hydraulic fracturing consists of using a highly pressurized solution of water and chemicals to create more fractures, thereby increasing the permeability of the rocks and allowing more gas to flow to the wellbore. The process has been used since the early 1960s in the Appalachian region of the United States, but recent advancements in fracture design and in the composition of the fluids have made hydraulic fracturing more productive (Arthur, Bohm and Layne 2008).

The chemical makeup of fracturing fluid has also changed over time as technology has advanced. The type of fluid used most frequently now is known as slickwater fracturing fluid which is composed primarily of water and includes a propping agent (usually sand) and small percentages of other chemicals that serve specific purposes. These include friction reducers, acids, and agents to kill micro-organisms (Arthur, Bohm and Layne 2008). The exact makeup of a fracturing fluid may be site specific, and may also remain undisclosed for proprietary reasons. This lack of disclosure has created some of the controversy, leading some to believe the industry has something to hide and fostering greater uncertainty regarding potential environmental

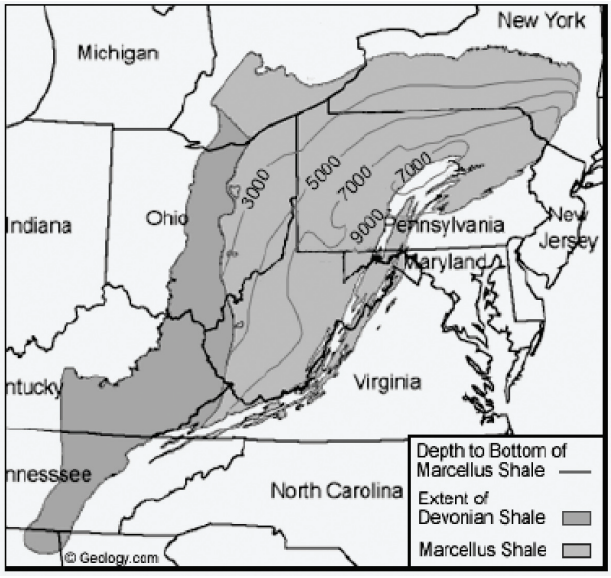

Figure 2. Depth of Marcellus Shale deposit (in feet) Geology.Com 2010

impacts.

Interest in developing the Marcellus shale in New York was fueled by construction of the Millennium Pipeline, a 182-mile long underground pipeline originally built to carry gas from Canada and New York to the New York City metropolitan area (Millennium Pipeline Company 2008). This reduces costs for energy companies because they need only connect with this pipeline rather than construct a new system or connect to the aging system. The route of this pipeline coincides well with the extent of the Marcellus shale in New York.

The Location

Although the Marcellus shale covers a large area, the research presented here is restricted to New York State, with the main focus on Broome County, New York. The affected area in New York has been undergoing an economic decline and a general population out-migration. Thus, Broome County provides a very good example of an area in need of an economic boost. According to census data from 2000 and 2008, the County's population declined from 200,536 people in 2000 to 195,018 in 2008, a 2.8 percent decrease. Similarly, employment in Broome County has declined from 118,800 to 113,700, indicating a larger proportional decrease of 4.3 percent. Indeed, local unemployment has increased and, in December 2008, was at its highest since 1990, at 7.1 percent (Swartz 2009).

Because many natural gas economic impact studies (Center for Business and Economic Research 2008; Perryman Group 2008) indicate significant increases in retail and trade, eating and drinking, and construction-related occupations, understanding the current composition of occupations is important. In 2000, according to the U.S. Bureau of the Census, the top four occupations in the county in terms of number of employees were management, sales and office, service, and production/transportation occupations (Table 1). Although the rankings remained the same, the service category experienced the greatest growth in 2000 – 2006.

Per capita income has also changed between 2000 and 2006 (Table 2). Although Broome County's per capita income shows an increase in that time period, it still is well below New York state's per capita income. Even with the increases in per capita income and service employment,

Figure 3. Vertical and Horizontal Wells (not to scale) (Arthur, Bohm and Layne 2008). The overlying layers are predominately siltstones and shales. The black marks emanating from the wells illustrate fractures.

Broome County and other counties in the region are experiencing losses of people and jobs. Based on these statistics and the current global economic turmoil, Broome County's economic outlook indicates that the county can benefit from activities to reverse these trends.

Although there has been gas production in the region for many years using vertical drilling, the most recent natural gas "rush" began in Broome County in 2006. At the outset, companies were able to obtain leases for approximately $50 per acre; however, as competition between the companies became more prominent, leases increased to the $2500 per acre range, leaving some landowners who signed leases early feeling disenfranchised, and "cheated" that their neighbors who signed later are receiving more in lease prices (Dooling 2008). As of December 2008, 630 natural gas leases were registered in the county since January 1, 2006 (Broome County Clerk, 2008).

Elements of the Controversy

Natural gas development and production in the Marcellus shale are steeped in controversy, with sometimes complex interconnections among the various elements of the debate and levels at which they are playing out, similar to that addressed by Ascher (2001). At the heart of the local controversy are land use conflicts, embedded in varying perceptions of the magnitude and beneficiaries of economic impacts, as well as uncertainties about environmental impacts. These are linked to questions associated with institutional capacity and inter-organizational conflicts at several governmental levels. Each is discussed below.

Occupation	Broome County - 2000	Broome County - 2006
Management and professional	31,581 (34.6 percent)	31,374 (33 percent)
Sales and office	24,779 (27.1 percent)	26,293 (27.6 percent)
Service	14,766 (16.2 percent)	18,095 (19 percent)
Production, transportation	13,567 (14.9 percent)	13,399 (14 percent)
Construction	6,369 (7.0 percent)	5,650 (5.9 percent)
Farming/forestry	269 (0.3 percent)	419 (0.4 percent)

Table 1. Occupation Trends for Broome County, New York.
Source: U.S. Bureau of the Census.

Broome County-2000	Broome County-2006	New York-2000	New York-2006
$19,168	$23,171	$23,389	$28,024

Table 2. Per capita Income Trends for Broome County, NY and New York State
Source: U.S. Bureau of the Census.

Local Controversy: Land Use

The land use controversy surrounding Marcellus Shale resource development relates to the leasing of private land to gas companies for production. As mentioned above, there is tension between those landowners who negotiated higher lease prices and those who signed contracts for lower prices. However, it goes beyond that. A number of landowners have so far refused to sign leases for a variety of reasons, including fears about loss of property values, negative environmental impacts, and concerns about changing quality of life. This "...has created a new social fault line in local society," (Klinkenborg 2009) wherein some landowners believe they have both a right and an obligation to allow development of resources on and under their property while others focus on their duty to protect the land.

Even so, non-lease holders' property may still be affected because of the extent to which horizontal drilling can reach. If a landowner's property is preventing the operator from reaching the minimum project area, the New York State Department of Environmental Conservation (DEC) may recommend participation through compulsory integration. As part of the application for a permit to drill for natural gas, New York State requires a map of the area that will be assigned to a well (New York State Department of Environmental Conservation 2008b). A piece of land that is assigned to a well (or an expected well) is divided into spacing units (Figure 4) which

might include some or all of the property of an adjacent landowner who is not involved in the lease. When a permit to drill is issued, all landowners in the spacing unit are required to choose how they want their land to be integrated with the leased property, with each landowner given three options (Table 3). Clearly, this process can only fuel existing differences of opinion about the desirability of gas production. While some argue that compulsory integration leads to more efficient resource development, others claim it is akin to eminent domain (Bernhard 2009).

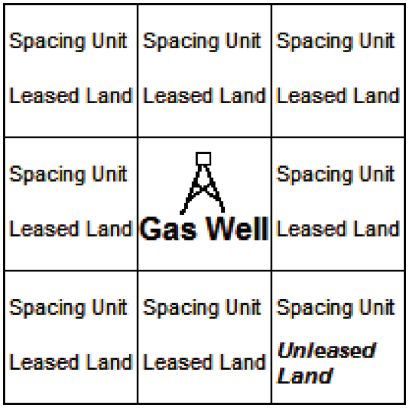

Figure 4. Example of Compulsory Integration (Adapted from New York State Department of Environmental Conservation 2008a) The size of parcels can vary but the spacing requirement for natural gas wells in New York is 660 feet.

Much of the land of interest to energy companies is rural land, either active farmland, or land that is no longer being actively farmed. In 2002, 54 percent of farm operators in Broome County reported that farming was their principal occupation (New York Agricultural Statistical Service 2005). It is not surprising, then, that some farmers are anxious to earn extra income from their land, and those on non-active farmland have similar interests. At the same time, the state's Farm Bureau has weighed in on this issue, providing information to farmers on leasing and landowner rights relating to oil and gas projects, recognizing the rights of farmers to lease their land for due compensation for the purposes of gas exploration (New York State Farm Bureau 2008). However, the Bureau recently drafted a bill supporting farmland protection, which would provide funds to farmers to increase the productivity of their land in return for assurance that farms will remain as working farmland

Option	Royalty Owner	Participating Owner	Non-Participation Owner
Company-to-Owner Payment of Royalties	Receive at least 12.5 percent of production profits	Receive full share of production profits	Receive royalties only when production profits exceed production and operation costs and fees
Owner-to-Company Payment of Operation Fees	No obligation	Required before hearing	No obligation
Loss of money if well is not profitable?	No	Yes	No

Table 3. Summary of the Three Compulsory Integration Options.

for the next generation. The bill recognizes that farmland protection is important to improve the sustainability of agricultural lands, and proposes increasing the state's share from 75 percent to 85 percent, with the balance matched by local governments or other organizations, thereby making the program more attractive to farmers (New York State Farm Bureau 2008). If the bill is passed, it is likely to have implications for gas leases. Although farming and gas production are not entirely incompatible uses, the disruption and environmental impacts that can result from gas production can be long-lasting.

The land use issues presented here are steeped in controversy with neighbor sometimes pitted against neighbor, based on differing views of appropriate and wise land use. As one landowner stated, "This is a huge opportunity for the area" (Wilber 2009b). Another recognizes this and has stated that gas production would bring "...some wealth and temporary business...to our area. The trouble is – at what cost?" (Coffman 2009). Clearly, it is impossible to separate entirely the land use considerations from economic impacts, and views of these differ as well.

Local Controversy: Economics

The potential magnitude of economic benefits throughout the Marcellus region is enormous. As a comparison, economic analyses of the Fayetteville shale formation in Arkansas and the Barnett shale formation in Texas, funded by energy companies, have shown $2.6 billion and $10.1 billion in total annual output, respectively (Center for Business and Economic Research 2008; Perryman Group 2008). The Fayetteville shale has proven reserves of 1.4 trillion cubic feet, and the Barnett shale has 30 trillion cubic feet. Although there are only estimates for the Marcellus shale, it exceeds these at 50 trillion cubic feet for the entire Marcellus region, of which New York's share comprises 10 to 20 percent (Weinstein and Clower 2009). Despite this relatively small proportion, the anticipated income is large.

Direct economic benefits are expected from lease and royalty payments, from tax revenues, and from additional jobs related to drilling and production. Lease payments vary, as discussed above. Currently, royalty payments to New York State are 12.5 percent. Landowners have been able to negotiate higher amounts, in some cases starting at 15 percent and increasing to 24 percent once a well produces 1 billion cubic feet (Dooling 2009). Indirect or spillover benefits are expected from increases in "...demand for professional services such as attorneys, accountants, and engineers," increased revenues associated with restaurant, hotel, and retail sales related to higher incomes and the new jobs created, and increased real estate activity (Weinstein and Clower 2009).

These expectations must be put in context. Studies elsewhere have shown that exploration, drilling, and operations account for the predominant share of economic activity. Leasing and royalty income, which currently is of much local interest in New York, actually accounts for a relatively small share of the economic impact in Texas (Perryman Group 2008). At the same time, spending by the natural gas industry stimulates the economy directly by generating jobs and indirectly as the demand for goods and services created by gas extraction flows through the economy.

Not surprisingly, the economic benefits and costs, both in absolute and relative terms, vary

among stages of the operation. Of particular concern here are the development and production stages. The post-production phase has no economic benefits and, besides reclamation costs, other impacts are unknown and probably long-term, related to environmental costs and changes in property values.

The development or drilling phase is the most labor-intensive period of an energy project and includes everything from road construction, drilling of the gas wells, hydraulic fracturing to produce gas, and construction of pipeline infrastructure. These activities can require hundreds of workers, many of whom may be transients. A study undertaken for Broome County estimates 8,100 person years of employment if 2000 wells are drilled (the lower estimate of the study) and effectively double that number for 4,000 wells (the high estimate). At an average of $49,000 per job, for the lower estimate, this totals some $400 million in salaries, wages, and benefits (Weinstein and Clower 2009). Other studies indicate that there is a large cash flow in this initial phase, which can total up to $15 million for a typical well (Julius and Mashayekhi 1990).

An influx of workers to provide many of those 8,100+ person years of employment has indirect effects leading to an increase in jobs in related sectors such as the service industry (food and accommodations) and construction. Towns in Northern Pennsylvania where production has begun are seeing increased construction and business (LaTourette 2009). At the same time, an increased population increases demand on county infrastructure and public services. On one hand, in New York State, natural gas production is subject to local property taxes, which means school districts, county governments, and municipal governments will receive higher local tax revenues associated with the extraction of the natural gas as well as lease and royalty incomes. On the other hand, demand for public services will increase as will the strain on infrastructure, particularly roads. Studies of other energy developments have found a five to ten year lag between the need for infrastructure and the tax revenue to pay for it (Black, McKinninsh and Sanders 2005). Estimating the amount of impact, both positive and negative is very difficult, if not impossible, though the range of impacts can be understood (Figure 5). Some controversy centers on the elements of this diagram with respect to three questions: How much, to whom, and for how long? The answer to the last question depends on the stage of the operation with production extending an estimated 10 to 20 years after the drilling is completed, perhaps even longer.

In Texas, the sectors with the greatest increases were retail and trade (27 percent of the new jobs), eating and drinking establishments (15 percent of the new jobs), construction (9 percent of the new jobs), and gas industry (7 percent of the new jobs) (Perryman Group 2008). At the same time, although eating and drinking establishments show the greatest increase, they make up a smaller percent of new personal income, indicating that many such jobs are relatively low paying. If a similar trend occurs in New York, and particularly in Broome County, based on current statistics, sales and office employment along with those occupations in the service category will make up more than 50 percent of total employment. A less diversified local economy could have serious implications, especially during the post production/reclamation phase which may occur as early as 10 years after production starts but could come after 20 to 30 years or more. Following the coal boom in the Appalachian region of the United States in the 1970s, for each 10 jobs lost in the coal sector, an estimated 35 were lost in construction, retail, and other service

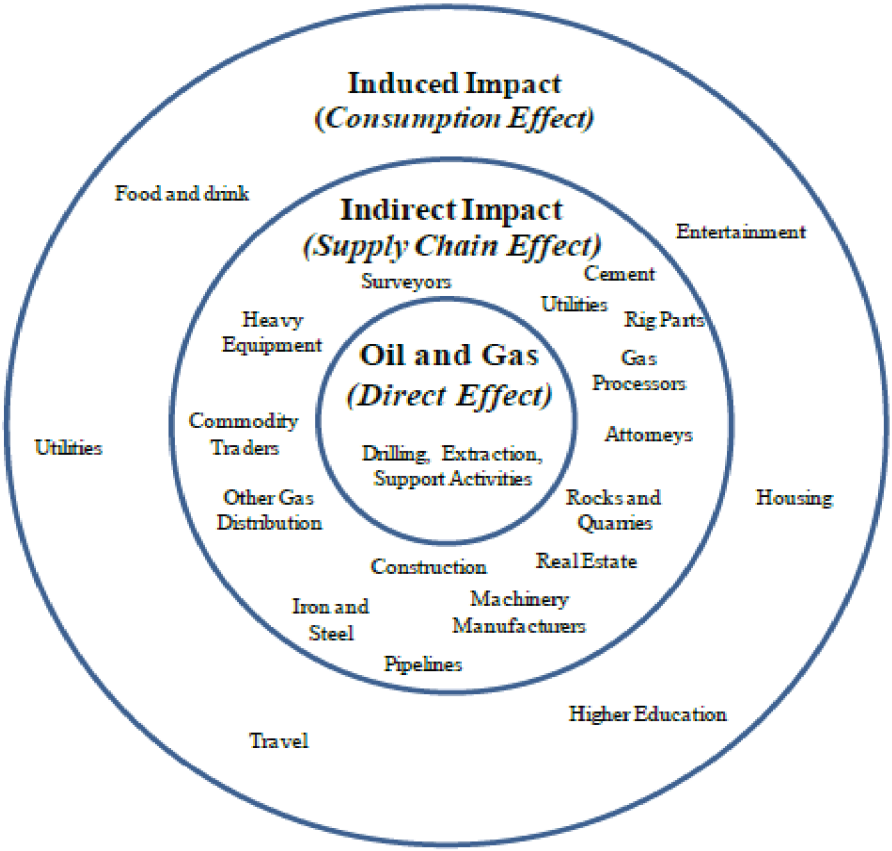

Figure 5. Range of Direct, Indirect and Induced Impacts of the Oil and Gas Industry (Pennsylvania Economy League 2008)

occupations (Black et al. 2005). To complicate matters, as jobs associated with different aspects of gas development become available at higher than local wages, local businesses also must increase costs to survive. Some workers will benefit directly through higher wages, but others will not. This type of "resource curse" can drive up the cost of living, including housing and services, making it harder for permanent residents to experience the same quality of life on the same income. One possible outcome is that higher wages drive up the prices on most goods, resulting in localized inflation.

Estimates suggest that economic benefits will be large (Weinstein and Clower 2009), but there are costs that will ripple through the economy that can have long term negative impacts.

Those expecting to reap the benefits, such as landowners who hold leases and county and town governments that anticipate increased revenues, are understandably anxious for drilling to start. Those who remain uncertain about how the benefits and costs will balance remain wary and promote caution in moving ahead — hence, the economic controversy.

Local Controversy: Environmental Impacts

There is much uncertainty surrounding the potential environmental impacts associated with development of the Marcellus Shale. The entire process of hydraulic fracturing takes many years, and spans much greater distances than just the drill site. The needed roads, water quantity and quality, increased truck traffic, as well as chemicals used in the production process make this a dynamic and complex topic, each with direct and indirect environmental impacts. Analysis of the range, nature, and potential magnitude of each of the impacts is beyond the scope of this paper. However, two impacts are of particular concern and are considered here: potential pollution from hydraulic fracturing and impacts on hydrologic systems.

Water is a critical component in hydraulic fracturing because of the quantities needed and the quality of the water after it has been used. Estimates of required amounts are varied. One source states that the fracturing process uses between two and nine million gallons for each well (Brownell 2008). In the Fayetteville Shale formation in Arkansas, the fracturing operation uses two to three million gallons of water, or 50,000 to 80,000 bbl (barrels, at 42 gallons per barrel). Water that is injected into the well flows back out of the well fastest at the start, about 150 bbl/hr, and then slows over time. Estimates of the total fluid extracted usually range around 50 percent (Veil 2007). Because the fluids used in the hydraulic fracturing process are proprietary, it is impossible to evaluate the potential environmental impacts. However, it is known that among the constituents are friction reducers, acids, and agents to kill micro-organisms. The flow back water will contain these as well as brine, hydrocarbons, metals, and radioactive elements.

Both surface and groundwater quality are local concerns. With respect to the former, surface water contamination could occur from spills or improper handling of fracturing fluids. Even without accidents, disposal of these fluids is viewed by many as problematic because they are classified as industrial waste rather than hazardous waste and may only be removed from a well site by a hauler with a valid waste transporter permit. They can be disposed of in several ways including injection wells, out-of-state industrial wastewater treatment plants, and on occasion local sewage treatment facilities (New York State Department of Environmental Conservation 2008a). The last option has not yet been seriously considered in Broome County because of the volume and unknown contaminants involved. Companies may recycle these fluids if they re-drill the same site in different directions, or for drilling on another site. Fortuna Energy is considering this option (Wilber 2008a), but the effectiveness of reuse has not yet been established. As noted earlier, lack of information regarding the composition of the fluids has increased uncertainty at the local level and has complicated efforts to address disposal.

Potential concerns about groundwater center on the possibility of contaminants from any stage of the hydraulic fracturing process entering aquifers. Usually contamination of groundwater from hydraulic fracturing comes from irresponsible handling of the fracturing fluids (New

York State Department of Environmental Conservation 2008a). Yet, even lined production pits can leak, allowing chemicals to seep into groundwater.

There have been complaints about changes in the quality of on-site well water and the functioning of wells. Decreased water pressure and increased sediment in groundwater that clog filters on residential wells have been reported. However, there is insufficient evidence relating these problems to drilling (Wilber 2008a). In Pennsylvania where drilling is taking place, gas has been detected in domestic well water. After much debate, including reports that gas is naturally occurring in well water in New York State, evidence has mounted that hydraulic fracturing in the area may have caused migration of gas to the well (Wilber 2009a). This has further exacerbated fears about the impacts of gas production on water quality.

The sources for the large amounts of water required for this process can include local rivers, tributaries, lakes, and groundwater. Sources of water in Broome County have not yet been identified, though the Susquehanna River Basin Commission (SRBC) recognizes that the Susquehanna River will be affected both directly and indirectly by such large withdrawals. Some local communities have considered selling water to gas companies (Wilber 2008b) in order to increase income. Water withdrawals will lower water levels and could increase pollutant concentrations, causing some stretches of river to, for example, exceed federal (and state) water quality standards and thereby increase treatment requirements for municipal water withdrawals. Using water for drilling means that the resource will not be available for other activities within the watershed, both locally and downstream. The hydrological and ecological impacts of this are potentially quite large but not well understood, contributing to the uncertainty surrounding the issue; the SRBC's concern over these impacts is discussed later.

In 1992, New York State issued a Generic Environmental Impact Statement (GEIS) on the oil, gas, and solution mining regulatory program (New York State Department of Environmental Conservation 1992). Because hydraulic fracturing represents a significant change to how gas mining is undertaken, a supplemental GEIS was begun in 2008. This process has slowed the start of gas production in New York and has provided venues in which the public can voice concerns about potential environmental impacts. Whether or not the supplemental GEIS resolves any of the controversies mentioned above is unknown at the time of writing, but the lead agency, the New York State Department of Environmental Conservation, is itself the center of some controversy, discussed next[1].

Beyond the Local Level: Institutional Capacity

The principal government agency responsible for regulating oil and gas exploration in New York is the Department of Environmental Conservation (DEC) which was established under Article 13 of the Environmental Conservation Law (ECL) (New York State 1972). The DEC's overall responsibilities are focused on the management and conservation of natural resources. The agency's tasks include regulating hazardous and toxic waste disposal, managing marine and coastal resources, forest management, water management, and generating public awareness on environmental issues.

In addition to the above, the DEC is responsible for regulation of oil and gas exploration and

production under the Oil, Gas, and Solution Mining Law Declaration of Policy as provided for by ECL Article 23. The DEC's responsibilities specifically relating to oil and gas are to regulate the development, manufacture, and use of oil and gas; to facilitate maximum recovery of oil and gas; and to provide for gas storage and wastewater disposal. The DEC also requires oil and gas companies to adhere to well spacing stipulations and submit an annual report on production and waste disposal practices. Furthermore, the DEC requires landowners to participate in the selling and leasing of land for oil and gas exploration through compulsory integration. As these policies reveal, the DEC's approach to oil and gas exploration is primarily development oriented, which is contrary to its core activities that are focused on environmental issues. DEC, then, is an excellent example of the multiple and conflicting responsibilities that complicate resource management (Ascher 2001)

The DEC requires an upfront payment from gas companies, known as a bonus payment, at the beginning of the lease, and annual delay payments of $3 - $5 per acre if gas is not produced within the lease period. Furthermore, royalty payments of 12.5 percent (or more if negotiated) are paid to the landowners for use of their land (Office of New York State Comptroller 2005). DEC collects 12.5 percent on state lands. These are among the lowest royalties in the country, an issue that has served to increase controversy with some arguing that the state is selling its resources too cheaply.

The New York State Comptroller's Audit Report cited several shortcomings in the agency's administrative operations. These include the lack of procedures and guidelines, inefficiencies in monitoring, and poor debt collection, all of which are critical for coordination and proper management of gas production. The first two of these are seen to be related to a shortage of staff and to inadequate training (Office of New York State Comptroller 2005). It is unlikely that these will change in the near future, given the economic crisis facing the State, yet one wonders why required fees and royalties have not been increased to pay for better management.

The DEC has a broad scope of activities which are both environmental and developmental in scope. While providing the necessary framework for regulating oil and gas leases, the duality of the DEC's role makes it difficult to define specific responsibilities. These difficulties arise partly from the mismatch of the agency's activities relating to oil and gas with that of its core environmental activities, and from inadequate administrative resources. At the same time, the DEC does not have regulatory control over all resources, as it shares responsibility for water management with, in this case, the Susquehanna River Basin Commission, which can lead to a "messy situation."

Beyond the Local Level: Interorganizational Conflicts

The Independent Oil & Gas Association of New York recognizes the SRBC as the primary authority governing the use, storage, and disposal of water for the purposes of oil and gas exploration in the Marcellus Shale formation (Independent Oil and Gas Association 2008). The SRBC operates under a Comprehensive Plan that outlines the Commission's obligations and objectives as to the maintenance of the Susquehanna River Basin (Susquehanna River Basin Commission 2008a).

In keeping with the Comprehensive Plan, the SRBC has adopted regulations pertaining to the allocation, diversion, withdrawal, and release of water resources for oil and gas exploration (Susquehanna River Basin Commission 2007). As stipulated in these regulations, the SRBC recognizes the riparian rights of landowners and downstream communities by regulating allocation and withdrawal of water to meet environmental quality standards. It also delineates protected areas where water shortages occur and has the authority to prohibit excessive use of water within these areas (Susquehanna River Basin Commission 2007).

In keeping with its mandate to manage and protect the basin's water resources, the SRBC recently adopted changes to incorporate special provisions relating to oil and gas projects. The rulemaking process resulted in the re-definition of the "project" for oil and gas exploration to include the drilling pad and all other water-related facilities and activities. Furthermore, projects will be subject to the review and approval of the Commission, and this provision extends to all consumptive use of water, not only to public water supply systems (Susquehanna River Basin Commission 2007). The approval will be valid for five years, after which it needs to be renewed if operations are to be continued on the drilling pad. In addition to approval of projects, the Commission requires operators to report on the constituents of flow back fluids, though apparently the specific mixture remains proprietary, and on the process adopted in the treatment and disposal of these fluids in keeping with state and federal law (Susquehanna River Basin Commission 2008b).

The outcome of the recent rulemaking process reveals that the SRBC has expanded the scope of its activities to include regulating oil and gas drilling projects in terms of their potential impacts on the river basin. In doing so, the Commission has now adopted a dual approach to managing water resources by recognizing environmental and development goals that focus on greater accountability and responsibility in the use of water in relation to oil and gas exploration. While the responsibilities of the SRBC are focused on water management issues that do not duplicate what the DEC does, the two agencies have held discussions to promote coordination and to reduce the potential for conflict, particularly given that DEC will be evaluating the adequacy of SRBC's reviews of water withdrawals to meet demands associated with hydraulic fracturing (New York State Department of Environmental Conservation 2009).

Discussion and Conclusions

The case study presented here illustrates the controversy that natural resources issues can spark. Some of the controversy is related to the anticipated distribution of benefits and costs, both in economic and environmental terms. At the same time, there are various entities involved: individual landowners with leases, individual landowners without leases, local, regional, and state agencies, and organizations and individuals who do not own land, but who are concerned about the future of the region. Some come down on the side of production; others do not. Although addressing alliances between Native and non-Native groups, Grossman's (2005) consideration of a common "place membership" applies here, though in the opposite way. In Grossman's case studies in several US states, groups previously in conflict over many issues developed alliances over a shared sense of place which was threatened by various resource devel-

opments. However, in the Marcellus shale case, it is different conceptions of the contingencies and outcomes associated with gas production that have fueled some of the conflict seen here. Complicating this are different temporal scales at which the various players evaluate benefits and costs. Thus, place membership is shared, in large part because of the shared resource; how it is valued, however, varies widely, reflecting the different time frames as well as perceptions of the utility and certainty of scientific information, similar to what Lee and Roth (2006) found.

Gas development in the state follows the general framework of a tri-sector partnership (Yakovleva and Alabaster 2003), involving government agencies, oil and gas companies, and the public. The different and often conflicting goals and aspirations of these stakeholders have emerged to shed light on the benefits and shortcomings of policies and regulations. Oil and gas companies approach the debate from a market-oriented perspective to maximize profits. Many in the public are interested in the prospects of increased income from gas production on their land. Others are concerned about landowner rights and the preservation of landscapes. Government agencies are caught in a dilemma of balancing energy exploration as an important development strategy on one hand, and of being responsible for environmental protection on the other. Thus, Ascher's (2001) "multiplicity of interconnected relationships and levels" is seen in this case to have led some, on both sides of the controversy, to oversimplify the issues (reflected in the rather matter-of-fact statements made by those of differing views, illustrated by the examples included earlier), further exacerbating the conflict. At various stages in the evolution of oil and gas exploration in the Marcellus Shale, there has been a concerted effort by government agencies, advocacy groups, and environmental organizations to get the public involved in discussions. While some of these efforts have fostered discussion and debate on economic, social, and environmental concerns, others have been designed to provide information. Throughout, the gap between scientific knowledge and public experience (White and Hall 2006) has emerged and called into question the ability of all stakeholders to contribute to discussions. Some of these shortcomings have been addressed through organizations representing different civic groups, such as landowners, farmers, and residents, but skepticism remains on all sides.

How this controversy will play out is uncertain, and the range, nature, and magnitude of impacts will not be known for decades. Many of the issues have been seen elsewhere, such as differences in how issues are framed, limited time and resources, and inequalities in access to power and information between decision-makers and the public. However, others are context-specific, including the current socio-economic conditions of the region, agency responsibilities and interactions, the decision-making process that has involved the environmental impact analysis process, and the local value of place. This case study is a clear illustration of the importance of bridging the gap in knowledge, particularly with respect to various aspects of the drilling and production process to reduce uncertainties in potential impacts, and of the need to disentangle agency responsibilities. The fact that the agency charged with environmental protection is the same agency that permits gas development makes it impossible for all to believe that their voices are being heard. This, then, is an excellent example of the "wicked problems and messy situations" (LaChappelle, McCool and Patterson 2003) that can plague natural resource planning.

BURRELL E. MONTZ is Professor and Chair in the Department of Geography at East Carolina University, Greenville, NC 27858. Email: *montzb@ecu.edu*. Her research interests center on natural hazards, resource management, emphasizing water, and environmental impact assessment.

KATIE WILMER, SEAN WALSH-HAEHLE, NAOMI LAZARUS, YENAL KUCUKER AND MICHAEL HERR
The co-authors were students in a graduate seminar on resource management at Binghamton University.

Notes

1. As of October, 2010, the Final Supplemental GEIS had not been issued by the DEC, likely because of the many comments received on the Draft GEIS to which the agency must respond. Anticipated release of the Final Supplemental GEIS is later in 2010 or early in 2011. There are indications that the New York City watershed in the Catskills will either be excluded from gas development, or site-specific EIS analysis may be required for any proposed development.

References

Arthur, J. D., B. Bohm, and M. Layne. 2008. Hydraulic fracturing considerations for natural gas wells of the Marcellus shale. *The Ground Water Protection Council 2008 Forum*. http://www.dec.ny.gov/about/47291.html (last accessed 9 February 2010).

Ascher, W. 2001. Coping with complexity and organizational interests in natural resource management. *Ecosystems* 4: 742-757.

Bernhard, M. 2009. Letter to the editor. *Evening Sun (Norwich, NY)*. 28 May.

Black, D., T. McKinnish, and S. Sanders. 2005. The economic impact of the coal boom and bust. *The Economic Journal* 115 (April): 449-476.

Brownell, M. 2008. Gas well drilling and development: Marcellus shale. *Susquehanna River Basin Commission*. http://www.srbc.net/whatsnew/docs/MarcellusShaleandGasWellDrillingPowerpoint061208.pdf (last accessed 22 September 2009).

Broome County Clerk. 2008. PARIS (Public Access Retrieval Information System) – The Broome County Clerk's Public Search System. http://www.gobcclerk.com (last accessed 22 September 2009).

Center for Business and Economic Research. 2008. *Projecting the Economic Impact of the Fayetteville Shale Play for 2008-2012: Executive Summary*. Fayetteville, AR: Sam M. Walton College of Business, University of Arkansas. http://cber.uark.edu/FayettevilleShaleEconomicImpactStudyEXECSUMMARY2008.pdf. (last accessed 8 February 2010).

Cheng, A.S., L.E. Kruger, and S.E. Daniels. 2003. Place as an integrating concept in natural resource politics: Propositions for a social science research agenda. *Society and Natural Resources* 16: 87-104.

Coffman, S. 2009. Viewpoint: Scrutiny needed for 'hydrofracking.' *Press and Sun-Bulletin*

(Binghamton, NY). 27 July.
Dooling, N. 2009. Kirkwood coalitions OK $48 million gas deal. *Press and Sun-Bulletin (Binghamton, NY)*. 11 January.
Dooling, N. 2008. Do gas homework, residents urged. *Press & Sun-Bulletin (Binghamton, NY)*. 9 April 2008.
Druckman, J.N. 2001. The implications of framing effects for citizen competence. *Political Behavior* 23(3): 225-256.
Geology.Com. 2010. Marcellus Shale - Appalachian Basin Natural Gas Play. http://geology.com/articles/marcellus-shale.shtml (last accessed 8 February 2010).
Grossman, Z. 2005. Unlikely alliances: Treaty conflicts and environmental cooperation between Native American and rural white communities. *American Indian Culture and Research Journal* 29 (4): 21-43.
Independent Oil and Gas Association of New York. 2008. *Homegrown Energy: The Facts About Natural Gas Exploration Of The Marcellus Shale*. http://www.marcellusfacts.com/pdf/homegrownenergy.pdf (last accessed 8 February 2010).
Julius, D. and A. Mashayekhi. 1990. *The Economics of Natural Gas: Pricing, Planning and Policy*. London: Oxford University Press.
Klinkenborg, V. 2009. Walking the land where the drilling rigs will go. *The New York Times*. 28 July.
LaChappelle, P.R., S.F. McCool, and M.E. Patterson. 2003. Barriers to effective natural resource planning in a "messy" world. *Society and Natural Resources* 16: 473-490.
LaTourette, B. 2009. Letters to the Editor: Another advantage to gas drilling. *The Evening Sun (Norwich, NY)*. 20 July.
Lee, S. and W-M Roth. 2006. Community-level controversy over a natural resource: Toward a more democratic science in society. *Society and Natural Resources* 19: 429-45.
Millennium Pipeline Company. 2008. *Bringing energy to New York, New England, and New Jersey*. http://www.millenniumpipeline.com/default.aspx (last accessed 22 September 2009).
Montz, B.E., J. Donato, V. Ehlen, and J. Knight. 2006. Conceptions of place: An analysis of the Alaska National Wildlife Refuge debate. *Research in Contemporary and Applied Geography: A Discussion Series* XXX: Article 2.
New York Agricultural Statistical Service. 2005. *Broome County Farm Statistics*. http://www.nass.usda.gov/Statistics_by_State/New_York/County_Profiles/broome.pdf (last accessed 22 September 2009).
New York State. 1972. *Environmental Conservation Law*. http://www.dec.ny.gov/regulations/40195.html (last accessed 8 February 2010).
New York State Department of Environmental Conservation. 2009. *Final Scope For Draft Generic Environmental Impact Statement On The Oil, Gas, And Solution Mining Regulatory Program.* Albany, NY: NY Department of Environmental Conservation. http://www.dec.ny.gov/energy/47554.html (last accessed 22 September 2009).
New York State Department of Environmental Conservation. 2008a. *Draft Scope For Draft Supplemental Generic Environmental Impact Statement On The Oil, Gas, And Solution Mining Regulatory Program*. Albany, NY: NY Department of Environmental Conservation.

http://www.dec.ny.gov/docs/materials_minerals_pdf/draftscope.pdf. (last accessed 22 September 2009).

New York State Department of Environmental Conservation. 2008b. *Landowner's Option Guide*. Albany, NY: NY Department of Environmental Conservation. http://www.dec.ny.gov/energy/1590.html. (last accessed 22 September 2009).

New York State Department of Environmental Conservation. 1992. *Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program.* Albany, NY: NY Department of Environmental Conservation. http://www.dec.ny.gov/energy/45912.html (last accessed 9 February 2010).

New York State Farm Bureau (NYFB). 2008. *Gas And Oil Leasing*. http://www.nyfb.org/Gas&OilLeasing.htm. (last accessed 8 February 2010).

Office of the New York State Comptroller. 2005. *Department Of Environmental Conservation: Lease Of State Land For Gas And Oil Exploration And Production*. Report 2005-S-54. Albany, NY: Office of the Comptroller. http://osc.state.ny.us/audits/allaudits/093007/05s54.pdf. (last accessed 22 September 2009).

Pennsylvania Economy League of Southwestern Pennsylvania. 2008. *The Economic Impact Of The Oil And Gas Industry In Pennsylvania*. http://www.alleghenyconference.org/PEL/PDFs/EconomicImpactOilGasInPA1108.pdf (last accessed 22 September 2009).

Perryman Group. 2008. *Drilling For Dollars: An Assessment Of The Ongoing And Expanding Economic Impact Of Activity In The Barnett Shale On Fort Worth And The Surrounding Area.* http://www.bseec.org/images/summaryreport.pdf. (last accessed 22 September 2009).

Sachs, J.D. and A.M. Warner. 2001. The curse of natural resources. *European Economic Review* 45: 827-838.

Susquehanna River Basin Commission. 2008a. *Comprehensive Plan For The Water Resources Of The Susquehanna River Basin*. http://www.srbc.net/planning/planning/ComprehensivePlanwAppendicesApprovedDec2008FINAL03-24-09edition2.PDF. (last accessed 22 September 2009).

Susquehanna River Basin Commission (SRBC). 2008b. *Marcellus Shale and Natural Gas Well Development*. http://www.srbc.net/programs/projreviewmarcellus.htm. (last accessed 22 September 2009).

Susquehanna River Basin Commission. 2008c. *Notice Of Determination For Natural Gas Well Development Projects.* Harrisburg, PA: Susquehanna River Basin Commission. http://www.srbc.net/programs/docs/RevisedNoticeofDetermination100808.pdf (last accessed 22 September 2009).

Susquehanna River Basin Commission (SRBC). 2007. *Regulation Of Projects. 18 CFR Parts 801, 806, 807, and 808*. Harrisburg, PA: Susquehanna River Basin Commission. http://www.srbc.net/policies/docs/srbc_regulation_of_projects.PDF. (last accessed 22 September 2009).

Swartz, D. 2009. 19-year High: Broome-Tioga Jobless Rate. *Press and Sun-Bulletin (Binghamton, NY)*. 23 January.

Tversky, A. and Kahnemann, D. 1987. Rational Choice and the Framing of Decisions. In Hogarth, R.M. and Reder, M.W. (eds.) *Rational Choice: The Contrast Between Economics and Psychology*. Chicago: University of Chicago Press. Pp. 67-94.

U.S. Bureau of the Census 2008. *State and County Quick Facts*. http://quickfacts.census.gov/qfd/index.html. (last accessed 22 September 2009).

Veil, J.A. 2007. *Trip Report for Field Visit to Fayetteville Shale Gas Wells*. Chicago: Argonne National Laboratory, Department of Energy. http://www.evs.anl.gov/pub/doc/ANL-EVS_R07-4TripReport.pdf (last accessed 98 February 2010).

Ward, K. 2003. *Strengthening the Economic Analysis of Natural Resource Management Projects*. ERD Technical Note No. 7. Manila, Philippines: Asian Development Bank.http://www.adb.org/Documents/ERD/Technical_Notes/tn007.pdf (last accessed 22 September 2009).

Weinstein, B.L. and T.L. Clower. 2009. *Potential economic and fiscal impacts from natural gas production in Broome County, New York.* Preliminary Report for Broome County Legislators. http://www.energyindepth.org/wp-content/uploads/2009/03/broome-county-potential-economic.pdf (last accessed 9 February 2010).

White, D.D. and T.E. Hall 2006. Public Understanding of Science in Pacific Northwest Salmon Recovery Policy. *Society and Natural Resources* 19: 305 – 320.

Wilber, T. 2009a. Natural Gas in Water Wells has N.Y. Officials on Alert. *Press and Sun-Bulletin (Binghamton, NY)*. 25 January.

Wilber, T. 2009b. Owner groups say gas-drilling deals near. *Press & Sun-Bulletin (Binghamton, NY)*. 15 June.

Wilber, T. 2008a. DEC to Discuss Impact of Drilling on Environment. *Press & Sun-Bulletin (Binghamton, NY)*. 17 November.

Wilber, T. 2008b. Johnson City OKs Water Sale to Gas Drillers. *Press and Sun-Bulletin (Binghamton, NY)*. 28 July.

Yakovleva, N. and T. Alabaster 2003. Tri-sector Partnership for Community Development in Mining: A Case Study of the SAPI Foundation and Target Fund in the Republic of Sakha (Yakutia). *Resources Policy*. 29: 83-98.