# Exploring the intersections between local knowledge and environmental regulation: a study of shale gas extraction in Texas and Lancashire

## Abstract

Contemporary shale gas extraction, also known as "fracking", has become one of the most contentious environmental issues facing Europe and North America. The advent of fracking exposes significant tensions for environmental planning and regulatory systems in relation to the scope of unconventional resource extraction. Academic and policy debates have hitherto focused principally on questions related to scientific disputes, risk perception, potential health impacts, and the wider economic and geo-political dimensions to energy security. This paper draws on extensive qualitative research in Texas and Lancashire, undertaken between 2012 and 2015, to explore how differing regulatory frameworks are shaped through highly localized discourses that include communities opposed to fracking. Whilst there are significant differences between these two examples, including the extent of environmental monitoring, the local context remains a pivotal arena within which the regulatory and technical dimensions to fracking are being contested and scrutinized.

## Keywords

Shale gas extraction; fracking; environmental planning; community engagement; local knowledge

## Introduction

Unconventional hydrocarbon extraction, also known as 'fracking', is now one of the most contentious issues facing environmental and planning regulation. It is a stark illustration of the capacity for local communities to contest the role of technical expertise in environmental decision making. Major unconventional gas deposits have been identified in over 40 countries worldwide, exploratory drilling has taken place in Australia, Germany, India, Poland, Romania, and the UK, and commercial extraction is now underway in the US, Canada, and China.[1] As the "shale gas revolution" has spread, however, including the identification of potential new sites in Europe, the political dynamics of fracking have become increasingly contentious and uncertain.

The regulation of fracking in the US and the UK has emerged out of strikingly different institutional, historical, and technical pathways. Yet in both cases there is intense community opposition. Whilst there is a growing literature exploring community mobilization (Briggle, 2015, Willow and Wylie, 2014), less attention has been placed on how local residents also become significant actors in the co-production of locally distinctive regulatory frameworks. This paper argues that an underexplored dimension to the development of shale gas is the role of these localized discourses spanning the industry, regulators, and community groups. We consider how local actors shape regulation on the ground through an examination of two ostensibly different localities: the US state of Texas, and Lancashire in the north-west of England.

Studies of communities opposed to fracking have placed an increasing emphasis on assessing the credibility of public perceptions and their capacity to interpret and act

upon scientific forms of knowledge (Jaspal and Nerlich, 2014; Jaspal *et al*, 2014; Metze, 2014). These accounts draw upon traditional viewpoints that separate "science" from other forms of knowledge, contributing to hierarchies where scientific "experts" are privileged over community or "lay" forms of knowledge. This unhelpful binary implicitly suggests that different actors hold more "objective" forms of knowledge. An emphasis on this lay / expert divide can miss the blurred boundaries between experts and communities, in an attempt to present certain decisions as technical rather than political (see Corburn, 2003, Haughton *et al*, 2015). For Andrew Feenberg (2010) the paucity of democratic deliberation over science and technology marks one of the most critical challenges facing public policy. The limitations of scientific knowledge become underemphasized and are assumed to contain an inherent capacity to anticipate localized impacts or guide future policy deliberations (see Keller, 2009).

Recent research on the US experience has centred on questions related to scientific disputes and risk management. A key focus has been community negotiation over environmental risk and the production of uneven patterns of mitigation and compensation (see Howarth *et al.*, 2011; Jacquet, 2014; Schafft *et al.*, 2013). The multiple challenges presented by the development of the industry span environmental, geological and economic considerations (see, for example, Boersma and Johnson, 2012; Brasier *et al.*, 2013; Davis and Hoffner, 2012). The technological complexities of fracking, along with the relatively rapid expansion of the industry, have presented barriers for communities seeking to influence debates. A related body of research, from a broadly bio-medical or environmental science perspective, has focused on the health and environmental impacts, from an epidemiological and toxicological

perspective (see McKenzie *et al*, 2014; Rabe and Borick, 2013; Spence, 2013). Given the contested nature of community impacts, qualitative studies have started to explore the health and social dimensions upon specific communities utilizing ethnographic insights (see Finewood and Stroup, 2012; Powers *et al*, 2014; Willow, 2014; Willow and Wylie, 2014).

~~These US based studies cannot be replicated within Europe given the limited development of the fracking industry. There are limited experiences to date as the UK industry has struggled to get local approvals for exploration. European regulatory frameworks have been established, partially as a response to perceived failures in the American system and also in response to seismic events in the UK following early test fracking (see Boersma and Johnson, 2012, Cairney *et al*, 2015; Small *et al*, 2014).~~

A particular focus has been on competing "storylines" that are based upon contradictory claims regarding the specific consequences of the industry (see Bomberg, 2015; Cotton *et al*, 2014; Jaspal and Nerlich, 2014; Jaspal *et al*, 2014; Metze, 2014). Within the highly contested terrain of fracking, technical forms of knowledge produced by industry or governmental actors are given greater credence than that produced within communities or activist groups. Community viewpoints cam become cast as unfounded and resistant to scientific and technical forms of knowledge (Metze, 2014). Yet the term "community" should be treated with caution in this context as it encompasses a wide range of opinions and dimensions of knowledge and expertise. Whilst there is unlikely to be consensus on industry impacts, existing studies further sustain expert and lay accounts of knowledge.

Questioning the credibility of public opposition or representing them as "parochial" concerns are familiar arguments that emerge during planning disputes. More sympathetic accounts argue that the stigmatization of residents opposing development as NIMBYs (not in my backyard) can be a superficial means to discredit opposition to development through questioning their motivations (see McClymont and O'Hare, 2008). ~~The geographer~~ The examination of large-scale infrastructure projects by Susan Owens (2004) explores how notions of a "public interest" dominate planning and regulatory systems, particularly in infrastructure decisions. Clashes with local communities can emerge when it is assumed that the rationale for development has gained tacit approval. Similarly, the geographer Karen Bickerstaff's examination of nuclear waste disposal notes that characterizations of communities as obstacles to development fail to account for "how people make sense of risk as well as constructions of place identity and quality of life" (2012, page 2612). Bickerstaff draws on Doreen Massey's conceptualization of the relational dimensions between space and place to show how "publics form around materially and politically complex issues" (2012, page 2614). These perceptions are based not only on media representations, but draw from a multitude of sources including historical planning disputes, and shared community histories.

Yet there is an ongoing routine simplification of knowledge that runs through planning processes. Mhari Aitkin's research examining opposition to wind farms notes that planning arenas such as public inquiries create quasi-judicial processes that privilege expert knowledge presented in support of the state. "The public inquiry," as Aitken notes, "is based on an unrealistic – perhaps idealised – vision of science" (Aitken, 2009, page 62). This can be coupled with a process of "recasting non-

scientists' problems into scientific terms" (Keller, 2009, page 178) thereby favoring these expert participants. These modes of engaging with knowledge overly simplify and ignore the complexities of decision-making through casting community based experts as biased but state approved scientific and technical assessments as neutral. Examinations of UK flooding, for example, note that attempts to create hierarchies of knowledge are dangerous as "dismissing particular forms of knowledge as somehow less reliable or valuable miss out on the insights that come from such sources" (Haughton *et al*, 2015, page 377). Technical expertise also resides within communities and how the state "participates in alliances on the ground" (ibid) may more useful to explore.

The study of unconventional hydrocarbon extraction provides an opportunity to explore emerging alliances as it draws together spatial planning, environmental regulation, and local communities within a nexus of technical expertise. Across the US there are varying regulatory frameworks and it would be misleading to talk about a unified industry given the diversity of individual state practices and the levels of power they hold in contrast to a comparatively highly centralized English regulatory and planning system. Texas in particular has developed a significant history of regulatory expertise of the oil and gas industry, whilst the UK has only limited experience of onshore production with a largely untested regulatory regime (see Small *et al*, 2014; Hilson, 2015).

Shale gas is one of a series of so-called "unconventional hydrocarbons", including tar sands, that are pivotal to the contemporary utilization of nature by the extractive industries. "To transform kerosene-impregnated rock formations and bitumen-filled sands into oilfields," writes the political scientist Timothy Mitchell in relation to tar

sands, "is to acknowledge that what we call nature is a machinated artificial territory in which all kinds of novel claims and political agendas can form" (Mitchell, 2011 page 252). For those living near to shale gas deposits, the newfound viability of fracking has reshaped the relationship between communities and their local environments as they become integrated into new energy landscapes. Feenberg challenges the dominant narrative of science and technology as a single linear trajectory. Rather "technical development is not an arrow seeking its target, but a tree branching out in many directions" (2003, 79).

The commercial potential of fracking was established in Texas during the late 1990s after nearly two decades of industry development in the Barnett Shale although the origins of the technique can be dated back to the early nineteenth century.[2] Whilst the usage of aspects of fracking has a long history, the proprietary mix of chemicals, the scale of water use, and the development of horizontal drilling technologies have radically intensified the extractive process with the life cycle of the industry from raw materials to waste disposal posing new environmental challenges for communities beyond the drilling sites. [3]

This paper is based on qualitative fieldwork conducted between 2012 and 2015 in Lancashire and Texas. The research draws on qualitative interviews and ethnographic insights including attendance at community and industry meetings. A series of twenty-seven semi-structured interviews in Texas (10) and Lancashire (17) were conducted with key individuals involved in the fracking industry, land use planning, environmental regulation, and community mobilization against fracking. For the Lancashire fieldwork the author participated in a series of meetings with a prominent anti-fracking group, attending around one event per month during 2012 and 2013, and

spoke informally with environmental campaigners, local politicians, state officials and representatives of the drilling company and their PR firm. The Texas fieldwork was primarily conducted during the spring and summer of 2014 and included attendance at campaign meetings and visits to the Eagle Ford Shale. The interviews explored the motivations for community opposition to fracking and the scope of public influence at the local and regional level within regulatory and decision-making frameworks. Interviewees discussed their perceptions of the fracking industry, their motivations for opposition (if relevant), any history of environmental activism, and their understanding of the social and environmental impacts of fracking. [4]

We begin with Texas, a state with a long history of oil and gas development where commercial fracking has grown in significance since 2005 (Davis, 2012). Local community opposition is increasing as production intensifies and we examine some of the responses to the regulation of the industry. We then turn to Lancashire, the initial focus of community opposition to fracking in the UK and a region where full commercial extraction has been on pause since May 2011. In the concluding section we reflect on some of the wider conceptual and policy related themes raised by this study of the local impacts of fracking.

## I Texas as centre and model

Texas is the one of the most significant global producers of shale gas along with Pennsylvania, Louisiana, and West Virginia, with three significant reserves located and actively drilled within the state. One of these reserves, the Eagle Ford Shale, is now "the largest single oil and gas development in the world based on capital

expenditures" (IED, 2013). There are over 2,521 oil and gas producing wells and the revenues are estimated in excess of 46 billion USD in total economic impacts for 2012 in the 14 counties where shale gas is being extracted (see figure one) (TRRC, 2015). The Eagle Ford Shale lies directly south of the cities of Austin and San Antonio, covering an area of over 3,000 square miles (7,770 square kilometres ) and spanning a mix of small towns, rural, and semi-rural areas.

Standards of environmental regulation and monitoring vary between US states. The oil and gas industry is regulated by the Texas Railroad Commission (TRRC) including the granting of permits for drilling and operations, and environmental oversight. As mineral rights can be owned by private individuals there is a presumption in favour of development if rights owners so choose although there are important variations.[5] The political scientist Charles Davis notes that "TRRC officials insist that fracking operations are safe, adding the caveat that no documented evidence exists of groundwater contamination in the 60- year history of frack jobs within Texas" (2012, 183). However, there are a number of environmental exclusions from their regulatory remit including road maintenance, noise issues, odor and air contaminants, and surface ownership disputes. The Texas Commission on Environmental Quality (TCEQ) monitors air quality issues and the Texas Department of Transport takes responsibility for road issues. Unlike states such as Colorado, Texas does not require any statutory environmental assessments or wildlife impact assessments (see Davis, 2012).

A significant theme emerging from studies of public perceptions of fracking is that fear or insufficient public knowledge forms the basis for unsubstantiated concerns

(see Jones *et al*, 2013). Such work can overemphasize scientific certainties and the difficulties of predicting or monitoring impacts. A growing body of ethnographic work questions the capacity of the state to monitor and regulate the industry. Declining air quality standards have become an issue across the state, not just within the shale gas fields. A major eight-month study of air quality found that within the 20,000 square miles of the Eagle Ford Shale there were only five permanent air monitors raising concerns about the challenges in gathering adequate environmental data (Morris *et al*, 2014). Texas relies on thousands of the oil and gas sites to audit their own emissions, and to notify the TCEQ in the event of a problem (see Briggle, 2015). The lack of state capacity to monitor environmental effects means that the shale gas industry and the public, including activists have become a vital component of the regulatory process. Even areas such as the city of San Antonio outside the commercial fracking zone have been breaching federal air targets (Buchele, 2014). A San Antonio environmental campaigner, noted that "air does not respect city limits" (Interview, "Vicky", March 2014), thereby highlighting the increasingly complex nexus of environmental impacts spanning different administrative boundaries, land uses, and local communities.

In towns such as Azle, located just north of Fort Worth, local communities have been drawn into significant campaigning activity. Between November 2013 and January 2014 alone, thirty earthquakes have been recorded in a local area that does not have a history of seismic activity. A town meeting was held in Azle by the Texas Railroad Commission in January 2014 to assuage local fears attracted over 800 residents (see CBS, 2014; City of Azle, 2014; USGS, 2013). Seismic activity had not been anticipated by the industry as a consequence of fracking and these localized

earthquake clusters have served to galvanize public concerns (see Frohlich, 2012). As one Texas activist explained:

> The TRRC commission is required to have public meetings and I went in January [2014]. Bus loads of people from Azle were bussed in and came to testify about the earthquakes they've been having from wastewater injections in their town, and it was a little bit of this is for show. So they listened, they had to listen! But it got a ton of media attention and that is good for something
>
> ("Anna", environmental campaigner, interview, March 2014).

The media attention and evidence from the communities was viewed to have positive effects. In the face of public testimony the Texas Railroad Commission appointed a seismologist to investigate the potential relationship between fracking and seismic activity due to the lack of nearby monitoring equipment (USGS, 2013). This study found a probable relationship between the injection of fracking wastewater for disposal and Azle's earthquakes, but has since been disputed by the Commission as unrelated to shale gas activities (Buchele, 2015). The political dynamics of how scientific studies are interpreted remains underexplored as the focus is often based upon disputes over whether studies as "correct" or "incorrect" and are reliant upon a unified vision of science. The contention that fracking is safe underpins the regulatory framework within Texas and elsewhere and is resistant to more complex interpretations of scientific information.

These attempts to keep scientific and technical information outside the realm of community deliberation have only been partially achieved. Even seemingly more mundane aspects of regulation are mediated between the local state, industry, and local communities. Planning and zoning frameworks primarily determine acceptable distances from other land uses (see Fry, 2013). The zoning system coupled with privatized mineral rights creates a seemingly standardized regulatory framework

facilitating shale gas development but managing localized impacts. Looking at local variations between municipalities reveals a different picture. Whilst the TRRC allow drilling within 200 feet (61 meters) from homes, municipalities have the discretion to vary setback sites. An examination of 26 zoning ordinances in Denton, Texas, found that the distances varied between 300 and 1500 feet (about 31 to 457 meters) (Fry, 2013). The rationale for these setbacks included public health concerns as well as visual impact. The ordinances also reflect the varying interest groups that were able to influence public deliberations. These differences do not represent technical negotiations: "Instead setback distances are highly politicized compromises between residents' concerns about the proximity of gas wells to their homes, mineral owners' rights to profit from gas drilling, and the city council's fear of legal lawsuits for a regulatory undertaking" (Fry, 2013, page 87).

~~The US is distinct from the UK (and many other countries) since mineral rights can be privately owned rather than automatically being the possession of the state. Direct payments to mineral rights owners per acre, alongside employment in the industry and economic opportunities for those supporting it, have major impacts on the local economy (see McAllister, 2013). However, benefits are uneven:~~

~~Western [Texas] communities are traditionally some of the poorest. People are impacted differently, some sold [their mineral rights] relatively inexpensively, if they had waited a while they would have got paid a whole lot more ("Paul", Engineering professor, interview, March 2014).Some homeowners may only own surface rights and simply find themselves obliged to allow drilling on their land, as mineral rights take precedence over surface rights. The Railroad Commission's advice is limited in this regard, suggesting that the best strategy for surface rights holders is to ensure they purchase at least a portion of the mineral rights and where~~

~~this is not the case negotiation could be entered into over surface usage and potential damage although there is no legal requirement for the mineral right's holder to do so (Texas Railroad Commission, 2014).~~

Mediating development has been restricted to the immediate vicinity of shale gas wells. However, the expansion of the industry has much wider impacts. Parts of Texas have seen temporary population increases as oil and gas workers receiving relatively higher wages move to the area. Local impacts to the economy are significant:

> The Eagle Ford Shale has put such a strain on services that we've had to move. Going south it was such an influx of all the oil workers coming in, the roads have been a huge issue, housing, finding temporary housing, you hear about people who have lived in the county, schoolteachers leaving rental property
> ("Monica" economic development officer, interview, March 2014).

Local residents talked about how technological developments meant that the industry and associated impacts had intensified during their own lifetime making parts of the state unrecognizable. This landscape is now extensively scattered with well pads, gas and oil storage facilities including condensate tanks, solid and wastewater disposal sites, and pits in fields adjacent to farmland with grazing cows and other livestock. These impacts can only partially be addressed through regulatory practiced focused on each specific shale gas well and not the cumulative spatial impact of technologies. A changing sense of place has become a catalyst for some forms of community opposition.

Critiques of NIMBYism emphasize that development processes often fail to consider peoples' emotional attachment to place sufficiently. Community opposition may be interpreted as a "selfish" desire to halt change but is much more complex with fear

and anxiety having material impacts on peoples' health and well-being. The rural town of Nordheim, located in the Eagle Ford Shale provides such an example. The town has just over 300 residents who have been organizing against a permit application for nearby waste dumps for fracking waste~~. The operator, Pyote, did not have to inform Nordheim's mayor as it is directly outside the city limits and not subject to their zoning ordinances.~~ One long-term Texan resident described the impacts upon her:

> Of course it [the Pyote waste disposal site] worries me… I have a hard time going to sleep, let's put it that way. But who cares? Most of the people feel that they can't do anything and that's why they haven't. They feel defeated from the beginning. They believe that the oil and gas industry rules the TRRC (Texas Railroad Commission)
> ("Rose", local resident, interview, March 2014).

Local residents of Nordheim and campaigners expressed a sense of distrust towards the Texas Railroad Commission's relationship with the industry. Interviewees also referred to a history of the oil and gas industry and "wildcatting" (unregulated drilling). Regulation was not understood not the outcome of top-down state power but described by "Rose", whose family had owned a farm for three generations, as battle between communities, regulators and less responsible industry operators. Two of the interviewees were part of families living in the local area for generations drew upon a more historical and locally situated knowledge of the area and expressed a sense of loss for the landscapes they loved. Their opposition to the waste disposal site was complex but also included a historical knowledge of the specific traits of the location including periods of flooding at the proposed site. This would have damaging consequences to adjacent agricultural land and further sustained a view that the TRRC's limited knowledge of the spatial impacts of their

decisions overlooked the possibilities of hybrid forms of knowledge that integrated community experiences.

The Texan case problematizes the existing literature on community opposition to development for several reasons. Texan resident groups have been important actors in identifying areas of concern in order to monitor, regulate, or challenge the shale gas industry. Their opposition emerge from the lived experiences of environmental change and reveal the limited technical capacity of regulators to anticipate and monitor impacts. These collaborations pose a challenge to interpret community concerns in more nuanced ways. Public engagement has been pivotal in assisting with basic data collection. In parts of the state communities have actively petitioned for technical and scientific studies or been involved in collecting data themselves. Grassroots monitoring and reporting of seismic activity is now actively encouraged by the US Geological Survey. These actions illustrate that complexities of community resistance cannot be understood solely as unsubstantiated opposition and do not not necessarily indicate withdrawal from local regulation. The data on earthquakes, for example, is being actively co-produced within communities and reflect desires to participate in more democratic forms of science and decision-making.

~~Examples from Texas show how different tiers of the state have acted upon public concerns and together they have demonstrated a range of environmental impacts.~~

~~Given the important role of Texas in the development of the oil and gas industry many aspects of fracking represent a local technology developed to suit its specific geologies, engineering expertise, and land rights framework. Although the fracking industry now operates in many states, local assumptions, regulatory procedures,~~

~~technical infrastructures, and geological conditions have been key factors influencing the scale and success of operations. The limited environmental role of the Texas Railroad Commission (TRRC) along with their public commitment to the oil and gas industry have created favourable conditions for industry development. However,~~

## II Lancashire as experimental field

The county of Lancashire in north west England has been at the forefront of European attempts to develop a viable shale gas industry. Onshore oil extraction in the UK has been in production since the 1973 discovery of the Wytch Farm oil basin, the largest onshore oil field in Europe (BGS and DCLG, 2011). However, the UK industry has limited experience of onshore gas exploration. The nascent location of the industry means that it has more impact upon residential areas than many parts of the USA, as the principal shale deposits are located beneath inhabited areas and near to major conurbations (Hilson, 2015).

~~The UK state apparatus is highly centralized, most recently the Conservative-led coalition government abolished regional tiers of government in 2010 (see Sandford, 2013).~~[6] UK Regulation involves national and local tiers of government and a number of agencies including environmental regulation through the Environment Agency, a non-departmental publicly funded body (see House of Commons, 2006). These bodies are all critically important but the main focus of public interaction is the local state. Lancashire County Council, the local planning authority for minerals, convenes a planning committee composed of locally elected politicians to decide upon applications for well pads in the area.

Since 2009 the Staffordshire based Anglo-American-Australian fracking company Cuadrilla have applied for planning permission to drill on sites in the region encompassed by a Petroleum Exploration Development Licence. This covers an area of approximately 436 square miles (1130 square kilometres) in Lancashire's Bowland-Hodder Shale, extending west of Preston to as far north as Blackpool (see figure 2). Cuadrilla claim that this shale deposit potentially contains 125 trillion cubic feet of shale gas, making it by far the UK's most significant unconventional gas reserve based on the British Geological Survey's calculations (Andrews, 2013).[6]

Sites spanning the Ribble estuary in Lancashire have been identified by Cuadrilla for exploratory drilling catalyzing local opposition to each site in turn. Banks, a small settlement located in a semi-rural area some forty miles north-west of Manchester and 25 miles north of Liverpool has been a centre for opposition. The first local group was started by "ten local residents meeting one evening" ("Irene", Interview, September 2012). Erroneously dismissed as "the desolate north east" in a UK Parliament debate on fracking, this region is in fact densely populated.[7] The area supports a significant population who travel daily from this rural location to employment in major urban centres, it has a well-established market gardening industry, and there are numerous farms supplying major retailers. The Ribble Estuary National Nature Reserve is managed by Natural England (the statutory agency responsible for the natural environment).

The development of the shale gas industry came as a surprise to many local residents with several recounting the first glimpse of the industry when they "looked out of a window" and saw well pads being constructed in an agricultural field ("James",

Interview, September 2012). From the outset interviewees referred to numerous occasions they had tried to find out information from Lancashire County Council or their local politicians with limited success. The lack of perceived transparency set a context within which activism started to emerge, not least as an attempt to check the perceived pro-industry approach of the UK government. Communities started to question the political context in which these decisions were being discussed. Whilst the local politicians ultimately rejected latter applications for exploratory drilling, this was against the strong advice of officers. These decisions have now been called in by central government. These disputes within the local state itself reveal further problems in creating an expert / lay binary between the state and communities. The difficulties of understanding the potential impacts of shale gas within Lancashire extended across the industry, the local state, and community groups. The local planning officers instead of engaging with uncertainties were seen as highly defensive by interviewees.

> When DECC [Department of Energy and Climate Change] issues PEDL [Petroleum Exploration Development licence] licences in 2008 no-one in the UK knew what fracking was [We had] no concept of tonnes of chemicals and millions of gallons of freshwater at very high pressures generated by diesel. Even the local authority didn't see a need for environmental oversight
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> ("Margaret", local resident, interview, July 2012).

~~The early stages of the process was described as a learning process for all actors. A lack of understanding of the implications of a commercial industry spanned public perceptions, the emergent shale gas industry itself, and different tiers of government with increasing efforts being made to improve nascent regulations.~~

These residents did not consider themselves to be environmental campaigners from the start. Instead, most of the interviewees had wanted further information about the fracking process following Cuadrilla's local planning applications. The local planning

authority's approach can be understood be a contributing factor in increasing local opposition. The chair of a more recently established resident's group who had no history of environmental activism said:

> We've gone from not really knowing what fracking was then wanting to know more about it, to wanting to find out about it. Not being anti-fracking initially then realising what fracking would do to our community and being very angry about it and then realising the wider implications from climate change and what this is going to do to the UK.
>
> ("Jules", local resident, interview, January 2015)

The local planning authority appeared to adopt a top-down view of shale gas extraction as manageable within existing forms of regulation. They gave far greater weight to the commercial operator's usage of technical and scientific information than to community viewpoints and experts particularly at latter stages of the planning process. Scientific and technical knowledge, rather than a basis for deliberative discussion, became a means of marginalizing community concerns. These processes raised critical questions about the capacity of the local planning system to adequately mediate between realms of expertise and differing forms of knowledge.

Opposition mobilized significantly following early test drills and fracks at Preese Hall, Blackpool. Cuadrilla's use of hydraulic fracturing at this site created wider public attention when test drilling and a series of six fracks triggered two seismic events and compromised well integrity, leading to a moratorium on exploration from the end of May 2011 until mid December 2012 (Green *et al*. 2012). Further complexities later emerged as the UK Environment Agency permitted disposal of waste water from the first exploratory fracks into the Manchester Ship Canal contrary to US industry best practice (BBC, 2014; Rodriguez and Soeder, 2015). Following this the UK government commissioned the Royal Society (2012) to report on the

seismic events and make a series of recommendations to strengthen industry regulation. The report strengthened consensus between the state and regulators and was used as a mechanism to try and increase public confidence. Yet such statements did little to allay the fears of many local residents in Lancashire and raised concerns regarding the viability of living and working in the area if the industry expanded.[8] Attending local resident meetings it was clear that the inability to anticipate these small earthquakes had increased mistrust in Cuadrilla and industry regulation. These events formed part of an evolving community narrative that further disputed that scientific expertise lay with the state or the industry given the chain of events.

The local planning process rather than mediating a debate to incorporate an increasingly engaged public, retreated into a technical process that valorized highly technical presentations of information as a mechanism to overcome local concerns. Instead further opposition was catalyzed. Cuadrilla's planning applications reveal a wealth of technical information spanning engineering, environmental, noise abatement, traffic flows, and wildlife issues. There are glaring asymmetries in the resources available to prepare systematic forms of evidence for communities opposing fracking. The production of evidence to support the industry case ran into thousands of pages and planning committee meetings took place over several days. The total number of representations, primarily objections to the most recent two sites is estimated at 30,000, and constitute the largest number of public comments ever received for a Lancashire planning application (The Blackpool Gazette, 2015).

Local resident groups started to offer presentations to the public as well as different tiers of local government based on interpretations of varying forms of evidence. They

started to look further afield to local residents' accounts in Texas and Pennsylvania becoming concerned about a range of environmental issues such as groundwater contamination, traffic, and noise. Through seeking to incorporate situated accounts within the debate, local communities problematized the expert / lay divide, working to develop hybrid forms of knowledge. Making connections to other communities was an important means to try and understand the daily consequences of development, and these fine grained accounts are often overlooked within technical assessments that attempt to generalize local impacts, underestimating their cumulative effects upon quality of life (see Corburn, 2003).

~~There are also consequences for communities when they express fears that may later go on to be disputed. Ongoing US studies show that fracking is unlikely to cause earthquakes but disposal of wastewater probably does. Nonetheless, because these fears were an early focus of opposition they contributed to a discourse that is sceptical of local communities fears as lacking credibility, underemphasizing the continually developing understanding of the industry (see Bomberg, 2015).~~

~~The UK government lifted the moratorium on fracking in December 2012 following political pressure (DECC, 2014).~~[10]

As in the case of Texas, communities were concerned about the pro-industry stance of government and regulators. Residents talked about Lancashire County Council as being under intense pressure to allow fracking to go ahead. The idea of public interest or energy security was disputed by interviewees who saw the industry as being "forced" upon them.[9] The uncertainties raised through the necessity of seismic monitoring itself has negative consequences for some local residents. The mere

presence of this equipment, for example, has the potential to depress land values as well as foster community anxieties. As one Lancashire campaigner explained:

> We had a lot of meetings [but] the National Farmers Union and growers are very cautious because if there is a loss of confidence in the area then [it is] worth millions [of pounds] to them
>
> ("Ivan", local campaigner, interview, April, 2012).

Some examinations of public participation suggest that planners see themselves as representing a silent consensus in the face of "NIMBYs" who form a vocal minority (Bell et al, 2005, Clifford, 2013). In this case a number of agricultural and tourist kept silent because images of a rural and safe environment underpinned their continuing success.

An "idealized" view of science dominated the public consultation process. Technical and scientific questions raised by local residents became discounted as the planning applications were considered and officials saw only their "experts" as reliable in contrast to independent scientists who worked with communities. An interesting divergence with other research is that communities neither started to internalize the local state's construction of expert forms of knowledge nor sought to present their claims only through the prism of local knowledge (Aitken, 2009; Haughton *et al*, 2015). The residents attempted to integrate an expanded definition of expertise or hybrid knowledge including the lived experiences of communities in the US. Whilst some concerns were discounted, objections regarding traffic, noise, and other local impacts played a large part in informing the decision-makers to reject later well-pad sites. Scientific knowledge is pivotal to developing new technologies but the narrow focus of the planning process obscures the uncertain and locally specific conditions of operation and development. The anxieties and fears of communities were seen as

extraneous to outside experts supporting development. The possibilities of co-constructing knowledge between the different interest groups remained unrealized.

Political dimensions of the debate have become subjugated to a technical planning process unable to consider critical dimensions of the debate. ~~They are less willing to engage with them on more scientific or technical issues.~~ The planning process itself has now become challenged as an inadequate mechanism to assess the potential impacts of a British shale gas industry. The emergence of nearly 200 local groups opposed to fracking within the UK points to discontent with the current planning system as insufficiently equipped to mediate different spheres of knowledge.

~~Although the UK government and industry suggest that they will learn from the US experience, the different geological, institutional, and regulatory context poses uncertainties beyond the current scope of scientific knowledge. Whilst communities have sought to raise objections through the planning process, the lack of discretion exercised by the local planning authority constrains the possibility of local residents making a greater contribution to energy debates. State regulators engage with communities when they focus on specific local environmental disturbances such as noise from overnight works or truck movements, or the visual amenity of the area. Lancashire County Council do not have the jurisdiction to ban fracking in any area or to consider opposition to fracking activities *per se* or the climate change implications (DCLG, 2013, 2014). Whilst a regulatory framework is emerging there is limited consideration of reducing local impacts. This reflects the ambiguity between the impacts of exploratory drilling and the future consequences of full commercial production.~~

## Conclusions

The production of knowledge in relation to hydrocarbon extraction has developed through technical and scientific advances that are embedded within distinctive local experiences and how different facets of community mobilization. "Energy" in this context is not a compliant entity to be extracted but requires a medley of different technologies and institutional structures to enable its material utilization. The utilization of shale gas is not pre-determined but a contested field spanning industry, the state, and a plethora of environmental organizations. Technological and scientific dimensions of regulation cannot be meaningfully confined to a sphere outside community engagement (see Cowell and Lennon, 2014; Keller, 2009). The cases illustrate that knowledge is not solely captured through top down regulation but within the interactions between communities, state agencies, and industry operators. Without a more fruitful engagement with the politicized nature of technology it becomes difficult for local communities concerns to be registered as useful contributions to the shale gas debate.

~~In the case of fracking, uncertainties prevail at every level from geological data to locally experienced anxieties. Estimates of shale gas reserves, for example, vary widely with the British Geological Survey estimates using less accurate methodologies than the US Geological survey due to lack of well production data (see Andrews, 2013). Between 20 and 40 wells will have to be test "fracked" in the UK order to assess commercial production and thus requires political action to facilitate further technical data (see Erbach, 2014).~~

The UK government's political rhetoric has suggested that fracking relies on the simple transference of technological innovation. Yet the idea of "transplanting" an industry involves far more than the movement of objects such as drilling rigs or the routine application of existing technical knowledge but extends to wider implications for institutions, regulatory practices, and the social and political dynamics of local communities. The collective experiences of seismic activity, whether in Azle or Blackpool, demonstrate how communities have been pivotal in directing further research into the effects of the industry. Regulation has been shown to be a much more complex set of processes mediated through localized discourses.

Statutory environmental and planning regulation is situated within a nexus of private commercial interests, political imperatives, and local concerns. The ways in which knowledge becomes transformed through these processes provide an important focus for understanding tensions creating by shale gas extraction. The study of shale gas extraction requires a more nuanced understanding of how specific forms of technical and scientific knowledge are generated, interpreted, and applied across different spatial contexts. Whilst scientific knowledge exists within political and social situations the response to the highly politicized fracking debate is often recourse to further scientific studies to resolve disputes. These are framed as processes that may verify or disprove community concerns rather than substantively engage with the inevitable impacts upon places. Communities' interests become framed as parochial as they are pitted against more abstract ideas of "energy security" that presume a knowable public interest is formulated at national tiers of government.

Fracking is not merely the application of technical expertise but extends to the discretion and power of regulators, the reach of environmental monitoring, and the capacity for community action. In Texas, communities experiencing the impact of fracking have revealed the limited scientific resources in place to measure impacts of seismicity or air quality. There are critical gaps in the evidence base upon which technical decisions are based. We are now witnessing new forms of direct engagement in Texas spurred by the unanticipated environmental impacts of the industry. Similarly, in Lancashire, community concerns have spilled over into wider debates that cannot be contained within existing planning processes. The development of a British anti-fracking movement demonstrates, in part, a dissatisfaction with the limitations of current regulatory processes that held within the confines of traditional notions of expertise and not open to wider public engagement.

The scaling up from local to global concerns challenges notions that resident based groups are solely concerned with their locality and unselectively utilize issues to object to the shale gas industry (see Bomberg, 2015). Such opposition creates risks for communities who become labelled as promoting "bad" forms of participation (McClymont and O'Hare, 2008). The conceptual helpfulness of seeing certain forms of participation as unwelcome is increasingly disputed. Further exploration of the underpinning motivations for community resistance shows how planning decisions insufficiently engages with the complexities of place (Devine-Wright, 2013) and fail to explore the deficiencies of a democratic process that rely on outmoded models of scientific knowledge (Feenberg, 2010).

Yet it is the local arena within which some of the most effective forms of public scrutiny of this industry have emerged. Whilst communities cannot command the resources of regulatory authorities or industry, they are not naïve groups blindly reacting to "objective" technical or scientific knowledge. For the affected residents in both Texas and Lancashire, these emerging dynamics of community mobilization now form part of an expanding network of activism and environmentalism in the face of new global patterns of resource extraction. Rather than simplifying narratives of community opposition there are opportunities to reflect on how space is being created for new forms of participation and deliberation.

~~The evidence from the US indicates that the regulatory and environmental challenges will more directly affect communities if fracking is extended to more densely populated regions such as Lancashire in the UK.~~

~~The experience of fracking highlights the limitations to public deliberation over technical data in scenarios where environmental regulation is highly politicized. In particular, the regulatory implications of a highly dispersed extractive industry, utilizing a range of new techniques and technologies, raise new challenges for those communities living with the impacts.~~

**Notes**

1. The US Environmental Information Agency (2013) *"Technical recoverable shale oil and shale gas resources: An assessment of 137 shale formations in 41 countries outside the United States"* estimates the largest unproved shale gas recoverable resources outside the US lie in France, Poland, the Former Soviet Union, Mexico, China Algeria and South Africa. Technological developments in oil and gas extraction, particularly since the late 1990s, have revived the onshore oil industry across parts of North America, contributing towards an economic boom in some states, and leading to a significant reduction in energy prices. Factors that contribute to the reduction in US consumer energy prices include the difficulties in exporting shale gas. Considerable efforts are now being made to construct liquefaction plants for export with the aim of increasing profits (see Stevens, 2010). However, there is instability in the shale gas market and variation in pricing. See Hilaire *et a*l (2015) for a more detailed analysis

2. We can trace its roots back far further with some dating it back to gunpower experiments in the mid 19th century or the 1947 "Hydrafrac" in Kansas (see Morton, 2013). The term "fracking" encompasses exploration for a range of hydrocarbon resources including so called "wet' and "dry" gas and to a more limited extent oil (see Glass, 2011).

3. The process referred to as fracking seeks to release gas trapped in shale rocks through micro-scale shattering or "fracturing" of rock formations, but this is only one part of the extraction process. Key technical dimensions involve drilling a series of horizontal wells at depth from a principal vertical well and the stimulation of gas release through the application of millions of gallons of water at high pressure. The water used in the process is mixed not only with sand—to forcibly hold rock fissures open —but also some 500 different chemical compounds to further intensify extraction and boost levels of profitability. Gas (and oil) is returned to the surface along with large quantities of wastewater containing fracking fluids whilst the remaining water is trapped underground (see Finewood and Stroup, 2012; Howarth *et al*, 2011; Jacquet, 2014). In the US, the exact composition of the fracturing fluids used by different companies varies depending on specific geological conditions but the precise identity of these added chemical components enjoys commercial confidentiality since the so-called "Halliburton loophole", enacted by the US federal government in 2005, to exempt fracking from federal regulation (see EPA, 2014). The legislation excludes "the underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities'' from regulatory oversight on the grounds of commercial confidentiality for private operators (Environmental Protection Agency, 2014, "*Regulation of hydraulic fracturing under the Safe Water Drinking Act"*). However, a number of producers disclose the chemical makeup of fracking fluids. The "Fracfocus" website gathers a registry of chemicals and an extensive list of companies provide this information under regulation or voluntarily (www.fracfocus.org). The key factor underpinning the commercial viability of fracking has been rising energy prices from conventional fuel sources. Although individual wells cost between 4 and 10 million USD, and experience a typical fall in production of over 80% within three years, the relative costs of different energy sources have recently enabled fracking to become highly profitable across parts of the

USA (see Oxburgh, 2014). Since the early 2000s the industry has grown significantly in Texas, West Virginia, North Dakota, Wyoming, and Pennsylvania, with commercial interest now extending to Colorado, Illinois, Michigan, and several other states.

4. Interviews were transcribed by the author and coded for key themes including effectiveness of regulation, personal motivations for opposition, and perceived impacts of fracking. Pseudonyms are used for interviewees throughout the paper.

5. US mineral rights are complex and differ from many other countries such as the UK. US mineral rights can be privately owned. Mineral and surface rights can be "severed" meaning that a homeowner may not own the subsurface. Federal government and government agencies can also own mineral rights. See Rahm D (2011) for more detail on Texas.

6. Cuadrilla were granted their first onshore PEDL licence during the 13th Onshore Licensing Round concluded in May 2008. A total of 93 licences were granted to 54 companies (Deloitte, 2008).

7. Lord Howell referred to the "desolate North East" during a UK House of Lords debate on fracking. He later clarified he was thinking of the Lancashire coast in the North West, which he goes on to describe as ideal for fracking since "we want the derricks for fracking to be far away from residences in unloved areas that are not environmentally sensitive." He further noted that affluent West Sussex is an "odd" place to consider fracking. "Lord Howell interview: the irony is that I go to the North East a lot" The Daily Telegraph, 31 July 2013, available at http://www.telegraph.co.uk/earth/energy/10215177/Lord-Howell-interview-The-irony-is-that-I-go-to-the-North-East-a-lot.html

8. Various recommendations made in the wake of the seismic events including a detailed traffic light monitoring system where seismic arrays will closely monitor any induced seismicity and shut down operations over a certain level of seismic activity attest to detailed planning to facilitate full commercial production. Further controversy has emerged following a Freedom of Information request showing close relationships between industry and regulators in supporting shale gas development. See DECC (2014).

9. A Freedom of Information request showed that George Osborne, Chancellor of the Exchequer was involved in efforts to "fast-track" fracking including offering central government support to the Lancashire County Council. See Guardian, 26 January 2015 "George Osborne urges ministers to fast-track fracking measures in leaked letter.

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