



**M4ShaleGas - Measuring, monitoring, mitigating and managing the
environmental impact of shale gas**

**PUBLIC PERCEPTIONS OF SHALE GAS OPERATIONS IN THE USA AND
CANADA – A REVIEW OF EVIDENCE**

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Public introduction

M4ShaleGas stands for *Measuring, monitoring, mitigating and managing the environmental impact of shale gas* and is funded by the *European Union's Horizon 2020 Research and Innovation Programme*. The main goal of the M4ShaleGas project is to study and evaluate potential risks and impacts of shale gas exploration and exploitation. The focus lies on four main areas of potential impact: the subsurface, the surface, the atmosphere, and social impacts.

The European Commission's Energy Roadmap 2050 identifies gas as a critical fuel for the transformation of the energy system in the direction of lower CO₂ emissions and more renewable energy. Shale gas may contribute to this transformation.

Shale gas is – by definition – a natural gas found trapped in shale, a fine grained sedimentary rock composed of mud. There are several concerns related to shale gas exploration and production, many of them being associated with hydraulic fracturing operations that are performed to stimulate gas flow in the shales. Potential risks and concerns include for example the fate of chemical compounds in the used hydraulic fracturing and drilling fluids and their potential impact on shallow ground water. The fracturing process may also induce small magnitude earthquakes. There is also an ongoing debate on greenhouse gas emissions of shale gas (CO₂ and methane) and its energy efficiency compared to other energy sources. There is a strong need for a better European knowledge base on shale gas operations and their environmental impacts particularly, if shale gas shall play a role in Europe's energy mix in the coming decennia. M4ShaleGas' main goal is to build such a knowledge base, including an inventory of best practices that minimise risks and impacts of shale gas exploration and production in Europe, as well as best practices for public engagement.

The M4ShaleGas project is carried out by 18 European research institutions and is coordinated by TNO- Netherlands Organization for Applied Scientific Research.

Executive Report Summary

We can learn much that will help to anticipate the emergence of public representations of shale gas in Europe by reviewing what has already occurred in North America where shale operations are more established. This report summarises findings of a systematic review of 55 research articles from 2009 until 2015, investigating public perceptions of shale gas / oil extraction via hydraulic fracturing ('fracking') in the USA and Canada.

The studies report mixed levels of awareness of shale operations, tending towards higher awareness in areas with existing development. Whilst individuals tend to have negative associations with the term 'fracking', public views are mixed as to whether benefits outweigh the risks or vice versa; indeed, perceptions appear more nuanced than a simple weighing up of gains and losses. Perceived benefits tend to be economic (e.g. job creation, boosts to local economies), while perceived risks tend to be environmental and/or social (e.g. impacts on water, increased traffic). A number of papers point to ethical issues (e.g. risk/benefit distribution, procedural justice and impacts upon quality of life), but reported levels of activism amongst the general public tend to be low thus far. Indeed, levels of support/opposition vary across regions, and also between studies. Views on regulation also vary geographically, but there is widespread distrust of the responsible parties (particularly industry and government), stemming from perceived unfairness, heavy-handed corporate tactics, and a lack of transparency.

A mix of approaches was used in the papers we reviewed, with a focus on quantitative surveys and qualitative interviews. The most commonly occurring themes were awareness, risk/benefit perceptions and acceptability; less widespread but of interest were accounts of citizen protest and activism, perceptions of regulation, and comparisons with other energy options. Most of the research focused on the US rather than Canada, with a strong focus on the Marcellus shale formation.



TABLE OF CONTENTS

	Page
1 INTRODUCTION	2
1.1 Context of M4ShaleGas	2
1.2 Aims and objectives for this report.....	2
2 REVIEW METHODOLOGY	5
3 FINDINGS	15
3.1 Awareness and knowledge of hydraulic fracturing for shale gas and oil.....	15
3.1.1 Extent of awareness and knowledge.....	15
3.1.2 Nature of awareness and knowledge	15
3.1.3 Sources of awareness and knowledge.....	16
3.2 Risk and benefit perceptions	16
3.2.1 Benefit perceptions	16
3.2.2 Risk perceptions.....	17
3.2.3 Weighing up the risks and benefits.....	18
3.2.4 Influences on risk and benefit perceptions	19
3.3 Attitudes towards hydraulic fracturing for shale gas and oil.....	20
3.3.1 <i>Level</i> of and <i>variation</i> in support / opposition.....	20
3.3.2 Factors affecting degree of support / opposition	21
3.4 Associations with hydraulic fracturing for shale gas and oil	23
3.4.1 Attitudinal associations.....	23
3.4.2 Agency.....	23
3.5 Protest and activism.....	24
3.5.1 Who the activists are.....	24
3.5.2 What activism entails.....	24
3.5.3 Factors explaining propensity to engage in activism.....	24
3.6 Regulation.....	25
3.7 Ethics	25
3.7.1 Distribution of benefits and harms	25
3.7.2 Processes by which decisions are made.....	26
3.7.3 Changes in community character and place attachment.....	26
3.8 Public perceptions of other actors, institutions and organisations.....	26
3.8.1 Industry	27
3.8.2 Government	27
3.8.3 Scientists and experts.....	28
3.8.4 Environmental groups and the media	28
3.9 Comparisons with other energy options	29
3.9.1 Comparisons with renewables	29
3.9.2 Comparisons with other fossil fuels	29
3.9.3 Comparisons between conventional and unconventional fossil fuels	30
4 CONCLUSIONS	31
5 REFERENCES	33



1 INTRODUCTION

1.1 Context of M4ShaleGas

Shale gas source rocks are widely distributed around the world and many countries have now started to investigate their shale gas potential. Some argue that shale gas has already proved to be a game changer in the U.S. energy market (EIA 2015¹). The European Commission's Energy Roadmap 2050 identifies gas as a critical energy source for the transformation of the energy system to a system with lower CO₂ emissions that combines gas with increasing contributions of renewable energy and increasing energy efficiency. It may be argued that in Europe, natural gas replacing coal and oil will contribute to emissions reduction on the short and medium terms.

There are, however, several concerns related to shale gas exploration and production, many of them being associated with the process of hydraulic fracturing. There is also a debate on the greenhouse gas emissions of shale gas (CO₂ and methane) and its energy return on investment compared to other energy sources. Questions are raised about the specific environmental footprint of shale gas in Europe as a whole as well as in individual Member States. Shale gas basins are unevenly distributed among the European Member States and are not restricted within national borders, which makes close cooperation between the involved Member States essential. There is relatively little knowledge on the footprint in regions with a variety of geological and geopolitical settings as are present in Europe. Concerns and risks are clustered in the following four areas: subsurface, surface, atmosphere and society. As the European continent is densely populated, it is most certainly of vital importance to understand public perceptions of shale gas and for European publics to be fully engaged in the debate about its potential development.

Accordingly, Europe has a strong need for a comprehensive knowledge base on potential environmental, societal and economic consequences of shale gas exploration and exploitation. Knowledge needs to be science-based, needs to be developed by research institutes with a strong track record in shale gas studies, and needs to cover the different attitudes and approaches to shale gas exploration and exploitation in Europe. The M4ShaleGas project is seeking to provide such a scientific knowledge base, integrating the scientific outcome of 18 research institutes across Europe. It addresses the issues raised in the Horizon 2020 call LCE 16 – 2014 on *Understanding, preventing and mitigating the potential environmental risks and impacts of shale gas exploration and exploitation*.

1.2 Aims and objectives for this report

Fiorino (1990) characterised three rationales for societal dialogue about the risks posed by novel technologies: normative, instrumental and substantive. The normative argument states that dialogue is a good thing in and of itself, and as Pidgeon (1998) points out, this is one part

¹ EIA (2015). Annual Energy Outlook 2015 with projections to 2040. U.S. Energy Information Administration (www.eia.gov).



of democratic processes for making controversial decisions. The instrumental argument is that dialogue increases the legitimacy of decisions and thus improves confidence in risk decisions. Third, the substantive argument is that dialogue will help to generate better quality outcomes and decisions; that some aspects of lay risk judgments are as sound (or more so) than expert risk judgments, and that local knowledge can add a valuable layer to risk understandings (see also Irwin and Wynne, 1996).

Public perceptions of energy technologies have been a topic of significant academic and policy research in Europe and North America for over 30 years (Freudenburg and Rosa 1984; Keeney et al., 1990; Wynne 1982). That work has investigated in detail public attitudes towards issues such as nuclear power and radioactive waste storage, renewable energy proposals such as marine and onshore wind, the use of fossil fuels with carbon capture and storage, and latterly of shale gas production. Such research is stimulated both by a desire to gain fundamental knowledge about the social and individual processes that underlie public discourses and views, and also the hope that such knowledge can better the debate within society about what choices and options might eventually lead to more environmentally sustainable and publicly acceptable future energy systems. We know for example from the previous work on perceptions of energy and other controversial technologies, that people's attitudes to environmental and technological risks involve a range of concerns and value-based questions that go beyond the formal measurement of risk (e.g. Mastop et al., 2015). These include the perceived risks and benefits, individuals' cultural values, spontaneous associations and 'affect', and levels of trust in risk regulation (Pidgeon et al, 1992; Slovic, 1993). Indeed, the emergence of intense local risk controversies are rarely, if ever, solely about 'risk' alone, but also involve a range of dynamic social and political issues that can pose severe threats to locally valued places and identities, and serve in turn to amplify existing risk perceptions (Henwood and Pidgeon, 2014; Pidgeon et al. 2003). In this sense, the extant risk perception literature provides some insight into the question of how various publics are responding to a controversial risk topic such as shale gas extraction.

As readily recoverable reserves of European conventional gas (e.g. in the North Sea) decline, and concern grows about growing dependency upon imports of gas for energy security, government policy in a number of European nations is looking for new ('unconventional') sources of fossil fuel energy. In this socio-political context, some argue that shale gas could be one way to reduce future dependency on imported gas. On the other hand, climate scientists forecast that we face a significant risk of breaching a four-degree centigrade global temperature rise by the end of this century if we do not make radical moves to curtail burning of fossil fuels, and reduce our own per capita use of energy (Jordan et al., 2014). More localised concerns relate to potential risks of water contamination and consumption and induced seismicity (McGarr et al., 2015; The Royal Society and The Royal Academy of Engineering, 2012), as well as social impacts such as stress and other health effects (Ferrari et al. 2013; Jacquet and Stedman 2014; HEI, 2015).

We can learn much that will help us to anticipate the emergence of public representations of shale gas in Europe by reviewing what has already occurred in the USA and Canada. North America provides an important model for Europe because of the many similarities in fossil fuel supply technologies and energy systems currently deployed, and the pressures to develop



reserves of shale gas in both regions. A further key consideration is the fact that in many US states and some Canadian provinces unconventional gas and oil development, and associated hydraulic fracturing techniques, have already been deployed for as long as 20 years –in effect shale gas extraction is a downstream, mature technology in parts of North America. In many cases that has led to full-scale extraction taking place (e.g. Pennsylvania, Michigan, Texas). In others, proposals have been surrounded by significant environmental and legal controversy about the risks and benefits of hydraulic fracturing, which in some cases has led to local, regional or state-wide moratoria on its use (e.g. Quebec, New York). This already suggests that the future for shale gas extraction in European countries may well hinge upon the key question of local public acceptability.

There are of course many entirely legitimate reasons why local communities or individuals might deem shale gas extraction problematic. There may be well founded worries that promises of post-development environmental restoration will be unrealised, or that initial small developments will lead to more locally damaging expansion of industry later on. Work on attitudes about renewable energy also shows that an important concern is the protection of valued landscapes (Devine-Wright and Howes, 2010; Pidgeon and Demski, 2012). In some circumstances major energy developments can even threaten local community identities and cohesion, which in turn generates intense opposition. Above all, distrust of large outside companies or government agencies will always mean that their actions and statements will be closely scrutinised by local communities, as will arrangements for regulation and risk management. Focusing only on communicating the concepts of environmental ‘risk’ – in terms of probabilities and damage estimates – is therefore unlikely to address people’s actual concerns about shale gas extraction and the many potential impacts, uncertainties and questions that it will raise for local communities. Public engagement must therefore aim for a genuine dialogue with potentially affected public(s), and one that aims to build trust.

The literature reviewed here is about a shale gas industry that expanded rapidly in the last decade (EIA, 2015). This period of boom has been followed by a recent decline in activity in some areas due to falling oil prices in 2015 (EIA, 2015; IEA, 2015). Alongside this, there is growing evidence of negative environmental impacts such as water contamination (Warner et al., 2013) and seismicity associated with waste water injection (Frohlich, 2012; Ellsworth, 2013). In line with these more recent developments, we can expect attitudes to be changing, and more recent studies -including those *currently* being conducted- may reflect an environment of more negative evidence.

This report has been assembled by a team of risk perception specialists from the Cardiff University Understanding Risk Group at its School of Psychology, and from the Center for Nanotechnology in Society at the University of California at Santa Barbara (UCSB). It provides a very first systematic evaluation of the available studies describing public perceptions of shale gas/oil extraction and ‘fracking’ in the US and Canada. We begin by outlining the methods used for this review (Chapter 2), before discussing its findings, organised into nine key themes (Chapter 3), and concluding in Chapter 4.



2 REVIEW METHODOLOGY

Two methods were used to select articles for this literature review. The first involved tracking the literature using various news websites, academic feeds and website ‘search alerts’ during the 18 months leading up to the review. The second was to carry out a systematic search for terms such as ‘hydraulic fracturing’, ‘fracking’, ‘shale’, ‘energy and public opinion’ and ‘drilling and public opinion’ using Google Scholar and UCSB Social Science Database, which includes all major English language social science journals. We also searched for specific authors whom we were aware had been active in the field. In this review, we include reports written in English only. One Canadian report (Fortin and Fournis, 2013) was excluded from the review because it was only available in French, which left a total number of 55 articles (Table 1). We primarily focus on peer reviewed academic literature, but also include relevant reports from think tanks, NGOs, governmental departments and universities.

Once the articles had been selected, we entered their details (e.g. title, methods, sample, energy medium, key variables) into an Excel spreadsheet. Based on our initial reading of these articles and those relating to wider energy perceptions literature, we developed nine themes, including: awareness/knowledge, attitudes, risk/benefit perceptions, and regulation. The articles were then examined for the details of how these themes manifested, and their findings entered into the table. Other topics outside of the pre-assigned themes were also recorded. Finally, we synthesised the findings to form the basis of our discussion below.

Throughout the review we use the term ‘shale operations’ as short hand to describe the process of extracting shale gas and/or oil via hydraulic fracturing, encompassing the range of terms used to describe the issue (from ‘shale gas development’ to ‘fracking’). As shown in Table 1, we use the term ‘public’ broadly, and the review includes the perceptions of other stakeholders such as landowners, educators and government officials. It is worth noting however that most of the articles use broader ‘lay’ publics as their samples.



Table 1: Literature reviewed.

AUTHOR	YEAR	TITLE	JOURNAL / SOURCE	LOCATION	METHOD / SAMPLE
Anderson and Theodori	2009	Local leaders' perceptions of energy development in the Barnett shale	Southern Rural Sociology <i>Refereed journal</i>	USA (Texas)	In person interviews with government officials and key informants (N=24)
Baldassare et al.	2014	Californians and the Environment	PPIC (Public policy institute of California) <i>Think Tank Report</i>	USA (California)	Telephone survey of adult residents throughout California (N=1,705)
Borick et al.	2014	Public Perceptions of Shale Gas Extraction and Hydraulic Fracturing in New York and Pennsylvania	CLOSUP (Center for Local, State, and Urban Policy) at University of Michigan <i>University Research Center Report</i>	USA (New York and Pennsylvania)	Telephone survey of New York (N=405) and Pennsylvania residents (N=411)
Boudet et al.	2014	“Fracking” controversy and communication: Using national survey data to understand public perceptions of hydraulic fracturing	Energy Policy <i>Refereed journal</i>	USA	Nationally representative telephone survey (N=1,061)
Braiser et al.	2011	Residents’ Perceptions of Community and Environmental Impacts from Development of Natural Gas in the Marcellus Shale: A Comparison of Pennsylvania and New York Cases	Journal of Rural Social Sciences <i>Refereed journal</i>	USA (Marcellus shale)	Interviews with key informants, in person and telephone (N=61)
Braiser et al.	2014	The Marcellus Shale Impacts Study: Chronicling Social and Economic Change in North Central and Southwest Pennsylvania	Report for the Center for Rural Pennsylvania <i>Legislative Agency Report</i>	USA (Marcellus Shale)	Focus groups with various stakeholders (N=84), educators (N=47), and students (N=36)
Brasier et al.	2015	Communities experiencing shale gas development	<i>Book Chapter</i> in Hefley, W.E. and Wang, Y. (Eds.)	USA (Pennsylvania)	Archival research and focus groups from four Pennsylvania counties



AUTHOR	YEAR	TITLE	JOURNAL / SOURCE	LOCATION	METHOD / SAMPLE
Brown et al.	2013	The National Surveys on Energy and Environment - Public Opinion on Fracking: Perspectives from Michigan and Pennsylvania	CLOSUP (Center for Local, State, and Urban Policy) at University of Michigan <i>University Research Center Report</i>	USA (Michigan, Pennsylvania)	Telephone survey of Michigan (N=415) and Pennsylvania residents (N=424)
Brooks	2013	UT Energy Poll Shows Divide on Fracking	Commentary on University of Texas Energy Poll <i>University Research Center Report</i>	USA	Online survey of adults (N= 2,113)
Clarke et al.	2012	Fracking in the American Mind: Americans' Views on Hydraulic Fracturing	George Mason and Yale Study results <i>University Research Center Report</i>	USA	Online survey of nationally representative sample of Americans (N=1,061)
Clarke et al.	2015	Public opinion on energy development: The interplay of issue framing, top-of-mind associations, and political ideology	Energy Policy <i>Refereed journal</i>	USA	Split-ballot national telephone survey (N=1000)
Council of Canadians	2012	Fracking Poll Results	Council of Canadians <i>Advocacy Organization Report</i>	Canada	National telephone survey, with a random sample (N=2000)
Evensen, Clarke, et al.	2014	A New York or Pennsylvania state of mind: social representations in newspaper coverage of gas development in the Marcellus Shale	Journal of Environmental Studies and Sciences <i>Refereed journal</i>	USA (Marcellus shale)	Content analysis of regional newspaper coverage; interviews with journalists (N=1,037 articles; 4 journalists)
Evensen, Jacquet, et al.	2014	What's the 'fracking' problem? One word can't say it all	The Extractive Industries and Society <i>Refereed journal</i>	USA (national, Marcellus shale, New	Three telephone surveys: one in Marcellus Shale region with a stratified sample (N=1,202), one in



AUTHOR	YEAR	TITLE	JOURNAL / SOURCE	LOCATION	METHOD / SAMPLE
				York)	New York random sample (N=800), and one of US national random sample (N=1000)
Evensen	2015	Policy decisions on shale gas development ('fracking'): The insufficiency of science and the necessity of moral thought	<i>Environmental Values</i> <i>Refereed journal</i>	North America (New York and Pennsylvania in USA; New Brunswick in Canada)	Content analysis of newspaper coverage; and in person interviews with local residents in three communities in each state/province (N=47)
Ferrar et al.	2013	Assessment and longitudinal analysis of health impacts and stressors perceived to result from unconventional shale gas development in the Marcellus Shale region	<i>International Journal of Occupational and Environmental Health</i> <i>Refereed journal</i>	USA (Marcellus shale)	Two sets of interviews with convenience sample of community members living proximal to Marcellus Shale development (N=33; and N=20). Does not specify whether interviews are in person or telephone
Hudgins	2013	Fracking's Future in a Coal Mining Past: Subjectivity Undermined	<i>Culture, Agriculture, Food and Environment</i> <i>Refereed journal</i>	USA	Interviews with local community members. Does not specify whether interviews are in person or telephone
Ivacko and Horner	2014	Fracking as a community issue in Michigan	CLOSUP (Center for Local, State, and Urban Policy) at University of Michigan <i>University Research Center Report</i>	USA (Michigan)	Survey of local government officials (N=1,353 jurisdictions), online and hard copy
Jacquet	2012	Landowner attitudes toward natural gas and wind farm development in northern Pennsylvania	<i>Energy Policy</i> <i>Refereed journal</i>	USA (Pennsylvania)	Survey of landowners (N=1,028), hard copies sent by mail
Jacquet	2014	Review of risks to communities from shale	<i>Environmental Science</i>	USA	Review



AUTHOR	YEAR	TITLE	JOURNAL / SOURCE	LOCATION	METHOD / SAMPLE
		energy development	and Technology <i>Refereed journal</i>		
Jacquet and Stedman	2011	Natural gas landowner coalitions in New York State: Emerging benefits of collective natural resource management	Journal of Rural Social Sciences <i>Refereed journal</i>	USA (New York)	Interviews with leaders of landowner coalitions (N=12); does not specify whether interviews are in person or telephone. Focus group with leaders of coalitions (N=4)
Jacquet and Stedman	2013	Perceived impacts from wind farm and natural gas development in northern Pennsylvania	Rural Sociology <i>Refereed journal</i>	USA (Pennsylvania)	Survey of landowners (N=1,028) hard copies sent by mail
Jacquet and Stedman	2014	The risk of social-psychological disruption as an impact of energy development and environmental change	Journal of Environmental Planning and Management <i>Refereed journal</i>	USA	Review
Jaspal et al.	2014	Fracking on YouTube - Exploring Risks, Benefits and Human Values	Environmental Values <i>Refereed journal</i>	USA/UK	Content Analysis of YouTube videos (N=50)
Kasperson and Ram	2013	The Public Acceptance of New Energy Technologies	Daedalus <i>Non-refereed, invitation-only journal</i>	USA	Review
Kriesky et al.	2013	Differing opinions about natural gas drilling in two adjacent counties with different levels of drilling activity	Energy Policy <i>Refereed journal</i>	USA (Pennsylvania)	Telephone survey in Washington County (N=502) and Allegheny County (N=799)
Kromer	2015	Public Perceptions of Hydraulic Fracturing in Three Marcellus Shale States	CLOSUP (Center for Local, State, and Urban Policy) at University of Michigan <i>University Research Center Report</i>	USA (Pennsylvania, New York, Maryland)	Three state-wide telephone surveys across Pennsylvania (N=411), New York (N=405) and Maryland (N=619)



AUTHOR	YEAR	TITLE	JOURNAL / SOURCE	LOCATION	METHOD / SAMPLE
Lachapelle and Montpetit	2014	Public Opinion on Hydraulic Fracturing in the Province of Quebec: A Comparison with Michigan and Pennsylvania	CLOSUP (Center for Local, State, and Urban Policy) at University of Michigan <i>University Research Center Report</i>	Canada (Quebec) and USA (Michigan, Pennsylvania)	Telephone survey of Quebecers (N=1,505) including a general population sample (N=974) and Utica shale oversample (N=531). Survey of Americans (N=839) drawn from Michigan (N=415) and Pennsylvania (N=424)
Lachapelle et al.	2014	Public Perceptions of Expert Credibility on Policy Issues: The Role of Expert Framing and Political Worldviews	<i>Policy Studies Journal</i> <i>Refereed journal</i>	Canada (Quebec)	Online survey (N=1,507)
Ladd	2013	Stakeholder perceptions of socioenvironmental impacts from unconventional natural gas development and hydraulic fracturing in the Haynesville Shale	<i>Journal of Rural Social Sciences</i> <i>Refereed journal</i>	USA (Louisiana)	In person, semi-structured interviews (N=35) with various stakeholders
Lerner	2014	Opportunity, Risk, and Public Acceptability: The Question of Shale Gas Exploitation in Québec	CLOSUP (Center for Local, State, and Urban Policy) at University of Michigan <i>University Research Center Report</i>	Canada	Review of survey data from Lachapelle and Montpetit (2014)
Malin	2014	There's no real choice but to sign: neoliberalization and normalization of hydraulic fracturing on Pennsylvania farmland	<i>Journal of Environmental Studies and Sciences</i> <i>Refereed journal</i>	USA (Pennsylvania)	In person interviews (N=47) and ethnographic data collected with farmers
Mallinson	2014	Upstream influence: The positive impact of PAC contributions on Marcellus Shale roll call votes in Pennsylvania	<i>Interest Groups and Advocacy</i> <i>Non-refereed journal</i>	USA (Pennsylvania)	Analysis of roll call votes
Mazur	2014	How did the fracking controversy emerge in	<i>Public Understanding of</i>	USA (also UK)	Content analysis of foreign and



AUTHOR	YEAR	TITLE	JOURNAL / SOURCE	LOCATION	METHOD / SAMPLE
		the period 2010-2012?	Science <i>Refereed journal</i>	and Australia)	domestic English-speaking newspapers and television; and secondary polling data (range of sample sizes)
Perry	2012	Development, land use, and collective trauma: The Marcellus Shale gas boom in rural Pennsylvania	Culture, Agriculture, Food and Environment <i>Refereed journal</i>	USA (Pennsylvania)	Ethnographic research (two years)
Perry	2013	Using Ethnography to Monitor the Community Health Implications of Onshore Unconventional Oil and Gas Developments: Examples from Pennsylvania's Marcellus Shale	New Solutions: A Journal of Environmental and Occupational Health Policy <i>Refereed journal</i>	USA (Pennsylvania)	Ethnographic research (two years) in one county in rural Pennsylvania
Pew Research Center	2013	What Energy Boom? Half Unaware of Rise in U.S. Production, Continued Support for Keystone XL Pipeline	Pew Report <i>Think Tank Report</i>	USA	Telephone survey of national sample of adults (N=1,506) in all 50 U.S. states and the District of Columbia
Rabe and Borick	2011	Fracking for Natural Gas: Public Opinion on State Policy Options (Pennsylvania)	CLOSUP (Center for Local, State, and Urban Policy) at University of Michigan <i>University Research Center Report</i>	USA (Pennsylvania)	Statistically representative telephone survey (N=525) of residents
Schafft and Biddle	2014	School and Community Impacts of Hydraulic Fracturing Within Pennsylvania's Marcellus Shale Region, and the Dilemmas of Educational Leadership in Gasfield Boomtowns	Peabody Journal of Education <i>Non-refereed journal</i>	USA (Pennsylvania)	In person interviews (N=6) and focus groups (N=41) with educators and administrators in communities experiencing intensive natural gas development



AUTHOR	YEAR	TITLE	JOURNAL / SOURCE	LOCATION	METHOD / SAMPLE
Schafft and Biddle	2015	Opportunity, Ambivalence, and Youth Perspectives on Community Change in Pennsylvania's Marcellus Shale Region	Human Organization <i>Refereed journal</i>	USA (Pennsylvania)	In person interviews (N=6) and focus groups with students (N=36) and educators (N=47)
Schafft et al.	2013	The Relationship between Marcellus Shale Gas Development in Pennsylvania and Local Perceptions of Risk and Opportunity	Rural Sociology <i>Refereed journal</i>	USA (Pennsylvania)	Web-based survey of school district superintendents, high school principals, and high school directors (N=891)
Schafft et al.	2014	Local Impacts of Unconventional Gas Development within Pennsylvania's Marcellus Shale Region: Gauging Boomtown Development through the Perspectives of Educational Administrators	Society and Natural Resources <i>Refereed journal</i>	USA (Pennsylvania)	Web-based survey (N=891) supplemented by interviews (N=6) and focus groups (N=7) with educators
Simonelli	2014	Home rule and natural gas development in New York: civil fracking rights	Journal of political ecology <i>Refereed journal</i>	USA (New York)	Interviews and oral histories, in person and online
Sovacool	2014	Cornucopia or curse? Reviewing the costs and benefits of shale gas hydraulic fracturing (fracking)	Renewable and Sustainable Energy Reviews <i>Refereed journal</i>	N/A	Review
Stedman et al.	2012	Marcellus Shale Gas Development and New Boomtown Research: Views of New York and Pennsylvania Residents	Environmental Practice <i>Refereed journal</i>	USA (New York and Pennsylvania)	Mail survey of a random sample in Pennsylvania (N=1,455) and New York (N=461)
Theodori	2009	Paradoxical perceptions of problems associated with unconventional natural gas development	Southern Rural Sociology <i>Refereed journal</i>	USA (Texas)	Mailed survey: general population random sample of two counties in Barnett Shale region of Texas (N=600).



AUTHOR	YEAR	TITLE	JOURNAL / SOURCE	LOCATION	METHOD / SAMPLE
Theodori	2012	Public perception of the natural gas industry: Data from the Barnett Shale	Energy Sources Part B: Economics, Planning, and Policy <i>Refereed journal</i>	USA (Texas)	Mailed survey: general population random sample of two counties in Barnett Shale region of Texas (N=600)
Theodori	2013	Perception of the natural gas industry and engagement in individual civic actions	Journal of Rural Social Sciences <i>Refereed journal</i>	USA (Texas)	Mailed survey: general population random sample of one county in the Barnett shale region of Texas (N=153)
Theodori et al.	2009	Public perceptions of desalinated water from oil and gas field operations: Data from Texas	Society and Natural Resources <i>Refereed journal</i>	USA (Texas)	Mailed survey: general population random sample of two counties in Barnett Shale region of Texas (N=600)
Theodori et al.	2012	Pennsylvania Marcellus Shale Region Public Perceptions Survey: A Summary Report	Center for Rural Studies, Sam Houston State University, Texas. <i>University Research Center Report</i>	USA (Pennsylvania)	Survey of residents, both telephone and mailed in questionnaires (N=800)
Theodori et al.	2014	Hydraulic fracturing and the management, disposal, and reuse of frac flowback waters: Views from the public in the Marcellus Shale	Energy Research and Social Science <i>Refereed journal</i>	USA (Pennsylvania)	Telephone and mailed surveys of the general population of 21 counties (N=400)
Israel et al.	2013	Concerns about Shale Gas Risks among Interested and Affected Parties	Workshop on Risks of Unconventional Shale Gas Development, National Research Council, Washington <i>Think Tank Report</i>	USA (various)	Internet survey of ‘interested and affected parties who are knowledgeable’ (N=372); open-ended responses.
Willow	2014	The new politics of environmental	Journal of political	USA / Canada	Interviews with Ohio residents



AUTHOR	YEAR	TITLE	JOURNAL / SOURCE	LOCATION	METHOD / SAMPLE
		degradation: un/expected landscapes of disempowerment and vulnerability	ecology <i>Refereed journal</i>		(N=19), does not specify whether interviews are in person or telephone
Willow et al.	2014	The contested landscape of unconventional energy development: a report from Ohio's shale gas country	Journal of Environmental Studies and Sciences <i>Refereed journal</i>	USA (Ohio)	Interviews with grassroots activists (N=7), non-profit affiliates (N=7) and government agents (N=5), does not specify whether interviews are in person or telephone
Wynveen	2011	A Thematic Analysis of Local Respondents' Perceptions of Barnett Shale Energy Development	Journal of Rural Social Sciences <i>Refereed journal</i>	USA (Texas)	Analysis of open-ended comments from a mailed survey (N=600)



3 FINDINGS

3.1 Awareness and knowledge of hydraulic fracturing for shale gas and oil

More than half of the publications that we reviewed gauged awareness or knowledge of ‘fracking’ and/or shale oil/gas development in some way. Broadly, they addressed three overarching questions: 1) to what extent are people aware of shale operations, 2) of what are they aware, and 3) what sources of information did they draw upon? Research in this area was commonly quantitative (from surveys), but did include some qualitative data from interviews and focus groups.

3.1.1 Extent of awareness and knowledge

Researchers found that close to 50% of individuals in areas exposed to shale operations, or with the potential for such activity, are aware of the issue (Borick et al., 2014; Brown et al., 2013; Rabe and Borick, 2011). Nevertheless, research frequently highlighted variations in levels of awareness. In surveys drawing on national US samples, awareness was shown to be much lower than in surveys of areas proximate to development (Boudet et al., 2014; Clarke et al., 2012). Numerous studies found that awareness differs across regions, typically asserting that awareness is higher in states, counties, or regions either closer to development or with higher density of development (Borick et al., 2014; Braiser et al., 2011; Brown et al., 2013; Ivacko and Horner, 2014; Kriesky et al., 2013; Theodori et al., 2012; Theodori et al., 2014). However, Stedman et al. (2012) found no significant differences between New Yorkers and Pennsylvanians in levels of perceived knowledge of Marcellus-related impacts or procedures despite the different levels of development in each state. In the only repeated survey analysis of awareness in our sample, Brooks (2013) showed that awareness increased moderately over time (from 32% to 42% over one year). Evensen, Jacquet et al. (2014) reveal that level of awareness could depend on question wording, as substantially more survey respondents were able to recognise the phrase ‘shale gas development’ compared with the term ‘fracking’.

3.1.2 Nature of awareness and knowledge

Some research has shown that economic benefits dominate framing of this issue for government officials (Anderson and Theodori, 2009), farmers (Malin, 2014) and local residents (Wynveen, 2011), with negative impacts being dismissed. Other research shows that residents are aware of negative impacts, even if positive impacts dominate their discourse on shale operations (Ladd, 2013). Still other research shows that residents in areas with development fully perceive and discuss positive and negative impacts of development (Schafft and Biddle, 2014; 2015). Whilst research on awareness revealed that approximately half of the respondents to several surveys were aware of shale operations, other research demonstrates that far fewer have any degree of in-depth understanding of the issue. Residents were shown to have little knowledge of a range of potential impacts from development (Stedman et al., 2012), of desalination used to treat wastewater from development (Theodori et al., 2009), and of the greater context surrounding energy issues and decisions in the US (Pew, 2013). Evensen (2015) reports



that whilst residents in areas exposed to development may have considerable knowledge about the process of development, they often seem to know little about what others know (including community members, institutional actors), particularly those with whom they disagree.

3.1.3 Sources of awareness and knowledge

Multiple authors provide data to contend that mass media (Mazur 2014) and particularly newspapers (Evensen, Clarke et al. 2014; Theodori et al., 2012; Theodori et al., 2014) are important sources of information on the topic of shale operations. Additional key sources of information are identified as: industry and conservation/environmental groups (Theodori et al., 2012), landowner coalitions (Jacquet and Stedman, 2011), and peers via word of mouth (Kriesky et al., 2013).

3.2 Risk and benefit perceptions

Most of the reviewed articles considered risk/benefit perceptions in some form. They show that public views are mixed as to whether benefits outweigh the risks or vice versa; indeed, perceptions appear more nuanced than a simple weighing up of gains and losses. There are a number of potential factors influencing risk perceptions, from the terminology used to describe the issue, personal values and demographics, to experience of shale operations. In turn, risk/benefit perceptions are shown to influence other aspects of individuals' responses to the issue, such as tendency to support or oppose, and propensity to take civic action. It is worth noting that risk/benefit issues tended in our sample to be explored via survey approaches, which may limit the suite of issues that are addressed. Many of the studies showing the importance of impacts outside the characteristic economic and environmental tropes were qualitative, highlighting the differential role of varied research approaches, and potentially pointing to why certain impacts were discussed more infrequently than others.

3.2.1 Benefit perceptions

Perceived benefits tend to be economic (Brasier et al., 2011; Theodori, 2013). By far the most commonly cited involve jobs (Brasier et al., 2011; Brown et al., 2013; Jacquet and Stedman, 2013; Jaspal et al., 2014; Ladd, 2013; Schafft et al., 2014; Theodori, 2009; Theodori et al., 2012) and boosts to local and individual economies (Brasier et al. 2011; Jacquet and Stedman, 2011; Jaspal et al., 2014; Schafft et al., 2014), for example due to increased business and investment activity (Brasier et al., 2011; Brown et al., 2013; Ladd, 2013; Theodori et al., 2012). When asked, people perceive employment benefits to be important or very important (Theodori et al., 2012), and overwhelming majorities in both Michigan and Pennsylvania believe that hydraulic fracturing is very or somewhat important to their state's economy (82% Michigan, 84% Pennsylvania), despite different levels of fracking in each (Brown et al., 2013). However, research by Hudgins (2013) and Jacquet (2014) suggests the reality is different, in that jobs for *local* people can be few. These latter findings reflect a body of work emerging on the negative and limited nature of the economic impacts of shale gas, reminiscent of historical boom-bust cycles in the US (Christopherson, 2015). Other perceived benefits include poverty alleviation (Theodori, 2009), energy independence (Brown et al., 2013),



and improvements in services such as local police/fire protection, medical and health care facilities (Ladd, 2013; Theodori, 2009).

3.2.2 Risk perceptions

While benefits tend to be economic, risks tend to be environmental or social (Brasier et al., 2011; Theodori, 2013). Impacts on water are some of the most commonly cited (Anderson and Theodori, 2009; Brasier et al., 2011; Brown et al., 2013; Ivacko and Horner 2014; Jaspal et al., 2014; Kromer, 2015; Ladd, 2013; Rabe and Borick, 2011; Theodori, 2009), and mainly focus on contamination rather than usage (note however that some of these findings are from closed survey questions rather than open-ended survey items or interviews, thus limiting the scope of responses). Some research points to water problems being the most important of all risks; for example Borick et al. (2014) find that more than half of New York and Pennsylvanian respondents agree or strongly agree that natural gas drilling poses a major risk to the state's water resources, and Theodori et al. (2012) find that most respondents in the Pennsylvania Marcellus Shale region think that impacts on water quality are very important (63%) or important (21%).

While impacts on water are commonly cited, a number of other impacts are also of concern amongst the publics in this review. These include other environmental impacts such as generic 'risks to the environment' (Ivacko and Horner, 2014) as well as air pollution (Anderson and Theodori, 2009), damage to the land and landscape (Jaspal et al., 2014), and associated impacts on wildlife (Brasier et al., 2011; Schafft and Biddle, 2015). Concerns also relate to social risks, the most commonly cited of which is the impact of shale gas exploitation on traffic, road safety and road conditions (Anderson and Theodori, 2009; Brasier et al., 2011; Schafft and Biddle, 2014; 2015; Schafft et al., 2014; Theodori, 2009; Wynveen, 2011). More broadly, individual and community health and safety were of concern in reports by Ferrar et al. (2013), Jaspal et al. (2014) and Wynveen (2011).

Participants also perceived issues of noise and/or light pollution (Anderson and Theodori, 2009; Ladd, 2013; Schafft and Biddle, 2015) and changes to the aesthetic value of the landscape/scenic beauty (Anderson and Theodori, 2009; Brasier et al. 2011; Jacquet and Stedman, 2013; Wynveen, 2011). Also of concern is the population influx caused by shale development (Brasier et al., 2011; Jacquet and Stedman, 2013; Jaspal et al., 2014; Ladd, 2013; Schafft and Biddle, 2014) and the associated risks of crime (Brasier et al., 2011), inconvenience/social disruption (Anderson and Theodori, 2009; Jacquet and Stedman, 2014; Wynveen, 2011), people not sharing the local way of life (Brasier et al., 2011), strained services/infrastructure (Brasier et al., 2011; Schafft and Biddle, 2014), housing availability (Brasier et al., 2011; Jaspal et al., 2014) and stress (Brasier et al., 2011). Participants also speak of spoiled place-based identities (Jacquet and Stedman, 2014; Wynveen, 2011), threats to rural lifestyles (Brasier et al., 2011), 'upended community meanings' (Jacquet and Stedman, 2014), the industrialisation of small towns (Jaspal et al., 2014), and a reduced ability to enjoy local natural amenities (Schafft and Biddle, 2015). Perry (2012) discusses how the psychological and sociocultural impacts of shale gas development on Bradford County may evidence a



phenomenon called ‘collective trauma’ in which a community's bonds are slowly but substantially weakened.

It is of note that whilst accelerated climate change has been cited as among the most significant impacts of shale exploitation, due to methane emissions and lock-in at the expense of renewable energy sources (e.g. Broderick et al, 2011), it features remarkably little in this review. This may be because climate change is a ‘distant’ risk (Leiserowitz, 2005; Spence et al, 2012). Indeed, results indicate that while media (Jaspal et al., 2014), stakeholders (Ladd, 2013) and ‘interested, affected and knowledgeable’ individuals (Israel et al., 2013) cite climate change as an issue, the general public tends to be concerned with more immediate, localised effects such as social impacts and water contamination. It may also be in part due to many of the samples being based in areas where shale gas development is occurring, suggesting a need for more national studies to explore this issue. Willow (2014, p.247) notes that ‘while several people I spoke with did list carbon emissions/climate change as a detrimental outcome of fracking, this issue has not emerged as a major motive for grassroots opposition’, and Clarke et al (2015, p.137) comment that ‘very few participants who mentioned environmental associations actually touched on climate change’.

3.2.3 **Weighing up the risks and benefits**

Views are mixed as to whether benefits outweigh the risks or vice versa. For example, while most Haynesville (Louisiana) respondents believed that the socioeconomic benefits of development had outweighed the socioeconomic/environmental costs to the region, a substantial minority of respondents was sceptical or disagreed that the benefits to date had been worth the risks (Ladd, 2013). Similarly, while 32% disagree or strongly disagree that the benefits of natural gas extraction from the Marcellus Shale will outweigh the costs, 41% agree or strongly agree (Theodori et al, 2012). Conversely, Lerner (2014, p.1) notes that public opinion in Quebec has arrived at near-consensus that the ‘natural/technological risks may outweigh relatively moderate economic gains’. Indeed, risk/benefit perceptions appear more nuanced than a simple weighing up of gains and losses. For example, while a greater proportion think the benefits outweigh the risks than vice versa in Theodori et al.’s (2012) study, 45% agree/strongly agree that they worry that there will be some sort of catastrophic accident involving natural gas extraction in the Marcellus Shale, and 46% disagree/strongly disagree that any negative impacts of natural gas extraction in this region can be fixed. This reflects wider risk literature that shows ambivalence in risk perceptions whereby both risks and benefits can be weighed highly at the same time (Pidgeon et al., 2005). Indeed, in the real world, high benefits often accompany high risks (see Fischhoff et al., 1978). Finally, it is also worth noting that the timing of the papers reviewed here is likely to influence results. Now that oil prices have fallen causing a contraction of shale gas operations in some areas, and considering more recent commentaries about shale boom-bust cycles (e.g. Christopherson, 2015), perceptions about the sustainability of benefits are likely to change.



3.2.4 Influences on risk and benefit perceptions

Factors that influence risk/benefit perceptions include the terminology used to describe the issue, respondents' values, and demographic factors. Clarke et al. (2015) found that the terms 'fracking' and 'shale gas development' elicited different risk/benefit perceptions in a split-sample survey, with perceptions more positive when the term 'shale gas development' was used. Drawing on the same data, Evensen, Jacquet et al. (2014) show how a higher percentage of participants felt that the risks outweigh the benefits when the issue was framed as 'fracking' vs. 'shale gas development' (note however that the terms refer to different aspects of the issue and carry different connotations). With respect to respondents' values, environmental attitudes were found to be strongly predictive of opposition to gas development (Jacquet, 2012). In a similar vein, Lachapelle and Montpetit (2014) suggest that residents of Quebec, being more egalitarian and less individualistic than the public in Michigan and Pennsylvania, perceive greater risks in the extraction of natural gas from shale, and tend to be less convinced of economic benefits. Regarding demographics, Kriesky et al. (2013) find that overall, men are far more likely to think that the Marcellus Shale is a significant economic opportunity (48.6% vs. 33.0%), while in the county with more drilling activity (Washington County) women were found to be statistically more likely than men to consider the Marcellus Shale to be a significant environmental and public health threat (26.4% vs. 16.2%). This finding reflects emerging patterns in the UK (O'Hara et al., 2015) and wider literature on gender effects and local environmental contamination (Davidson and Freudenberg, 1996). However, it is important to recognise current thinking, which is that gender effects that do exist are not due to gender per se, but due to other issues that prompt men and women participants to construct risk differently (Flynn et al., 1994; Henwood and Pidgeon, 2015; Satterfield et al., 2004).

A key question of interest is whether risk/benefit perceptions are related to experience of shale gas exploitation. A number of the papers we reviewed do find that those with more experience of fracking are more positive. For example, New York residents (where shale operations are not happening) are almost three times more likely than those in Pennsylvania (where shale operations are happening) to give the risks to Americans' health, safety and the environment from hydraulic fracturing the highest rating on a ten-point scale (Borick et al., 2014). Stedman (2012) also found that New Yorkers were less likely than Pennsylvanians to agree that the benefits outweigh the costs of natural gas extraction (24.6% vs. 32.8% agree). Kriesky et al. (2013) found that in the Pennsylvanian county with more activity (Washington County), residents were less likely to perceive environment threat, and more likely to perceive the Marcellus shale as an economic opportunity than in the Pennsylvanian county with less activity (Allegheny County). In line with these findings, Lachapelle and Montpetit (2014) find that residents of Quebec (with its relatively low levels of drilling activity and a quasi-moratorium) are more likely than residents of Michigan and Pennsylvania to view risks as being high. Indeed, Quebecers are much less likely to perceive the development of shale resources as being important for the economy, and a majority perceive that drilling for natural gas in their province will cause more problems than benefits in the future (Lachapelle and Montpetit, 2014).



Whilst the above research indicates that greater experience is related to higher benefit perceptions and lower risk perceptions (note that we cannot comment on causality), other research shows that the situation is more complex, and that those with more experience hold more polarised or stronger perceptions of both risks and benefits. For example, Theodori (2009) found that Texans in Wise County (where the natural gas industry is more mature) were significantly more likely than Texans in Johnson County (where it is less well established), to view one social and/or environmental issue *more negatively* and five economic and/or service-related issues *more positively*. Work by Schafft et al. (2013, 2014) support this. Schafft et al.'s (2013) survey of school administrators for example suggests that the same people are likely to see positive and negative potential and that people who live near sites have greater risk and opportunity perceptions than those who live in areas with less activity. Indeed, there was a strong correlation between perceived risks and opportunity, and 'the intensity of perception of both risk and opportunity is directly associated with the amount of local drilling, suggesting the complexity of local contexts within which local stakeholders evaluate rapid boomtown-associated community change' (Schafft et al., 2013, p.143). Furthermore, interviews by Brasier et al. (2011) suggest that a regional history of extraction (coal/shallow natural gas) helps explain perceptions of development; perhaps more than level of development itself. As an aside, such histories can also complicate the allocation of environmental impacts to shale gas because many of the problems may be the legacy of earlier industrial history, for example coal mining in the Marcellus (Vidic et al, 2013).

3.3 Attitudes towards hydraulic fracturing for shale gas and oil

More than half of the publications in our sample offered some degree of attention to overall attitudes (support/opposition) towards shale operations. Broadly, this research addressed three overarching questions: 1) what level of support exists for development, 2) to what extent support/opposition varies spatially and temporally, and 3) which factors affect individuals' degree of support/opposition. Research that explored overall attitudes was more commonly quantitative, though some qualitative studies also addressed these issues.

3.3.1 Level of and variation in support / opposition

The research in our sample revealed differences in support/opposition within the US and across regions of North America. For some areas, multiple studies consistently showed similar levels of support; yet, in other areas, research exhibited contrasting relationships. Several studies revealed support, on average, for shale operations in Pennsylvania (Borick et al., 2014; Brown et al., 2013; Kromer, 2015; Lachapelle and Montpetit, 2014; Malin, 2014; Stedman et al., 2012; Theodori et al., 2012). The one study that explicitly examined California found more opposition than support (Baldassare et al., 2014); the same was true of the one study of Maryland (Kromer, 2015). Whilst two studies showed overall support in Michigan (Brown et al., 2013; Lachapelle and Montpetit, 2014), one suggested overall opposition (Ivacko and Horner, 2014). The majority of research on New York showed overall opposition (Borick et al., 2013; Kromer, 2015); however, one study of residents in New York's Marcellus Shale region revealed support on average



(Stedman et al., 2012). The limited research on Quebec showed decided overall opposition (Lachapelle and Montpetit, 2014; Lerner, 2014). Notably, while there has been unrest over shale development in New Brunswick, there is a shortage of published research on public perceptions there. Whilst the above studies in combination show differences across regions, some studies explicitly compared regions. Many found marked differences across states/provinces (Borick et al., 2013; Kromer, 2015; Lachapelle and Montpetit, 2014; Stedman et al., 2012), or variation within a state (Ivacko and Horner, 2014; Kriesky et al., 2013; Theodori, 2012).

The aforementioned studies examined attitudes towards shale operations in areas with current development or with the potential for development. Studies using national samples had different findings (Boudet et al., 2014; Brooks, 2013; Clarke et al., 2012; Pew, 2013): whilst all showed slightly more support, on average, than opposition, they mainly demonstrated that the majority of survey respondents across the US at large are undecided on this issue (Boudet et al., 2014; Clarke et al., 2012; Pew, 2013). One national-sample study demonstrated general support for shale operations in the Midwest and South in the US, but opposition on average in West and Northeast (Pew, 2013). Temporal variation in support/opposition was also manifest. Mazur (2014) asserted that attitudes have become more *divided* over time, while two studies showed increased *opposition* over time (Perry, 2012; Pew, 2013). Indeed, both of these can happen when a large number of people are initially undecided and then make a judgement, as has occurred with European perceptions of shale operations recently (Lis and Braendle, 2015).

When reporting overall levels of support/opposition, most studies relied on percentages or averages of linear scales from surveys. However, this might mask important nuances in support/opposition. For example, (Jacquet, 2012; Jacquet and Stedman, 2013) show that while survey respondents exhibited similar *average* levels of support for shale gas and wind energy, their evaluation of shale gas was substantially more bimodal than it was for wind energy. Furthermore, (Clarke et al., 2015; Evensen, Clarke et al., 2014) illustrate the need to consider whether respondents were asked about their perspectives on ‘fracking’ or ‘shale gas development’ on account of their national USA survey showing overall *support* for shale gas development, but *opposition* to ‘fracking’.

3.3.2 Factors affecting degree of support / opposition

The following findings closely relate to section 3.2 (risk/benefit perceptions). Beliefs about impacts of shale operations were the most common factors cited as being associated with overall attitudes about the issue. Several studies pointed to the salience of expected economic benefits (Anderson and Theodori, 2009; Brown et al., 2013; Jacquet and Stedman, 2011; Kriesky et al., 2013; Malin, 2014; Perry, 2012; Schafft and Biddle, 2014; 2015; Sovacool, 2014; Willow et al., 2014) and potential environmental damage (Anderson and Theodori, 2009; Brown et al., 2013; Jacquet and Stedman, 2013; Kriesky et al., 2013; Perry, 2012; Schafft and Biddle, 2015; Sovacool, 2014; Theodori et al., 2012; Willow, 2014; Willow et al., 2014, Wynveen, 2011). For example, in top of mind association tasks, those who more readily cite economic and energy supply impacts are more likely to support fracking, whilst those who more readily cite



environmental impacts are more likely to be opposed (Clarke et al., 2012; Clarke et al., 2015). Perceptions of social/environmental impacts are also a key predictor of engagement in civic action in response to shale gas development (Theodori, 2013), with the primary impetus for the anti-fracking movement (in Ohio at least) being personal and immediate impacts rather than more abstract global impacts (Willow, 2014).

It is by no means surprising that these two sets of impacts (economic and environmental) dominated coverage of factors associated with support/opposition; nevertheless, several studies highlighted the relevance of additional factors. Authors cited local community impacts, including concerns about disruption to place identity and psycho-social stress from dramatic changes in the community structure (Jacquet and Stedman, 2014; Perry, 2012; Schafft and Biddle, 2015; Willow, 2014; Willow et al., 2014; Wynveen, 2011). Evensen (2015) reveals that moral/ethical views on shale operations can also be strong influences on support/opposition; while Schafft and Biddle (2015) also point to equity (distribution of risks and benefits) being a concern affecting attitudes towards development. Whilst all the aforementioned factors have been shown to be associated with support/opposition, to our knowledge no published research offers a rigorous analysis of whether they actually lead to attitudes or whether they might *stem* from overall support/opposition (but see Sovacool, 2014 for a discussion of this issue).

As with risk/benefit perceptions, personal attributes and demographic characteristics were also associated with overall attitudes. Several studies showed men as significantly more likely to support shale operations than women (Brooks, 2013; Clarke et al., 2012; Kriesky et al., 2013; Pew, 2013); other research revealed that democrats were generally prone to oppose development whilst republicans were liable to support it (Baldassare et al., 2014; Brown et al., 2013; Brooks, 2013; Clarke et al., 2012; Mallinson, 2014; Pew, 2013). It should be noted that much of the research in which gender and political ideology were strongly associated with overall attitudes did not also control for beliefs about impacts.

Other variables were cited as relevant in a more limited sample of studies: age (Clarke et al., 2012) [younger people were more likely to oppose], being a lease holder (Kriesky et al., 2013; Jacquet 2014) [more likely to support], association of shale gas development with energy independence (Perry, 2012) [more likely to support], and living in areas with development (Kriesky et al., 2013, Lerner, 2014, Theodori et al., 2012) [contrasting findings on support/opposition] – also see Section 3.2.4. Additionally, a few studies cited societal power dynamics and the marginalisation of small rural communities as factors that shape attitudes towards shale operations (Malin, 2014; Willow et al., 2014; Wynveen, 2011). Finally, regarding the relationship between awareness of development and support/opposition, the limited scholarship in this area suggests that the relationship between awareness and support for /opposition to development is either non-existent (Jacquet, 2012; Pew, 2013) or tenuous at best (Lachapelle and Montpetit, 2014). Echoing years of commentary on the ‘deficit model’ of risk communication (House of Lords Science and Technology Committee, 2000), researchers therefore caution against concluding that ‘education’ can change



support/opposition on this issue (Kasperson and Ram, 2013; Lachapelle and Montpetit, 2014).

3.4 Associations with hydraulic fracturing for shale gas and oil

3.4.1 Attitudinal associations

The reviewed research assessed attitudinal associations in different ways. These included eliciting open-ended ‘top of mind’ responses via surveys (Boudet et al., 2014; Clarke et al., 2015), more structured surveys with pre-set associations (Jacquet and Stedman, 2013), and interviews with affected individuals (Ferrar et al., 2013). Negative associations included environmental impacts, water contamination, pollution, human health, pet and livestock health and community degradation (Boudet et al., 2014; Clarke et al., 2015, Ferrar et al., 2013; Jacquet and Stedman, 2013, 2014), while positive associations tended to focus on economic impacts and energy supply (Clarke et al., 2012). The terminology used in eliciting these associations is important, with Clarke et al. (2015) and Evensen et al (2014) showing that “fracking” prompts more negative associations than “shale gas development”. Interestingly, Kromer (2015) found regional differences in the perception of the word “fracking”; and associations were found to be influenced by media coverage, which helps to frame fracking as an issue of morals or ethics (Evensen, 2015; Evensen, Clarke et al., 2014). Indeed, associations vary by state. For example, whilst most New York participants feel negative towards fracking, only about half of Pennsylvania participants report negative feelings towards it (Borick et al., 2014). In counties where shale development is occurring, people said that they could perceive quality of life lessening in terms of resources, pollution, and personal histories with the land (Perry, 2013).

3.4.2 Agency

A number of the articles report associations with a perceived lack of agency and volitional control over development (i.e. a lack of personal control over determining outcomes). Participants express concerns about corruption, being taken advantage of, lack of transparency, dependence on energy industry for jobs, and literal and figurative displacement (Ferrar et al., 2013; Schafft and Biddle, 2015; Willow, 2014; Willow et al., 2014). Willow (2014, p247) in particular found that those who oppose shale development associate it with strong feelings of disempowerment, arguing that ‘the activities of a powerful industry are infringing on fundamental rights and undermining core democratic values’. Similarly, Wynveen (2011, p22) cites a lack of power and local control, including within government, with one respondent claiming that ‘county government has no say in gas issues.’ Participants point to development in their community that began without their consent, knowledge, or engagement (Hudgins, 2013; Israel et al., 2013). Others ‘yielded to inevitability’ to allow shale operations and were afraid to resist pressure because they felt they might be labelled ‘un-American’ or ‘un-patriotic’ (Malin, 2014; Perry, 2012). Simonelli (2014) refers to this as internal colonisation, arguing that when industry moves into economically vulnerable rural areas promising financial benefits, communities are often not in a position to resist, despite negative environmental and community impacts. In response to these power struggles, research has found that landowner coalitions are seen as a way of average citizens



gaining more power over development decisions by combining collective bargaining power and legal/time/financial resources (Jacquet and Stedman, 2011), and Jacquet (2012) suggests that possessing a lease could itself be seen as a form of power and/or control. Agency is an important factor in risk responses (e.g. Breakwell, 2007), and indeed Jacquet and Stedman (2014) suggest that in the case of shale operations, feelings of hopelessness can exacerbate social disruption.

3.5 Protest and activism

Only eight of the publications in our sample offered some degree of attention to protests and/or activism directed at shale operations. The limited attention to this topic addressed three overarching issues: 1) who the *activists* are, 2) what form *activism* takes, and 3) which *factors* explain people's propensity to engage in activism. Research that spoke to protest and activism was more commonly based on in-depth interviews, but did include some quantitative surveys.

3.5.1 Who the activists are

Whilst newspaper coverage commonly refers to 'activists' as those who oppose development (Mazur, 2014), the research in our sample shows different types of activists. Jacquet and Stedman (2011) highlight the activist role played by landowner coalitions who engage in group activism by advocating collectively for provisions in lease agreements. Conversely, Perry (2012) points to the traditional conception of activists as environmentally-minded individuals and groups opposed to development, noting that (at least during early stages of shale operations) this type of activist benefited from less trust than state regulators amongst the Pennsylvanian farmers she interviewed. Theodori and colleagues (2012) illustrate how even members of the general public can be activists on this issue to the extent that they become 'active' in the debate, for example, by simply attending meetings on the topic. They report that the number of 'activists' on this issue, even so broadly conceived, is small, with meeting attendance the most common way of being active (at only 18% of their survey respondents).

3.5.2 What activism entails

Activism takes a number of forms. Simonelli (2014) cites the use of zoning laws to protect local communities from development, while Sovacool (2014) lists a broad array of actions including multiple forms of legal action in courts, placing signs on front lawns (in favour or opposed to shale operations), and attending rallies. Theodori (2013) offers more mainstream actions such as voting for candidates who agree with one's perspectives on the issue and contacting officials to comment. Finally, Jacquet and Stedman (2011) explain how landowner coalitions advocate and negotiate with gas companies for better lease and royalty rates, more stringent environmental protections, and provision of community benefits.

3.5.3 Factors explaining propensity to engage in activism

Theodori (2013) found beliefs about social and environmental impacts to be associated with action on shale gas development, including voting behaviour and contacting local



officials. In a similar vein, Willow (2014) acknowledged beliefs about local impacts infringing on ‘fundamental rights’ as predicting activism. Willow and colleagues (2014) identified beliefs about whether and how shale operations might affect one’s ‘way of life’ as most likely to affect proclivity to protest on this issue.

3.6 Regulation

In the US, the public is evenly split on whether to allow fracking on public lands (Brooks, 2013), whilst in Canada there is widespread support for a moratorium on fracking until the government completes a comprehensive review of the technology (Council of Canadians, 2012). There are also of course those in the US that support a moratorium on fracking, with some states (e.g. New York), counties and individual towns adopting bans and moratoria (e.g. Ladd, 2013; Simonelli, 2014). Indeed, as discussed in section 3.3, public support for fracking regulation varies by state. For example, in Pennsylvania most residents support taxes on companies drilling in the state, although the support varies a little depending on what those tax revenues would be spent on; most do not believe that this would discourage companies from doing business in the state (Borick et al., 2014; Rabe and Borick, 2011). This is contrary to findings in Maryland, which show that most participants *are* concerned that a tax would discourage companies from conducting business in the state (Kromer, 2015). A plurality of residents in New York and Pennsylvania feel that regulations of neighbouring states should influence policies in their own state, though the regulations are very different (Borick et al., 2014).

3.7 Ethics

Around half of the papers offered some degree of attention to the ethical considerations related to shale operations. These addressed three overarching sets of ethical claims: 1) those related to distribution of benefits and harms, 2) those concerning the processes by which decisions were made and the role of the general public in such decisions, and 3) those focused on changes in community character, place attachment, and quality of life. Research that spoke to ethical considerations relied on both quantitative and qualitative methods.

3.7.1 Distribution of benefits and harms

A major focus in our sample was the degree to which wealth, social costs, and changes in quality of life are distributed (un)evenly or (in)equitably amongst a range of actors exposed to shale operations (Anderson and Theodori, 2009; Braiser et al., 2011; Evensen, 2015; Jacquet, 2014; Kasperson and Ram, 2013; Kromer, 2015; Schafft and Biddle, 2014; Sovacool, 2014; Theodori, 2012; Wynveen, 2011). Most of these authors provided evidence for uneven distribution of benefits and/or harms associated with development, or for people’s concerns about such uneven distribution. These included concerns about: different residents benefiting from those being harmed (Anderson and Theodori, 2009; Braiser et al., 2011; Jacquet, 2014; Schafft and Biddle, 2014; Sovacool, 2014); gas companies benefiting whilst residents are harmed (Kromer, 2015; Wynveen, 2011); and long-term, generational differences in who benefits or is harmed (e.g.,



benefiting in the short-term, but harming future generations) (Kasperson and Ram, 2013; Schafft and Biddle, 2014; Sovacool, 2014).

3.7.2 Processes by which decisions are made

A second key ethical consideration was the extent to which procedurally fair processes existed for decision-making on shale operations. Several authors identified procedural concerns. As discussed in Section 3.4.2, some researchers revealed that their research participants felt a sense of powerlessness to affect the multitude of changes in their communities. This was due to: the immense power of large gas companies (Wynveen, 2011), social norms (Malin, 2014; Willow et al., 2014), or existing regulations that marginalise certain actors (Evensen, 2015; Willow, 2014). Jacquet and Stedman (2011), however, recognised landowner coalitions as one method for the general public to reclaim some decision-making power on this issue.

3.7.3 Changes in community character and place attachment

A third dominant ethical consideration was the extent to which shale operations could change the character of small, rural communities and, by doing so, affect place meanings and place attachment for residents. Evensen (2015) ties such changes and concerns about them to the concept of philosophical perfectionism, whereby shale operations affect respondents' capacity to live or attain 'the good life' in New Brunswick (Canada), as well as in Pennsylvania and New York (US). There are also issues surrounding a lack of procedural fairness, and the violation of 'rights'; whether it be the right to clean air and water if fracking goes ahead, or the right to 'dispose of their property as they see fit' (Evensen, 2015, p. 525). Several authors explain how rapid industrialisation, increased intra-community conflict, an influx of outsiders, prominent changes in the landscape and associated psychological stress can lead to or have led to threats to place meanings and place attachment (Israel et al., 2013; Jacquet and Stedman, 2013, 2014; Perry, 2012; Schafft and Biddle, 2015). Multiple authors explicitly assert that threats to community character and place attachment are more complex than simply NIMBY (not in my backyard) arguments; indeed, as has been illustrated with other energy technologies (e.g. Devine-Wright, 2005), NIMBY cannot adequately explain opposition to shale operations (Jacquet, 2012; Jacquet and Stedman, 2013; Lachapelle and Montpetit, 2014).

3.8 Public perceptions of other actors, institutions and organisations

The dominant theme emerging with regard to public perceptions of stakeholders is (mis)trust; of industry, government, scientists and environmental groups. This is important because such perceptions have implications for how risks are interpreted (Poortinga and Pidgeon, 2003; Slovic 1993). For example, Jacquet (2014) suggests that levels of trust in governing bodies may be important for risk perceptions, with decreased trust in governing bodies and officials correlating strongly with increased perception of risks.



3.8.1 Industry

Mistrust of natural gas companies is common. For example, Ladd (2013) notes that four in ten respondents were sceptical of gas industry promises, while Stedman et al. (2012) note that many respondents had very little or no trust in the natural gas industry (48.8% in New York vs. 37.2% in Pennsylvania). It is unclear as to whether those more exposed to shale operations are more or less trusting of the companies involved: while Theodori (2012) found that views of the energy industry were slightly more negative in the areas where the industry was more mature, Theodori, et al. (2014) found *higher* trust in regulatory agencies and the natural gas industry in areas with higher density drilling.

Aside from industry exposure, the articles suggest that mistrust may stem from various factors, including perceived unfairness, lack of information provision, and heavy handed corporate tactics, or ‘bullying’. For example, in the Marcellus Shale, over half of participants (72% in New York, 69% in Pennsylvania) strongly or somewhat agreed that the gas industry benefits from natural gas extraction at the expense of local communities and citizens (Borick et al., 2014). Regarding information provision, Ferrar et al. (2013) discuss experiences of being denied information or being provided with false information, or having their concerns ignored. Similarly, Israel et al. (2013) cite a wide range of concerns relating to the availability and quality of information needed by policy-makers and the general public. Many respondents expressed concern about industry secrecy over the chemical composition of fracturing fluid, and others raised concerns about the withholding of information from affected people, by gas companies and even by neighbours and medical personnel under *gag orders*. With regard to bullying, interviewees in Pennsylvania’s Marcellus Shale described being bullied or intimidated by gas industry employees and their agents (Perry, 2013). This bullying is not restricted to companies: interviewees also described being bullied or intimidated by their neighbours when there were disagreements about the pros and cons of gas development; and even by local politicians (Perry, 2013).

3.8.2 Government

A number of studies describe negative perceptions of government with regard to shale operations. Many respondents had very little or no trust in state departments of environmental protection/conservation (28.7% in New York vs. 32.3% in Pennsylvania) (Stedman et al., 2012). Borick et al. (2014) find that both Governor Cuomo’s (New York) and Governor Corbett’s (Pennsylvania) handling of the shale gas issue in their states drew more negative reviews than positive appraisals; with Corbett viewed most negatively. Pennsylvanians believe he is too closely aligned with the preferences of energy extraction groups on the issue, with 60% agreeing (strongly or somewhat) that his decisions on drilling taxation are influenced too much by natural gas companies, and 60% that they are influenced too much on drilling regulation (Rabe and Borick, 2011).

Other research indicates that views are mixed. Brown et al. (2013) found that participants tended to be uncertain about governor- and legislature actions on hydraulic fracturing in Pennsylvania and Michigan. For those who did hold an opinion, Michigan residents are divided over whether they approve or disapprove of Governor Snyder’s actions (24% approval to 26% disapproval), while more Pennsylvanians object to



Governor Corbett's handling of natural gas drilling in the state (36% disapproval to 19% approval) (Brown et al., 2013). Furthermore, although confidence in state elected officials regarding shale policy is 'tepid', most respondents in Pennsylvania and Michigan express a preference for maintaining governmental decision-making at the state level, rather than at federal or local levels (Brown et al., 2013, p.2). Finally, Perry (2013) finds that many citizens express the belief that the Environmental Protection Agency (EPA) would not allow shale development if it were truly dangerous, suggesting high levels of trust in this governmental organisation.

3.8.3 Scientists and experts

In line with research showing that (independent) scientists are consistently amongst the most highly trusted sources of scientific information (e.g. Hargreaves et al., 2003), Stedman et al. (2012) and Theodori et al. (2012) found high levels of trust in scientists and 'experts'. However, the picture is again mixed. Some local residents believe that experts have intentionally avoided researching cases of cancer close to wells, fearing the implications of potential findings (Anderson and Theodori, 2009), and others raised concerns about possible bias in scientific studies funded by industry (Israel et al., 2013). This concern has also been voiced in the UK recently (Mobbs, 2015).

'Trust' of course does not necessarily translate to attitude change, and whilst Lachapelle and Montpetit (2014) note that Quebecers adjust their perceptions of risk when provided with new scientific information, even a strong signal from credible experts was unlikely to alter attitudes to such an extent as to produce overall support. In the US, Pennsylvanians have significant doubts about the credibility of scientists on this issue (Rabe and Borick, 2011), and in both Pennsylvania and Michigan some segments of the population suggest their perception of hydraulic fracturing will not change in response to an expert saying that the risks are either high or low (Brown et al., 2013). Brown et al. (2013) suggest that respondents are more likely to believe an expert determination of high risk than low risk associated with shale operations; and it is apparent that, in line with wider risk perception research (e.g. Kahan et al., 2011), trust in scientists is contingent upon factors such as whether the experts' views align with the dominant discourse or with their own views. Indeed, Lachapelle et al. (2014) find that perceptions of expert credibility in Quebec depend on the extent to which expert framings are consistent with the dominant frames found in public discourse.

3.8.4 Environmental groups and the media

With regard to environmental groups, the limited coverage in our sample suggests that levels of trust are again mixed. Respondents in Pennsylvania and Michigan would be most likely to turn to environmental groups for reliable information on drilling in their state rather than government, industry, or the media (Brown et al., 2013); but both Rabe and Borick (2011) and Stedman et al. (2012) found that many Pennsylvanians have little trust in environmental groups on this issue. Whilst little of the research here focused on media coverage, indications are that Pennsylvanians at least have significant doubts about the credibility of the media on the issue of shale operations (Rabe and Borick, 2011), yet Theodori (2012, 2014) and Evensen, Clarke, et al. (2014) all report that local



newspapers are the most commonly consulted source of information on this topic in Pennsylvania.

3.9 Comparisons with other energy options

In the sample that we reviewed, comparisons were made between hydraulically fractured shale gas/oil and other energy options including renewables (e.g. wind), other fossil fuels (e.g. coal), and conventional oil and gas.

3.9.1 Comparisons with renewables

Findings are consistent with research elsewhere (e.g. Demski et al., 2015; Greenberg, 2009; Parkhill et al., 2013) that consistently show public preference for renewables over fossil fuels. For example, local leaders' support for shale operations ranks near last when compared with a range of Michigan-specific energy sources that could be developed in the state, well behind renewable sources such as wind and solar, and other sources including nuclear power (Ivacko and Horner, 2014). Furthermore, a majority of Americans (58%) say it is more important to develop alternative energy sources (e.g. wind, solar, hydrogen technology) compared to 34% who think expanding exploration and production of oil, coal and natural gas is the more important priority (Pew, 2013). Related to this, Israel et al. (2013) cite respondents' concerns about gas development hindering the progress/conservation of renewable energy resources and technologies.

At the local level, Jacquet and Stedman (2013) found that although the perceived magnitude of positive and negative impacts is greater from natural gas drilling, the *types* of perceived impact from wind and natural gas are similar overall; for example traffic is seen to be among the most adverse impacts from both wind farm and natural gas development. However, wind still proves more popular: Jacquet (2012) found that landowner attitudes towards natural gas drilling tended to be negative, while attitudes towards wind farm development were much more mixed, becoming more positive when development occurred, as opposed to more negative when drilling began.

3.9.2 Comparisons with other fossil fuels

Although renewables are preferable, natural gas (per se) remains more popular than other fossil fuels. In some research, this includes the Keystone XL pipeline for tar sand oil (Brooks, 2013), although Baldassare et al. (2014) found that even support for this was higher than for 'fracking'. The higher support for gas than other fossil fuels is consistent with research in the UK (RSPB Market Research 2001, cited in McGowan and Sauter, 2005), and may in part be due to fewer people seeing natural gas as a culprit of climate change than oil and coal (Brooks, 2013). In some ways however, fracking for shale gas is seen as *more negative* than even coal. This stems from the social aspects of development, as described by Hudgins (2013) who notes that unlike coal miners who are a more localised, populous, networked labour force with deep roots in the area, much of the labour associated with natural gas drilling is diffuse and transient.



3.9.3 Comparisons between conventional and unconventional fossil fuels

Wynveen (2011) cites similarities between unconventional energy development in the Barnett Shale and conventional energy development. For example, many positive comments regarded the economic benefits of development, and concerns over the distribution of those benefits were common across both conventional and unconventional development. For both, communities reported increased crime, and impacts on air quality and wildlife. Wynveen (2011) notes however that impacts on water quality and quantity are unique to unconventional development.



4 CONCLUSIONS

The most commonly occurring themes in the papers that we reviewed were awareness, risk/benefit perceptions and acceptability of shale operations. Less widespread but of interest were accounts of citizen protest and activism, perceptions of regulation, and comparisons with other energy options. Most of the research focused on the US rather than Canada, with a strong focus on the Marcellus shale formation (particularly in Pennsylvania) and much less attention to other shale plays. There is a particular lack of research pertaining to public perceptions in Canada, especially in New Brunswick, where there has recently been unrest and public protest over shale operations.

Broadly, the literature shows mixed levels of awareness, tending towards higher awareness in areas with shale operations. However, whilst awareness tends to stand at around 50% of respondents, far fewer have in-depth understanding. Individuals tend to have negative associations with the term ‘fracking’, but research finds that public views are mixed as to whether benefits of shale operations outweigh the risks or vice versa; indeed, perceptions appear more nuanced than a simple weighing up of gains and losses. Whilst perceived benefits tend to be economic (e.g. job creation, boosts to local economies), perceived risks tend to be environmental/social (e.g. impacts on water, traffic).

Whilst a number of papers point to ethical issues (e.g. concerning risk/benefit distribution, procedural justice and impacts upon quality of life), levels of reported activism amongst the general public tend to be low thus far. Levels of support/opposition differ across regions within the US and Canada, which would be expected considering the varying regulatory contexts in different states and provinces. Residents of Pennsylvania and Michigan tend to show higher support, whilst residents of New York, Maryland, California and Quebec tend to show greater opposition. Views on regulation also vary spatially, but there is widespread distrust of the parties responsible (particularly industry and government), stemming from perceived unfairness, heavy-handed corporate tactics, and a lack of transparency.

Some of the research shows relationships between levels of experience with shale operations and perceptions (e.g. risk/benefit evaluations), but it is likely that the situation is more complex than simply ‘more experience equals more positive perceptions’. Research also found relationships with demographic factors (e.g. gender, age) and personal values. Terminology is also important, affecting reported levels of awareness, attitudinal associations and risk/benefit perceptions.

A mix of qualitative and quantitative approaches were used in the papers we reviewed, both of which of course offer their own merits, and together provide a more thorough exploration of the issue than any one method can alone. However, there is a strong focus on two particular methods: quantitative surveys and qualitative interviews. Much less of the research utilised techniques such as focus groups (Bickerstaff et al., 2008),



deliberative (Pidgeon et al., 2014) or ethnographic approaches (Malin, 2014; Perry, 2012; 2013; Willow, 2014; Willow et al. 2014), which would arguably offer more insight into co-produced meanings and ‘slow thinking’ judgements.

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