Living with oil and natural gas:
A risk perception study among adults in Kansas and Oklahoma

by

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B.S., University of Pune, 2006
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AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Geography
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Abstract

Technological advances such as combining hydraulic fracturing and directional drilling (HFDD) have given access to oil and gas reserves previously deemed uneconomical to recover in parts of the U.S. where these resources exist. The oil and gas industry is an important economic contributor for Kansas and Oklahoma. Thus, with untapped oil and gas resources now within economical reach, the Mississippian Limestone Play (MLP) region of Kansas and Oklahoma witnessed a new oil rush in the late 2000s.

Amidst the expansion of HFDD, heated controversy about the new technology's impacts on humans and the natural environment has generated uncertainty about its support or opposition within local communities. Despite the ambiguity, development has continued. For rural areas and small communities in Kansas and Oklahoma, volatile industrial development can increase their vulnerability to related hazards and economic perturbations. With a shortage of environmental risk perception studies about HFDD development and exclusion of social psychological disruption factors in technological risk perception studies, our explanation for different public views about HFDD has perforce been limited.

In this dissertation, I draw upon the tradition of risk perception research to investigate risk perception associated with HFDD in the MLP region of Kansas and Oklahoma, and whether environmental risk perception varies spatially. A mixed method approach combining mailed questionnaires and follow-up key informant interviews was used to gather self-reported knowledge, awareness, environmental risk perception, evaluation of benefits and risks, worldviews, sources of information and trust and socio-demographic data, from ten randomly selected counties within the MLP. I build on the theoretical premise that people's risk

perceptions are based on subjective interpretation of information, previous experience, and knowledge, rather than objective information.

My results show that despite similarities, regional meanings of the concept of 'risk' are tied to an individual's experience and interactions with their immediate surroundings. Environmental risk perceptions varied spatially for several reasons. These include experiences of the community and individuals with the industry, length of association, knowledge, awareness, and community life experience in addition to trust in local authorities. The finding supports social disruption theory for communities experiencing their first fossil fuel industry, but communities with longer familiarity and experience ended up adjusting better to industrial ebbs and flows. The psychological element of place-based disruption showed a significant relation to risk perception. As respondents' enthusiasm for HFDD in their communities grew, environmental risk perception decreased.

In Kansas, public officials expressed a need for better local financial management for the future and more community awareness programs focusing on legal, technical, and economic aspects of the industry. In Oklahoma, public officials identified better management of investments in infrastructure projects associated with industrial demands.

This study recommends inclusion of local risk perceptions and factors contributing to it for effective policymaking. Inclusion of locally sourced, socially constructed knowledge will help in making stronger place-based policy to solve regional issues in a timely and cost-effective way. Collaboration to share knowledge and strategies will help build communities resilient to ebbs and flows of industrial dynamics in the future.

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Dedication

In loving memory for my parents…

Chapter 1 - Introduction

1.1 Overview

Rural communities form an integral part of the United States. They share some common characteristics and serve diverse functions, but they evoke different meanings for different people, making it difficult to define them precisely. A given rural community, for instance, may have a single resource dependence or activity, or multiple economic activities with varying importance contributing to its economy. Some rural economies depend solely on commodities, frequently associated with either agriculture (food and fibre production) or extractive industries (energy and non-fuel minerals production) (Woods 2011). Even though rural economies change over time, they generally rely on the activities oriented around the natural resources found locally. In the Great Plains region of the U.S., most of the counties are rural and depend largely on primary sector economic activities, including both agriculture and extractive industries. In communities that mostly—and sometimes exclusively—depend on a local commodity, community members develop a unique way of connecting to that industry's role in local economic and community identity and development. In the past, their isolation and small size helped rural communities develop relatively homogenous and unique local identities (Flora, Flora, and Gasteyer 2016). Today, however, rural communities and their economies may experience rapid change.

Factors like low transport costs; demand for rural commodities beyond the area of production; better connectivity to regional, national, and global markets; and the advent of internet and other technological improvements for business have ushered in rural change. Consequently, rural communities today stand neither isolated nor homogenous as they once

were. They are more embedded in the global economy today than in the past. However, even if the changing conditions have created diversified economic atmospheres and more employment opportunities for these communities, becoming a part of global economies has also inflated uncertainties for them. The absence of substantial political, social, and economic support has rendered a large percentage of rural and small-town populations in affected areas vulnerable to rapidly changing industrial dynamics. One such volatile segment is the oil and natural gas industry, frequently rocked by changes in global oil and gas prices as well as by domestic supply and demand. Even without these market shifts, petroleum and natural gas production tends to undergo periods of growth and decline, typically linked to mineral extraction.

The United States consumes more energy than it produces and makes up the difference through import of fossil fuel. Because it depends on imported foreign fossil fuel, many consider this a national security issue (Mehany and Guggemos 2015). Thus, for the United States, energy independence becomes a key political issue. This is reflected in the U.S. Energy Independence and Security Act of 2007, whose aim is to move the nation toward greater energy independence and security.

Extraction of natural gas, oil, and other hydrocarbons locked inside tight sandstone, shale, and other low-permeability geological formations (Jackson et al. 2011), made more accessible by horizontal drilling combined with hydraulic fracturing, largely drove the increase in oil and natural gas production. Geographically, this energy development occurred in rural areas (Weber, Brown, and Pender 2014), although the pace of development varied widely among states (Kriesky et al. 2013). The boom of the early 2000s began in Pennsylvania and expanded to other regions, reaching Oklahoma about a decade later, culminating with peak production in 2011.

In many states across the U.S., newfound technological access has unveiled vast reserves of natural gas. Natural gas is expected to play a key role in the country's clean energy future (EPA 2014). Naturally, the industry has rushed to start drilling wells and extracting oil and gas from subterranean shale deposits across the country (Apple 2014). The combined use of horizontal drilling and hydraulic fracturing (fracking) has generated a great deal of controversy about impacts on humans (or people) and the natural environment in both the United States and abroad (Boudet et al. 2014). Proponents who argue in favour of this technology view it as an alternative source of energy with the potential to spur economic growth, leading to more secure domestic energy supplies and facilitating a rapid transition away from carbon-intensive coal-based electricity generation (Boudet et al. 2013). On the other hand, the scientific community, public and media have raised concerns about the new technology's environmental and human impacts (Bamberger and Oswald 2012).

Even amidst dilemma to support or oppose the industrial activity and the uncertainty it generates; the oil and natural gas industry has continued to expand to different areas. One such region is the Mississippian Limestone Play (MLP) regional carbonate, a porous limestone formation found under parts of Western Kansas and North central Oklahoma, historically known for its conventional wells. Although Oklahoma and Kansas have known the oil and gas industry, the use of hydraulic fracturing (fracking) coupled with directional drilling triggered new extraction during the mid- to late 2000s.

The expansion of the use of hydraulic fracturing with directional drilling prompted a diverse set of scholars to explore how and why individuals and groups evaluate and respond to risks related to emergence of fracking (e.g., Steg and Sievers 2000, Sjoberg 2000, Cutter 1993, Jacquet and Stedman 2014). There still, however, remains a noticeable dearth of contemporary

knowledge about several aspects of the local responses to fracking such as place-based perception of risk, concerns about impacts on individuals, effective ways and channels of risk communication, and economic opportunities with new oil and natural gas development (e.g., McKenzie et al. 2012, Goldstein et al. 2012, Hays and Law 2014, Walsh et al. 2020). My study examines the risk perceptions in local communities associated with rapidly changing oil and gas industrial dynamics in and their variance across space in the MLP region.

1.2 Research Setting and Study Objectives

For Kansas and Oklahoma, the oil and natural gas industry serves as one of the most important economic contributors. Hydraulic fracturing and directional drilling (HFDD) set off a new oil rush in the MLP. The period from 2000 to end of 2014 witnessed increased drilling activity, which left lasting impacts - economic, social, psychological, and environmental - on local communities. While some community members benefited from the industry through direct gains, employed in the industry, some benefitted via indirect gains, by working in service industry that supported the oil and gas industry. On the other hand, several community experienced negative impacts, thus causing concern over risk and the emergence of risk as a topic).

While experts from physical and technical science give the best estimate of physical harm from a risk, experts from social science identify and analyze the issues that individuals, societies, or communities associate with a certain risk. The absence of 1) analysis of environmental risk perception about oil and natural gas development in the MLP region and 2) inclusion of social and psychological factor in technological risk perception (risk perception associated with industrial development like oil and natural gas) represent limitations in the ability of existing

studies to explain differences in public attitudes toward such technologies, specifically in the MLP.

In my study, I draw upon the tradition of risk perception research to investigate how environmental risk is perceived with HFDD development in the MLP region of Kansas and Oklahoma, whether it varies within the region, and which factors are associated with HFDD risk perception. I furthermore investigate how risk perception varies spatially within this sub-region. My general assumption is that, when new HFDD development occurs, all communities experience some volatility or instability. However, the questions here are: 1) when communities are within similar geographical or cultural areas, do environmental risk perceptions vary or are they similar? and 2) which local influences drive risk perceptions? I consider here influence of both internal (social and cultural) and external (economic and media) factors. Risk perception itself can be a very broad topic. Therefore, in this study I limit my discussion to environmental risk perception. Thus, the main research question my study aims to answer is: ***what are the risk perceptions associated with hydraulic fracturing and directional drilling (HFDD) in rural communities within the Mississippian Limestone Play (MLP) region, and how do they vary spatially?***

Thus, this study's specific objectives for the region of investigation are:

1) To explore regional perceptions of the concept of 'risk;'
2) To assess the variation in perceived environmental risk associated with hydraulic fracturing and directional drilling among affected rural communities in Kansas and Oklahoma; and
3) To identify factors associated with hydraulic fracturing and directional drilling risk perception in the Mississippian Limestone Play region regarding

a) the oil and gas industry, generally and

b) hydraulic fracturing and directional drilling risk, specifically.

1.3 Resource Extraction and Rural Volatility

To understand contemporary energy development, it becomes necessary to consider the past relationships between rural communities and resource extraction in the United States. This relationship can be traced back to the original European settlers of the area (Knight and Bates 1995). It is well known that resource demand and supply vary through space and time. In the present age, though, the resources available to humans are rapidly expanding, mainly owing to increases in knowledge and advancements in technology enabling the harnessing of new and old resources. Yet, resource production accompanies enhanced socio-economic volatility, as changing individual and societal objectives contribute an element of dynamicity to resource demand and supply.

As mentioned earlier, rural communities' economic functions can be broadly divided in two categories: agricultural/biological and extractive/mineral/abiotic industry (England and Brown, 2003). While social agricultural landscape is perceived as "serene, calmly individualistic, and structured as in, life has an order based on seasons and responds to weather patterns and cycles, the idyllic way life is "supposed to be" (England and Brown, 2003, 317), extractive industries, as the name suggests, involve removal of raw materials from nature. The extractive industry connotes or hints at negative social landscapes, often perceived as disorderly, wildly individualistic, and non-conforming to the structured way individual, family, and community life is expected to be lived. Moreover, the extractive industry often smacks of unsavory local level problems such as tensions between different ethnic populations, labor

disputes, high alcohol consumption, prostitution, riotous living, and boom-and-bust cycles that are the exact antithesis of the quiet Midwestern farm town or rustic New England village ethos (England and Brown 2003).

Communities with undiversified economies depend extensively on one extractive resource. However, if not managed properly in the development phases, the withdrawal and/or processing of the resource can adversely affect the community (Brown and Schafft 2011). Factors like industrial trends, investment, ownership, and local conditions heavily influence the fortunes of forest-, mining-, fishing-, and agriculture-dependent communities. Historically, resource-based communities have had little control over their own destinies and remained relatively poor because of power relationship between owners and managers and residents/workers (England and Brown, 2003). These communities are "always in a position of dependence, because the raw materials acquire value through processing" (England and Brown, 2003, 318). The extracted resources must be mined, pumped, cut or refined, and made into something else to gain market value. Thus, the production and sale of extractive resources depend on the potential profit expected from the material.

During the 2020 COVID-19 pandemic, global travel restrictions coupled with curtailed domestic travel reduced the demand for oil and gas. For the first time in history, oil producers had to pay buyers (oil companies) in the U.S. to buy oil as the producers' storages were filling rapidly (Krauss 2020). Several oil companies slashed their budgets and refineries reduced their production to save themselves from economic losses. At the local level, several small private American oil companies in Great Plains and American West face huge looming economic losses. These companies once stood as backbones of their respective communities. Today, they pose significant liabilities for local economies because they may not be able to repay loans to regional

banks (Krauss 2020). Additionally, and especially for national to international companies, people who make the decision to extract raw material often remain away and outside of the location, meaning the management, manufacturing, and markets remain removed from the locations where the extraction takes place. This means several factors, many beyond the control of resource-based communities, regulate the demand and supply of resources. In other words, industrial decision-makers may have scant concern for socio-cultural impacts on the community. Despite this, however, extraction continues because of economic benefits to the communities, and because communities often do not have power to stop extractive activities.

When communities largely and sometimes exclusively depend on a natural resource, their residents develop a unique way of looking at the role the extractive industry plays in the local economy (Knight and Bates 1995). For rural communities depending on a single resource or having one economic activity exceeding the economic potential of other activities, decline in that activity can severely impact the community, sometimes creating "pockets of deprivation" in an otherwise prosperous rural area (Wood, 2011). Individuals, businesses, and the community itself tend to adjust to accommodate the resource-based industry. Residents begin to develop a shared sense of community with a vision and identity that revolve around the industry. Often the industry itself contributes to the economic and social aspects of the community, and individuals in the community may split their employment between extractive and other activities. In the United States, about thirty-five percent of the total agriculture acreage is in counties with shale gas development, making overlays of land use possible (Haggerty et al. 2019).

Any change in the pattern of economic activity requires the community to adjust, and this adjustment takes time. Studies have shown that the development of extractive industries like oil and natural gas influences a community's socio-demography, economic status, and

environmental quality (Bugden 2014, Adgate et al. 2014, Bamberger and Oswald 2012, Boudet et al. 2014). The adjustment period varies from community to community, depending on the community's experience with the industry, length of interaction, economic diversity, socio-demographic composition, and resilience.

1.4 Resource Development and Technological Challenge

Hydraulic fracturing and directional drilling (HFDD) have led to rapid increase in the availability of oil and gas resources (McKenzie et al. 2012). According to the available information at the end of 2011, 95 percent of the natural gas consumed in the United States was produced domestically, and production is projected to increase from 23 trillion cubic feet in 2011 to 33.1 trillion cubic feet in 2040, with almost all projected growth coming from fracking-based production (Adgate et al. 2014). Researchers who argue in favor of this technology view it as an alternative source of energy with the potential to spur economic growth, leading to more secure domestic energy supplies and facilitating a rapid transition away from carbon intensive coal-based electricity generation (Boudet et al. 2014). The scientific community, the public, and media, on the other hand, have voiced concerns about the environmental and human impact of fracking (Bamberger and Oswald 2012). For instance, New York state and Maryland have imposed a state-wide moratorium on the use of fracking for shale gas development, while Denton, Texas, has banned fracking at the local level. Despite such safety concerns, though, construction continued for a large number of development sites into the 2010s and drilling expanded to new locations.

Researchers across different fields have devoted themselves to understanding how individuals and communities evaluate and respond to the risks, uncertainty, and hazards of new

or emerging technology (Kasperson and Dow 1993). This evaluation plays a critical role in the understanding of public perceptions of risk and is deemed increasingly important for sound policy decisions (Marris et al. 1997). Owing to their limited experience and vague information, people turn to the scientific community and authoritative figures for regulation and guidance about hazard mitigation (Cutter 1993). With technological progress, studies of risk perception have expanded from natural hazards to include technological ones. Our current understanding of acceptance, uncertainty and risk of technology is substantial but also uneven, with surfeit of knowledge in a few areas (both geographical and ontological) and gaps in others (McKenzie et al. 2012, Walsh et al. 2020).

1.5 Significance

This doctoral research addresses risk perception related to HFDD development the rural MLP region. My study advances the understanding of place-specific risk perception, knowledge about within-region variation of risk perception and contributes to risk and environmental perceptions research and natural resource (energy) policymaking and management. ***The research contributes to three important areas of knowledge generation: subject knowledge related to fossil fuel development and risk perception in rural communities, geographical/locational understanding of the role of fossil fuels at the community or county level, and recommendation for place-based policymaking.***

Resource extraction forms a major theme of human-environment interaction, a prominent sub-field of geography that also includes research on both natural and technological hazards (Galvani et al. 2016). The United States has a long history of energy development, and energy boomtowns and community impacts received increased attention in the 1970s and early 1980s

(see Jacquet and Stedman et al. 2014). By extracting the resource, communities impact the environment and are themselves socially and economically impacted. Technological innovations like HFDD promise transformation of our lives and economies, but these innovations can also destabilize our natural and built environments.

In the last two decades in the United States, the HFDD boom produced a surge of social science research about the industry's impact on community, individuals, environment, and sustainability issues. Stedman et al. (2012) expect the communities experiencing this development to undergo changes comparable to the previous fossil fuel industrial related boom-and-bust experiences. However, recent developments are occurring in communities and regions with demographically and culturally different histories than past energy towns. Therefore, the new developments may create new community impacts ranging from environmental risks to resident participation in community activities, both missing in previous boomtown research (Stedman et al. 2012). To understand a community's support for or opposition to land use change (fossil fuel development), Jacquet and Stedman (2013) argued in favor of including place and community meanings in risk analysis and risk perception frameworks. Previous studies excluded these two factors, as both are subjective in nature and difficult to predict. However, Jacquet and Stedman (2013) maintained that subjective experiences are more important than concrete secondary data often used in social impact assessments. The ignorance of social and psychological variables in understanding community's reaction (support or opposition) constitutes a major gap in risk analysis studies (Jacquet and Stedman 2014). It is necessary to include social and psychological factors in risk perception studies because "disruption to closely held place and community meanings can be a real and potentially traumatic consequence of rapid land use change" (Jacquet and Stedman 2014, 1297). This will not only help scholars better

understand how non-experts formulate risks and what local factors of place guide the perception of risk but will also help the formulation of sound place-based policies for the future. The current study fills both these gaps in fossil fuel industrial development and community impacts.

While it seems apparent that there should be a connection between an individual's affection for a place and the level of risk perceived, first, there is inconclusive research about the relationship between ties with the place and risk perception (Bernardo 2013) and secondly sociologists and environmental psychologists have led most of the research in this field. Our current understanding of risk perception comes from different fields of science. Risk perception research in geography originally focused on understanding human behavior in the face of natural hazards and later expanded to technological hazards (Slovic 1983). My study focuses on understanding local risk perceptions with respect to HFDD development and thus includes place characteristics. This research recognizes local knowledge creation and highlights the factors contributing to place-based risk perception studies.

For this study, I focus on rural communities in Great Plains of the U.S., specifically in Kansas and Oklahoma. The recent HFDD expansion occurred mainly in rural areas (Weber, Brown, and Pender 2014). Since the early part of 20th century (Lu and Paull 2007), some rural communities in Great Plains of America have been witnessing few economic development opportunities and consistent population loss. These small rural towns have often been known for close-knit community ties, well-defined social structures, and social patterns (Jacquet and Stedman 2014). With HFDD, it is generally assumed that communities would be impacted but the amount and nature of impact would vary depending on the community. Although rural areas of Kansas and Oklahoma are familiar with the fossil fuel industry, HFDD development has the potential to usher in dramatic changes to the communities and their residents. These changes

have temporal patterns (Stedman et al. 2013) that can influence perceptions about the industry, eventually playing a role of citizen support or opposition to the industrial activity. Understanding the risk perceptions of rural communities thus promotes stronger and more systematic engagement with risks, allowing better mitigation efforts for future industrial development.

Walshe et al. (2020) conducted a systematic review on topics related to HDFF. This review comprised peer reviewed articles, theses, and dissertations by geography, focusing on the timing, spatial distribution, and data collection methods for different locations within the U.S. between 2000 and 2018. New energy development projects promise transformative changes to landscape and communities. Interestingly, on one hand communities experience a mix of impacts that vary across locales, between residents within the locales, and over time, and on the other hand new projects provide opportunities to measure, compare, and contrast socio-psychological disruptions associated with the development (Stedman et al. 2012, Jacquet and Stedman 2014). However, Walshe et al. (2020) found a gap in geographical coverage of research studies on HFDD development: research locations were concentrated in Marcellus Shale region, Bakken Shale and Eagle Ford region, but only one study location was found in MLP region of Kansas and Oklahoma's HFDD development. My research focuses on the MLP region of Kansas and Oklahoma. It fills this geographical knowledge gap regarding industrial dynamics and local experiences. This study's efforts will help define a reference study for identifying public concern, values and perceptions of risk for future studies, which will play a role to devise place-based policymaking, including the ad-hoc regionalism advocated by Lu (2011) for overcoming institutional challenges in rural development.

1.6 Dissertation Structure

This dissertation is segmented into seven chapters. Chapter 2 presents background information, including theoretical ideas on which I have based this study. The focus is on perception of risk, including geographical and psychological factors that influence it. The chapter also addresses the concept of place and links it to concepts of 'the rural' and rural communities.

Chapter 3 considers the study area, including historical associations of Kansas and Oklahoma with the oil and natural gas industry. The Mississippian Limestone Play (MLP, or Mississippian Lime) is then described in more detail. This chapter also clarifies differences between conventional and contemporary oil and natural gas development and the roles of regulatory agencies in the area.

Chapter 4 presents the methods employed for this research. The chapter begins with a brief overview of mixed methods approach to scientific inquiry, followed by discussion of survey rationale and design, including pilot work, participant selection, handling and processing of returned questionnaires, and statistical analysis of the returns. This chapter's second half discusses the role of interviews as a way of giving more context to the quantitative data collected via mailed questionnaire and describes participant selection and interview questions.

Results are presented in Chapter 5, starting with an overview of sample characteristics and a summary of questionnaire returns. It is divided into descriptions of results from the two major data-gathering activities: 1) statistical analyses of closed-ended responses and qualitative analysis of open-ended data presented for surveys, and 2) qualitative information from key-informant interviews. General results are followed by answers to specific questions and locational comparisons. The chapter's final section compares results from interviews with those

of mailed responses for a more holistic understanding of oil and gas activities and views of risk in the study region.

Chapter 6 comprises discussion of findings. This chapter revisits the original research aim and objectives and provides answers suggested by the study. I also discuss community needs, and the research context and positionality of the research and researcher. The study is summarized in Chapter 7. The final chapter also includes discussion of lessons learned and potential future research. This is followed by a list of references cited and appendices.

Chapter 2 - Literature review

2.1 Overview

In the mid-2000s, hydraulic fracturing (fracking) drew attention from the scientific community, the public, and the media. The fracking method of oil and natural gas recovery generated extensive debates among these communities. The newly applied technique, with technological advancement of horizontal fracturing and directional drilling, had given many states in the country access to previously unavailable vast reserves of natural gas. As the oil and gas industry rushed to begin drilling wells and extracting oil and gas from subterranean shale deposits across the country (Apple 2014), heated controversies about its negative impacts on humans and the natural environment, both in the United States and abroad (Boudet et al. 2014), focused on this technology's safety.

The reason for debate stemmed from conflicting reports of impacts circulating in the media and differences of opinion about the activity's safety. People living in newly explored areas confronted the dilemma of either supporting or opposing the activity. When it comes to questions of safety, researchers across diverse fields devote themselves to identify and understand how individuals and groups evaluate and respond to risks and nature's hazards and to new or emerging technology (Kasperson and Dow 1993). Understanding public perceptions is increasingly important because it helps authorities make sound policy decisions based on local community concerns and prepare effective plans for risk communication by disseminating current correct information about industrial activity in their community. To date, several attempts have been made to understand impacts of fracking on rural communities. However,

there remains a noticeable dearth in contemporary research on several aspects of hydraulic fracturing with directional drilling (HFDD): perception of risk, concerns of individuals and benefits and values linked with oil and natural gas development (e.g., McKenzie et al. 2012, Goldstein et al. 2012, Hays and Law 2014).

In this chapter, I explore the existing body of literature that guides my research about place-specific risk perceptions related to oil and natural gas industrial dynamics. This literature review's main aim is to inform my approach to this study. Based on my review of literature, I derive expected findings for my study.

Topics explored in literature review are oriented around several areas of research that inform this work: 1) to identify theories that are apt to contribute to (or be expanded by) research on risk perception and fossil fuels extraction, 2) to explore regional perceptions of the concept of risk, 3) to examine the research for works addressing spatial variation in perceived risk, and 4) to identify factors related to their risk perceptions. Published literature helps to develop my notions and guide my understanding about how setting up a new industry alters the physical piece of land and lives of individuals and community located in its proximity. The ideas and prior results featuring in literature relevant to such development in other parts of the country guide my approach to examine risk perceptions of fossil fuel industrial development in rural communities and how they vary spatially.

The chapter begins with description of the concepts of risk and perceived risk. This leads to a review of literature on different approaches and theories used to understand perceived risk. At the chapter's end, how the study builds on the existing body of knowledge is explained.

2.2 The Concept of Risk

It is important to understand risk as it shapes an individual's and a group's collective perceptions and actions in in response to natural hazards (Paul, 2011). In latter part of 20th century, technological risks became, among various factions in society, an increasingly important topic of discussion. But stark distinctions between natural and technological hazards decreased. According to Wachinger et al. (2013), natural hazards are now often conceived as "human-induced" hazards. Human interference in natural systems can increase intensity or frequency of hazard events and impacts. For example, earthquakes are a frequently induced occurrence from hydraulic fracturing in Oklahoma and Kansas. As these earthquakes are linked to human activity, they are called as induced seismicity (Buchanan et al. 2015). In Kansas and Oklahoma, since the early 2000s, concerns began to rise about increase in earthquakes in vicinity of oil and gas exploration and production sites. The disposal of wastewater (including salt-water, a by-product of fracking) under pressure back in the earth's deep and confined porous rocks triggered these earthquakes (Buchanan et al. 2015). Although these earthquakes may not have caused loss to human life, damage to property was reported widely in MLP region especially along the Kansas- Oklahoma border.

Today, within hazard studies, study of risk has developed into a specialization (Paul 2011, Freudenburg and Pastor 1992). Technological advances have provided new opportunities and challenges encouraging discussion of risk and risk analysis. Douglas and Wildavsky (1982) identified three peculiar characteristics of risk in modern times. These are: disagreement about the problem, disagreement over what is risky and how to measure risk. Different disciplines have explored the topic of risk, including sociology, geography, anthropology and psychology. The geographic lens in risk studies help understand the distribution of risks, where and who is

impacted and how to reduce risk from a hazard (Cutter 1993). Moreover, it expands our understanding of interaction between technology and society (community) and impacts of technology on society (community) and environment (Cutter 1993). Initially, these studies were focused on natural hazard, but with technological advance, studies have expanded to include technological hazards and risks. Consequently, risk means different things for different researchers. For instance, sometimes uncertainty and risk are used interchangeably. While uncertainty is "a description of precision and accuracy with which something is known or predicted on knowledge" (Golledge and Stimson 1997, 207), risk is the likelihood of harm of uncertain events. Hence, it is important to understand and define risk.

One of the difficulties in defining and evaluating risk is that evaluations are done on multiple dimensions. Risk may be evaluated as acceptable or unacceptable, voluntary or involuntary, significant, or insignificant (Golledge and Stimson 1997). Risk may also be evaluated quantitatively, as in the likelihood of a flood magnitude in any given year (e.g., for 100-year flood).

Furthermore, professional judgements involve assumptions on amount of risk involved and level of acceptance (Tarr and Jacobson, 1987). Tarr and Johnson (1987) argue that experts working on same problem have different solutions based on their professional training. For instance, in the first quarter of the 20th century saw disagreement between sanitary engineers and physicians over methods to reduce hazards to protect drinking water supplies (Tarr and Johnson 1987). This suggests that even among experts, disagreements can exist about what is risk and how risky is the risk.

A better understanding of risk perceptions has implications for policymaking, political campaigns and public acceptance or rejection of technology. How risks are defined and how the

definition is implemented can possibly increase or lessen power of political institutions. It can potentially change legal responsibility and compensation roles post an undesirable outcome - spill, damage, pollution, and legal complexities. Consequently, choice of definition of risk can affect policy outcome and allocation of resources, while considering safety implications and political power in society (Fischhoff and Watson 1984). Therefore, it is imperative to understand public perceptions of risk to form effective risk reduction strategies, improve risk communication and enhance institutional efficiency with limited economic and human resources in vulnerable communities. Public perceptions may be illuminated by risk definitions as explored in this research.

There is a long association between development and willingness to take technological risks for successful outcomes, but there is no consensus about how one measures successful outcomes of development (Freudenburg and Pastor 1992). This disagreement arises when there is a difference in view of who assumes burden of consequences of development. For example, if a farming community was asked to accept an energy development project, such as an unconventional oil and natural gas development, a potential source for conflict would be the difference between risks and benefit analyses done by community members and experts. While some community members may see the energy project as potentially beneficial for economic reasons, others may see it as compromising sense of community or diluting community spirit, owing to addition of unfamiliar faces. Alternatively, experts may see this as an opportunity for the area to grow economically, to receive more financial benefits and improve quality of life, owing to increased life opportunities. In such situations, development or economic activity quickly initiates conflict over perceived damages and (versus) benefits (Freudenburg and Pastor 1992). Thus, the source, amount and consequence of risk related to events and situations differ.

The differences arise partially because the term risk has multiple conceptions and meanings (Paul 2011).

Risk is often discussed in terms of hazard and vulnerability. It is important to understand here that risks may always be present in a situation, but until there is interaction between risks, people and places, risks do not become hazards (Cutter 1993). Both hazard and vulnerability are conventionally defined with respect to natural hazards. A natural hazard is an extreme geophysical event capable of causing a disaster (Paul 2011). This means that a hazard is a precursor to a disaster: a threat, not the actual event. Cutter (1993) presents hazards in a social context by defining them as threats to people and things they value (Paul 2011).

Hazards can be defined in terms of vulnerability. Addition of a social element to defining risk, the focus shifts from hazard itself to combination and interaction of people's vulnerability to events (natural or human-induced), and so individuals' diverse conditions add to complexity of vulnerability conditions. Cutter et al. (2003) maintained that quality of built environment influences human vulnerability (Paul 2011). Broadly, vulnerability can be defined as the likelihood that an individual or group of individuals would be exposed to or adversely affected by a hazard (Cutter 1993).

Vulnerability can be viewed in terms of people and places or communities and can be understood at different geographical scales: local, regional or national. Most vulnerability definitions are based on biophysical or environmental conditions or on people in terms of politico-economic situations. Hewitt and Burton (1971), as cited by Cutter (1993), were the first to develop concept of vulnerability in terms of a range of hazards affecting specific places and responses. Cutter and Solecki (1989) expanded Hewitt and Burton's conception to incorporate social and political structures to identify not only vulnerable places but also vulnerable people

within those places - biophysical vulnerability and social vulnerability respectively (Cutter 1993; Paul 2011).

The interest in studying risk has increased because of people's exposure to natural and/or human-induced (technological) hazards that may or may not have been experienced in the past. Borrowing from natural hazards, technological hazards can be defined as an interaction between technology, society, and environment (Cutter 1993). With growth in industries and their impacts on environment and human communities, geographers have broadened their scope of study of risk perceptions to technological hazards (Slovic 1987). With technological advances, the scientific community, industrial experts, and public policy planners widely discuss analysis and management of technological risk. Management questions include who is to manage a risk, who is responsible for cleaning up after an incident and who will compensate affected people and communities. Technological hazards, as compared to natural hazards, can be thought of as individual or collective use of technology that presents a different set of challenges and opportunities (Cutter 1993). Moreover, unlike natural hazards, technological hazards are often prevalent and less publicly recognized until they reach a critical event impacting environment and communities.

2.2.1 Defining Risks: Differences between experts and non-experts

Experts and non-experts define risk in different ways and have different perceived levels of risk. A study conducted by the EPA on 24 ecological risk items found that non-experts are more concerned about low-probability, high consequence risks, while experts are more concerned about long term ecosystem-level impacts (Slimak and Dietz, 2006). As compared to non-experts, experts tend to have a lower level of risk perception. Objective and subjective ways of thinking about the information explains the difference. While objective thinking of risks is a

product of scientific research, statistically modelled outcomes, probabilistic risk analysis and experimental studies, subjective thinking is an outcome of non-expert perceptions (Cutter 1993, Paul 2011).

Definition of Risk: Expert or Technical

Technical assessment of risk examines probability of events and magnitude of consequences (Cutter 1993). It does not consider the hazard's social accountability. I provide summaries of risk definitions of experts in Table 2.1.

The problem with expressing a hazard's risk using probability dimensions is that identical values may represent significantly different outcomes. Paul (2011) cites an example of a Category 4 hurricane that may have a return period of about 100 years along a specific coastal area, with a probability of 0.01 occurrence in any given year. Thus, as per the formula of risk as a product of probability of occurrence and magnitude, the risk would be 0.04. However, a Category 2 hurricane with a return period of 50 years (i.e., having 0.02 probability of occurrence) would also pose the same risk. Thus, a major aspect of all above definitions is that they rely on the hazard's nature (timing and physical strength). These definitions (except Rosa 1998, Aven and Renn 2009) leave out the hazard's social dimensions of risk, which include people's views and perceptions. These definitions also fail to consider attitudes toward risk.

Table 2.1. Experts' definition of risk (modified from Brooks, 2003; Paul, 2011 and Jacquet and Stedman, 2014).

Risk definition	**Author(s)**
Risk = (Probability of occurrence of an extreme event) (Magnitude)	Lowrance (1976)
Risk = {(Hazard probability) (Expected loss)}/ Preparedness (loss mitigation)	Fournier d'Albe (1979)
Risk = (Probability of occurrence of an extreme event) (Magnitude)^n n= social values/affect component	Whyte (1982)
Risk = (Likelihood of Hazard Occurrence) (Consequence)	Ansel and Wharton (1992)
Risk = (Hazard Probability) (Vulnerability)	Van Dissen and McVerry (1994); Twigg (1998)
Risk is two dimensional: it considers the probability of occurrence and extent of probable consequences	Tobin and Montz (1997)
Risk is a "situation or event in which something of human value (including humans themselves) has been put at stake and where the outcome is uncertain"	Rosa (1998)
Risk is the probability of a loss, and depends on three elements, hazard, vulnerability, and exposure	Crichton (1999)
Risk = f (probability and magnitude of different impacts)	IPCC (2001)
Risk = (Hazard) + (Vulnerability)	CARE (2003)
Risk = f {(Probability of hazard occurrence) (Population) (Vulnerability)}	UNDP (2004)
Risk = f {(Hazard) (Vulnerability) (Exposure) (Resilience)}	Thywissen (2006)
"Risk refers to uncertainty about and severity of the events and consequences (or outcomes) of an activity with respect to something that humans value"	Aven and Renn (2009)

Definition of Risk: Non-Experts or the Public

Kasperson et al. (1988) provided the first social contextualization of risks (Cutter 1993). In their pioneering social amplification of risk model, they suggested that risks interact with psychological, social and cultural processes in ways that may amplify or lessen them. According

to Cutter (1993), Kasperson et al. (1988) tried to answer why minor risks gain massive public reaction. If technological risk is socially constructed, it makes more sense to look at non-experts' definition of risk. Social construction of risk creates risk definition while attempting to fill the gap between expert judgements and societal constructs. This means that social construction of risk tends to define risk more as a condition of mind as opposed to strict statistical probability (Flint and Luloff 2005). But addition of social dimension of risk has its own complications. To begin with, risk means different things to different people, so accommodating all views may not always be possible. In this study's context, I use the UNDP's (year) definition of risk:

$$\text{Risk} = f\{(\text{Probability of hazard occurrence})\ (\text{Population})\ (\text{Vulnerability})\}$$

2.2.2 Expert versus Public Perceptions

What contributes to different levels of risk perceived by experts and layman? Cutter (1993) has discussed this question in detail. According to Cutter (1993), social changes, especially from 1960 to 1990, have contributed to levels of difference in perceived risks by experts and public. These changes have been especially noticeable in American society. One of major factors Cutter (1992) identified was American people's comfortable circumstances that have allowed them to invest time in politics and social issues. A second major factor was increasing reliance on technology, whether cars for transportation or computers for accounting or gaining information. Large corporations often control these technologies, which can influence politics and economics. The third major factor was change in American society's trust in institutions. It has been observed that American public has lost trust in their institutions, including government bodies (McGrath 2017). This feeling of distrust partially stemmed from

social reforms in the 1960s-70s, political events (Watergate) and environmental catastrophes or near catastrophes (Love Canal, Three Mile Island), all coupled with general cynicism about governing agencies (Tarr and Jacobson 1987).

Experts and non-experts define risk in different ways. "Even among risk managers, there is no single accepted definition for the term" (Paul 2011, 93). This is because professional judgements on amount of risk require assumptions to find solutions, and solutions based on assumptions vary according to the field in which the professional is trained (Tarr and Jacobson 1987). For instance, during early 19th century, the Sanitary Movement in United States encouraged establishment of local and state health boards. This brought two important professions, sanitation engineers and health professionals, to heightened levels of importance: both were assigned the task of protecting drinking water sources from pollution. They agreed on the sanitation policy's broad outlines but disagreed significantly on "the technical design in relation to public health priority and standard setting and technical competence" (Tarr and Jacobson, 1987, pp 318). These two groups of experts tried to impose their respective expertise for standards and values in public health, with applications of quantitative approaches.

At the other spectrum, when non-experts are asked to evaluate risks, they rarely use statistical approaches. Public reliance on risk judgements is more intuitive in nature (Slovic, 2000). For members of public, personal values, beliefs, experience, attitudes, social networks, socio-demographic characteristics, and worldviews play an important role in defining and gauging risk. In other words, they rely more on "…what they remember hearing or observing about the risk in question" (Slovic 2000, 105). This became obvious with the 1970s contamination of Love Canal site in Niagara Falls, New York. Prior to the 1970s, environmental activism was almost non-existent, because only a few experts from different fields possessed

scientific knowledge, so there was greater willingness to rely on expert judgments. After the 1960s, increased concerns arose about environmental and human effects of industrial pollutants, triggering more research and legislation and lessening trust in government agencies. By the 1970s, institutions' failure to protect public health at local, state, and regional levels gave rise to citizen activism that demanded state accountability for remedial measures (Tarr and Jacobson 1987). More people began participating in grassroots-level environmental activism at about the time Love Canal environmental contamination event attracted public recognition. Public turned to media to attract sympathetic attention, held demonstrations, protests and media appearances, which all sustained public attention. Moreover, experts publicly disagreed on mitigation measures and politization of environmental issue escalated perceived risk (Tarr and Jacobson 1987). Finally, the public used available scientific studies to learn about and publicize hazards of unregulated industrial chemical pollution to environment and, more importantly, human health. Thus, risk assessments are both subjective and objective; risk judgements are a by-product of social, cultural, and psychological influences (McComas 2006, Slovic 1993). For several decades, this made risk perception studies a central part of risk literature (Slimak and Dietz 2006).

2.3 Perception of Risk

According to Slovic (2000), while experts employ risk assessments, citizens use intuitive risk judgements (commonly known as risk perceptions). Risk perception is a term "…commonly used in reference to natural hazards and refers to subjective judgments that individuals make about characteristics and severity of a risk" (Paul 2011, 99).

Paul (2011) pointed out that people base their risk appraisals on personal perceptions of risk rather than on more scientific and objective findings. Bunting and Guelke (1979, 448) stated, "People behave in real world not on basis of objective knowledge, but in terms of subjective images." Source of information and trust in the source play a role in how much risk is perceived. For instance, large volumes of information or receiving conflicting information and dramatization of issue may amplify risks. Several factors govern the interpretation of information: an individual's values, social group relations, political influences, significance of event to them on a personal level and the risk event itself, including stigma associated with it (Cutter 1993).

Unlike natural hazards, technological hazards and their risks do not offer visual or auditory cues at the outset. Consequently, the public relies on experts or scientific community, regulators, and trusted sources of information for guidance. But owing to over-reactions, under-reactions, or no reactions at all, public's response to technological hazards is often ambiguous.

Perception plays a critical role in how individuals and community view uncertainty, risk, and new technology. Among scientific, industrial and policy planners, managing risks related to technology is a growing concern. But to manage risks, we need to understand what contributes to public perceptions. Risk perceptions change over space and time (Miller and Sinclair 2012), as they spring from multidimensional factors, including experience, structures of economic and political power, environmental factors, personal exposure to related situations and community processes (Flint and Luloff 2005).

Environmental perception about technological hazards is now viewed from societal context with increasing participation of peoples in decision-making process (Kasperson and Dow 1993). Intrinsic and extrinsic factors drive perception of environment. Intrinsic factors that

influence individuals' perception include their values, beliefs, and norms, while extrinsic factors include information availability, social interaction, and communication (Fishbein and Ajzen 1980). Risk perception occurs in a social context where community influences, such as experience and power relationships, filter an individual's notions of risk (Petty and Cacioppo 1981). Based on community experiences and interaction with a specific development, risks associated with it may be amplified or attenuated.

At individual level, disruption of individual's identity can induce stress-related disorders, anxiety; psychological harm can increase with major changes to one's life (Wilkinson et al. 1982, Jacquet and Stedman 2014). Perceived risks and benefits are strong predictors of support or opposition to the energy development activity at both individual and community level (Boudet et al. 2014). Boudet et al. (2014) mention that scholars are increasingly including affect or affective imagery in their studies because it relies on fast and efficient way of processing information. Boudet et al. 2014 define affective imagery as "the specific quality of 'goodness' or 'badness' experienced as a feeling state (with or without conscious awareness) or the positive or negative quality of a stimulus" (pp59). Information that is easily recalled is used in decision making and thus affective images serve as "top of mind" associations that influence perceptions of risks and orient researchers to community member's reactions, positive or negative towards changes, in this case, energy developments (Boudet et al. 2014).

Residents of communities facing energy-related growth may be forced to adapt to substantially altered community conditions (Smith et al. 2001). Consequently, owing to these rapid changes in community, different community actors may face different types of stress. For example, some power-figures may feel stress with threat to their power status, while some other community members may be stressed owing to sudden expansion of local opportunities

weakening the once close-knit community networks. While a few may see the situation as an opportunity, others may see it as stressful. Such an environment becomes a setting for conflict. Thus, it is safe to say that technological hazards are socially constructed; they are a product of our society (Cutter 1993). They are inherently embedded in a society in the larger political, economic, and historical context. The Love Canal incident served as an example of environment-public health risk. It brought forth dynamics between media, public-administration relationship, and institutionalized definition of risk.

2.4 Communication of Risk

Risk communication is a process that develops and delivers a message from experts to non-experts (Cutter 1993). People's perception of risk, derived from sources of information, is often ambiguous owing to over-reaction, under-reaction, or no reaction. A significant gap exists between public's perception of risk and one identified by experts (Paul 2011). During the Love Canal incident, divisions between expert scientific opinions erupted openly in public. Public debates have become increasingly politicized, though public involvement in policy decision-making has improved. Further complicating matters, too much of public science has become more a way of viewing the world rather than a supplier of objective truth (Tarr and Johnson 1987, Dunwoody and Peters 1992). To add to the ambiguity, unlike natural hazards, technological hazards get uneven media coverage: large events with low frequency may get more attention, amplifying perceived risk, while small events with high frequency may not receive any attention (Cutter 1993). The hazard's geographical location is important, too. If the event takes place in a large metropolitan area, media coverage tends be higher, compared to events occurring in rural and small-town locations, even though the damage may be more extensive (Cross 2001).

How a risk is communicated plays an important role in development of attitudes and beliefs, which can affect an individual's behavior in a community. Behavior, in turn, can help amplify or attenuate risk associated with new or different activities. In case of new technologies, scientists often do not know the likely full impacts on environment and surrounding communities. In such cases, conflicting reports can confuse people, affecting their support for or opposition to the new activity. Therefore, to make informed decisions, individuals need to have proper information about the activity and its possible effects.

In recent times, the importance to understand drivers of public risk perception has increased, especially from policy planning perspective. With respect to technological hazards, the issue of public acceptance of new technology or alternative use of old or already existing technology commands interest. Stoutenborough et al. (2015) have suggested that a more nuanced understanding of risk perceptions provides a better understanding of how risk perceptions influence policy preferences. Knowledge and awareness exert profound influence on individuals' decision-making capacities. A lack of understanding may cause an individual, and by extension, community leaders and eventually the community overall, to reach a less than efficient policy solution to address that topic (Stoutenborough et al. 2015). Thus, it becomes important to understand public perceptions of risk for effective and sound policy decisions and planning (Marris et al. 1997, Paul 2011).

2.5 Understanding Perception of Risk

It can be complex to understand perception of risk because a multitude of factors contributes to its formation (Sjöberg 1998). Our current understanding of risk perception comes from different subjects: geography, sociology, anthropology, psychology and political science.

Owing to the multidisciplinary interest focusing on perception of risk, different approaches have been employed for its understanding. Sociology and anthropology consider socio-cultural factors that affect risk, while psychology looks at discovering a set of mental strategies or heuristics that people use to make sense of an uncertain world (Slovic 1987). Geographers have focused their research on human behavior's response to natural hazards and have broadened scope of consideration to technological hazards (Slovic 1987).

Perception studies developed during the 1960s find grounding in Gilbert White's early work on natural hazard perception (Wood 1969). In the early 1980s, risk assessment and analysis relied on highly technical process to quantify the probability and magnitude of harm to human health and property from various technological endeavors (Jacquet and Stedman, 2013). This approach soon had to be broadened to understand and include individuals' differential risk perceptions. According to Slovic (1987, 285),

> There is wisdom and error in public attitude and perceptions. Lay people sometimes lack certain information about hazards. However, their basic conceptualization of risk is much richer than that of the experts' risk assessment.

Another way of understanding perception of risk is to look at the individual who is defining it. When risk perception is visualized as a continuous spectrum, on one end is strong technical approach and on the other is a constructionist approach. This means there is a difference between how experts perceive risk and how community, non-experts perceive it. (Miller and Sinclair 2012). New risks involve changed perception of severity among publics. In the definition and perception of risks, lay people assess risks using a different, often broader framework than experts (Starr 1969, Cutter 1993, Kasperson and Ram 2013).

To explain the theoretical framework on which I built my dissertation research, I begin by discussing idiosyncrasies of individual human minds. To gain a broader perspective, I then provide a spatial perspective by introducing the idea of how humans behave in their immediate surroundings and further discuss resource-based industries and risk perceptions in them. I end this chapter by providing a theoretical framework that guides my work.

2.5.1 A Psychological Approach to Risk Perception

Perception and Cognition

To understand how people perceive risk, I conceptualize causal factors of risk perception in three categories (Figure 2.1). These include psychological factor where cognition and affect shape risk perceptions, and other factors like imagery and sensory perception (individual level).

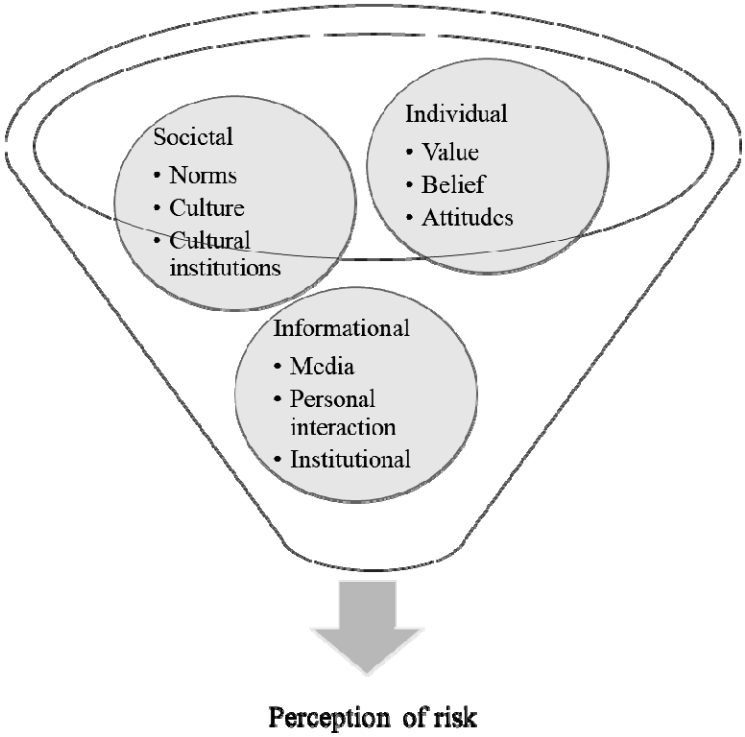


Figure 2.1. Causal factors of risk perception.

Societal factors include social norms, culture and cultural institutions (community level). The third is the information factor that can influence perception of risk (external factors). These three factors are subject to change over space and through time based on an individual's and community's experience with the industry.

The terms perception and cognition are often used in confusing manner. Two fields of study, geography and psychology often use these terms, and how researchers apply the terms is crucial to understanding what they mean. For instance, psychologists use the term perception as a subset of cognition, while geographers use it to understand humans' view of their environment (Wood 1970).

Cognition is the way information, when received, is coded, stored and organized in the brain. Perception, on the other hand, is the sense of how people remember or recall things. Perception is more immediate and stimulus-dependent, whereas cognition is concerned with linking the present with the past and how the future is projected. I use Stea's (1969) explanation to distinguish cognition and perception. Stea (1969), as cited as (Golledge and Stimson 1997) used a scale-dependent explanation, arguing that when spaces of interest are extensive, they cannot be perceived or apprehended all at once and cognition occurs. With more immediate surroundings or surroundings with which humans interact, perception takes place. Perception, then, is a subset or function of cognition (Golledge and Stimson 1997).

Perception necessitates an individual's interaction with their surroundings. How people observe their environment contributes to forming their attitude toward it. The real world is complex, and we as researchers can probably understand only a small fraction of how an individual receives signals about all aspects of life and environment (Golledge and Stimson 1997). An individual receives information (signals) through their senses: sight, hearing, smell,

taste and touch. As active information seekers, our senses only record those stimuli that have a bearing on our individual needs and ignore the rest. All experiences an individual undergoes with their immediate surroundings take place in a specific space and time frame.

When making decisions, individuals refer to their immediate surrounding and the knowledge related to their immediate surroundings. So, although on the larger scale cognitive processes – perceptions, attitudes and learning – work together to produce spatio-temporal awareness and knowledge for people about their environment, individuals make decisions based on experience of their immediate surroundings (Golledge and Stimson 1997). That is why, different people may have different interpretations of the same spatial structure or phenomenon. This variation may provide some explanation of divergence in different people's behavior in the same environment.

Importance of Belief, Attitudes and Behaviors in Perception of Risk

The way we perceive our environment and react to it depends on intrinsic and extrinsic information. How an individual sees the world is expressed in their language, choice of phrasing or terms used to describe objects. An individual's value, belief and attitude system work to guide an individual's behavior. Though a group of people may voice the same opinion about some object or event, each individual has arrived at that conclusion based on their individual senses, past experiences, cultural biases, knowledge and awareness gained from different sources, values, beliefs and professional training (Fridirici 1983). The source and frequency of information received play an important role. If individuals are provided with precise data on the magnitude and severity of events, they process that information to gauge the associated risk. In absence of precise data, individuals use subjective probabilities. The subjective probabilities are often not as well formed as real probabilities (Golledge and Stimson 1997). For instance, "it

can't happen to me" or "out of sight, out of mind" patterns are often reflected in people's attitude of anticipating future occurrence of events (Golledge and Stimson 1997). In such underlying assumptions that individuals make, psychologists recognize a method people use to protect themselves from possible adverse situations. As a person's experience grows, one can expect an alteration in their beliefs, attitudes and, eventually, behavior. It is expected that their attitude will tend more toward reality. Even then, the gap between expectation and reality in the real world can remain wide. This perception varies over space and through time based on changes in people's experiences which, in turn, can change their decisions.

The social psychology field is viewed as the scientific study of attitudes (Regan and Fazio, 1977, Ajzen and Fishbein, 2005). The field tries to understand the connections between beliefs, attitudes, and behavior. I understand the relationships between attitude, belief and behavior as shown in Figure 2.2. In short, attitudes are summaries of what people believe and

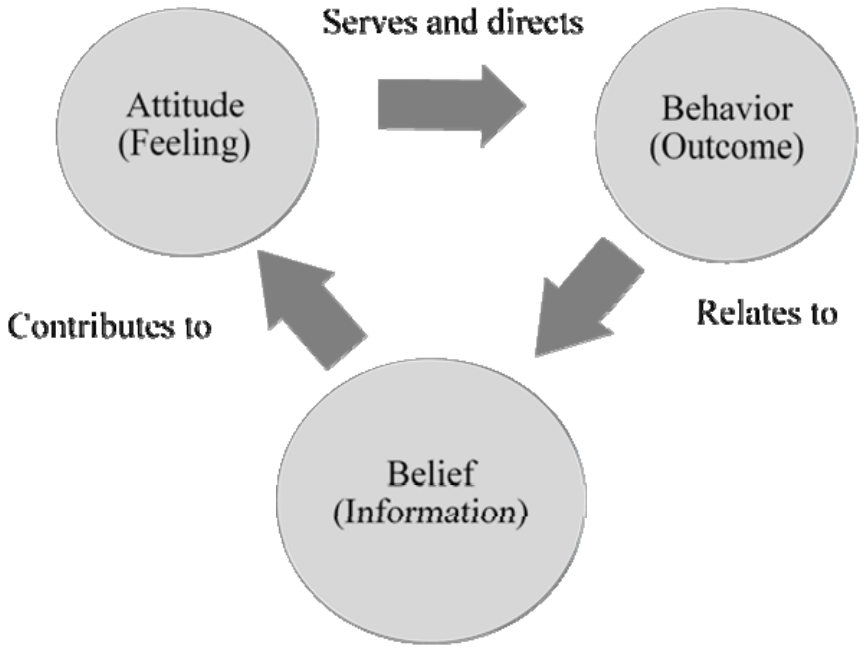


Figure 2.2. Connection between belief, attitude, behavior.

can reflect an individual's personality; they refer to the general and enduring positive or negative feelings about some person, object, or issue (Petty and Cacioppo 1981). In other words, attitude is regarded as "learned disposition to respond to a situation in a consistent way" (p 200).

Belief

Modern Anglophone philosophers of mind use the term "belief" to refer to the stance individuals adopt whenever they regard something as true (Schwitzgebel 2006). Belief is the information, factual or opinion – positive, negative or evaluative – a person has about a person, object, or issue. When a person learns a fact, they acquire a new belief. This belief may be stored in memory and accessed or recalled as needed. One may not actively reflect on the facts or things; they may simply be accepted as true. Consequently, many things that individuals believe are quite mundane or are facts. Forming beliefs is thus one of the most basic functions of mind (Schwitzgebel 2006).

Beliefs may be considered as propositional attitudes. A propositional attitude is "the mental state of having some attitude, stance, take or opinion about a proposition or about potential state of affairs…" (Schwitzgebel 2006), which means that something one individual fears or doubts might be believed, accepted or desired as another; hence individuals may have different attitudes toward the same propositions.

Attitude

Individuals hold attitudes toward some aspect of their world: it may be another person, a physical object, a technology or a policy. Attitudes are defined in various ways, but most investigators agree that attitudes are an individual's evaluations of an entity in question (Ajzen and Fishbein 1977). With advances in social psychology and improved understanding of connections between attitudes and behavior, researchers are beginning to realize that under some

circumstances, attitudes alone affect behavior. Renewed interest in attitude research may also be attributed to progress in cognitive processes' research in social psychology and other fields. A frequently asked question in social psychology is: can attitudes predict behavior? A key assumption of social psychological studies is, "that attitudes occupy a crucial position in an individual's mental makeup, and that, in particular, they serve as a powerful energizer and director of overt behavior" (Regan and Fazio 1977, 28).

Past research has doubted the ability of attitude to predict behavior. Beginning in early 1930s, LaPiere (1934) and Corey (1937), as cited by Ajzen and Fishbein (2005), challenged the view that verbal reactions to attitudes provide insight into how people behave in real world. In the following years, attitude and behavior studies started appearing in increasing frequency. The results of studies in the late 1960s and early 1970s were inconclusive, and researchers strongly suggested against using attitude to predict behavior (Ajzen and Fishbein 2005). Dillehay (1973), Kelman (1974) made several attempts to explain attitude-behavior relationship, as social psychologists recognized that the field needed to address these issues (Ajzen and Fishbein 2005). Moreover, concerns over validity of verbal attitude measures arose. An attempt to fix this problem by controlling response biases arising from participant's socially acceptable responses proved insufficient to solve it. Likewise, validity issues dogged the use of indirect methods of attitude measurement (Ajzen and Fishbein 2005). Additionally, Allport (1935) pointed out that a single-score evaluative dimension could not assess the multidimensional nature of attitude.

Ajzen and Fishbein (1977) point to the attitude's variable ability to explain behavior. They argued that attitude and behavior may be viewed as consisting of four different elements: action, target, time, and content. The failure to predict behavior from attitude resulted from attempts to understand specific behavior by measuring general attitudes. Therefore, if one wants

to predict specific behavior, then one has to measure the specific corresponding attitude. Hence, it is important to be sensitive to the time lapse between attitude and behavior measurement, as research has shown attitudes change over time and the researcher also needs to understand the subject's attention to "inner state' (Petty and Cacioppo 1981, Ajzen and Fishbein 1977). Therefore, as the predictive relation between attitude and behavior is complex, the focus of 'whether attitudes can predict behaviors' changes to 'when attitudes can predict behavior.' The degree of correspondence between attitudinal and behavioral entity determines the strength of attitude-behavior relationship. Thus, in my study, I employ the direct technique to measure attitudes using Likert scale of measurement.

Behavior

Social scientists are interested in understanding how decisions are made about technological risks (Clarke 1988). In social psychology, the relationship between belief, attitude and behavior is a common topic of study. It is generally assumed that people who hold positive attitudes are expected to engage in behaviors that support or enhance those attitudes (Stedman 2002). This does not mean attitudes can predict behavior, but knowing what people believe can help in understanding their decision-making processes and, eventually, help explain their behavior. Humans often make decisions in uncertain environments. They make these decisions based on awareness, imperfect knowledge and – in context of uncertainty – what other people are deciding and expected impacts of decision. They make choices based on an expected likely outcome.

By understanding an individual's beliefs on one hand and risk perceptions on the other, we can elaborate on the psychometric tradition in a way that makes risk perception research in

environment and technology more applicable to controversial situations. Behavior is an outcome or observed action that may be positive, negative, or not evaluative at all (reference).

Beliefs play a causal role in production of behavior. Belief contributes to forming of attitudes and attitudes serve and direct behavior. Belief is information (whether factual or not) and intentional behavior is triggered by electrochemical event but regulated as an outcome of processing information (Dretske 1988 as cited by Sandis 2008). Once we understand what influences a person's attitude, we can understand their likely behaviors better. So, if the aim is to bring about change in attitudes, one can use those determining characteristics to persuade attitudinal change.

Ajzen and Fishbein (1977) argued that a person's attitude toward an object affects the overall pattern of their response toward the object but need not predict behavior. To predict a single act from an attitude toward that act, there needs to be a high correlation between intention and behavior. Thus, it has become an important aspect of social-environmental interaction studies to examine how individuals and groups perceive and value their natural and social environments. It can be useful to understand attitudes and, when possible, realistic predictions of behavior for persuasion and planning.

2.5.2 A Geographical Approach to Risk Perception

Humans constantly interact with their environment. Individuals' environmental beliefs become reference frames that are used to utilize natural resources. Land and environment(s) are integral to the study of geography. In geography, environmental perception is one of the important themes of human-environment studies. Others include human impacts on environment and environmental impacts on people (generally considered through hazards research). Risk perception refers to an individual's views about the risk involved in a situation (Wen 2015), so

environmental risk perception involves the risk an individual perceives about their surroundings or environment. Beliefs and attitudes also guide an individual's behavior in their surroundings and are often used as predictors of environmentally responsible behavior (Corral-Verdugo et al. 2003). Environment and public health studies started getting attention in post-World War II period after traditional industry's expansion and absence of regulatory restrictions caused negative effects on people and their surroundings (Tarr and Jacobson, 1987). After the 1960s in the United States, environmental risk studies and environmental risk perception research took place. (Tarr and Jacobson 1987). The uncertain nature, seriousness and consequences of most environmental problems and their management require environmental risk perception evaluations of experts and laypersons, as the starting point for environmental policymaking (Steg and Sievers 2000).

To understand this changing dynamic, we can use environmental psychology and advances in transactional approaches (Aitken and Bjorklund 1988). To an individual, places have meanings and importance. But both meaning and importance are subjective, an outcome of an individual's experience and interaction with the place. Transactionalism is a position that understands the person in an environmental context, as a function of on-going transactions between the person and environment. "This transaction includes the person's construal of past and future expectation" Aitken and Bjorklund (1988, 55). In this context, behavioral and environmental perception geography plays a critical role in understanding how societies and individuals view risk, acceptance, and uncertainty of new technology.

Behavioral geography is developed on the tenet that human behavior is an outcome of subjective images rather than objective information. Bunting and Guelke (1979) suggest that "People behave in real world not on the basis of objective knowledge but in terms of subjective

images." Thus, behavioral geography studies collect data at a disaggregated (individual) level, recognizing that individuals' behavior varies on their perception of environment. This field attempts to understand human activities in space, place and environment (Montello 2013).

Early behavioral research relied on theories from psychology. These theories were later modified to fit the spatial regime (Golledge 2008). Behavioral geography tries to explain what individuals think or how an individual behaves or takes decision in space. Individuals rely on perceptual knowledge they gather through their senses and organize, and then translate their thoughts into belief, eventually building knowledge structures. Their experience of place influences these structures, with events around them and knowledge gathered over time through changing circumstances. Influences on individuals can relate to their history, politics, social structures, psychology, and experience in place. Behavioral researchers want to change the simplistic and mechanistic conception of man-environment relations with a new perspective, one that recognizes the complexity of human behavior (Bunting and Guelke 1979).

Behavioral and perceptional geography is built on the theory that humans react to environment as they perceive and interpret it through previous knowledge and experience (Bunting and Guelke 1979). The aim of behavioral and perceptional geography, then, is to try and answer questions about ways of dealing with a continuously or abruptly changing environment for both people and their physical surroundings. Both people and places are susceptible to change, the situational or personal factors that account for variable changes and reactions that may be unique to a place or environment (Aitken and Bjorklund 1988). Understanding of how people perceive their environment helps researchers interpret better the nature-society interactions with location. For instance, a change in interpretation of behavior by a person at that place follows a change in behavior of an environmental system.

How individuals and groups perceive and value their natural and social environments, giving place meanings, is an important aspect of socio-environment interaction. Thus, perception of environment plays an important role in determining attachment to place and environmentally responsible behavior (Bunting and Guelke 1979, Flint and Luloff 2005).

2.6 Risk Perception Theories

The current knowledge of risk perception is multidisciplinary and a variety of measurements of risk perceptions exists. Starr (1969) put forth one of the earliest theories of risk perception. This theory involved the psychometric analysis of risk perception, the "Psychometric Paradigm." Other frequently used theories of risk perceptions include Knowledge Theory, Personality Theory, and Economic Theory, including Materialistic and Post-Materialistic Theory, Political Theory, and Cultural Theory (Cutter 1993, Wildavsky and Dake 1990, Sjoberg 2002). Of these, the Psychometric Paradigm and Cultural Theory are the most relevant to the current study and are described below. The last theory, Social Disruption Theory provides a lens for understanding community changes. This theory ties in with understanding social and psychological place-based risk perceptions, in this study, environmental risk perception.

2.6.1 The Psychometric Paradigm

Although initial studies on risk perceptions date back to the 1960s, the concept of perceived risk became prominent only in the 1970s after the work of Paul Slovic, Baruch Fischhoff, and Sarah Lichtenstein (Paul 2011). Starr put forth one of the earliest approaches to the study of technological risk perception (1969): the psychometric analysis of risk perception. Starr (1969) argued that technological analysis for disclosing relationship between expected

performance and monetary costs is a traditional part of all engineering planning and design. The inclusion of societal costs is less customary, as that analysis is more difficult and less definitive (Jacquet and Stedman 2014). Moreover, Starr added that assessment of social value as a function of technological performance is not uncommon but may not always be quantitative.

Starr developed a method for weighing technological risks against the benefits a society gets in exchange for the risks (Slovic 1987). Starr reasons that since there is no predictive system analysis for understanding quantitatively the causal relationship between specific technological developments and societal values, either positive or negative; historically, the society reaches through trial and error method an "optimum" position.

Fischhoff et al. (1981) conducted an analogous psychometric analysis resulting in expressed preference of risk perception. A psychological scaling and multivariate analysis technique are used in a psychometric analysis to produce quantitative representations of risk attitudes and perceptions. Following on Starr's work, Slovic (1987) built on Starr's (1969) study about the cost society is willing to pay for benefits it receives from technological advances. Studies that use the Psychometric Paradigm claim that for most people risk is more than a combination of "size of damage" and "probability of damage," which are the core parameters of technical risk (Paul, 2012). Slovic (1987) suggested developing a taxonomy for hazards that can be used to understand and predict people's responses to their risks, with the idea that it could explain the variance of people's risk perception toward hazards in combination with psychometric analysis. The main goal of this analysis is to produce quantitative representations or "cognitive maps of risk attitudes and perceptions" (Slovic 1987, 237). This approach is often extended to current and acceptable riskiness of diverse hazards and desired level of regulation of each risk (Slovic 1987).

One of the Psychometric Paradigm's most important assumptions is that risk is inherently subjective. According to Slovic (1993), risk does not exist 'out there,' independent of our mind and cultures, waiting to be measured. In short, the Psychometric Paradigm encompasses a theoretical framework that assumes risk to be subjectively defined by individuals who may be influenced by a wide array of psychological, social, institutional, and cultural factors (Sjöberg, 2000). If one appropriately designs the survey instrument, the factors that account for risk perceptions among individuals can be quantified (Sjöberg 2000). Slovic (1987) suggested that psychometric techniques are well suited for identifying similarities and differences among groups about risk perception and attitude. Psychometric Paradigm's proponents accept that cultural theory carries important explanatory power with respect to perceived risk (Sjöberg 2003).

2.6.2 Cultural Theory

Cultural theorists view individuals as active organizers of their own perceptions because of cultural biases that are connected to worldviews or ideologies encompassing deeply held values and beliefs that defend different patterns of social relations. Douglas (1978) introduced the approach and Douglas and Wildavsky expanded it (1982). During the 1980s, with the rise of Cultural Theory, sociologists and anthropologists began analyzing socio-cultural influences on risk perception (Rippl 2002). Wildavsky and Dake (1990) stated that individuals choose what to fear and how much to fear to support their way of life. In their view, risk perception and concerns about environment or social issues are socially and culturally framed (Wildavsky and Dake 1990, Rippl 2002). This implies that risks are socially constructed (Steg and Sievers 2000). Differences in risk perceptions are a consequence of social relationships, cultural biases and preferred behavior (Wildavsky and Dake 1990, Steg and Sievers 2000). These three factors

together form ideologies grounded in deeply held values and beliefs and explain the variation in selection of worry or dismissal of worry (Wildavsky and Dake 1990).

Cultural biases drive social relations. Steg and Sievers (2000, 251) stated that "Cultural Theory implies that people can be classified into four groups (i.e. four ways of life) based on their views and values." These four ways of life are: hierarchical, egalitarian, fatalists and individualist. There is no causal priority between cultural bias and social relations. These qualities influence risk perceptions, judgements, and preferences for management strategies. Cultural bias and social relations together have an impact on the ways of life or political cultures (Wildavsky and Dake 1990). All possible risks selected for worry or dismissal are functional in the sense that they strengthen one of these ways of life and weaken others. Wildavsky and Dake (1990, 57) found that "knowing what sort of perceptions come from which kind of people may allow for practical applications of cultural theory and a variety of policy context." Moreover, cultural dimension may provide a better explanation of risk perception, a view supported by psychometric analysts (Marris et al. 1997).

A combined analysis of psychometric data and more qualitative explorations of motivations behind risk perceptions of an individual's response can together lead to a more detailed and deeper understanding of perceptions of risk, and hence better targeted risk communication approaches. Wildavsky and Dake (1990, 50) compared theories to understand risk perceptions and concluded that "cultural biases provide predictors of risk perceptions and risk-taking preferences that are more powerful than measures of knowledge and personality and are at least as predictive as political orientation." Sjöberg (2000) has suggested that effective studies of risk perception are possible through combined use of the Psychometric Paradigm and Cultural Theory. The rationale for this suggestion stems from the argument that risk perception

varies among respondents, depending on the issue being evaluated and the definition of risk being used. Moreover, knowledge about the risk, personality and the individual's political orientation or demographic characteristics provide one of the best predictions of a broad range of perceived risks in an interpretative framework. At the end, though, individuals perceive risk in a manner that supports their way of life. They, however, provide a cautionary note that "perception of danger is selective; it varies with the object of attention."

2.6.3 Social Disruption Theory and Addictive Economies

A place is a bio-physical area, whereas community refers to a realm of social interaction that may have a locational (place-based) identity. Gusfield (1975) defines two types of communities, territorial or geographical and relational (as cited by McMillan and Chavis 1986). Jacquet and Stedman (2013) use the same concepts but call them place and community. Flint and Luloff (2005) describe community as a source of mutual identity for local actors. Place and community are not mutually exclusive (McMillan and Chavis, 1986; Jacquet and Stedman, 2013). The interaction of an individual in place and community is important, as biophysical experience can transform local landscapes into symbolic extensions of oneself with personal meanings of life experiences (Jacquet and Steadman, 2013).

Beginning in the early to mid-1970s and continuing into the mid-1980s, large-scale energy resource development projects became widespread throughout the American West (Krannich 2012; Council on Foreign Relations 2019). Experiences with these developments provided the first step toward developing a scientific understanding of social effects of rapid energy-related growth at local level (Wilkinson et al. 1982). In most instances, these developments occurred in sparsely populated, geographically isolated areas. Few places had prior experience with large-scale energy developments. Those towns that had prior experience

were facing recent declines in population and economic downturn, a common cyclic phenomenon associated with extractive industries (Krannich 2012). Consequently, several communities affected by energy development did not have enough local labor force to meet employment demands and commuting of employees was not a viable option.

With new surge of economic activity, the 1970s-80s resource development towns experienced intense economic, demographic, and social changes that were different from those documented in previous rural industrialization locales (Krannich 2012). The media at the time, though, often sensitized the studies based on patterns of community change in modern-day boomtowns affected by large-scale energy resource development. However, numerous state and federal policy initiatives designed to mitigate adverse socio-economic effects zeroed in on communities linked with energy development (Smith et al. 2001). Over nearly two decades, a large body of social science research emerged addressing social-economic consequences of energy development in boomtowns. Much of this research adopted a social disruption perspective (Smith et al. 2001).

Wilkinson et al. (1982) critically reviewed social disruption caused by energy development. They found that Kohrs, who worked as a clinical director of a counseling center in Wyoming, recorded accounts in 1974, which formed early studies. Kohrs argued that overcrowding and inadequate planning for meeting people's need produced what he called the "Gillette Syndrome." He described "Gillette Syndrome" as increased accounts of drunkenness, anomie, mental discord, suicide attempts, teen-age rebellion, and divorces (Wilkinson et al. 1982; Weber et al. 2014). Researchers used Kohrs' observations as primary documentation of social disruption (Wilkinson et al. 1982). According to this hypothesis, rapid growth leads to crisis, loss of community norms and less effective community services.

Gilmore (1976) produced an oft-quoted paper where he gives an example of an imaginary town with boomtown problems, but he claims it to be typical of a modern-day boomtown. Gilmore (1976) argued that rapid population growth resulting from increasing employment opportunities linked with oil and gas energy development can put a strain on small communities to provide services. A town's growth can eventually cause institutional breakdowns in labor market, housing sector and financial support of public systems. There is an increased gap between demand and supply of services, which can lead to mistrust and criticism of authority. As regards the social fabric, newcomers can be isolated from the community and young people may drop out of school to take up jobs in construction. But revenue source from mining can be temporary and when mining production declines, individuals lose their source of income and their way of life gets disturbed, causing increase in mental health issues (Wilkinson et al. 1982).

The early social disruption studies drew criticism for their use of undocumented assertions as evidence, questionable interpretation of empirical data, over generalization of conclusions and absence of controls in measures of relationships (Wilkinson et al. 1982; Smith et al. 2001; Krannich 2011). Furthermore, Krannich (2011) points out that Freudenberg's (1976) studies on social disruption research focused on the impact of people on service agencies and not on people's reactions to changes. The other criticisms of this approach included focus on a single community approach, lack of methodological rigor, lack of comparative studies to understand differential growth trajectories and impacts and lack of longitudinal studies to get a holistic understanding of the boom bust cycle. Essentially, the social disruption hypothesis provides a context for examination of negative impacts of boom bust cycles but fails to provide mitigation measures to negate the impacts (Weber et al. 2014).

In the 1990s, Freudenburg introduced a new theoretical approach dwelling on broader concerns of resource dependent communities, the *addictive economies* approach. This approach focuses on socio-economic vulnerabilities of communities dependent on resource extraction. According to this notion, volatility of resource prices and related cyclic shifts in employment and economic activity make it difficult for resource-based communities to pursue developmental strategies effectively (Krannich 2012). In many locales where extractive industry becomes dominant, economic diversification is limited. This is because extraction-based industry creates jobs but, at the same time, precludes investment in other industries. Whether the resource may or may not exhaust in the future or fails to give economic benefit, the community may have over-adapted itself to suit the needs of only one industry. Such socio-economic conditions may limit sustainable development trajectories (Krannich 2012). Consequently, long term, vulnerability and instability of community increase.

2.7 Conceptual Framework for This Research

To investigate the level of and variation in risk perception in resource extraction related communities in Kansas and Oklahoma (objective one and two), I use the social disruption hypothesis lens to understand changes in the community. To explore factors associated with risk perception, Cultural Theory and the Psychometric Paradigm inform the research (Objective 3). I apply the geographical approach to risk perception to explore place-based differences in meaning of risk, variation in perceived risk, and factors associated with risk perceptions. These theories are informed understanding data observations and making a sense of findings.

The interface between environment and society is most explicitly found in natural resource-based communities (Flint and Luloff 2005). These are places where environmental and

societal interrelationships have multiple values and interpretations in the context of local interactions, decision-making and collective action (Flint and Luloff 2005). When rapid changes happen in communities, they affect both the physical place and the community. These changes can often bring out feelings or emotional bonds, previously subtle or subconscious, that people have with places. Paul (2011) points out that Kasperson et al. (1988) maintained that risk bore a close relation with an individual's psychology, culture, social and institutional factors, which may contribute to or reduce public perception of risk. Therefore, understanding how people base their personal identity in social relationships and their role in society, along with their role or function in the place where they live, has become a topic of interest (Jacquet and Stedman, 2013). The intricate ways in which self or individual is placed in socio-spatial environment changes the meaning of place and community.

Resource extraction, typically, occurs in rural communities. Rural communities are often projected as "complete and self-contained local society" (Wilkinson et al. 1982). Outside forces influence local conditions and events, leading to the proposition that small communities can do little to influence outside forces controlling their development. Kaufman (1959) and Warren (1978), however, provided an alternative view of a modern community as a dynamic form with interactive forces tending toward systemic unity. These are places where interactions between local and extra-local interests are at play and neither can be ignored in understanding community outcomes (Wilkinson et al. 1982). This also means that the residents' actions can influence outcomes, no matter how large the outside forces at play.

Place-based meanings are the values or interpretations of places that individuals or groups develop through their interactions and experiences of places. The nature of these experiences then become the basis of evaluation for individual interpretations or social

constructions of meaning, and determines the bond an individual develops with the place and the value and degree of uniqueness an individual associates with the place and later extends to community characteristics (Jacquet and Stedman 2014). Residents and leaders of rural towns often see extraction of natural resources as providing an antidote to regional poverty (Frickel and Freudenburg 1996). Previous experience of communities dependent on extractive industry have seen mixed results, where some regions have seen benefits, and some have faced challenges. Extractive industry is connected to periods of rapid expansion, including rapid population growth, unprecedented job opportunities and heavy demand on community services and facilities, followed by decline (Weber et al. 2014).

Since resource-based communities have multiple meanings and interpretations of environment, it is difficult to find consensus on an issue. Disruption of place-based identities can have profound traumatic effects on individuals in a community, increasing the perceived risk about an activity. Conflict can mobilize community activity (Flintoff and Luloff 2005). Additionally, disruption becomes an important motivator for human behavior, including mobilization of community resources to deal with problems (Jacquet and Stedman 2014; Wilkinson et al. 1982). For instance, Kassover and McKeown's (1981) study in Gillette, Wyoming, looked at mental health impacts from energy development and found that the community perceived higher negative impacts in the development's initial stages, even though the growth did not occur for several years (as cited by Jacquet and Stedman 2014). On the individual level, mental health analysis of caseloads dealing with stress of a changed community increased disproportionately when the boom started (Jacquet and Stedman 2014). On a community level, mobilization of resources and community action depended on a shared

community perception of risk. Eventually, it is essential to include place-cultural considerations in risk mitigation to prepare effective plans for risk communication.

Studies have shown that development of industries, including energy development, influences a community's socio-demography, economic status, and environmental quality (Bugden 2014, Adgate et al. 2014, Bamberger and Oswald 2012, Boudet et al. 2014). Furthermore, development of oil and gas requires support from local communities, industrial players and government policy. Several attempts have been made to understand the impact of energy development (e.g., Hays 2014, McKenzie et al. 2011, Goldstein 2012, Hays and Law 2014), but there remains a dearth of contemporary data on perception of risk, concerns of individuals and benefits and values associated with such development.

This research advances current evaluation of perception of risk by including social and psychological disruptions to place-based risk perception studies. A place-based risk perception identification helps to identify effective channels of communication, especially in rural areas. I use the social disruption hypothesis lens to understand changes across selected counties in Kansas and Oklahoma. I also employ a multi-county or multi-community approach to identify different experiences and help learn valuable lessons for sustainable planning. Such a place-based approach aids in planning more acceptable/effective development policy. Rural America is a very diverse place, so "one size fits all" policy does not work (Browne and Swanson 1995). Rural needs are best met at the local level. Therefore, this local-level evaluation integrating psychological, geographical, behavioral, and environmental aspects of perception of risk provides a more holistic understanding of places and place-based factors that contribute to perception of risk. Above all, it helps identify effective channels to aid fruitful communication

of risk, as well as education of public and their involvement in the research and decision-making process.

Perception of risks is the result of subjective judgements rather than scientific, objective outcomes (Paul 2011, Bunting and Guelke 1979). Behavioral and environmental perceptional geography assumes that humans behave according to subjective images they create about the world (Bunting and Guelke, 1979). The behavioral and environmental geography approach builds on the theoretical premise that a person people reacts to their environments as they perceive and interpret it “through previous experience and knowledge" (Bunting and Guelke, 1979, 449). On the other hand, social psychological studies assume that “attitudes occupy a crucial position in the individual’s mental makeup and serve as a powerful energizer and director of overt behavior" (Regan and Fazio 1977, 28). By combining psychological and geographical principles together, the factors contributing to subjective interpretations can help increase the explanatory value of risk perception models. Risk perceptions are a valid component of risk mitigation and communication, along with the scientific or technical assessment of risk. Empowered and equipped with this information, risk managers can identify effective routes for risk communication.

In the next chapter, I discuss the study area and relevant aspects of the states of Kansas and Oklahoma. The chapter includes sociodemographic characteristics of the counties included in the study and their relationship over time with the oil and natural gas industry.

Chapter 3 - Study Area

3.1 Overview

In this chapter, I talk about rural America and then present a brief history of oil and natural gas in Kansas and Oklahoma. In these two states, I make a distinction between conventional and contemporary development and regulation of fossil fuel industry. I discuss Oklahoma first and then Kansas, as it precedes Kansas oil and gas timeline. Later, I describe attributes of study counties, including their socio-demographic characteristics, relationships to fossil fuel industry and social vulnerability. This discussion about study counties lays a foundation to understand the contexts in which oil and natural gas development took place and to potentially help explain and give context to data collected in this study.

3.2 Rural Context

For this study, I restrict analysis to only those counties in Kansas and Oklahoma underlain by the Mississippian Limestone Play (MLP). Counties are used for data summarization and analysis, as they have stable boundaries and are the basic unit for reporting socio-economic and demographic data by agencies (Johnson and Rathge 2006). This region is predominantly rural, as are most resource-dependent areas.

The way we think about regions in general, and rural areas specifically, reflects our understanding of a place (Isserman 2005). Rural is often synonymous with agriculture, hence agricultural policy is considered as rural policy (Mario 2001). Rural areas are deemed as regions of lagging economic growth, population loss, low skilled labor, and overall decline.

With improved transportation, infrastructure, communication, and access to the internet, coupled with rural amenities and perceived positive characteristics, rural areas are attracting

people and businesses. For instance, rural landscapes can provide plenty of land at low cost and be free of traffic congestion and pollution, factors that appeal to some people. Little wonder, there has been a trend among urban residents to move to rural areas for "quality of life factors including proximity to open countryside and natural amenities" (Pezzini 2001, 135). Similarly, lower cost of manufacturing and lower labor costs have been attractive features for many industries.

Development in rural America presents unique opportunities and challenges. How researchers define 'rural' plays an important role in how policy is planned (Ward and Hite 1998). Currently, rural areas are defined in relation to urban areas: 'rural' places are generally those left over after metropolitan or urban areas have been identified. For this study, I use USDA's ERS typology of metro and non- metro (Cromartie and Bucholtz 2008) for understanding socio-economic characteristics of counties. Although this is a coarse classification, metro (urban) and non-metro (rural), it is a common practice among researchers to use this classification.

Social scientists in advanced economies are realizing that specific rural areas are different from the generalized picture of rural decline because of heterogeneous local conditions (Ward and Brown 2009). OECD's recent analysis suggested that a 'traditional rural problem' of decline is being replaced by a 'new rural dynamism' around growth, innovation and interconnectedness (Ward and Brown 2009). Thus, the idea of rural dynamism focuses on heterogeneity of rural areas rather than similarity (Ward and Brown 2009).

3.3 Petroleum Industry in Oklahoma and Kansas

Petroleum and natural gas industries in Kansas and Oklahoma constitute an important economic contributor for both states, although since early 20th century the two states have

shown different trajectories of oil and gas production. For instance, according to the U.S. Energy Information Administration (EIA), in 2017 Kansas produced 815 trillion BTUs of energy, ranking the state 24th in U.S., while Oklahoma generated 4160 trillion BTUs, placing the state 5th in the country. In oil and natural gas production Oklahoma has always ranked higher than Kansas.

Conventionally, in these state local oil and gas companies explored fossil fuel riches. In recent times, larger regional and international players have been interested in exploring the area for oil and natural gas reserves. In several parts of central and western Kansas and north central Oklahoma, Mississippian rock layers bear oil (Evans and Newell 2013). Rocks deposited during the Mississippian (sub) Period (395-323 million years ago) are found in the subsurface through most of Kansas and northern Oklahoma (Figure 3.1). In geology, a group of oil fields or prospective oil fields in the same geologically controlled circumstances is called a Play. Western Kansas and north-central Oklahoma are underlain by a geological formation known as the Mississippian Limestone Play (MLP), also known as Mississippian Lime. The Mississippian layers are progressively deeper from east to west. The MLP is low-permeability limestone.

The MLP is shallower and easier to frack than the Bakken formation in North Dakota and Montana, Eagle Ford Shale in Texas, and the Marcellus shale formation in Pennsylvania. However, the MLP produces more saltwater compared to the Bakken formation, but disposal is a problem. This has prompted many companies to experiment with optimizing production rates and minimizing costs. However, as oil production from rural sites is more embedded in global energy and economic systems, their vulnerability to volatile economic conditions increases. For instance, some small rural communities get attracted by potential economic growth opportunities in the form of jobs and investment from oil and natural gas extraction through hydrological

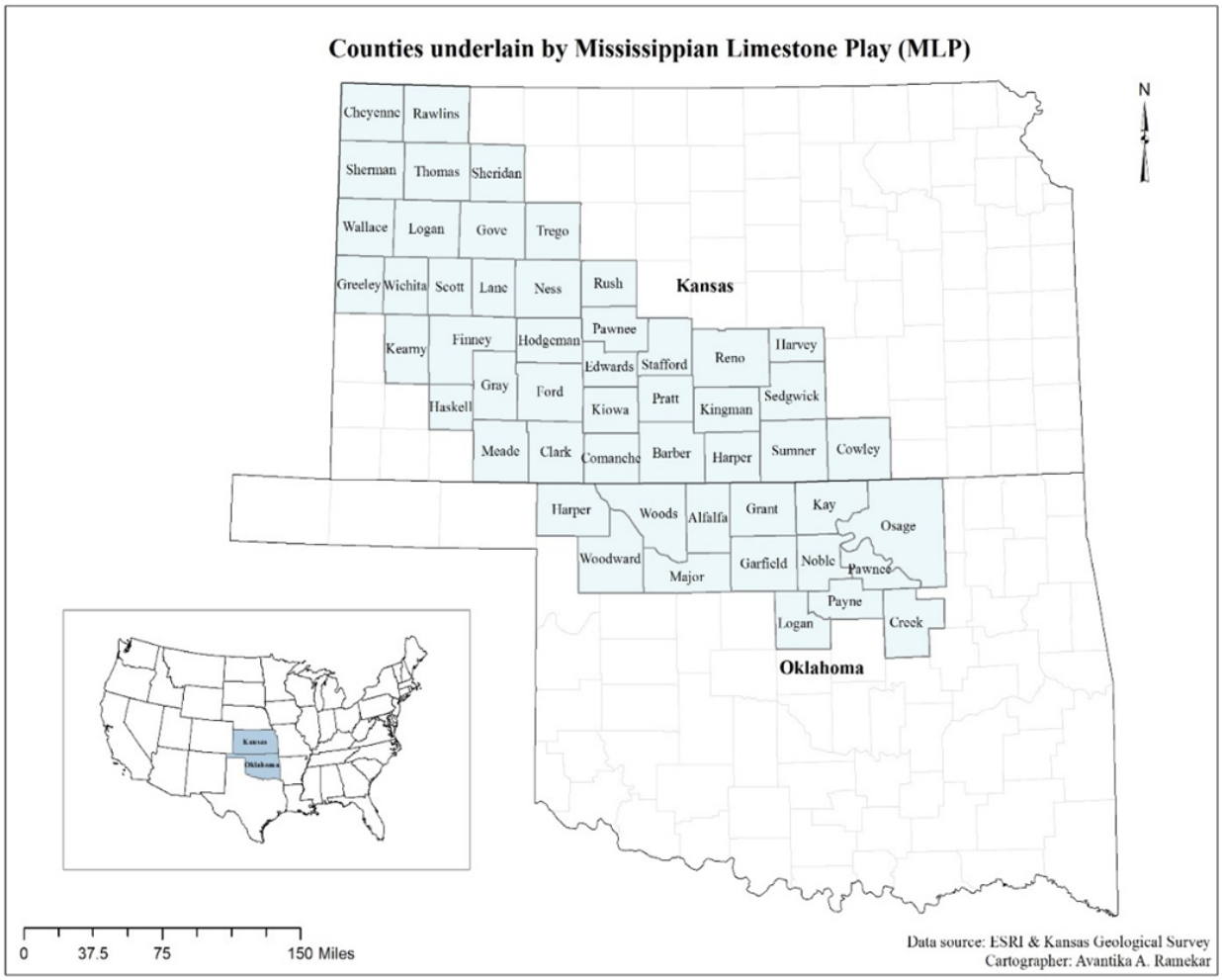


Figure 3.1. Counties underlain by MLP in Kansas and Oklahoma.

fracturing technology (Flora, Flora, and Gasteyer 2016). However, it is the world market's crude oil and gas prices that dictate decisions of when to produce and how much. These prices are based on the demand and supply at the time, and corporations make the decisions of production: which means production is beyond the control of local areas.

While quantities of natural resource reserves and their monetary value can be evaluated based on physical assessments and historical trends, impacts of extractive industries at the local level vary from one community to another based on the community's nature and its resilience to

change. Thus, impacts of extraction and use (and interruption of extraction) on a community are unknown.

3.4 Oil and Gas History

3.4.1 Oklahoma Oil and Gas History and Regulation

Long before European settlers arrived and settled in this place, Oklahoma had identified oil seeps. In oil industry, Oklahoma's prominent place comes from its hydrocarbon-rich geological basins and their associated oil and gas pools. Before petroleum industry's formal development in the state, Native Americans or First Nations people used the black liquid that oozed from beneath rocks and accumulated on surface of creeks and springs as medicine for themselves and animals (Frank, n.d.). Frank (n.d.) in Oklahoma Petroleum History (n.d.) reports the accidental discovery of the first subsurface oil in 1859 in Mayes County in a well drilled for salt. Since 1859, many individuals at different locations and through different means came across Oklahoma's oil and natural gas. In 1872, a company attempted to set up the first petroleum enterprise, but Federal laws at the time did not recognize the company. In 1878, a method of prospecting for oil known as 'creekology' was used, and the U.S. Geological Survey released a document describing surface signs useful in identifying prospective oil and natural gas reserves (Franks n.d.). 'Creekology' was a petroleum prospecting method based on identifying oil seeps in streams from iridescent surface sheen and/or blackish fluid oozing into the water. These signs were quickly linked with occurrences in Oklahoma. By 1901, Tulsa was called the "Oil capital of the world" (Frank n.d.).

During first three decades of 20th century, Oklahoma had discovered oil and natural gas in several places (Franks n.d.). The development of the Hugoton-Guymon Gas Field started in

Texas panhandle and spread northward across Oklahoma panhandle into southwestern Kansas. This field became the nation's largest natural gas discovery and a principle source of helium. The year 1928 marked the transition of 'creekology' to modern geology, and discovery of the Oklahoma City oilfield (Franks n.d.). The economic challenges of Great Depression and plunge in crude oil prices triggered decreased petroleum production. It was not until World War II that demand for oil and natural gas shot up again, spurring increased drilling (Frank n.d.). The then-governor W. H. Murray ordered a prorationing program to limit production and allocate it among the wells in a reservoir. In the petroleum industry, prorationing means the government allocates a fixed amount of acreage that one well can (theoretically) drain in a specific formation or at a specific depth. This system ensures regulation of production in proportion to recoverable reserves (Cook 1978). This measure made Oklahoma the first producing state in the U.S. to enforce conservation by regulation. Governor Murray advanced the argument that he was securing oil and natural gas resources for future generations (Cook 1978).

During the 1950s, stress erupted between consumption and discovery of the oil and gas industry. Although U.S. oil fields were producing, major oil and gas companies were shifting overseas. In the early 1970s, the Arab oil embargo and deregulation of deep natural gas helped reverse the previous trend. During the 1973 Arab-Israeli war, Arab members of Organization of Petroleum Exporting Countries (OPEC) imposed an embargo against the United States, banning petroleum exports and cutting off oil production in retaliation for the U. S. decision to resupply Israeli military. The Arab oil embargo strained the U.S. economy, which had grown increasingly dependent on foreign oil.

Then, development of the Deep Anadarko Basin in southwestern Oklahoma triggered a new oil boom. In the early 1980s, oil production declined sharply, with state production reduced

to 40 percent of the 1986 level. It was not until 2000 that the state saw renewed interest in oil and natural gas production.

In early years of oil and natural gas industrial development, conservation-related regulation focused only on preventing surface damage and physical waste of oil (Cook, 1978). With greater awareness based largely on lessons from past experience, most states now have regulatory bodies that keep a check on oil and natural gas activities. The Oklahoma Corporation Commission (OCC), established in 1907, regulates oil and gas drilling, production, safety aspects of transportation (motor carrier, rail, and pipelines), environmental safety and integrity of petroleum storage tanks in Oklahoma. In 1914, the Commission began regulating oil and gas, including oil and gas drilling, production, and environmental protection. It also administers federal regulations for underground injection of water and chemicals, injection of wastewater and remediation of soil and groundwater pollution caused by leaking petroleum products. The OCC's Oil and Gas Division is responsible for ensuring that oil and natural gas operations are fair and function in an orderly manner while protecting the environment and ensuring public safety.

3.4.2 Kansas Oil and Gas History and Regulation

The connection of Kansas to oil and natural gas industry dates to 1860 when the first oil well was drilled in the area, which is now Miami County. Although the 1860 well was marginal, it did produce, and development and exploration continued for next three decades. It was only after 1892 that the State established commercial oil production. Some of the wells encountered natural gas, which was then considered an annoyance. After the 1890s, natural gas began serving as a desirable cheap energy source for brick plants, zinc smelters and cement plants, especially in the state's southeastern part. This cheap natural gas for fuel set off industrial

development in the region, especially in first few years of 1890s (Nixon 1948). However, it led to overexploitation of natural gas, causing declines in production because of depletion and subsequently, reducing industries in Kansas that depended on this energy source.

It was only after discovery of the Augusta and El Dorado oil pools in Butler county in 1914, that State of Kansas earned in 1915 the standing of a significant oil producer (Nixon 1948). In 1922, a large natural gas area was discovered, the Hugoton Field, under southwestern Kansas. After 1930s, construction of major pipelines facilitated Hugoton's development as one of the world's largest natural gas fields. Over the years, though, exploitation reduced the amount of production from the Hugoton Field. Today, it produces only about 13% of total production of 1966 (Kansas Geological Survey, last accessed in May 2020.).

In 1923, southwestern Kansas gained significance in oil and gas industry with discovery of oil in Russell County. Since then, Kansas has discovered more than 7000 oil and gas fields (big and small). Several of these fields are located along a geological subsurface structure that runs along the Central Kansas Uplift (Figure 3.2). Oil and natural gas production from the MLP is positioned along the edges of Central Kansas Uplift.

Depending on global oil prices, production varies, and a region goes through oil boom and bust cycles (Rapier 2015). Since 1940s, the Mississippian Limestone Play formation has been drilled using vertical drilling. In 2007, with advances in drilling technology, such as use of directional or horizontal drilling coupled with hydraulic fracturing (fracking), the MLP witnessed drilling of the first horizontal well. Historically, local independent companies have drilled most of the oil and gas wells in Kansas, with considerable production rates and profits (Evans and Newell 2013). Since 2010, however, larger regional and international companies leased

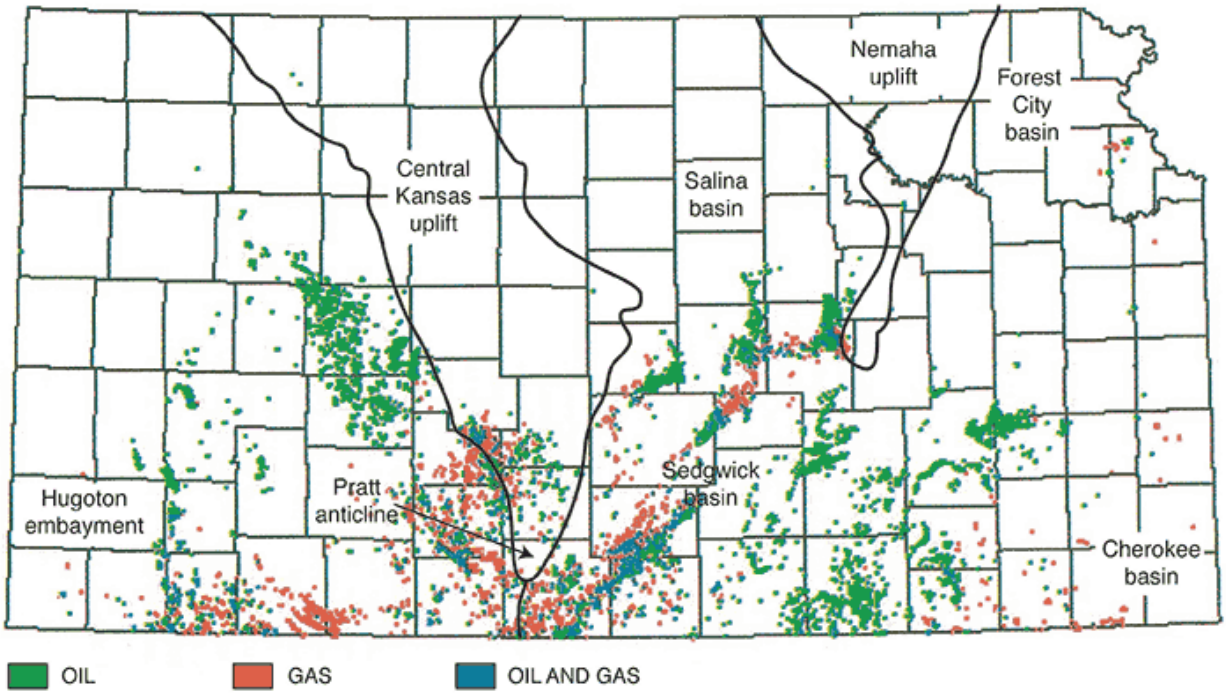


Figure 3.2. Major subsurface geological structures in Kansas.
(Source: Evans and Newell (2013))

substantial acreage in Kansas to develop the MLP, using horizontal drilling and multistage hydraulic fracturing. Being a limestone/carbonate play, the MLP is more permeable than the tight (e.g., shale) formations being tapped elsewhere for oil and natural gas. Drilling a horizontal well is expensive; it can cost 10 times more than a conventional vertical well. Hence, before choosing to drill a well, oil companies conduct a cost-benefit analysis. Essentially, the companies wager that one horizontal well would be less expensive than several vertical wells and would produce more hydrocarbon over its lifetime. Oil companies such as SandRidge Energy, Chesapeake Energy, and Shell Oil-Gulf of Mexico achieved successes in the MLP in Oklahoma, and embarked on leasing substantial acreage in Kansas, hoping to replicate the same success. The MLP is shallower and easier to fracture compared to Bakken Shale or Eagle Ford Shale. This makes the overall cost of drilling a well cheaper. For instance, the average cost per well in

Bakken Shale Play is $7 million, while in MLP it is $3 million (Evans and Newell 2013). Since 1970, in Kansas, 12 percent of state's total oil production came from the MLP. In 2015, it was 15 percent (Evans and Newell 2013), although several major operators either abandoned or sold their MLP holdings in Kansas in 2014, after prices fell (Evans and Newell 2013).

The Kansas Corporation Commission (KCC) is the main state governmental agency responsible for regulating fossil fuel exploration and production in Kansas. KCC's functions include rules and regulations related to drilling, permissions for drilling and production reports, maintaining industrial standards and drilling records, handling environmental issues, keeping a track of abandoned wells, plugging procedures, safety plans and inspections. KCC's Oil and Gas Conservation Division mainly oversees these activities. A Kansas statute established this division as a 12-member oil and gas advisory committee representing industry, landowners, and other interested parties to develop state's rules and regulations.

Another agency involved in issuing permits for air emissions related to horizontal drilling is the Kansas Department of Health and Environment (KDHE). High volume hydraulic fracturing requires huge quantities of water. But for any direct diversion of surface or ground water, permission of Kansas Department of Agriculture's division of water resources must be obtained. To facilitate disposal of saltwater produced by wells, the KCC created its Underground Injection Control Program with sole responsibility of permitting injection wells. In 2013, Kansas Department of Health and Environment announced that, in the event of spills, depending on material and volume of spill, oil and gas companies are required to report to KDHE, KCC, Kansas Division of Emergency Management and other state and federal agencies.

With heightened interest in tapping into the MLP, companies rapidly started leasing land in Kansas, especially in towns along Kansas-Oklahoma border. Concerns about potential

problems, such as housing shortages, infrastructure damage and repairs and electricity supply started surfacing in county meetings in Barber, Harper, and Comanche in south central Kansas. Thus, KCC formed an Inter-Agency Working Group (IAWG), an Industry Advisory Group, and a Community Advisory Group to address issues related to activity in the MLP. The IAWG consisted of representatives from KCC, Kansas Geological Survey, Kansas Water Office, Kansas Attorney General's Office, Kansas Housing Resources Corporation and Kansas Departments of Agriculture, Transportation, Revenue, Health and Environment and Wildlife, Parks and Tourism (Evans and David 2013).

3.5 Contemporary Oil and Natural Gas Trends in the MLP

In 2007, horizontal drilling was introduced to the Mississippian Limestone Play. With its favorable geology, the oil- and gas-producing formation appeared economically attractive to several companies. In 2000-2001, higher gas prices encouraged drilling and Oklahoma experienced an increase in petroleum industrial activity (Boyd 2009, 2011).

Broadly speaking, extractive industry goes through three distinct developmental phases (England and Brown 2003, Brown and Schafft 2011). The initial phase demands extensive labor input and infrastructure development. Here the community experiences an influx of new individuals and rapid expansion of local businesses. In the second phase, the operational phase, workers from the initial phase become redundant and the strain on local community resources decreases, but at the same time, causes a decline in need for local goods and services. This phase continues until the resource is depleted and the industry eventually shuts down. The last phase looms when the industry collapses locally (busts) and workers lose their jobs and eventually move elsewhere.

Domestic oil and gas industry conditions are closely connected to global oil and gas prices; production depends on demand, supplies and pricing, internationally. In the early 2000s, demand grew faster than supply, leading to a tightening supply/demand balance. Oil prices began to rise. From 2006 to 2008, in several parts of the United States, oil prices skyrocketed, with gasoline prices reaching an average $4 per gallon. In 2007, Congress passed the Energy Independence and Security Act that sought to reduce U.S. dependence on foreign oil; it meant that domestic production was to increase. For oil companies, rising prices meant an incentive to produce more, which, in turn, meant more money for investment in new projects (Sam et al. 2018). It became more economical to explore additional oil plays (geological areas), especially given the technological advances of directional drilling combined with fracking. Thus, from 2011 to 2014, light oil production in Oklahoma rose from 50,000 barrels per day to 300,000 bbl. per day because of horizontal drilling. (A barrel is 42 gallons of crude—unprocessed—oil.) In 2014-2015, most operators' horizontal drilling activity in the state centered in northern Oklahoma and along Kansas-Oklahoma border.

The use of fracking helped the U.S. increase domestic production, decreasing oil imports in two decades. In 2014, significant increase in oil production created an oversupply that sent prices plummeting. To keep oil extraction from fracking profitable, per barrel cost of oil needed to be above an average of $70 (Sam et al. 2018). Thus, when oil prices began to fall in mid-2014, companies started slashing capital expenditure, reducing or completely ending production from low cost wells (Rapier 2015, Sam et al. 2018). In 2015, drilling plunged and the MLP experienced the sharpest decline in rig counts as compared to other Plays extracting hydrocarbons using horizontal drilling. The Play being shallow, when oil prices dropped below $50/bbl. oil companies no longer found it economically viable to keep production high in the

area. By October 2015, with oil prices dropping to $40 per barrel, many oil companies stopped production (Sam et al. 2018). In 2015, after an initial slowdown, the oil and gas industry busted in Kansas, but Oklahoma experienced only a reduction in production.

3.6 Study Counties

For place-based policymaking aimed at developing sustainable communities, it is imperative for researchers, public officials, and policymakers to understand past and present local socio-economic conditions. An area's economic and social characteristics can have significant impacts on the region's development. In the next section, I discuss socio-economic and demographic conditions within Kansas and Oklahoma counties selected for this study.

3.6.1 Selection of Study Counties

Development and economic opportunities differ spatially. Several factors play a role in differential experiences. The idea of rurality invokes widely shared images of landscape in the form of farms, ranches, small towns, and open spaces. But when seen more closely, each rural area has a different story to tell. For instance, rural and urban communities have experienced development in different ways. The Great Recession affected and lasted longer in rural areas. Several states, especially predominantly rural ones, have still to recover fully from those impacts (Heinrich 2017).

Researchers studying rural America often study conditions in non-metropolitan areas using county as basis (Cromartie and Parker 2018). The Department of Agriculture's (USDA) Economic Research Service (ERS) Rural-Urban Continuum Codes and Data USA's public platform help explore characteristics of individual counties. For effective policy development

and sustainability of rural communities, it is essential to understand socio-demographic, economic and political context in which industry operates.

3.6.2 County Profiles

Rural-Urban Continuum Codes (RUCC) are used to form a classification scheme, which helps to separate metropolitan counties by population size of their metro areas and non-metropolitan counties by degree of urbanization and adjacency to a metro area or areas. All U.S. counties and county equivalents are grouped according to their official metropolitan and non-metropolitan status, as defined by the Office of Management and Budget (OMB). The ERS used two OMB metro and non-metro categories to further designate nine codes in its 2013 RUCC (Table 3.2). This coding helps differentiate rural areas better, especially as regards their accessibility and metropolitan connections.

Table 3.2. Rural-Urban Continuum Codes (USDA ERS 2013)

Metropolitan Counties	
Code	Description
1	Counties in metro areas of 1 million population or more
2	Counties in metro areas of 250,000 to 1 million population
3	Counties in metro areas of fewer than 250,000 population
Nonmetropolitan Counties	
4	Urban population of 20,000 or more, adjacent to a metro area
5	Urban population of 20,000 or more, not adjacent to a metro area
6	Urban population of 2,500 to 19,999, adjacent to a metro area
7	Urban population of 2,500 to 19,999, not adjacent to a metro area
8	Completely rural or less than 2,500 urban population, adjacent to a metro area
9	Completely rural or less than 2,500 urban population, not adjacent to a metro area

The United State Department of Agriculture's Economic Research Service (ERS) features the county typology. It classifies all U.S. counties in six mutually exclusive categories of economic dependence and six overlapping categories of policy-relevant themes. The USDA's ERS typology is designed to recognize an area's economic and social characteristics for various types of public programs, as it can have a significant effect on an area's development and assistance needs.

The ERS takes into account earnings of labor and proprietors and employment by place of work to determine economic dependence categories. The Bureau of Economic Analysis (BEA) Regional Local Area Personal Income and Employment furnishes data for county level estimates of earnings and employment by place of work that serves to define economic dependencies. For the latest (2015) codes, 2014 BEA income and employment data are used.

The six non-overlapping economic dependencies categories are: farming, manufacturing, mining, federal/state government dependent, recreational and non-specific. The six policy related themes that can overlap include housing stress, low education, low employment, persistent poverty, population loss and retirement destination (USDA ERS 2015a). For my purpose, I only looked at the six non-overlapping themes to get an overall idea of social and economic characteristics for the study counties. These characteristics have significant effect on the region's development and on necessity of public programs in the area. This project started in 2014 and used the 2004 ERS typology. In 2015, when the typology was revised, the classification of a few counties shifted. This shift in classification shows change in a county's economic dependence and growing importance of the oil and gas industry as a major revenue base for a county (Table 3.3).

Data USA is an open data platform that aids in visualizing government data in a simple manner (<https://datausa.io/>). This is a good tool to help researchers visualize data effectively. I used Data USA along with U.S. Census Bureau Quick Facts to summarize socio-demographic and economic information at county level for selected study counties (Table 3.3).

A common characteristic for nine of ten selected counties is their rural nature. The counties are sparsely populated, with higher older and predominantly White population. Decline in rural population is a typical characteristic in the Great Plains region because of out-migration of young adults to more urban areas and mortality of larger older population (Rathge n.d.). Sumner County, Kansas, is the only metropolitan county; the rest are classified as non-metropolitan counties (Table 3.3). Sumner is considered 'metropolitan' because of its adjacency to Wichita urban area. However, its population at the 2010 census was less than 25,000, making it relatively rural under other considerations. Additionally, Sumner County has been losing population (-5.4%).

Table 3.3. Study counties and characteristics. (Sources: U.S. Census Bureau (2014))

State	County	Population (2010)	% of the total study area population	Economic type (ERS 2004)	Economic type (ERS 2015)	Rural-urban category (2013)	Rural-urban continuum code (2013)
KS	Stafford	4,437	5	Farming	Farming	Nonmetro	9
	Harper	6,034	7	Nonspecialized	Mining	Nonmetro	8
	Barber	4,861	5	Nonspecialized	Mining	Nonmetro	9
	Sumner	24,132	27	Nonspecialized	Nonspecialized	Metro	2
	Wichita	2,234	2	Farming	Farming	Nonmetro	9
	Logan	2,756	3	Nonspecialized	Farming	Nonmetro	9
OK	Woods	8,878	10	Nonspecialized	Mining	Nonmetro	7
	Alfalfa	5,642	6	Farming	Farming	Nonmetro	9
	Woodward	20,081	22	Nonspecialized	Mining	Nonmetro	7
	Noble	11,561	13	Manufacturing	Manufacturing	Nonmetro	6
Totals		**90,616**	**100**				

According to USDA's ERS typology, four of ten counties, Harper and Barber, Kansas, and Woods and Woodward, Oklahoma, are classified as mining dependent. This category includes all types of mineral extraction, including petroleum and natural gas production. Another four counties, Stafford, Wichita, and Logan in Kansas and Alfalfa in Oklahoma are classified as farming dependent. Sumner County, Kansas, is non-specialized, while Noble county, Oklahoma, is manufacturing dependent. Although ERS typology classifies a county under a specific dominant category, a county can have more than one important industry.
In 2017, Stafford county, Kansas, had a total population of 4,251. Between 2016 and 2017, Stafford lost about 1 percent of its population. A predominantly White county (83.7%), Stafford is about 13 percent Hispanic or Latino. Primary sector industries - agriculture and mining - are the highest paying, followed by utilities, transportation and warehousing. In Stafford county, median annual income of households was about $47,121, which is below median annual income across the United States (Table 3.4). Spatially, the county's western half has higher median annual household income than eastern half. Stafford county shares its western border with Edwards county.

According to data summarized by Data USA (2019), among six study counties in Kansas, Harper and Barber are "mining" (minerals) dependent (USDA ERS 2015). When Kansas experienced an oil boom in 2014, the bulk of exploration occurred in Harper county and neighboring Barber and Comanche counties. Both Harper and Barber counties share a border to the south with Oklahoma. These counties are typical of many rural counties in Kansas: both sparsely populated, predominantly White (more than 90 percent) and with more than 15 percent of citizens over 65 years of age (DataUSA 2019). In 2017, Harper had a total population of 5746 and Barber 4905. Between 2016 and 2017, Harper county lost about 1 percent of its population;

Table 3.4. Summary of selected socio-demographic and economic characteristics.

County	ERS typology (2015)	County type (Completely Rural-CR; Urban-U)	Population	Population density	Population change (%) 2019	Racial composition (% White alone)	Median Household income ($)	Persons in Poverty (%)	Employment Change (%) 2016-2017
Stafford	Farming	CR	4437	5.6	-6.4	83.4	48,563	13.4	-3.8
Harper	Mining	CR	6034	7.5	-9.9	89.6	49,455	14.3	-6.1
Barber	Mining	CR	4861	4.3	-9	91.6	50,613	12.8	-3.1
Sumner	Non-specialized	Metro	24132	20.4	-5.4	89.4	54,915	13.4	0.8
Wichita	Farming	CR	2234	3.1	-5.1	67.6	57,566	11.9	-2.8
Logan	Farming	CR	2756	2.6	1.3	90.4	51,597	9.1	-0.3
Woods	Mining	U	8878	6.9	-1	82.8	56,899	15.2	-5.1
Alfalfa	Farming	CR	5642	6.5	1.1	83.6	59,569	15.2	-24
Wood-ward	Mining	U	20081	16.2	0.6	79.5	58,706	14.8	-0.4
Noble	Mfg	U	11561	15.8	-3.8	80.9	53,253	12.9	1.1
Kansas			2,853,126	34.9	2.1	75.7	57,422	12	-
Oklahoma			3,751,583	54.7	5.5	65.3	52,424	15.6	-
United States			327,000, 000	-	0.45	-	61,937	13.1	1.21

Barber county saw an increase of about 1.5 percent. The largest industry in Barber county is healthcare and social assistance, and the highest paying industries are mining, including quarrying (much smaller share than the fossil fuel industry) and oil and gas extraction. In the case of Harper, manufacturing is the largest industry, while utilities, mining, quarrying, and oil and gas extraction are the highest paying industries. Employment is highest in natural resource-based industries: agriculture and mining. Since 2012, Harper and Barber county produced more than 2,000,000 mcf (1000 cubic feet) of gas and more than 150,000 barrels of oil.

To the east of Harper county is Sumner county, only county in study area categorized as metropolitan, although in 2010 its population was only 24132. Between 2016 to 2017, Sumner county lost about 1 percent of its total population. It is predominantly White (90 percent), and almost all of its residents are American citizens. The largest industry in Sumner county is manufacturing, which is also the highest paying, followed by petroleum and natural gas industry (DataUSA 2019). Here, median annual household income is about $47,121, which is less than national median annual household income ($60,336).

Wichita and Logan counties, Kansas, are in northern part of the MLP region. These counties are farthest away from Oklahoma and the bustle of latest oil boom. These counties were selected for inclusion primarily because the MLP underlies them and they have potential for development. Although there has been little or no recent petroleum exploration in the country, since there is potential for future exploration it is important to understand residents' knowledge and opinions for possible policy development and planning. With a population of 2157 people, Wichita is one of the least populated counties within the study area. In 2017, Logan county was also relatively sparsely populated, with 2790 people. Between 2016 and 2017, both Wichita and Logan counties lost 0.5 percent and 0.35 percent of population,

respectively. In terms of Caucasian or White population, Logan county has about 90 percent and Wichita about 70 percent. Economically, both counties show similar trends. The largest industries in both are agriculture and hunting; the highest paying industry in Wichita is manufacturing and in Logan utilities. Wichita county has higher median annual household income ($55,109) than Logan county ($49,926), but both are below national median income.

Among Oklahoma counties, Woods and Woodward are mining dependent (i.e., mostly oil and gas). In terms of total county populations in 2017, Woods (population 9132) is smaller than Woodward county (21,140). Both are considered non-metropolitan, not adjacent to a metro area, with urban populations ranging from 2500 to 19,999, respectively. These two counties have at least 80 percent of White populations. The largest industries in Woods county are educational services, retail trade, healthcare and social assistance and the highest paying are transportation, warehousing, utilities, mining, quarrying and oil and gas extraction. In Woodward county, the largest industries are mining, quarrying, oil and gas extraction, retail trade, healthcare, and social assistance, while the highest paying are utilities, wholesales trade, transportation, and warehousing. Woods and Woodward have similar median annual household incomes $57,097 and $57,602 respectively, only slightly below national median.

Alfalfa County, Oklahoma, is a farming-dependent rural county on the state's northern border. In 2017, its population was 5877. Between 2016 and 2017, Alfalfa County gained 1.6 percent of population. About 75 percent of its population is White, making it one of the most diverse counties in the study. Primary sector industries such as agriculture, forestry, fishing, hunting, mining, quarrying, and oil and gas extraction are the largest industries in the county. These primary industries, along with real estate rental and leasing are the highest paying industries. The median household income is below national average.

In the study area, Noble County is the only non-metropolitan county adjacent to a metro area (Oklahoma City). With a population of 11,421, it is the second largest Oklahoma study county and third largest study county overall. The county is about 82 percent White, seven percent American Indian/Alaska Native, and six percent multi-racial. Its largest industries are manufacturing, educational services, healthcare and social assistance and its highest paying are utilities, transportation, warehousing, and professional, scientific and technical services. Among selected counties, Noble County's median annual income is closest to the national average. It also has seen nearly 10 percent annual growth in median income.

3.7 Summary

For both Kansas and Oklahoma, the oil and natural gas industry has been an important economic contributor. While local oil and gas companies historically undertook conventional development, larger regional and sometimes international companies have carried on contemporary development. Established regulatory authorities exercise oversight of rules and regulations in both states. They work with federal government to monitor and regulate petroleum and natural gas industry activities. Economic development varies spatially. To better identify variation, I used the USDA ERS economic typology and rural-urban continuum codes. Among study counties, all but Sumner are classified as non-metropolitan. Despite this ERS designation, though, Sumner may also be considered as largely rural. According to the ERS typology classification, four counties are classified as mining-dependent, four as farming-dependent, one as a non-specialized county and only one as manufacturing-dependent. Socio-demographic and economic data indicate a great deal of similarity.

Methods used to collect and analyze data are described in the next chapter. These include both survey (quantitative and qualitative) and interview (qualitative) information sources.

Chapter 4 - Methods

4.1 Research Design

This project's research design was structured to elicit answers to questions about regional perceptions of the concept of risk, assess the variation in perceived environmental risk, and factors influencing perception of risk related to oil and natural gas industry in rural communities within the MLP region in Kansas and Oklahoma. The MLP region has witnessed recent expansion in HFDD activities. Rural communities are familiar with fossil fuel industry, but the new technology has brought new challenges to these already vulnerable areas. This research investigates risk perceptions associated with HFDD activities in rural communities of Kansas and Oklahoma and if this risk varies spatially and why. Thus, this research aims at exploring regional concept of risk, identifying local factors contributing to the variation of risk perceptions.

A mixed method approach of mailed questionnaire surveys and in-depth interviews was used for data-gathering. Mixed methods research comprises a combination of both quantitative and qualitative techniques to solve a research problem (Creswell 2009, Hay 2010). This method confers a major benefit because it reduces the bias embedded in using a single data collection method (Creswell 2009, Hay 2010, Wetherholt 2016). In the last 50 years, researchers have used mixed methods approaches in different fields by incorporating a multitude of combinations to confirm their findings (Wetherholt 2016). Hay (2010) argues that researchers employ mixed methods research for three purposes: triangulation, complementarity, and information expansion.

Triangulation is a form of research strategy sometimes described as convergent methodology or convergent validation (Jick 1979), involving the use of multiple methods or approaches to gathering data for a particular research topic. The word "triangulation", as

explained by Jick (1979), finds its origin in military and navigation strategies where multiple references are used to locate an object's exact position. In social science, triangulation is used to enhance the belief that results are valid and not simply a methodological outcome (Jick 1979, Hay 2010), although the effectiveness of triangulation rests upon the assumption that the weakness of one technique is identified and covered by the other technique (Jick 1979).

The advantage of triangulating data is that researchers can improve the accuracy of their interpretations by collecting different kinds of data on the same phenomenon, complementing and expanding information found in one method (mailed surveys) with the other (interviews), thus improving confidence in their research findings (Jick 1979, Hay 2010, Wetherholt 2016). Moreover, methodological convergence may give rise to theoretical convergence, meaning diverse theories can be used to explain a common problem (Jick 1979). However, one of the biggest challenges in data triangulation is that it is the investigator's responsibility to identify patterns in mixed-methods research to draw meaningful conclusions from the rich data gathered. This demands creativity from the user and insightful interpretation of the data (Jick 1979).

4.2 Mixed Methods Research Design

After quantitative and qualitative approaches, mixed methods research constitutes the "third major research approach or research paradigm" (Denscombe 2008). Hay (2010) defines mixed methods as use of a combination of both qualitative and quantitative techniques to solve a research problem. Several researchers' books - Creswell (2003), Tashakkori & Teddlie (1998, 2003), Johnson & Christensen (2004), Greene, Caracelli & Graham (1989) and Newman & Benz (1998) - have contributed a great deal to this research approach, making it a distinct field (Johnson and Onwuegbuzie 2004).

For more than a century, quantitative and qualitative researchers have debated the underlying assumptions of the two approaches. Quantitative traditionalists believe social observers should emotionally detach themselves from their study objects or subjects and researchers should treat entities in the same way "as physical scientists treat physical phenomena" (Johnson and Onwuegbuzie 2004, 14). According to this school of thought, researchers should remove their biases, detach themselves from objects of study and empirically justify their stated hypotheses. On the other hand, qualitative purists argue for multiple-constructed realities, stating that time- and context-free generalizations are neither desirable nor possible. They further argue that research is value-bound, and it is impossible to separate the "knower and known,", as subjectivity of the knower is the source of reality (Johnson and Onwuegbuzie 2004).

Researching extractive communities is tricky. A researcher enters a volatile, dynamic environment with complex interaction between humans and natural environment and must deal with human emotions associated with this interaction (Jenkins 2015). With mixed methods research, researchers hope that investigations will move beyond the dichotomy of quantitative versus qualitative and more toward building on the strengths and minimizing the weaknesses of both approaches by using them in concert. This research paradigm encourages researchers to look at quantitative and qualitative research as complementary techniques used to compensate for the weaknesses of single data types (Jick 1979). Johnson and Onwuegbuzie (2004) caution that mixed methods techniques cannot provide perfect results, but by using both the methods and philosophies of qualitative and quantitative techniques, effective interpretations can be achieved.

For this research, I used an explanatory sequential mixed method design (Wetherholt 2016). In a sequential mixed method design, a combination of procedures is used, one after the

other. For this study, I used mailed questionnaire survey and interviews. In this case, a mailed questionnaire (focused on gathering quantitative data, with supplemental qualitative information) was administered first, followed by interviews to further develop understanding of survey results (see Creswell 2007). The combination of methods allowed me to design components to answer specific research objectives, and to clarify the status of MLP communities and residents' views regarding the fossil fuel industry and risk.

Throughout this study, the county is the spatial unit of study. A county basis is appropriate because of the availability of statistical data; boundaries of counties also have remained constant more than a sufficient time frame. Community denotes a group of people organized around common interests, shared values, attributes, and shared identity (Brown and Schafft 2011). "Being a part of a community implies long-term, continuous social interaction that contributes to the formation of personal identity and to social and economic production and reproduction this means there is a sense of "we-ness" (Brown and Schafft 2011, 35). I use the term community more frequently than city or town because this concept more appropriately describes social relations and conditions for the study locations.

4.2.1 Questionnaire Surveys

Hay (2010) argues that questionnaires provide insights into relevant social trends, processes, attitudes, values, and interpretations. Researchers use a wide spectrum of survey techniques, including mailed questionnaire surveys, telephonic surveys, and internet surveys. Questionnaires gathered via various survey techniques are frequently used in conjunction with other techniques for triangulation and expanding the depth and extent of qualitative data. I used mailed questionnaires to pose identical questions to a sample of individuals selected from the ten counties described in Chapter 3.

A mailed questionnaire survey poses standard questions to a sample of a population. I chose to use a questionnaire as it helps gather original data about people, their experiences, social interactions, and views. Questions related to all three objectives were incorporated in the mailed questionnaire. To garner quantitative and qualitative data, the questionnaire included both open- and closed-ended questions. For instance, to explore perceptions of the concept of risk, the open-ended question "what does the term risk mean to you?" was included. For assessment of variations in perceived environmental risk, a closed-ended Likert scale section was used. Respondents were asked to identify their level of perceived environmental risk with oil and gas industry and fracking (in two separate questions) on the scale of 1 to 10, 1 being the lowest and 10 being the highest. I assumed that local-level variation in perceived risk arose from the following factors: experiences with oil and gas industry and industrial dynamics, length of interactions with industry, benefits obtained by the community and individuals, trust in local officials, community capital and availability and communication of industrial information.

For objective three, questions were divided into three categories, knowledge and awareness, community factors, source of information and trust in them, worldviews and perceived benefits and drawbacks, and participants were asked to provide their agreement or disagreement with the statements under each category. Jacquet and Stedman's (2013) recommendations about inclusion of socio-psychological disruption as an impact of energy development were influential in development of this research, and the Boudet et al. (2012) study about factors that shape Americans' views on fracking informed questionnaire development. With anonymity ensured, it was hoped people would express their opinions honestly. Since the 1970s, mixed method questionnaires have been used to gather data on complex matters, such as environmental perception, social identity, and quality of life (Hay 2010). Although getting

people to respond to questionnaires may be a challenge, especially in changing socio-political conditions (discussed in Chapter 7), the use of mailed surveys confers several advantages. Firstly, they provide valuable insights into attitudes and experiences; secondly, unlike most other methods, for data collection they help cover a larger geographical area; and thirdly, they can be combined with other research techniques such as interviews or focus group discussions to triangulate research findings (Hay 2010). Gathering data over larger geographical area within the MLP is important to obtain a range of views on risk. This helps in comparing the variations in perceived risks and identifying factors to understand local reactions to industrial development. The structure and delivery of mailed questionnaire follow *The Tailored Design Method* (Dillman, Smyth and Christian 2009). I used a modified Dillman (2009) technique to disseminate the survey questionnaires.

Still, I recognized there existed limitations on the depth and extent to which questionnaires could gather qualitative answers. For instance, establishing a rapport with participants and expecting them to give in-depth answers to questions seemed difficult. For respondents, rather than formulating a response to a question, choosing, or checking an option might look easy. Moreover, in the small space provided in survey, full expression of one's outlook could prove difficult. Some respondents might choose not to respond to qualitative/open ended questions, deeming it time consuming. Therefore, to expand on the responses from survey data, I followed up the mailed survey with in-depth interviews of local public officials.

4.2.2 Interviews

Key informant interviews were used following administration of the mailed questionnaire mainly for triangulation of data and interpretation of survey results. The data collected from the survey generated questions that required clarification. A purposive sampling strategy was used

to select counties for interviews from among those that had received the mailed survey. Three Kansas counties and two Oklahoma counties were chosen for key informant interviews. The combination of key informant interviews with survey results provided for triangulation of data, improved interpretation of survey results, and further exploration of local conditions. Counties selected for interviews included Sumner, Harper, and Stafford in Kansas; and Woodward and Noble counties in Oklahoma. Selections were based on having varying survey response rates and varying fossil fuel activity and experience. Early contacts (county extension personnel) also provided advice as to selection. Public officials were chosen as key informants with good local understandings. They also serve as important links between local communities and some aspects of state and federal governments. Key informants included economic development officers, county extension agents, Chamber of Commerce representatives, town planners, and county commissioners. These are people serving in roles providing them substantial understanding of the local area, community members, and decision-making, and thus could provide insights for this project. Additionally, individuals serving in these roles may be expected to be relatively open to contributing to state university-based research.

Based on questionnaire responses, I submitted questions that arose from processing of mailed survey data to key informants, to help address objectives two and three of this study.

Objective two addresses variation in perceived environmental risk. In mailed surveys, I gathered community members' level of perceived environmental risk. These levels showed variation between counties. Affective imagery and psychological factors provided some information for reasons of variation: positive imagery reflected lower perceived environmental risk, while negative imagery mirrored higher perceived environmental risk. Similarly, the more enthusiastic community members felt about the development, the lower environmental risk they

perceived. The interviewees gave insight into community experiences to better understand reasons for variation in perceived environmental risk between affected rural communities and factors that may be associated with HFDD risk perceptions.

Objective three addresses factors that may be associated with HFDD risk perception. The surveys gathered information from community members on different factors that could impact a community's perceived environmental risk. These factors were grouped in five categories, knowledge and awareness, community characteristics, information sources and trust, worldviews, and perceived benefits and drawbacks. Interviewees helped connect the gathered information with their experiences with the community members, industry, and the needs of the community. The important factors contributing to perceived environmental risk that emerged were experience with the industry, length of association with the industrial activity, and trust in local authorities.

The interviews were semi-structured, with guiding questions based on analysis of survey data. I chose three counties in Kansas: one with a relatively high response rate (Sumner County), one low response (Stafford County) and one that had recently experienced the boom-and-bust cycle with hydraulic fracturing (Harper County). I also selected two Oklahoma counties: one with a higher response rate (Woodward County) and one with low response (Noble County). My original points of contact for selected interview locations were the counties' Cooperative Extension Service offices (affiliated with Kansas State University and Oklahoma State University and funded through the USDA National Institute of Food and Agriculture [NIFA]). The extension agents proved key individuals who helped me identify and contact appropriate interviewees, as well as served, in some cases, as advisors about local situations and my overall research. Some county agents scheduled interviews for me, and others provided contacts with

whom I worked to schedule my own visits. The public officials knew each other in a given county and often coordinated days and times to accommodate me in their routines. I conducted all interviews in key informants' offices.

Face-to-face interviewing is preferable over other methods because it ensures increased clarity of communication. Thus, triangulation among multiple data sources contributes to greater confidence in findings and yields a holistic view of the subject under investigation. In this study, I used triangulation to capture a more complete, holistic, explanatory, and contextual understanding of the study topic in given study area. This was done by gathering both quantitative data and qualitative information in questionnaire surveys, and discussing survey information with knowledgeable key informant interviewees to gain confidence in and clarify survey data.

4.3 Selection of Study Counties and Population

Information about unconventionally drilled wells in Kansas, was obtained by consulting University of Kansas and Kansas Geological Survey websites. I also used the Oklahoma Corporation Commission (OCC) website for information on oil and gas wells in Oklahoma state. In 2016, I secured additional information from fracfocus.com about the locations of horizontally fracked wells. FracFocus is a national hydraulic fracturing chemical registry managed by the Ground Water Protection Council and Interstate Oil and Gas Compact Commission. This site mainly provides objective information about hydraulic fracturing and groundwater, without arguing for or against hydraulic fracturing as a technology (FracFocus.org, last accessed in December 2016). Currently, 23 states, including Kansas and Oklahoma, use FracFocus.

To select counties for mailing questionnaire survey, I performed a simple overlay analysis using ESRI's ArcGIS 10.2.1. I overlaid counties from both the states on the MLP

region. I then extracted and exported the counties that intersected with the MLP. I found that the MLP region encompasses 37 counties in Kansas and 14 counties in Oklahoma (see Figure 3.1). From these 51 counties, based on the number of horizontally fracked wells, counties' population, and spatial distribution, I created a purposive sample of 10 counties (Figure 4.1).The presence of an industry may be direct or in the form of allied activity. For example, for the oil and gas industry an increase in construction and maintenance services to keep their machinery running may constitute a direct activity. Opening of new restaurants to cater to needs of incoming oil and natural gas workers may form an allied activity. I used the number of wells as a proxy for level of activity and identified population for community's size. Selected counties were included partly to include different levels of oil and gas activity. For example, Logan county showed very low number of oil and natural gas wells, Stafford county higher number of wells than Logan county and Harper county the highest number of wells in the whole of Kansas state. I selected some adjacent counties or spatially somewhat close ones along the Kansas and Oklahoma border, as they had recently experienced oil boom and, during my initial scoping trips, county extension agents also had suggested them.

4.4 Data Collection Preparation

The mailed questionnaire gathered primary data needed to address all three objectives. The first objective was to explore regional perceptions of the concept of 'risk'. The second was to assess variation in perceived risk associated with HFDD within and between affected rural communities in the study area. The third was to identify factors related to HFDD risk perception. Considering the findings related to these objectives, I noticed that respondents had listed local University extension services and other public offices as trusted sources. I began to explore how these sources could be effectively used as channels of communication to bridge the

gap between latest scientific research and its implications for public. I designed interview questions to gain clarification on data collected in mailed surveys. Additionally, if new questions or concerns arose during surveys, I sought explanation for those in interviews.

The questionnaire measured self-reported knowledge, awareness, self-reported specific and general risk perception, evaluation of benefits and risks, cultural biases and values, sources of information and socio-demographic data. To create an MLP-specific questionnaire, I undertook scoping trips to counties where questionnaires were mailed. The scoping trips helped me build connections with key informants and community members. I particularly met with County extension agents, Economic development officers and an officer managing one of the Kampgrounds of America (KOA) sites, as knowledgeable persons willing to provide insights on the study counties. In creating the questionnaire, I incorporated suggestions from these key informants. The key informants suggested that people might be less technologically savvy and that using mailed surveys would probably be a better choice due to generally older population in the area. This is seen with the average age of respondents was 64 years. Additionally, two reasons stood out for this choice. One was to reduce the possibility of responses from absentee owners (with electronic communication this would have been a concern as the study focused on lived experiences in the community with oil and gas industry). The second reason concerned issues of internet access, digital skills, and general discomfort with electronic data collection. Moreover, I wanted to ensure that respondents with local addresses (the study area's actual residents) would be the most likely to receive questionnaires. In September 2016, a group of 12 students - a combination of graduates and undergraduates in the Department of Geography at Kansas State University - prechecked the preliminary questionnaire for cosmetic aspects, clarity of questions, and testing coding strategies.

I incorporated in the design suggestions from these students and reframed the questions. Additionally, I mitigated coding problems with the help of Statistical consultation lab. The Institutional Review Board (IRB) at Kansas State University approved the procedure and questionnaire for pilot study (IRB 8511). On approval from the IRB, I conducted a pilot survey in Ness county, Kansas.

From all counties in the MLP, Ness County, Kansas, was selected for a pilot survey conducted in December 2016. I dropped 50 survey packets containing a cover letter, questionnaire, a self-stamped self-addressed envelope, and a thank-you note at randomly chosen houses from selected blocks demarcated on maps provided by open records for Kansas appraisers provided by Kansas GIS portal. The pilot consisted of one round of contact with the survey population. The pilot survey's main aim was to ensure that the survey questions were clear and understood by the intended audience. A return rate of 16 percent was achieved. Based on comments from respondents, I further changed some survey questions and refined some others. Changes were approved by IRB (8511.1, Appendix A). The final questionnaire is included in Appendix H.

4.4.1 Mailed Questionnaire

Participant Selection for Mailed Survey Questionnaire

Dillman et al. (2009) recommended specific formulas at three different confidence intervals to decide an adequate sample size to draw a confident conclusion. The formulas help researchers decide how large the sample size should be to account for sampling error, tolerance margin at the desired confidence interval, confidence level, practical survey challenges, and a

$$Ns = \frac{(Np)(p)(1-p)}{(((Np-1)(B/C)^2) + (p)(1-p))}$$

population's variance with respect to its characteristics of interest, and population size from which the sample is drawn. Based on this information, my study required 384 responses for a 95 percent confidence level (with 5 percent potential error):

Ns is the completed sample size needed for desired level of precision, *Np* is the size of population, *p* is the proportion of population expected to choose one of two response categories (50% chance), *B* is the margin of error (i.e., half of desired confidence interval): 0.03 = ±3%, and *C* is the Z-score associated with the confidence level (1.96 corresponds to the 95% level).

For the selected counties, I purchased address files from Lorton Data in the form of a single excel sheet and accompanying metadata pdf file. I randomly selected addresses proportional to county population to whom surveys were mailed in each county. Based on counties, I separated the addresses into different *Excel* files. Microsoft Office's *Excel* was used to generate random numbers for each address, using the function *fx* (RANDOM). Each address had a machine generated unique random number, used to choose the needed number of addresses corresponding to proportion of county population in the study area. These addresses included only residential addresses without names or any occupational or demographic information, as the respondents were expected to provide that information.

Mailing Procedures

The main survey was mailed in summer 2017. Before the mailing, I wrote a 500-word article about my study, mainly to create awareness about it, introduce the research, and alert the community at large about questionnaire mailings. To distribute the article, I contacted county extension agents. Some of them preferred to circulate the informational piece via email, while others had it published in local newspapers (Appendix C). This was done prior to any mailings to the randomly selected addresses. A modified Dillman et al. (2009) 5-step procedure was used

(Figure 4.2). This included 1) a brief pre-notice cover letter, 2) the questionnaire with a self-addressed stamped return envelope (SASE), 3) a thank-you letter, 4) a replacement questionnaire with SASE, and 5) a thank-you postcard to respondents replying late. (Procedures for maintaining confidentiality are described below.) In the first round, 1001 packets were sent to ten study counties in Kansas (six) and Oklahoma (four). The second round consisted of 500 packets with replacement questionnaires mailed to a sample of non-responders from the first round. Ideally, all non-respondents should have been contacted, but this proved impractical in terms of resources (time and finances).

Figure 4.2. Execution of survey using modified Dillman method.

Handling of Returned Questionnaires

The Dillman approach required multiple contacts with members of sample population with thank-you notes and additional questionnaire for those who had not yet provided completed questionnaires. For this, I needed to keep a record of who had been contacted and who had responded, and I needed to separate responses from this information. Therefore, to manage returned responses and cost optimize the process, each randomly selected address was coded with a numerical value from 1 to 1001. Each corresponding return envelope was marked with the same number as the address. On receiving responses, I recorded the number of the envelope in *Excel* and separated the questionnaire from the envelope. This helped keep track of addresses that had sent in responses; separating envelopes from questionnaires ensured respondent's anonymity. For the survey's second round, I filtered non-respondent addresses and randomly selected 500 addresses proportional to population to receive the questionnaire's second copy (Table 4.1).

Table 4.1. Questionnaire distribution across study counties.

State	County	Population (2010)	Proportion of the total study area population (%)	Number of surveys mailed (Round 1)	Number of surveys mailed (Round 2)
KS	Stafford	4,437	5	49	24
	Harper	6,034	7	67	33
	Barber	4,861	5	54	27
	Sumner	24,132	27	266	133
	Wichita	2,234	2	25	12
	Logan	2,756	3	30	15
OK	Woods	8,878	10	98	49
	Alfalfa	5,642	6	63	31
	Woodward	20,081	22	222	111
	Noble	11,561	13	128	64
Totals		**90,616**	**100**	**1001**	**500**

Handling of returned questionnaires was straightforward. I coded each questionnaire independently as a row in an *Excel* file. Each row corresponded to one returned questionnaire, while each column corresponded to a question. Initially, I coded both open- and closed-ended questions in the same *Excel* sheet. Later, I separated open and closed questions and analysed them, depending on response type, in two different software programs. I processed open-ended questions in *NVivo* and analyzed closed-ended questions using SAS software.

Questionnaire Analyses

Closed-ended Questions

Statistics is crucial for comprehensive analysis and interpretation of results, especially in case of quantitative data (Wetherholt 2016, McGrew and Munroe 2009). With the help of the Statistical Consultation laboratory at the Kansas State University, responses from completed mailed questionnaire were analyzed. To code responses and analyze them I worked with a statistician. For most quantitative analysis, I used SAS (statistical analysis software) and employed descriptive statistics such as measures of central tendency (mean, median), frequency distributions and measures of degree of variability. Inferential statistics were used to explore relationships among responses, including Spearman's rank correlation coefficient (r_s) and the Cochran-Mantel and Haenszel test (CMH).

The Spearman's rank correlation analysis mainly helped determine whether an association existed between two variables at the ordinal scale (McGrew and Monroe 2000, Wetherholt 2016). The CMH test was applied to categorical data to investigate the association between the binary predictor (yes/no; no/maybe; yes/maybe) question and binary outcome.

Open-ended Questions

I sorted and separated from the main codebook open-ended questions from the questionnaire for analysis. *Excel* was used for questions that needed only frequency counts of single items. For more detailed computer-assisted qualitative data analysis software (CAQDAS), QSR International's *NVivo* software was used. Coding constitutes an important process in qualitative data analysis. The software helps with word frequency counts and better data visualization. Pre-processing and cleaning of the data (sorting, storing, and coding) was completed in *Excel* and querying of data was performed in *NVivo* 12.

4.4.2 Key Informant (or Key Actor) Interviews

Both survey and interview approaches yielded positive results. While mailed questionnaire surveys helped gather general opinions from individuals, in-depth interviews helped explain trends and get clarifications on patterns revealed in the quantitative analysis. Discussions with key informants helped fill gaps in knowledge by providing further insights about survey results. I identified key informants as people who held public positions in major community (settlement) in each of the counties, such as extension agents, economic development officers, chamber of commerce representatives, city commissioners, town planners. Key informants constitute important insiders of communities/study counties. They proved a crucial link between me (researcher) and community (research interest).

For successful collection of data through interviews, a researcher needs to be well informed about the respondents' culture and must have a good understanding of the group's discourse under study (Hay 2010). A researcher needs to develop rapport with interviewees by understanding their "model of the world" and communicating one's (researcher's) own understanding symmetrically. Therefore, it requires considerable time and effort to formulate

questions for interviews. Questions should be able to achieve the purpose of conducting interviews. Maxwell (2013) argued that good interview questions require creativity and insight and should be placed in the context of research. Moreover, research questions and interview questions need to have a logical connection for them to help the researcher gain useful insights in the study.

Participant Selection for Key Informant Interviews

To select the counties for interviews from among all counties that received mailed survey, I used a purposive sampling strategy. I conducted in-depth interviews with public officials from five of the study counties: three of six in Kansas (Stafford, Sumner, and Harper) and two of four in Oklahoma (Woodward and Noble). I selected these counties based on differential survey response rates, recommendations of other key informants and networks with key informants in the county.

I initially contacted county extension officers who helped me establish contacts with other public officials in the community, such as the chamber of commerce, county commissioners and town planners. Once these contacts were established, I scheduled interviews. To select counties, I initially used response rate as the only criterion. After interacting with these key-informants, though, I adjusted and selected the above-mentioned five counties. For instance, Kansas, Wichita, and Logan counties gave lower response rates (4% and 1% respectively) than Stafford county. However, I did not select these to conduct interviews for two reasons: first, difficulty in contacting community's key informants, and second, mailed survey respondents from these counties explicitly noted a lack of oil and gas activity in their counties. Later, in interviews with public officials in other counties, this factor was cited as a reason for lack of interest and participation in the study. Hence, I selected Stafford county, Kansas, with

the next lowest response rate (10%). In the entire study area, Sumner County registered the highest response rate (32%), while Harper and Barber counties exhibited same response rate. I selected Harper county (9%) for two reasons: 1) key-informants suggested it as one of the prime counties recently experiencing oil boom in Kansas and 2) it featured in media reports for various oil and natural gas related activities in Kansas. In Oklahoma, Woodward emerged as one of the highest response counties (14%).

I chose Noble county because one key informant suggested it owing to its proximity to Oklahoma City and because it lies relatively distant from the cluster of counties in the heart of the MLP region and spatially closest to the Oklahoma City's oil and gas region. This region has attracted media coverage because of earthquakes linked to fracking and wastewater disposal.

The addition of key informant interviews thus provided better understanding of community level experiences and insights into industrial dynamics at local level. Given the low survey return rates, this proved especially desirable. Interviews were semi-structured with guiding questions (see Appendix P for detailed questions), based on analysis of survey data (Table 4.2). The interview questions and procedure were approved by the Kansas State University's Institutional Review Board (IRB) (8511.2 see Appendix B).

Table 4.2. Themes for questions asked of public officials (key informants).

Role of public office in the community
Public officer involvement in the community
Reasons for public involvement or non-involvement in the community
Trust building between public office and community members
Communication of information to the community
Type of information shared with the community
Lessons learned from experience and planning for sustainable future

In-person interviewing is preferable to other methods because one can gain increased clarity of communication. The interviewing technique should bring people 'into' the research process (Hay 2010). Interviews display people's behavior, attitudes, experiences, and life views in their own words. As noted above, when mixed methods are used for research, interviews provide a means of triangulation.

For interviews, I identified and recruited participants through purposeful convenience and snowball sampling. The counties' Cooperative Extension Service offices (affiliated with Kansas State University and Oklahoma State University and funded through the USDA National Institute of Food and Agriculture [NIFA]) served as my original points of contact for selected interview counties and communities. Extension agents proved as key individuals who helped me identify and contact appropriate interviewees, as well as served, in some cases, as advisors about local situations and my overall research. Some county agents scheduled interviews for me, and others provided contacts with whom I worked to schedule my own visits. In a given county, public officials knew each other and frequently coordinated days and times to accommodate me in their routines. I conducted all interviews in offices of respective public officials.

I selected interviewees using following criteria: the interviewee must have been a resident in one of five selected counties, above the age of 18, a public official of some type and available for a minimum 30-45-minute session. For my purposes, public officials included economic development officers (EDOs), county extension agents (CEAs), Chamber of Commerce presidents (CCPs), town planners (TPs) and county commissioners (CCs). In essence, people serving in roles providing them substantial understanding of local area, community members and planning procedures. From February 2019 to April 2019, I conducted 14 interviews with public officials in three counties in Kansas and two in Oklahoma (Table 4.3).

Table 4.3. Interviews per county

County	Number of Interviews
Stafford (KS)	2
Harper (KS)	4
Sumner (KS)	3
Woodward (OK)	3
Noble (OK)	2

Before the start of interview, I gave interviewees a brief description of the study as well as a consent form (see Appendix N and O). I left it to participants to choose whether the researcher could record interviews or only take written notes. I kept the responses confidential and reported them in a way that masked individual identity, except when interviewees gave permission to identify them by their role (e.g., elected officials, Chamber of Commerce representative) and/or county name. I have downloaded interview recordings and stored them in an external drive in password-protected files.

Pilot Interviews

Since interviews were semi-structured and used guiding questions, I pre-tested the guiding questions for clarity with a group of students (a mix of undergraduate and graduate students). I did this to ensure the questions were unambiguous, not offensive, clear, and easy to understand. In addition to checking clarity of questions, I wanted to estimate the time required to complete the questions, although this could vary depending on interviewee, our rapport and amount of information they were willing to share.

4.5 Summary

An explanatory sequential mixed method design was developed to gain an understanding of how rural communities experience industrial changes and how industrial dynamics help shape opinions about the industry. The study focuses on 10 counties in the Mississippian Limestone Play region of Kansas and Oklahoma, undergoing horizontal drilling and hydrologic fracturing (fracking) to recover petroleum and natural gas. To collect quantitative data, I used mailed questionnaire surveys and followed up with in-depth interviews of public officials to gain further understanding of survey data and local conditions. Based on consulting with peers and a pilot survey, I modified the final questionnaire for clarity. The final survey was conducted between July 2017 and the end of October 2017. I used a modified Dillman technique to administer questionnaires mailed to 1000 randomly selected addresses. I coded the returned responses and used them to develop interview questions for public officials. From February 2019 to April 2019, I conducted 14 interviews in 5 counties, 3 in Kansas and 2 in Oklahoma.

In the next chapter, I describe the results from surveys and interviews. This will help address this dissertation's three objectives and explore channels for better risk communication.

Chapter 5 - Results

5.1 Overview

Results are aligned with the study's three objectives: 1) to explore regional perceptions of the concept of risk, 2) to assess variation in perceived risk, and 3) to identify factors associated with HFDD risk perception. This chapter is divided into two parts. The first part (5.2) summarizes results from the mailed questionnaire and the second part (5.3) describes findings from key informant interviews. To address the first objective, survey respondents were asked to define risk. Results for risk definition are presented under open-ended questions section (5.2.3) in this chapter. The open-ended nature of this question was intended to best elicit respondent views without potentially leading them with specific options. The second and third objectives were particularly addressed through closed-ended survey questions and are described before the key open-ended/qualitative material: conceptually, reporting of closed-ended/quantitative data first and open-ended/qualitative data second is preferable here because much of the qualitative data further explores the more quantitative information. Descriptive statistics are presented for the closed-ended responses to the mailed questionnaire and correlation analyses explore relationships among closed-ended questionnaire responses.

Following presentation of survey results, key informant interview contributions to the research are described. Results from interviews provide rich qualitative data that help illuminate quantitative results and offer a more holistic understanding of community experience and factors that may contribute to perception of risk.

5.2 Mailed Questionnaire

5.2.1 General Response

The questionnaire gathered information about respondents' self-reported fossil fuel extraction knowledge, awareness, risk perception, evaluation of benefits and risks, worldviews, sources of information and socio-demographic data. Questionnaires were sent to 1001 addresses in 10 counties. The number of questionnaires sent was proportional to the population represented by each county in the study area (Table 5.1). In all, 168 questionnaires were returned, but 6 were unusable. The numbers below reflect the 162 usable returns. Sixty-three percent of these are from Kansas.

Table 5.1. Questionnaire mailings and returns.

State	County	Population (2010)	Proportion of total study population %	Mailed questionnaires N	Deliverable questionnaires N	Usable responses N	Percentage of total usable responses
KS	Stafford	4 437	4.9	49	49	16	10
	Harper	6 034	6.7	67	67	15	9
	Barber	4 861	5.4	54	54	15	9
	Sumner	24 132	26.6	266	262	53	32
	Wichita	2 234	2.5	25	24	2	1
	Logan	2 756	3.0	30	30	6	4
OK	Woods	8 878	9.8	98	95	8	5
	Alfalfa	5 642	6.2	63	60	13	8
	Woodward	20 081	22.2	222	218	23	14
	Noble	11 561	12.8	128	125	17	10
Total		90 616	100.1[1]	1001	984	168	100

[1]Slightly exceeds 100% due to rounding

When I sent the first-round of 1001 contact letters, 60 letters were returned for residents who could not be contacted. I replaced these with 60 letters to additional randomly selected addresses. Of the new 60 letters, 17 corresponding addresses could not be reached (Table 5.2). Of the responses received, six were unusable (blank or irrelevant responses). I received a total of

162 usable responses out of 984(presumably) deliverable addresses, yielding a response rate of 16.5 percent.

Table 5.2. Undeliverable and unusable questionnaires following second mailing.

Type of unusable returned questionnaires	Number
Vacant	8
Unfinished questionnaire/excluded	6
Attempted- not known	3
Not deliverable as addressed	3
No mail receptacle	1
No such number	1
Refused	1
Total	**23**

The mean ages of respondents are given in (Table 5.3). Overall, the respondents' average age was about 64 years old.

Table 5.3. Respondent average age by county.

State	County	Average age of respondent
Kansas	Barber	50
	Logan	54
	Harper	62
	Stafford	66
	Sumner	60
	Wichita	89
Oklahoma	Alfalfa	64
	Noble	67
	Woods	64
	Woodward	63

More males than females responded to the survey. About 25 percent of respondents' average household incomes were in the range of $51,000-70,000, closely followed by 22 percent

of respondents in the range of $31,000-50,000. About 63 percent of the respondents were married. Eighty-nine percent of respondents where ethnically White, while 5 percent had identified themselves as more than of one racial category or ethnicity. Thirty-one percent of respondents had a bachelor's degree, while 26 percent of them had some college education but no bachelor's degree. Several respondents, 29 percent, were retired; 28 percent had dual income or other income sources than those listed in the questionnaire. About 13 percent of respondents listed agriculture as their only source of income. Respondents were either born in the community or had lived there for most of their lives.

5.2.2 Closed-ended Questions

Most of my closed-ended questions were Likert-scale, with five potential response options. Potential responses were listed from high to low or from completely agree to completely disagree and were coded from 5 (completely agree) to 1 (completely disagree). For instance, question 31 (Q31) asked respondents "How safe do you feel in your community?" The possible responses were *completely safe* (5), *somewhat safe* (4), *neither safe nor unsafe* (3), *somewhat unsafe* (2) and *complete unsafe* (1). This made it possible to calculate measures of central tendency; although this number is not statistically valid, it does provide an overall indication of respondents' tendencies. For example, the mean for Q31 was 4.31, indicating that respondents generally felt somewhat safe in their community.

Environmental Risk Perception

This study's second objective was to assess the variation in perceived risk related to hydraulic fracturing and directional drilling among affected rural communities in Kansas and Oklahoma. Two central questions in the mailed survey asked for ratings of respondents' level of perceived environmental risk of the oil and gas industry (Q2) and environmental risk associated

with just one step in the industrial operation, fracking (Q13). To get a fine scale understanding of the level of perceived risk among respondents, the potential responses for two questions were scaled from 1 to 10, with 1 being the lowest perceived risk and 10 being the highest. For interpretation, responses were later rescaled to correspond to a 5-point Likert scale. In the reclassified perceived risk categories, 1-2 is interpreted as very low, 3-4 low, 5-6 moderate, 7-8 high and 9-10 very high. For instance, the mean for Q2 (environmental risk - oil and natural gas industry) was 5.81: respondents saw moderate environmental risk with oil and natural gas industry. Of the 151 respondents who answered this question, about 43 percent perceived higher than moderate level of environmental risk (Figure 5.1)

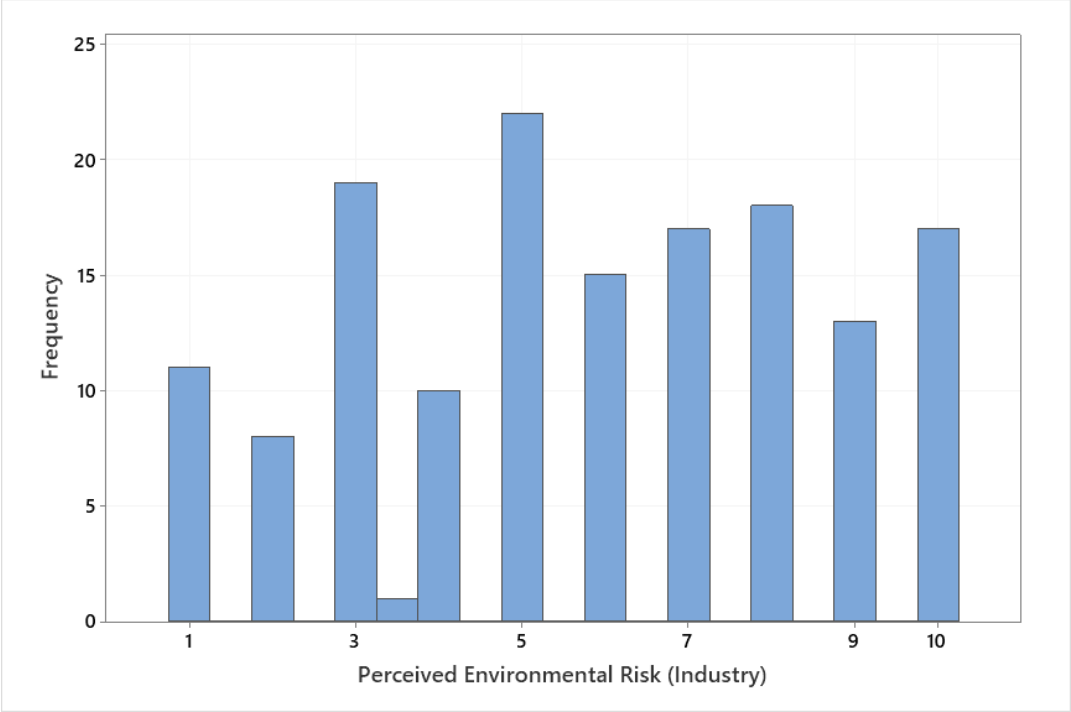


Figure 5.1. Level of perceived environmental risk, oil and gas industry.

(Note: On respondent recorded their level between 3 and 4 and hence the level was recorded as 3.5)

In the case of Q13 (environmental risk - fracking), 6.10 was the average: respondents also had moderate perceived environmental risk with respect to fracking (Table 5.4). Although still considered "moderate" perceived risk, this was somewhat higher than for oil and natural gas industry overall. I have summarized county-wise variation in perceived environmental risk in Table 5.4. Of the 154 respondents who answered this question, 48 percent perceived higher than moderate environmental risk (Figure 5.2). Although considered as "moderate" perceived risk perceived environmental risk associated with fracking was still somewhat higher than for oil and natural gas industry overall. For both items, responses were negatively skewed (-0.10 and -0.27 respectively), meaning perceived levels of risk were more than neutral.

Table 5.4. Perceived environmental risk for the oil and natural gas industry and for hydraulic fracturing, specifically.

State	County	Response rate (% of total)	Perceived risk: oil and gas industry	Perceived risk: fracking
KS	Barber	15 (9)	4.9	4.8
	Harper	15 (9)	6.5	7.0
	Logan	6 (4)	4.0	5.8
	Stafford	16 (10)	4.8	6.4
	Sumner	53 (32)	6.5	7.0
	Wichita	2 (1)	3.0	2.0
OK	Alfalfa	13 (8)	6.3	6.3
	Noble	17 (10)	6.8	5.8
	Woods	8 (5)	6.3	6.6
	Woodward	23 (14)	4.6	4.7
	Total	**168 (100)**	**5.8**	**6.1**

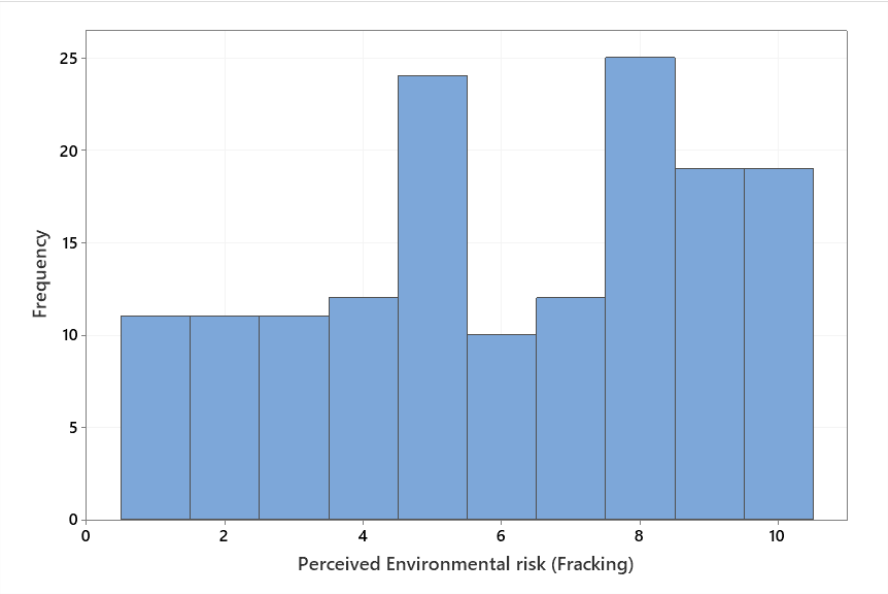


Figure 5.2. Level of perceived environmental risk, fracking.

Factors Associated with HFDD Risk Perception in the Study Area

The study's third objective was to identify factors most associated with perception of risk of HFDD. For purpose of analysis, these factors are divided into the following categories: awareness and knowledge, community experience (socio-psychological factors), news outlets and trust, perceived benefits and drawbacks, and worldviews.

Table 5.5. presents means, standard deviations, and response ranges for most closed-ended questions. The typical response for both knowledge and willingness to take risks was 3.3 (on scale of 5). Perceived characteristics of communities of residence (safety, community spirit, physical appearance, and local environment) were rated highly on the Likert scale. Most (59%) respondents identified themselves as having conservative political views, and a plurality of them were long-term residents of their communities.

Table 5.5. Summary statistics for closed-ended questions.

Question type	Variable	Question number	N	Mean	Standard deviation	Min	Median	Max
Likert 10-point (10 high)	Perceived environmental risk (Oil & Natural Gas industry)	2	151	5.8	2.7	1	6	10
	Perceived environmental risk (fracking)	13	154	6.1	2.8	1	6	10
Likert 5-point (5 high)	Willingness to take risk	3	154	3.3	1.2	1	3	5
	Knowledge	4	151	3.3	1.3	1	4	5
	Emotional affect	8	153	3.1	1.1	1	3	5
	Self-reported knowledge (fracking)	11	157	2.4	0.8	1	3	5
	Support for technology (fracking)	15	160	3.2	1.3	1	3	5
	Political inclination	25	157	2.3	1.1	1	2	5
	Participation	26	158	3.3	1.0	1	3	5
	Visual appearance	30	158	3.3	0.9	1	4	5
	Safety	31	159	4.3	0.8	1	4	5
	Community spirit	32	159	3.9	1	1	4	5
	Physical appearance	33	159	3.9	0.9	1	4	5
	Local environment	34	152	4.7	0.5	1	5	5
Open-ended	Residential length (years)	27	156	36.9	23.0	2	33.5	88

Correlations Between Closed-ended Questions

Spearman's rank correlation (r_S) helps to clarify the relationships between perceived environmental risk and different variables. This is a non-parametric test used to measure the strength and direction of association between closed-ended questions. This test is used to

analyze data collected in surveys with Likert scale questions on economic, social or environmental variables. The r_S calculation provides answers between 1.0 (perfect positive correlation between two variables) and -1.0 (perfect negative correlation between two variables). If r_S is 0, the variables are not at all correlated. To further summarize the strength of correlation between the variables, I use the guide by Fowler et al. (2009) (Table 5.6).

Table 5.6. Strength of correlation (Fowler et al. 2009).

Value of r_S (positive or negative)	**Interpretation**
0.00 to 0.19	very weak correlation
0.20 to 0.39	weak correlation
0.40 to 0.69	moderate correlation
0.70 to 0.89	strong correlation
0.90 to 1.00	very strong correlation

The probability, or *p*-value, of r_s tells us whether the likelihood that the correlation between two variables is by chance. The *p*-values range from 0 to 1. These are often discussed as percentages, with 0 being 0 percent and 1 being 100 percent. If the *p*-value is close to one, any correlation between the variables is by chance. If closer to 0, the correlation between variables is not by chance. Thus, the smaller the *p*-value, the stronger the relationship between the variable and the null hypothesis (H_0), that there is no correlation between the variables, so the lack of relationship can be rejected (Table 5.7); in other words, a relationship may be indicated.

Table 5.7. Interpretation of the *p*-value as evidence to reject a null hypothesis (Source: Fowler et al. 2009).

***P*-value**	***P*-value (%)**	**Evidence for rejecting H_0**
More than 0.1	>10%	very weak to none
Between 0.1-0.05	10% to 5%	weak
Between 0.05-0.01	5% to 1%	strong
Less than 0.01	<1%	very strong

Here, a 5 percent probability level (p= 0.05) or less is considered statistically significant. This means that if the *p*-value is above 0.05, the null hypothesis is accepted: either the correlation between variables is by chance, or there is no correlation between the variables at all. Since the study's central goal is to contribute to the understanding of factors adding to perceived environmental risk related to oil and natural gas industry, the associations between level of perceived environmental risk (industry and fracking) and different variables are examined.

Awareness, knowledge, and perceived risk

Respondents were asked whether the community (stated as "we") had enough knowledge about the oil and gas industry to let development take place (Q4). While 51 percent of respondents thought they had enough knowledge to let development take place in their community, 31 percent did not agree with this statement and 19 percent of respondents were unsure. When testing the correlation of self-assessed knowledge to perceived environmental risk with the overall industry and with fracking, both showed significant strong negative correlations: as supposed knowledge increased, perceived risk decreased.

Several questions focused on hydraulic fracturing. These questions were designed to understand sources from which respondents had *heard about fracking* (question 10*), how much*

they knew about fracking (Q11), if respondents *knew the type of fracking happening around them* (Q14), and, based on the definition of fracking provided to them, whether they *supported or opposed it* (Q15). Respondents could choose multiple sources of information. The largest number of respondents (113) had heard about fracking from television, 87 had heard from friends and family, and 84 from newspapers. Most respondents had one to four sources from which they had heard about fracking.

Space was provided to respondents to mention sources not listed in the question; 36 chose to write a response. Twenty-two identified self-experience, including friends and family working in the oil field or fracking taking place close to their house; 12 respondents heard about it from internet, news, and educational organizations; one respondent had heard about it from the government and one from a farmer.

Fifty-five percent of respondents claimed *some* knowledge about fracking, while 24 percent said they knew little about it. Of the 159 respondents who answered the question about whether they knew what type of fracking happened on their land or land around them (horizontal, vertical, slant or unsure), 70 respondents were unsure. Based on the definition of fracking provided in the survey ("a way to extract natural gas and oil from shale rock deep underground" (Q15), 26 percent of 159 respondents who answered the question said they supported it somewhat, 22 percent were unsure whether they supported or opposed it, and 52 percent opposed fracking.

Community Experience and Perceived Risk

Six closed-ended questions in the survey were included to explore community capital by asking respondents about their communities. These included the respondent's involvement in the community (question 26), evaluation of visual appearance of community (Q30), level of

safety felt by the respondent (Q31), community spirit (Q32), belonging to the community (Q33) and the importance of the local natural environment (Q34). The mean for all these variables ranged from 3.3 (Q30) to 4.7 (Q34). Thus, on a scale of 1 (low) to 5 (high), respondents had moderate to positive ratings for variables measuring community capital. I then tested these variables for correlation to perceived environmental risk from both industry and fracking. Respondents were free to interpret the idea of environmental risk. Except for question 26, all variables had some statistically significant relation with perceived environmental risk from the fossil fuel industry (in general) or from fracking (Table 5.8).

Table 5.8. Correlations between community capital variables and perceived environmental risk.

Variable	Industry risk r_s	*p*-value	Fracking risk r_s	*p*-value
Community involvement	-0.12	0.1591	-0.01	0.9124
Visual appearance	-0.19	0.0219	-0.13	0.1060
Safety	-0.29	0.0003	-0.22	0.0073
Community spirit	-0.18	0.0247	-0.22	0.0061
Feeling of belonging	-0.23	0.0053	-0.19	0.0204
Local natural environment	0.16	0.0608	0.19	0.0213

When an industry with a long association with a community employs a new technology, people's risk perceptions may be different than if the industry itself is a new addition. Question 8 asked respondents how they felt about the technological advances in oil and natural gas drilling techniques (enthusiastic, optimistic, uncertain, concerned, or panicked; coded from 1 low to 5 high). Additional space was provided for comments. About 33 percent of respondents were concerned about the application of new oil and gas technology in their community, 27 percent were optimistic, and 22 percent said they were uncertain about it. Only 12 percent were enthusiastic about the development and 5 percent said they were panicked about it. Spearman's correlations indicate a significant strong negative correlation between how respondents felt about

the new technology and their perceptions of environmental risk (r_s -0.70 for the oil and gas industry, with a probability of <0.0001, and r_s -0.76 for fracking, with a probability of <0.0001); the more enthusiastic they were about the new technology's application in their community, the lower their perception of environmental risk.

News Outlets, Trust, and Perceived Risk

Two questions (17 and 19) asked respondents about their frequency of use of news sources (print and digital, respectively) to get information. Follow-up questions asked respondents to identify specific sources of information for both general information and for the oil and gas industry. This information was sought to investigate whether the source of information had any impact on perceived risk. There was a higher mean for digital media (3.9) than for print media (3.4). Additionally, about 57 percent of respondents saw news on television every day, compared to only 40 percent who read newspaper daily. Frequently used newspapers and news channels are shown in Table 5.9.

Table 5.9. High frequency newspapers and television networks mentioned by respondents.

Newspaper	**Number of times mentioned**
Wichita Eagle (or "Eagle")	28
Woodward News	14
Hutchinson News (or "Hutch news")	13
The Oklahoman	10
Other local newspapers	26
News channel	
FOX	39
CBS	20
NBC	19
CNN	18
ABC	11
Local stations (not identified by major network)	26

Spearman's correlation values for industry-associated environmental risk and fracking-related environmental risk information with newspapers were 0.07 and 0.08, respectively, while correlations with news channels were -0.13 and -0.08. The *p*-values for all cases were above 0.05: there was no strong evidence of a relation between source of news and perceived environmental risk.

One question (21) asked respondents about the level of trust they had in different sources of information about fracking: the oil and gas industry, federal agencies, state agencies, universities, independent researchers, local environmental groups, television, newspapers, magazines, and radio. Respondents were asked to select their level of trust from complete trust (5) to no trust (1). Respondents had overall low trust in the listed sources of information (averaging 3 and below on scale of 5). The least trusted source was local environmental groups (2.7), while oil and gas industry (3.04), state agencies (3.08), and universities (3.47) were somewhat more trusted sources. Sixty-one percent of respondents reported some trust in independent researchers (4 on a scale of 5). Eleven percent identified having complete trust (5 on the 5-point scale) in the oil and natural gas industry and in universities as sources of information about fracking.

There were weak negative but statistically significant correlations between perceived environmental risk for both oil and gas industry overall and for fracking and trust in information coming from the industry and from state agencies (Table 5.10). This means that as trust in these agencies increased, perceived risk decreased. Local environmental groups and magazines also showed weak positive but statistically significant correlations with perceived environmental risk related to both industry and fracking. With respect to fracking, there was a weak but significant

positive correlation between perceived environmental risk and information coming from newspaper and television.

Table 5.10. Relationships between information sources and perceived risk.

Source	Industry risk r_s	p-value	Fracking risk r_s	p-value
Oil and Gas industry	-0.57	<0.0001	-0.57	<0.0001
Federal agencies	-0.03	0.7293	0.12	0.1576
State agencies	-0.24	0.0029	-0.16	0.0491
Universities	0.12	0.1350	0.15	0.0674
Independent researchers	0.12	0.1324	0.11	0.1800
Local environmental groups	0.20	0.0151	0.27	0.0009
Television	0.09	0.2714	0.22	0.0055
Newspaper	0.11	0.1749	0.19	0.0189
Magazines	0.18	0.0319	0.28	0.0006
Radio	0.12	0.1537	0.16	0.0547

Perceived Benefits, Drawbacks, and Risk Related to Oil and Natural Gas Activity

Four questions (1, 9, 16, and 3) explored respondents' experiences with effects attributed to the oil and gas industry and their assessments of drawbacks and benefits of petroleum and natural gas industry (Table 5.11). Respondents were asked to use their experience with oil and gas industry in their community to identify their level of agreement with five statements. These statements related to *increased truck traffic, new businesses in town, local businesses losing customers, new faces in the community,* and *discomfort with new faces*. If a respondent affirmed complete agreement, it was coded as 5; complete disagreement was coded as 1.

Respondents generally disagreed with listed potential local experiences, except for responses about new businesses and new people moving into the community. With respect to

Table 5.11. Respondents' expressed views related to some potential results of oil and gas industry activities.

Variable	N	Mean	Standard deviation	Median
Expressed local experiences				
Significant increase in truck traffic	155	3.58	1.13	4
New businesses established	156	2.54	1.06	2
Local businesses losing customers	154	2.73	0.99	3
New faces in the community	154	3.21	1.00	3
Discomfort with new faces	152	2.30	1.07	2
Views of benefits and drawbacks				
Job creation	156	3.98	0.91	4
Quality of life	158	3.40	1.03	3
Noisy	158	3.22	0.93	3
Negative impacts can be fixed	156	3.09	1.14	3
Air quality bothers me	156	2.60	0.94	3

correlations between expressed experiences and perceived risk related to fossil fuel industry and to fracking (Table 5.12), statistically significant correlations were seen with all variables except for new faces in the community. All correlations were positive except for setting up of new businesses.

Table 5.12. Correlations between perceived risk (industry and fracking) and community experience of the oil and gas industry.

Variable	Industry risk r_s	*p*-value	Fracking risk r_s	*p*-value
Expressed local experiences				
Significant increase in truck traffic	0.26	0.0011	0.16	0.0520
New businesses established	-0.21	0.0105	-0.26	0.0013
Local businesses losing customers	0.23	0.0052	0.18	0.0317
New faces in the community	0.07	0.4219	0.01	0.9173
Discomfort with new faces	0.21	0.0113	0.20	0.0129
Views of benefits and drawbacks				
Job creation	-0.40	<0.0001	-0.44	<0.0001
Quality of life	-0.59	<0.0001	-0.59	<0.0001
Noisy	0.26	0.0016	0.19	0.0203
Negative impacts can be fixed	-0.41	<0.0001	-0.44	<0.0001
Air quality bothers me	0.43	<0.0001	0.45	<0.0001

Respondents were asked about specific potential benefits and drawbacks (or 'costs') of oil and gas activities (Q9). They were asked to indicate levels of agreement/disagreement on three statements about possible benefits, creation of jobs and improved quality of life, and two statements about potential negative impacts on the environment (it was left to respondents to interpret 'environment), noise, and air quality (detectable odor). Respondents disagreed about whether odor, owing to the oil and gas activity, had negatively affected the air quality near their homes. Most agreed or completely agreed (78 %) on the benefits to the community in terms of job creation. A few respondents wrote "temporarily," "initially" or "for some time" next to the job creation item, indicating a short-lived experience or an expectation that it would be short-lived. All variables had statistically significant correlations with perceived risk. Job creation, quality of life, and "negative impacts can be corrected" were negatively correlated.

In contrast to questions more focused on experience, question 16 asked respondents to evaluate environmental risks specifically associated with fracking, based on what they had heard, read, or "know." Summary statistics are shown in Table 5.13. About drawbacks and benefits of fracking, respondents had moderate to high agreement on all statements except one. Respondents did not agree that fracking could cause irreversible damage to their community. As for views of the oil and gas industry, all variables showed statistically significant correlations with perceived risk related to the overall industry and to hydraulic fracturing (Table 5.14). The only negative correlation was found with one variable: the idea that proceeding cautiously could prevent negative impacts.

Table 5.13. Respondents' perceptions of potential effects of fracking.

Variable	N	Mean	Standard deviation	Median
Causes earthquakes	158	3.63	1.13	4
Uses excessive water	157	3.45	1.06	3
Concerns about wastewater disposal	157	3.83	1.06	4
Cautious proceeding can prevent negative impacts	158	3.41	1.04	4
Can cause irreversible damage to community	158	2.96	1.19	3
Should not be done anywhere near my house	158	3.35	1.30	3

Table 5.14. Correlations between perceptions of potential negative fracking effects and perceived risk (industry and fracking).

Variable	Industry risk r_s	*p*-value	Fracking risk r_s	*p*-value
Causes earthquakes	0.62	<0.0001	0.74	<0.0001
Uses excessive water	0.54	<0.0001	0.63	<0.0001
Concerns about wastewater disposal	0.62	<0.0001	0.63	<0.0001
Cautious proceeding can prevent negative impacts	-0.58	<0.0001	-0.58	<0.0001
Can cause irreversible damage to community	0.68	<0.0001	0.72	<0.0001
Should not be done anywhere near my house	0.64	<0.0001	0.72	<0.0001

Respondents were asked whether benefits outweighed drawbacks for the community (Q3). A plurality of respondents neither agreed nor disagreed, but there was a statistically significant negative correlation between benefits and perceived environmental risk: outweighed (Υ_S Industry: -0.62; Υ_S fracking: -0.61; Probability for both <0.0001). The negative correlation suggests that if the community were to experience more benefits, respondents' perceived drawbacks would reduce.

Worldviews and Perceived Risk

Worldviews are individuals' latent predispositions that can be observed in the form of professed attitudes (Kahan 2012). Individuals in a society identify risks based on deeply held

values, worldviews, and social relations (Cutter 1993). There are four types of worldviews: individualist, hierarchical, egalitarian, and fatalist outlooks (Boudet et al. 2014). Holders of each worldview would have different risk perceptions and risk-taking attitudes. For individuals, risks of concern or those ignored serve to strengthen one of these ways of life and weaken others (Wildavsky and Dake 1990). For instance, individualistic and heirarchists both assume that long-term threatening dangers may not materialize (Douglas and Wildavsky 1982). These people may have lower perceived risk and higher trust in institutions to prevent the risks. People with egalitarian biases perceive higher dangers with technology and small benefits (Wildavsky and Dake 1990).

To better understand respondents' worldviews, I provided eight statements, two each oriented toward egalitarian, fatalistic, hierarchical, and individualistic views. The statements represented one personal situation and one societal situation for each of the four worldviews, and were modified from the Boudet et al. (2014) study on fracking opinions in Pennsylvania. For instance, for the hierarchical view, a personal situation was: '*I would not participate in civil action groups,*' while a societal situation was: '*Important questions for our society should not be decided by experts but by people.*' Out of the four, only two, egalitarian and individualistic worldviews had significant correlations with perceived environmental risk, 1) the oil and gas industry as a whole and worldview and 2) fracking as one step in the industrial process and worldview. A statistically significant positive correlation (probability level for industry is 0.03 and for fracking is 0.01) was seen between the egalitarian view and the industry as a whole, and the egalitarian view and fracking, specifically. A statistically significant but negative correlation (probability level for industry is 0.0003 and for fracking is 0.0004) was also found for the individualistic view (personal) and perceived environmental risk, industry, and fracking.

Research has shown that people with different political ideologies view risks differently (Wildavsky and Dake 1990, Boudet et al. 2013), so respondents were asked to identify their political approach. Fifty-nine percent of respondents (157) identified themselves as either conservative or somewhat conservative. I asked this question because There were significant positive correlations between political ideology and perceived environmental risk for both the industry overall (r_s 0.28; p = 0.0006) and for fracking, specifically (r_s 0.35; p < 0.0001).

Categorical Data

The Cochran-Mantel-Haenszel (CMH) test is used when data are categorical and collected at different locations. There are two assumptions of the CMH test: 1) observations are independent from each other and 2) all observations are identically distributed. In practice, this means that each observation comes from a different subject, subjects are randomly selected, and all observations are obtained in the same way (McDonald 2014). In this study, I applied the CMH test to four questions. These included questions as to whether the respondent was currently leasing land to an oil/gas company (Q6) and whether the respondent would undertake future leasing (Q7), with possible responses of *Yes, No,* and *I don't know/Unsure*. Survey questions also asked whether respondents thought there was enough regulation of the oil and gas industry from state government (Q22) and by the federal government (Q23), with responses of *True, False,* and *Unsure.* Using the CMH test, I compared odds ratios of two by two tables. An odds ratio helps us understand if the two groups are independent. For instance, for Q6, I generated three tables: one each for yes/no, no/unsure and yes/unsure. In each of these tables, I tested two categories assuming that the third category was independent. I then calculated probabilities for the two categories under consideration. If $p < 0.05$, then the responses are considered to be independent of each other.

Seventy-one percent of respondents had not currently leased their land to an oil and gas company. Thirty-nine percent of respondents said they would lease their land to an oil and gas company in the future, while 36 percent said they would not. I calculated probabilities for respondents falling in yes/no, no/unsure and yes/unsure categories. Since the *p*-value for respondents in each category was ≤ 0.05, the responses were significantly different both questions for the three categories, meaning the responses were significantly different for categories under consideration.

Thirty-two percent of respondents did not believe the state government had sufficiently regulated this source of energy, while 36 percent believed the federal government had not sufficiently regulated this source of energy. *P*-values for both questions for true/false, false/unsure, and true/unsure were all ≤ 0.05. Thus, it could be concluded that the respondents fell in different categories for Q22 and Q23: responses were significantly different.

5.2.3 Open-ended Questions

Nine of the 45 questions in the questionnaire were open-ended. Open-ended responses helped provide context and added related qualitative information. For instance, question 17, "*In a typical week, how many days do you read the newspaper or news magazines?*" was a closed-ended question followed by an open-ended question asking the respondent "*Are there any newspaper or news magazines you read regularly? If so, please list them below*." Similarly, while question 19 asked about frequency of viewing news on television, the following question asked respondents to list the news outlets they followed regularly. *NVivo* 12, a qualitative data analysis software package was used to examine open-ended responses. Each of the open-ended questions were analyzed for response for word frequencies, which were then grouped by synonyms. In this section, I present results from these nine open-ended questions.

Conceptualization of Risk (Q12)

This study's first objective was to explore regional perceptions of the concept of risk. As the study's central theme was to understand factors contributing to perceived risk related to oil and natural gas industry activities at a local level through lived experiences, it was important to understand how community members understood and defined risk in their own words. Question 12, one of the central open-ended questions asked, "*What does risk mean to you*?" Meanings (or definitions) of risk provided by respondents included the following:

- *"A chance of adverse or beneficial result."*
- *"TAKING A CHANCE FOR PROFIT."*
- *"A negative result is possible or probable."*
- *"Anything that negatively affects our environment."*
- *"My long-term concern is for the chemicals being put back underground. I think the citizens have a right to know what they are and their effects on the environment. For me, the immediate "risk" has been extensive cracking of the walls of my house and concerns about the value of my home."*
- *"No risk No Gain."*
- *"Potential consequences, both "known" and "unknown" consequences."*
- *"You have to take risks. We will only understand the miracles of life fully when we allow the unexpected to happen."*

Key terms related to risk are shown in Table 5.15. While the most frequent term respondents associated with risk was 'chance,' the connotation was in terms of negative emotions or danger associated with change. Thirty-six respondents defined risks in terms of chance. Respondents sometimes defined risks as a necessary step to make economic profit (see quotes above and 'gain' synonyms in Table 5.15). Risk taking also was seen as a step toward the future or to have future security (5 times). When addressing the future, respondents seemed to

be more positive in terms of 'risk taking,' but when addressing the present the emphasis was more on harm or damage caused to the environment.

Table 5.15. Key terms/concepts from respondents' definitions of risk.

Word	Frequency	Synonyms
risk	70	chance, chances, danger, dangerous, dangers, gambling, hazard, hazardous, 'risk', risks
chance	36	chances, happen, happening, hazard, hazardous, probability, probable, probability
negative	32	damage/s, damaging, negatively
possible	32	maybe, possibility, potential, potentially
consequences	28	effect/s, event, events, important, outcome/s, result
damage	27	damages, damaging, harm, harmful, hurt, hurting, term, wrong
taking	23	brings, carries, carry, driving, get, involves, involving, make, needs, returns, study, take, win
gain	17	benefits, hitting, increased, make, pay, profit, win
loss	12	lose, losing
potential	12	likely, potentially
action	10	activity, process
harm	10	harmful, hurt, hurting, injury

Affective Association (Q5 and Q8)

Question 5 asked participants to identify three words they associated with fracking or terms that came to mind related to 'fracking.' The purpose of this question was to assess affective imagery people retain and link to industrial activity. Participant responses might be an outcome of what they had seen or heard in media, read in newspapers, discussed in social circles, or had experienced directly with HFDD. Synonyms were again grouped: for instance, for Q5, 'earthquake,' 'quakes,' and 'shocks' were all grouped under earthquake (Table 5.16).

Table 5.16. High frequency concepts associated with 'fracking' by respondents.

Concept	Frequency	Words associated with concept
Earthquake	81	Earthquake, Earthquakes, quakes, shocks
Water	38	Water, H2O
Oil	31	Oil, oiling, oilfields
Jobs	22	Business, worked, work, employment, economic, income, pay, economy
Fracturing	17	Frack, fracking, fracturing, fracturing, extractive, extraction, injection, injecting
Gas	15	Production
Well	12	Well, wells

Question 8 asked respondents to elaborate on their feelings about recent technological advances in oil and natural gas drilling techniques. Fifty respondents provided comments. Their comments are divided into four categories: positive (in support of the activity), negative (discussing negative impacts), concern (sharing information or experience they have had or asking for more information), and alternative solutions (presenting views on alternative energy) (Table 5.17).

Table 5.17. Categories of respondent comments.

Comment connotation	Interpretation	Frequency
Negative	Reject the activity due to damage to personal property and environment	22
Concern	Sharing information and experience or requesting more knowledge on the activity	21
Positive	Support for the activity for economic benefits	4
Alternative solution	Use of green technology or alternative source of energy	3

In terms of concept frequencies, earthquakes were the most frequently mentioned topic, associated with damage or wanting more information about links of the oil and gas industry to earthquakes. Examples of concerns as expressed by respondents include the following:

- *"Amount of water used is frightening."*
- *"Earthquakes have damaged our homes. Our taxes skyrocket because of oil aftermath."*
- *"Need to learn more, especially when it comes to earthquakes and fracking."*
- *"We need to focus on renewable energy - wind, solar, hydraulic [hydrologic]."*
- *"Without oil and gas, Oklahoma returns to the Dark Ages."*

Community Factors (Q28, Q29, Q35)

In questions 28 and 29, respondents were asked about their community. Respondents were first asked to describe their community in a few words, then asked what they liked the most about their community. Some respondents had unique answers for each question, but other gave related answers. As an example of differing answers, respondents who made a distinction between Q28 and Q29 sometimes described the community (for Q28) in terms of economic functions, but people's relations with each other were mentioned as to what they liked (Q29). Table 5.18 summarizes high frequency words for Q28 and Q29.

Table 5.18. Community characteristics: Description of the community (Q28) and fondness for the community (Q29).

Word	Description (Q28)	Fondness (Q29)	Synonyms
Small	158	47	Diminished, small, little, low, smallness
People	38	25	people
Friendly	38	17	Friendly, friends, support, supportive
Community	58	13	
Place	30	17	Home, homes, local, place, seat, space, town, towns
Help/ supportive	54	12	Aid, help, helpful, helping, helps, supports, supportive
Family	30	9	families
Rural	62	8	
Quiet	26	12	serenity, still, quietness
School	10	9	Education, schools, educated

For question 28, example responses include the following:

- *"Medium- small rural community with solid agriculture and manufacturing sector. County Seat and local hospital contribute to a broad-based feel with also a healthy retail foundation."*
- *"Small, rural community with hardworking, honest folks. Low to no crime."*
- *"Resilient, steadfast, resourceful."*
- *"Nosey, stuck up, unpleasant."*

For Q29, example responses include these observations:

- *"Knowing people on a personal level."*
- *"Farming and oil production."*
- *"I like that [I] know people. There is minimal traffic, although I live on a street that leads to a grain elevator and as many as 57-18 wheelers, I have counted during the harvest. I can get around on a bicycle although [I] have a car, the city has an original Carnegie library, wonderful swimming pool plus recreation center program. There is a beautiful park across the street."*
- *"City Council and community leaders work hard to provide and support our hospital, schools, Carnegie library, well maintained parks and critical resources such as police and fire department."*

Question 35 asked respondents whether they wanted to change anything in their community about oil and gas industry activities. Ninety-seven respondents provided comments. I have broadly divided their comments into seven categories: against, caution, comment, not applicable (n/a), negative, supportive, and uncertain (Table 5.19). For instance, 'Ban it' and 'Stop it' were classified as against; 'Watch and manage it more closely' and 'I would like people to be more aware of the dangers of fracking' were considered caution; 'It is mainly south of us,' 'No,' 'Non' and 'N/A' responses were coded as general observations. Two respondents' comments were classified as not applicable and omitted, as they were unrelated to the survey.

Only one comment was classified as negative: it was strongly worded against saltwater disposal, although it did not directly oppose oil and gas activity.

Table 5.19. Summary of comment connotations regarding views of local oil and/or gas activities (Q35).

Category	Interpretation	Frequency
General observation	Sharing experience or general observations	38
Against	Strong wording against the activity	21
Negative	Would like to stop one step in the process, but is neither against nor supportive of activity	1
Caution	Wanting more information to make an informed decision	21
Supportive	Strongly worded statements in support of the activity	13
Uncertain	Doesn't know what can be changed	1
n/a	Unrelated to the survey question	2

In terms of word frequency, words such as 'stop' occurred 17 times, 'need' nine times, "care" and "damage" (as individual words) six times each, and "fix" seven times. Examples of respondents' comments are:

- *"I want to see more of it. I want some drilling rigs on my land and family ranch."*
- *"If to start* [sic] *fracking here again, maybe better paying jobs, cost of living cheaper."*
- *"Ban fracking entirely."*
- *"Better regulation of saltwater disposal."*
- *"Fracking should be limited. We built a new house on our property and within a year we had 8 horizontal wells drilled one mile north of our house in about a 2½ mile line (east to west)."*

Additional Comments from Participants (Q45)

The last question in the survey (Q45) provided space for respondents to write any additional comments they wished to make. Sixty respondents chose to use the space to voice their opinions. Some gave thoughtful insights into the industry's presence in their community over time, some gave personal experience with the industry's economic benefits, and some did

not like the media's and educational institutions' approaches to the topic. The comments were coded into general observations, education/research, supportive, regulation, and uncertain (Table 5.20). Education and research were combined into one category because respondents indicated research-based education for community members in the future.

Table 5.20. Summary of respondents' general comments.

Category	Interpretation	Frequency
General observation	Respondent shared their association with the industry or discussed presence of the industry in their community	32
Regulation	Respondent has discussed the need for more regulation or has disapproved over regulation. Former is discussed with cautionary tone for environmental concern while later as a criticism for in connection to economic impacts for the community	10
Education/ research	Respondent demanded either more education of the population on the matter or more research on the industrial activities	9
Industry-affirmative	Respondent has experienced the benefits of the industry either for themselves or in their community	8
Uncertain	Unknown	1

Examples of respondent comments related to education and/or research included the following:

- *"I wish the fracking issue would be more definite on: is it safe or not for the land?"*
- *"I think it is necessary to find ways for this country to be more independent, but I have concerns about the fracking upsetting nature's balance."*

One contributor provided a lengthy, optimistic view of the industry:

> *Our small community, between the years of 2009-2015, saw a marked increase in newly available job opportunities, new businesses, an increase in local community donations and an increase in local business revenue. The fear-mongering tactics of those opposed to the oil industry (possibly ill-informed or uneducated about the reality of the practices of drilling) hurt the communities as well as the state as a whole. It is also a step*

> *backwards in efforts to create a more self-sufficient energy industry for our nation. There are indeed issues that need to be addressed about waste water disposal, and those practices should be investigated and improved upon. However, the targeting of the oil and gas industry and fracking and drilling specifically, is a misplaced concern that only serves to harm a necessary industry at the expense of blue-collar families. It is estimated that over 6000 daily products are produced from the oil and gas industry alone (shampoo, soap, lotion, makeup, ink, trash bags, contact lenses, diapers etc...), and each of these products will also see an increase in price with the decrease of fracking and drilling. Every household will also see an increase in natural gas prices as well as an increase at the fuel pumps. So in my humble opinion, the benefits most certainly outweigh the "risks" of drilling and fracking in our everyday lives as Kansans, as well as the future of our children and grandchildren as they are faced with the daunting task of dealing with a shaky and internationally dependent energy crisis in decades to come.*

Reflecting on the need or desire for more regulation, one responded:

> *"Until a trustworthy in-depth review of fracking with all things are on the table and open to all, I will not trust them."*

To further explore the survey results, interviews with key informants provided local knowledge. The outcomes from interviews conducted with public officials from five counties are described in the next part of this chapter.

5.3 Interviews

5.3.1 Interviewee Selection

I used a purposive sampling strategy to select the counties for interviews from among the counties that had received the mailed survey (see Chapter 3, Figure 3.1). I chose to interview public officials as key informants with good local understandings. They also serve as important links between local communities and some aspects of state and federal governments. Key informants included economic development officers (EDOs), county extension agents (CEAs), Chamber of Commerce representatives (CCRs), town planners (TPs) and county commissioners

(CCs): people serving in roles providing them substantial understanding of the local area, community members, and decision-making (Table 5.21). Interviews were semi-structured and with guiding questions (see appendix P) based on survey data's analysis. I preferred face-to-face interviewing to other methods (e.g., telephone, email) because of increased clarity of communication culled from body language and other cues and convenience of follow-ups. Interviews were conducted from February to April 2019.

Table 5.21. County-wise position and number of public officials interviewed.

State	County	Interviews (N)	Public officials interviewed
KS	Stafford	2	EDO, CEA
	Harper	4	CC, TP, CEA, CCR
	Sumner	3	EDO, CEA, CCR
OK	Woodward	3	CEA, CCR, EDO
	Noble	2	CEA, EDO

Initially, three interviews per county were planned. During my scoping trips early in the study, I had established contact with the CEAs. These key informants were helpful for connecting with other interviewees and scheduling the interviews. Except for Woodward, Oklahoma, all interviews entailed one-day trips per county. In Stafford County, the CEA and EDO worked in the same building and coordinated to find a suitable day and time, so I could interview them one after the other. Repeated attempts to contact the Stafford County Chamber of Commerce were unsuccessful, so only two interviews were completed there. In Harper County, the county extension agent coordinated with the town planner, county commissioner, and Chamber of Commerce representative, and provided a schedule for all four interviews on the same day.

In the case of Sumner County, I contacted the EDO and CEA individually and scheduled the interviews. The CCR was not available at that time. Due to time conflicts, I scheduled a telephone interview with the Sumner county Chamber of Commerce president, sharing consent forms, the IRB approval letter, and list of guiding questions prior to the interview. For Woodward County, the CEA helped me connect with the Chamber of Commerce president and the EDO and provided a schedule for interviews. For Noble County, I contacted individually the CEA and the EDO, along with the CCR. Interviews of the extension agent and development officer were scheduled for the same day. Because of scheduling difficulties with the Chamber of Commerce representative, only two interviews were conducted in Noble County.

Overall, an equal number of males and females participated in the interviews, seven each, although there were county differences (Table 5.22). On average, interviews lasted approximately 75-minutes. The shortest interview was 55 minutes, while the longest was about 120 minutes.

Table 5.22. Interviews by county.

State	County	Total interviews	Female	Male
KS	Stafford	2	2	-
	Harper	4	3	1
	Sumner	3	1	2
OK	Woodward	3	1	2
	Noble	2	-	2

5.3.2 Interview Procedures

Interview guiding questions (Appendix P) were developed based on survey responses. The interview questions aimed at addressing which factors (place, personal, and social

conditions) contributed to development of risk perception. In addition to study objective-related topics, I also wanted to ask public officials whether they had encountered similar low responses in other surveys, as well as their impressions of channels of information that community members trusted and used. Public officials also were asked about what could be done differently in the future to make more sustainable decisions for the community. At the end of the interview, I asked how I should share information that I had discovered through my work. A majority of the public officials wanted a report in simple language so they could use the information for their respective counties.

All the interviews began with description of the research and why the interviewee was chosen as a community representative. In order to understand and place the interviewees' positions in the research, I asked them about themselves, what brought them to the community, the length of time they had lived there and served in their current public position, and their impressions about the community. After this, I directed the conversation to their office's involvement in the community and decision-making. We spoke about the opportunities and challenges the community faced in interactions with the fossil fuel industry, the levels of risk perception people reported through the questionnaire and possible explanations for those levels. This discussion led to who communicated the risk and which channels/agencies were used for communication of risk and risk information shared with the community. We also spoke about disagreements with activities related, directly or indirectly, to the industry introduced in the community and how different offices within the community would or might handle these disputes. Interviewees cited a few examples, such as: who would be responsible for repairing road damage caused by heavy truck traffic, or was it the company's or local government's responsibility to dispose of earth material generated while clearing the land to drill a well, or

who was accountable for regulation in case of damage during industrial operations? Originally, I had not included in the list of question the issue of "lessons learned." However, while conducting interviews, the interviewees in Sumner County and Stafford county brought up the topic of future development and sustainability for community. Hence, I absorbed this question as a part of a formal question at the end of the interview for the remaining counties. Officials identified the lessons learned from their recent experiences and spoke about what they would do differently in the future, if faced with a similar situation.

5.3.3 Interviewees' Positions in the Community

The positions and experiences of interviewees helped shape their views, as well as their knowledge of the local area. In this section, I summarize the role of each of the offices represented in the community, as described by the public officials.

Role of Extension Offices and Agents in the Community

The extension agents from both states identified themselves as someone who the community recognized as a trusted source of resource-based information. All the extension officers liked the communities in which they lived and noted positive attributes that contributed to their experiences: friendly, a good place to raise a family, safe and of small size. The extension agents were community insiders. They themselves had lived in the community for a long time, had family ties or had moved there because of their spouse and his/her ties to the location. For extension personnel, family ties and personal relationships with community members had served to build trust. For instance, one agent said people trusted him because of having been forthright in past dealings, while another said that longtime residents trusted her because of her family's connection to the community. Another extension agent pointed out that he had moved to the community about six years prior to the time of the interview, so people were

initially skeptical and wanted to know whether he would really stay, before beginning to trust him.

All the extension agents said that they relied on the university-provided research-based information, which helped them form correct unbiased opinions on sensitive and/or controversial topics. All the agents pointed out that, at times, when community members asked them to give personal opinions on any issue or to choose between options, they had to disassociate themselves. For example, one agent commented:

> *We are seen as a non-biased source for information. We only promote research-based information from universities - that's Kansas State University or Oklahoma State. As long as it has .edu behind it, we share it…*

> *[I] don't pick sides if they have a specific question, I try to answer it, I hope both sides get some information that helps validate their point of view forward…*

Of the three county extension agents I spoke to in Kansas, two of them said the community was not using the extension offices to their full potential. For example, one interviewee said:

> *You know, we are the best kept secret. So, you know sometimes they forget that we're even here or that where you been are resources available for free or very low cost of them so that's one of our biggest challenges…*

The two agents said that community members did not know their offices' functions and mostly the community's older members came to their offices for agriculture-based information. The younger generation relied more on "googled" information and rarely came to speak to extension specialists. One extension officer said the community members came to their office for help when it was too late to help them. Had the people come earlier, it would have been easier to find a solution, he added.

During the oil and gas industry's boom period, citizens often approached extension offices in Kansas and Oklahoma with questions about leases and leasing rates. The offices commonly directed such citizens to attorneys:

> *[In] some instances, [they ask] who has been approached by the gas company, what is the lease, what everybody else is being presented, if the lease is standard, if it has anything strange in it, [you know] things like that, of those questions I can answer very basic ones but when it gets very deep (technical questions) 'you've got to get an attorney' - that's my response.*

Two extension personnel discussed soil and water testing and kits provided to concerned citizens.

A recurring theme in community participation was some members' over-exhaustion resulting from intense involvement in the community and lack of participation by others. One interviewee noted that when he tried to arrange for an informational session on current topic or topics that community members had requested, he observed that over time, each year, he started with the potential for 60 participants, but he was "lucky to get ten." One agent had only recently joined the extension office. She therefore had little experience in working with the community in that position; most of her responses comprised personal perceptions she had developed while living in the community.

Chamber of Commerce

The Chamber of Commerce is a local community-based organization formed by businesses in the community (Figure 5.2). Local Chambers mainly promote local businesses, community growth and outreach. The three Chamber interviewees I dealt with worked mostly with businesses within the community and helped new and struggling businesses stay afloat. Their positions ranged from volunteer to full-time CoC presidents. Of these, one individual owned a business and another worked for a local business.

Figure 5.1. Chamber of Commerce, Woodward County, Oklahoma (photo: A. Ramekar).

All three Chamber of Commerce interviewees were long-term residents of their communities. The newest to the position had been in and out of the community for educational and economic opportunities and had recently moved back to the community and taken up the job. All three of them were involved in the community and undertook business outreach and business networking programs. The Chamber often engages in the community by hosting luncheons, coffee hours, dinners, and festivals (e.g., the Wheat Festival in Sumner County). When asked their personal opinions about a business, they had to disassociate their roles and offer unbiased information. Unlike extension agents, all three Chamber presidents went to the industry rather than educational institutions, when community members questioned them about inconsistent information from different sources. They believed in getting "first-hand information from the source." For instance, one community was getting a new plant from a German company to convert wheat straw into methane gas for commercial uses. This project had been under public scrutiny and the community was divided over supporting or opposing the project. Since the

project was going to expand business opportunities in the community, the Chamber president said that concerned citizens had constantly contacted their office. More than once, the citizens had communicated to office members conflicting or incorrect information. In this situation, the office contacted the German company directly for clarification. Additionally, the chamber was asked to take a stand on the project. In such a situation, the Chamber and president felt that they must present the business point of view, keeping aside personal interpretations:

> *We have no political action. We are not trying to be a political entity and support or oppose. Our mission is to support the greater … area from the business side, state of commerce side…*

All three Chambers collaborated with other organizations, such as Rotary Club and Lions Club, which facilitated networking in the community. They also worked with city administrators.

Economic Development Office/ Industrial Foundation

Interviews included EDOs in two counties and the Industrial Foundation chairman in another. These two offices perform similar functions. The Chamber of Commerce and Economic Development office work together for community development: the Chamber works with local businesses and provides support, while the Economic Development office or Industrial Foundation works with larger national and/or international entities to bring industrial units to the community to aid economic development. Both roles are being referred to here as economic development.

One economic development interviewee moved to the county for personal reasons. This individual had assisted the former director and later joined the organization as director. Another economic development officer also moved to the locale for personal reasons, after working elsewhere. As she had previously worked with the Office of Economic Development, she was

offered the current Economic Development Officer position in the county. The third economic development interviewee was born and raised in the community and worked locally before taking this position.

The Industrial Foundation has a contractual agreement with Woodward city. According to director of Industrial Foundation, their main aim is to "provide industrial recruitment and community or industrial recruitment and community development for Woodward city. And so, Woodward city has some property and if an industrial client moves out, they rely on us to try to recruit new industry to town."

The Stafford County Economic Development Office started in 2010 and is structured as a nonprofit (501 3C) organization. It operates county-wide and is involved in community-based, community-involved activities. Since it is a nonprofit organization, local organizations and county public representatives or officers apply for grants for community development. The director noted that:

> *We interact a lot with the various city councils in the County commission again kind of coming back to that shared both side of things various specific grants had specific activities community so we've had you know healthy community type activities that had specific advisory groups involved in it.*

The Sumner County Economic Development Commission is a quasi-governmental organization funded by the county. Its role is like that of Industrial Foundation of Woodward County, but unlike Woodward county, the Economic Development Office is not a contractual organization. They not only help businesses establish themselves in the community but also assist them with networking to get loans or help write grants. When a new business wants to set up in the community, other businesses helped by the EDO work as EDO's ambassadors and help promote the community to new incoming businesses.

City Representatives

I interviewed County commissioner (CC) in one county, Economic development director who also served as assistant to board of county commissioner and a town planner in one of these. Interestingly, the city originally hired one CC to assist them with planning, zoning, and permissions. The commissioner described the job as "*a direct product of employment because of the oil boom.*" The city council initially hired the person currently serving as the CC to manage administrative work related to oil and gas industry. But after the oil and gas industrial operations had reduced, she had to be absorbed elsewhere in the office and was later appointed as a CC. The town planner had worked with the city for a long time. The TP started as the assistant city clerk, got promoted to city clerk and later became a TP. This individual was born and raised in the community and had seen the oil and natural gas industry's impacts, from both personal and professional points of view. In this county, during the oil boom period (2012- 2015), the city commissioner's office mostly handled the planning under a joint commission of three cities. In one city, post-boom, most planning activities were transferred to the current town planning office. The current town planner said,

> *Fortunately for the city itself the other than our subdivision regulations the planning and zoning didn't really impact us 'cause obviously oil and gas drilling and production doesn't happen within our city limits we certainly felt the effects of it due to housing and employment and things like that…*

In the case of another county, the CC had lived for 33 years in the city. The commissioner was associated with the oil and gas industry as a drilling contractor. The commissioner had to often monitor his response to oil and natural gas related questions. For instance:

> *...most of it was all about the leasing. Oh, you're in the oil business, can you tell me that. Well no, really I'm not. No. Because I'm a drilling contractor, two different things. ... So they basically come to you for the cost...*

All three individuals said their offices were trusted sources of information and that people felt comfortable not only approaching them for questions but also voicing their opinions. For one county, it was their first experience with contemporary oil and gas industrial dynamics. Officials shared one common topic: their lack of experience with sudden industrial dynamics. Despite the difference in exposure, both these counties encountered common gripes: "eyesore" infrastructure constructed during the boom and now either scarcely used or lying vacant, damage to roads and challenges with housing availability and rent.

In the next section, based on interview findings, I identify and explore spatial similarities and differences in five categories: perceived risks, trust in source of information, risk communication, trends toward community's future, and community participation in public surveys. These contribute directly and indirectly to objectives two and three of my study that helps us understand the level of and factors related to oil and natural gas industry that contribute to perception of risk in a community. In case of objective three, they elaborate the factors that are associated with perceived risk and contribute to explaining relations observed in survey data.

5.3.4 Perceived Risk

The mailed questionnaire provided data about environmental risk that community members perceived on a scale of 1 to 10, with 1 being the lowest and 10 being the highest. The questionnaire focused on perceived environmental risk for oil and natural gas industry and for

one specific step in the industry: fracking. For sample of both the categories, environmental risk perception averages were very close. But when interviewees were asked for likely reasons behind levels of perceived risk, different counties cited different explanations.

My interviews showed that perceived risk was constantly linked to experience: experience related to the industry itself or events associated with the industry. Even within experience, type of experience was important. For instance, high perceived risk in Sumner County was associated with respondents' recent experience of increased earthquakes:

> *Between 2010 -2015 we thought arguably that we noticed that there were more tremors and more earthquakes and so from a community point of view, what everybody wondered to know that with fracking and this process, its affection us, out land?... (Sumner County interviewee)*

As this interviewee said, 'Now when residents apply for earthquake insurance, to file a claim, "the earth would literally have had to open up and swallow your house."'

For Harper County, it was their first experience in recent times with a boom-and-bust cycle. The officials said they did not have much material to fall back on and the community was more in a "reactive" mode rather than a planning or active mode.

> *This is our first one there really wasn't any (experience). We've always had a teeny tiny bit of oil here, that almost ended (boom) and they were gone so that was our first experience with it we don't really have anything to look back…* (Harper County interviewee)

Stafford County, on the other hand, did not have much oil and gas activity. When the boom hit nearby in south-central Kansas, the community talked a lot about possible exploration. The Economic Development officer recollected geo-technicians scoping land for possible oil and gas pockets and leasing a few land parcels in the community, but it amounted to nothing. The

community felt disappointed that oil and gas industry did not flourish there, as per their expectations.

Woodward and Noble counties had very long associations with oil and natural gas industry. The interviewees thought perceived risk was lower in these counties owing to their historical links with the industry. Even with the new technology's introduction and its related controversy, citizens remained unruffled because they felt they knew how the industry worked. Moreover, these two counties' respondents associated higher risk with the entire industry rather than just with fracking. One interviewee spoke in a low voice when speaking about accidents related to the industry. She had a colleague in office who had lost a son while he was working in the industry. An interviewee in a different county corroborated the observation that many citizens had direct or indirect association with oil and natural gas industry:

> *I think so many people here either work in the industry or they have a family member who works in the industry so they have a lot of personal knowledge, so they know that they can direct their questions related [to oil and gas industry] to someone who is working in it. So, I think that personal knowledge and understanding general.*

Interviewees cited another reason for people accepting risks linked with oil and gas industry and possibly perceiving it as low because of the balance between risk and benefits accruing from the activity:

> *But the benefits far outweigh the risks… the industry hires and it's so many people on that rely on the industry for their livelihood. You can sit here in my office and watch the traffic… you can see the service pickups and the trucks and so on so forth… You know you can really tell you that it's that there is a viable part of this this community in this region.*
>
> *… so the oil and gas would be another industry if we can somehow capitalize on that in the future when the next boom happens, it's going to benefit us and so I think we were open to business is a common thing. So, I think, oil and gas will be another arrow in out quiver. It would diversify our county.*

The officials discussed some residents' concerns during the industry's boom and bust periods. For instance, interviewees from one county talked about perceived increase in crime in their communities, although officials assured community members that they could handle it. Still, incidents of bar fights and substance abuse had increased in the community. Officials in another county also spoke of crime, but the time was different: crime incidents increased during beginning of the bust. This was the time when oil workers were being fired from their jobs. One interviewee offered this explanation: during the boom paychecks were hefty, allowing employees higher purchasing power for luxury goods. When the industrial downturn began, though, those paychecks started reducing and eventually vanished. But people by then had adjusted to a new lifestyle that they no longer could support, and this triggered increased crime incidents. Sumner County officials did not notice a stark increase in crime, as their oil and gas-related activities were far from city limits.

5.3.5 Trust in Sources of Information

All the interviewees confirmed that residents who contacted them trusted the information they provided. They agreed that personal relationships and communication were the key to honest and trusted conversations. If people requested specific information that the officials needed time to gather, the officials took pains to reply to the questioners after finding reliable information. Officials gauged the reliability of information based on the source. I asked the officials about whom they went to for clarification of information when in doubt. All the extension agents said they contacted the university and looked for academic sources to gain clarity on issues. The chambers of commerce representatives and economic development officers, however, contacted the industry. They justified this by saying they wanted to get information from the source. They also often spoke with the extension agents: their relationships

with county agents were built over time and individuals in the community often spoke to each other formally and informally to get clarity on topics. Informal conversations and information centered mostly on personal interests, but formal conversations often involved citizens' concerns and community developments at large.

Two interviewees noted that community members often did not like what they heard back. Despite this, they still trusted the source of information, whether public official or individuals from whom they sought information, because members knew the individual personally. Secondly, the public official's long-time association with community indicated investment in the community's wellbeing. Another key respondent supported the second comment:

> *When I moved here in 2006, people did not trust me. The longest anybody in this position stayed here was two years. Now, it is getting easier for them to trust me since I am still here.*

One key informant interviewee said that an agent's longtime family connection to the community and respect for the family prompted citizens to trust the agent's information. Another interviewee had a different take on it: during the oil boom, a company contacted their city to sell water for a "decent" price. After reading the fine print and consulting an attorney and governing body, the town planning office declined the offer. This incident elevated the trust between their office and community. Coincidently, after that event, the county faced a drought, but trust remained intact because of the previous well-thought-out administrative decision and the feeling that the governing body had not fallen for "the metro area smooth talkers."

Then, officials in one county felt that some citizens would remain skeptical about all information given to them, and they could really do nothing about it.

5.3.6 Risk Communication

Different counties had different ways of communicating with their communities. I observed that nowadays all are using multiple platforms to reach information to different age groups in the area. For instance, local newspapers were a good source for older generation, while social media platforms such as Facebook and Twitter were more accessed by young adults in the communities. Personal communication in coffee shops, restaurants and grocery stores often proved a good way of getting information to key individuals. I asked about the use of town hall meetings, workshops and special sessions to share information. Officials pointed out that attendance depended on the topic, time of the session and interest of individuals. They recognized that it was becoming more and more difficult to reach people. The community often got divided into people who were invested and actively contributed to the larger community and those who did not participate. So, most often, town hall meetings, workshops and special sessions got low attendance. Using multiple platforms to disseminate the same information had a higher chance of reaching more people in the community. But a challenge some county officials faced was, the people googling information and not checking the authenticity of the information's source.

Officials in only one county (Woodward) spoke of using a local radio station. Key informants noted various news outlets in different locations: a weekly local newspaper and its online website (Sumner), personal contacts to identify key individuals in community to help spread information through word of mouth (Harper), and a workshop on leasing land and its legal aspects (Harper and Sumner). The workshop materialized as a collaborative effort where Reno, Harper and Sumner county officials helped spread the message. In Sumner county, a local agency had started a text alert system to inform citizens about local news and community

updates. The Sumner Chamber of Commerce president applauded the effort, declaring that it helped within-community communication.

5.3.7 Lessons Learned for Future Reference

At the end of the interview, I asked my interviewees what lessons they had learnt from the recent interaction with oil and gas industry and the community's reactions to the industrial dynamics and what would they do differently in the future. Interviewees responded differently based on experience and community's ability to adjust to changes. For instance, Woodward county, Oklahoma had several years of experience with oil and gas industry. But despite this, new technology brought new challenges and the officials said they needed to readjust. For instance, Noble County officials pointed out that excitement about prospective economic benefits and lack of previous experience prompted some country people to invest in infrastructure construction, specifically hotels to accommodate oil workers, without a careful cost-benefit analysis. Now, with the bust in the oil industry, the buildings had turned into 'eye-sores' with expensive maintenance to boot. Key informants in Harper, Noble, and Sumner counties mentioned damage to roads and bridges caused by heavy truck traffic. With changes in the industry's technical operations and demands of directional fracturing, Noble County officials pointed an added grievance: problematic disposal of soil from ditches and trenches dug for oil pads. Woodward County also mentioned the soil concern.

In terms of planning, all county officials said they would plan better in the future. This planning was mainly discussed in terms of better using the capital gathered during boom, whether it involved building new schools or hotels to accommodate oil workers, and some income with respect to decision making process. County officials also mentioned exercising caution while spending money and making decisions, as well as desirability of considering past

industrial growth trends, learning from patterns and using the knowledge for financial planning for the community's future. They also made references to the need for information gathering and its application to decisions.

During the interviews, one difference emerged between Kansas and Oklahoma officials dealing with oil and natural gas industry. Kansas officials, irrespective of petroleum industrial dynamics or its impact on the community, held an optimistic view of the industry's benefits. At the other spectrum, Oklahoma officials, whose counties generally had more past experience with the industry, had accepted the opportunities and challenges linked with the industry and were comfortable with its cyclic nature. The industrial dynamic affected communities in Kansas more than in Oklahoma.

5.4 Summary

The study's main goal is to understand how people define risk and what factors contribute to formation of their risk perceptions. Survey respondents defined risks broadly in two categories: as danger in the present and possibility of danger in the future. In defining risks in the present, respondents used more negative words, but in defining risks in the future, they were more optimistic. The level of environmental risk perceived related to oil and gas industry and fracking varied spatially between both counties and states. Current data shows that Oklahoma respondents registered higher perceived risk than Kansas respondents did.

Among the factors affecting perception of risk, major contributors were trust, knowledge, and experience with the industry. Respondents recorded lower trust in federal sources of information and local environmental groups and higher trust in state agencies, universities and independents researchers. Interviews with public officials noticeably echoed the trust component. The respondents' self-reported knowledge about fracking was low. To gain

information, they relied on television channels and social networks. Respondents rated community capital as high and social capital as the most defining characteristic of the community. Occasionally, respondents discussed economic ties to the community. They voiced no strong opposition to fracking or oil and gas industry. Some respondents talked about feelings of discomfort with new faces in the community, perceived increase in crime, short-lived job increase in the community and growth in traffic.

Chapter 6 - Discussion

6.1 Introduction

In this chapter, research findings are discussed and placed in the context of several considerations, including research objectives, the larger body of literature, my positionality, specifics of resource extraction, residents' views in the study area and implications for rural communities. Background and factors potentially affecting results are addressed first, followed by discussion of results in the context of the specific research objectives, including regional perceptions of the concept of risk, variations in perceived risk associated with HFDD, and identification of the relationship of local factors to respondents' oil and gas industry risk perception. To address the implications of results to the specific research objectives, and to build connections to current knowledge, data and analyses from Chapter 5 are combined with relevant literature to explain the observed trends to improve understanding of the local situation. Implications for economic choices, future actions with respect to energy development in rural communities, and policy implications, including risk communication and education are addressed.

6.2 Background

"Research is a process, not a product" (Bourke 2014, 1). Research does not end with the diffusion of one's findings. The more one interacts with the data, the more information can be extrapolated. At the same time, reflecting on the research process and data can lead a researcher – especially in qualitative research – to think about their own interactions with the process, interactions with participants and possible impacts of those interactions on the research project itself. Research represents a shared space between the researcher and research participants

(Bourke, 2014). In this space, identities of both researcher and participants interact. Each side brings to the table their own perceptions, understandings, and biases, which cannot be nullified in a social science setting. Hence, recognizing them is important.

Factors such as race, gender, class, and other forms of lived experiences may influence a researcher's social, locational, and ideological position relative to the research project or to its participants (Hay 2010). The concept of positionality recognizes that identity is fluid and is affected by historical and social changes (Kezar and Lester 2010). During the late 1980s and early 1990s, positionality theory was developed as an addendum to Sandra Harding's standpoint theory (Kezar and Lester 2010). Positionality theory claims that individuals have a position through which they socially construct their world. The concept of positionality focuses on the intersections of various aspects of a person's identity such as race, class, and gender in shaping perspectives. It acknowledges that people have multiple overlapping identities and make meanings from various aspects of their identity (Bourke 2014). The multiple identities inform, construct and reinforce individual perspectives. Therefore, as a social scientist who used mixed methods in research, I had to be aware of these influences during my research to address findings transparently and realistically.

The act of examining the research process in the context of personal positionality is termed as reflexivity. Critical reflexivity is important to understand researcher's positionality and its influence on the research process and its outcomes, especially with qualitative and mixed methods research techniques (Corlett and Mavin 2018). Therefore, I approached research recognizing that my position and temporal changes to social, economic and political environments influenced data collection.

To illuminate this study's context and social conditions that might have affected responses, I describe below the timing of data gathering and coincident socio-political conditions. I also address possible external influences on data characteristics and my reactions to them. Throughout this research, from beginning to interviewing public officials to later interpreting findings, I have been aware of my positionality as an international researcher, a female of color.

6.4 Researcher Positionality

In August 2014, during a boom in fossil fuel extraction in MLP region of Kansas and Oklahoma, I began to develop my dissertation research. The oil and natural gas industry is volatile. Additionally, the national social-political environment affects local perceptions and expressions of attitudes. Combined together, these aspects can influence participants' responses or even the choice of whether to provide responses.

In 2014, both Kansas and Oklahoma were reaping the benefits of the 2011 energy boom. At the end of 2014, the boom began to slow down and by mid-2015 some Kansas and Oklahoma counties registered very low production. In the communities of this region, the industrial slowdown's impacts had just begun to surface. The degree of impacts varied from community to community. During my interviews with public officials, this became clearer. For instance, Harper County, Kansas, first experienced fracking-related oil and gas expansion in 2011, but when industrial production busted, this community felt its economic turndown and accompanying psychological hardships more severely than Woodward County, Oklahoma, which had previous experience with the industry and had adjusted at least somewhat to industrial changes.

To add to this volatility, a changing political climate can create an emotionally charged atmosphere. During the presidential campaign, the pledge to "Make America Great Again" reverberated through numerous emotionally charged political speeches. These included, mostly, a push to bring manufacturing jobs back to the U.S., to tear up unfavorable trade deals, and - especially - to curb illegal immigration and keep a check on non-European immigration in general. As an international student, it was the first U.S. election I witnessed personally. In this country's changing political climate, it felt that politics had turned personal. In the U.S., there was now an increasing "stranger danger" feeling. I now recognize that my position as an international student - a researcher with an unfamiliar name and the assumptions generated by it - may have affected the survey response rate. To my position of an assumed 'foreigner', respondents gave mixed reactions. Individuals may not have been able to discern my gender, owing to unfamiliarity with South Asian names. Some respondents disliked me for even contacting them. Four returned surveys had seemingly hostile comments such as "unfamiliar name" and "foreigner interested in our resources," and mentioned unrelated but 'non-American' topics: ""It was the Russians, right" and "Saudis." Despite furnishing the project's details in the survey packet, I also received a personal postcard questioning my intentions with the research. Because of these experiences, I revised the data collection's second part from focus group discussion to in-depth interviews with public officials, as it felt safer and more likely to yield useful information. I assumed that public officials knew how to interact with diverse populations and harbored greater understanding of academic efforts and student make-up, making them more likely to be willing to share their experiences with me. Moreover, as people in administrative positions, I assumed they would explain and help me understand the planning and decision-making processes in the study locations.

While some survey recipients reacted negatively to the research and to my presumed identity, others thanked me for asking their opinions. My association with a state university added another dimension to my position as a researcher. Because of this association, two respondents expressed their reservations. They harbored high distrust of government and educational institutions linked with the government (i.e., state universities), so showed skepticism about sharing their opinions. On the other hand, two respondents expressed happiness that the Department of Geography was conducting such a study and seven others wished me luck for the study. One respondent wished to see the results, and another not only wrote their response in the survey's comment section but also used space on the envelope to voice their opinion more fully (Figure 6.1).

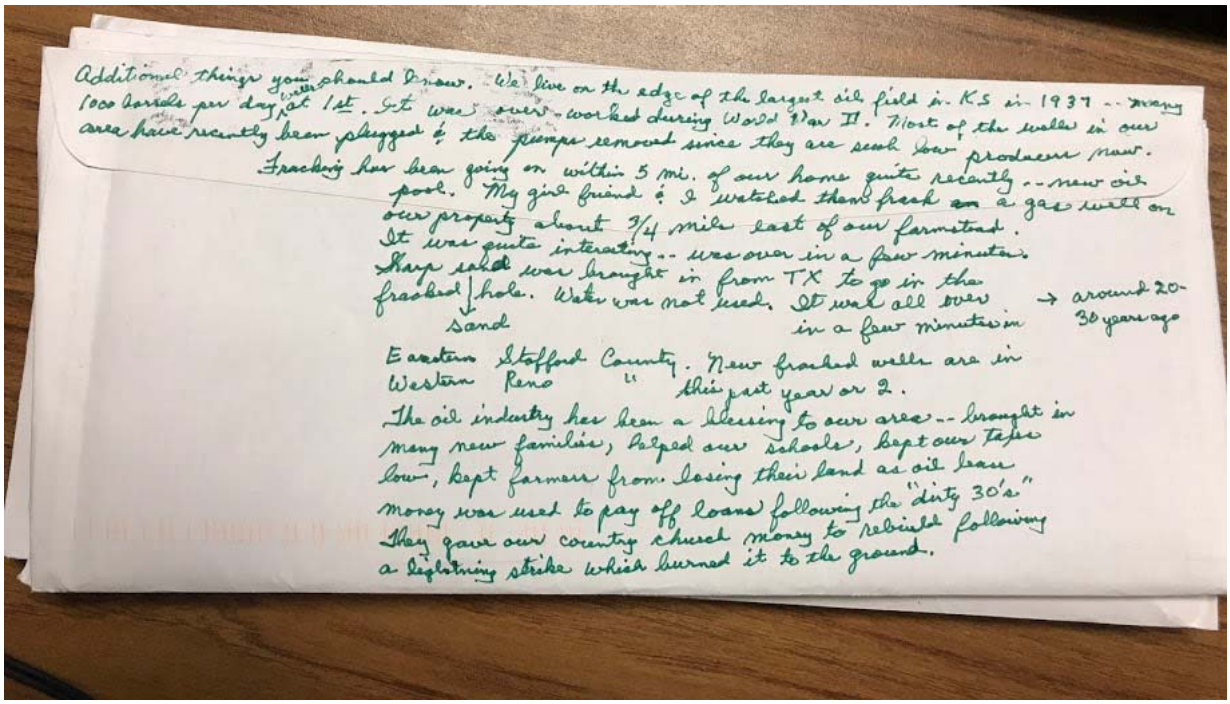


Figure 6.1. Respondent's space utilization to share experience with oil and gas industry.

6.3 Survey Timing and the U.S. Socio-political Environment

In 2014, significant increase in oil production created an oversupply, causing prices to plummet. To keep oil extraction from fracking profitable, per barrel cost of oil needed to be above an average of $70 (Sam et al. 2018). By October of 2015, many oil companies had stopped production as oil prices dropped to $40 per barrel (Sam et al. 2018). In 2015, after an initial slowdown, oil and gas industry busted in Kansas but Oklahoma experienced only a reduction in production. Additionally, hydraulic fracturing's potential environmental impacts began gaining more attention because of increase in earthquakes in the region. Unfortunately, for local economies this period coincided with the busting of the oil and natural gas industry. For small communities in Kansas and Oklahoma whose economies depended on this industry, such volatile industrial dynamics could have lasting impacts at the local level in a community.

Adding to this, political and government policy changes also influence resource production, unleashing other impacts. The U.S., undoubtedly, is the world's leading economic and military power with unmatched global reach, but national policies fluctuate with shifts in political control. The 2016 election results ended eight years of Democratic party control at the national level, triggering significant shifts in policy (and political rhetoric). Since 1992, national politics has witnessed the two major parties, Democratic and Republican, rooting themselves in "extreme wings" (Abrams 2016). Political analysts have observed that in the recent past both parties have shifted toward extremes to appeal to their core ideological loyalists. While doing this, both parties have become ideologically distinct and have "pushed away centrist supporters and overreached their electoral mandates, pushing for divisive, narrow agendas" (Abrams 2016). The *New York Times* advanced this argument, which a Pew Research Center (2014) study corroborated. This study showed that Democrats and Republicans are more divided along

ideological lines and partisan antipathy is deeper and more extensive than at any point in the last two decades. These trends manifest themselves in myriad ways, both in politics and in daily life (Pew Research Center 2014). The U.S. also has the most highly developed mass media in the world, with television as the most popular medium (BBC 2014). With nearly unrestricted internet access and prolific use of social media, the capacity to amplify opinions on both sides has exponentially increased.

At the time when I mailed the survey, the oil and gas industry was drawing attention for its possible link with earthquakes. The media had been circulating discussions about the environmental impact of directional hydraulic fracturing. In 2016, a year after the downturn in the industry, some individuals readily discussed the topic during my scoping trips, but others appeared reluctant to talk me. It is possible that unwanted media attention had created a sense of stigma for community residents. For instance, a few respondents conceded the earthquake issue, but two others rationalized and pointed to other communities or places where earthquakes were happening. Opinions were divided on the merits and drawbacks of the industry. On one hand, community members voiced happiness with the economic inflow linked with the industry. On the other hand, respondents recognized the negative impacts ensuing after the industry's busting. Three respondents, two respondents hailing from Harper and Barber counties (Kansas) and one from Noble county (Oklahoma) spoke about the industry's benefits and risks. One respondent from Barber County and another from Woodward, weighing the risks and benefits, said explicitly that the benefits far outweighed the risks. Barber County survey respondents pointed out the negative impacts of the oil boom on their community and the failure of the oil industry to support it. Two respondents expressed displeasure at me for asking questions: one thought I was feeding the liberal agenda and the other believed I was trying to stir up a controversy.

During interviews with public officials, I asked that they address the relatively low survey participation and possible solutions for future reference (see below). About surveys and data collection, Noble and Sumner county interviewees pointed out that participation was likely low due to skepticism over the use of the data. Interviewees felt that response rates would have varied with the survey's timing, topics, and confidence in the surveying agency. For future reference, they suggested using key personnel to connect the researcher to community members. Sometimes low participation could result from the survey reaching individuals with no long-term connection to the community and hence prompting them to ignore it. This possibility came up in an interview in Woodward County, one of the higher population counties sampled in the study. I did not specifically ask, but I surmised that the following factors might have deterred residents from participating in the study: a sense of stigma, my identification as an outsider, and repeated approaches by researchers. During my scoping trip to a county in Kansas, I learned that other researchers had approached Harper county for information on the oil and natural gas industry. Thus, the interest of multiple researchers might have caused community members to feel that they were subjects of investigation or their community was over-studied for sensitive topics. Whatever the reasons, many potential respondents chose not to participate, affecting the overall response rate.

6.5 Research Findings

A desirable level of participation was not obtained, both the mailed questionnaire surveys and the interviews with public officials generated a large amount of data. In this section, the focus of data and findings discussion is on themes that are consistent with the study's main research question and objectives. These include regional perceptions of the concept of risk, assessment of variation in perceived environmental risk related to hydraulic fracturing and

directional drilling among communities, and identifying factors related to HFDD risk perception. Multiple channels of communication are then explored, with the aim of improving local risk communication strategies.

Results indicate that, across the surveyed communities, interactions between individuals, communities, and industry have strong relationships with different levels of perceived risks. In the next section, I discuss findings for each objective.

6.5.1 Exploring Regional Perceptions of the Concept of Risk

The first objective of this research was to explore regional perceptions of the concept of risk. Respondents therefore were asked to provide their meaning of risk. The goal was to understand how respondents conceptualized risk. How an individual sees the world is expressed in their language, choice of phrasing, or terms used to describe objects (Fridirici 1983). In all ten counties, respondents most frequently used words like 'danger,' 'chance,' 'damage,' and 'uncertainty.' As Fridirici (1983) noted, although a group of people may voice similar opinions about some object, event or landscape, each individual has arrived at that conclusion based on their individual senses, experiences, cultural biases, knowledge, and awareness gained from different sources, values, beliefs, and professional training. To understand regional perceptions of the concept of risk, responses according theme or idea were first considered, followed by attention to risk concepts by county.

The respondents' indicated meanings of risk showed a wide range but featured one common characteristic: absence of numerical expression of risk. A majority of the respondents presented risk as evaluation between two choices with a positive or negative outcome, such as "*Reward vs Failure.*" Five respondents defined risk as a necessary step in the present for an optimistic expectation in the future (e.g., "*The cost to succeed*). The responses hinted at

confidence and belief that technological progress would make industrial activities safer in the future or would effectively increase abilities to cope with its side effects.

Additionally, spatial differences could be discerned in risk descriptions. Few respondents from each of the five counties (Alfalfa, Noble, Harper, Logan, and Stafford) - half of those in the study - explicitly associated environment damage to the meaning of risk. When explaining the meaning of risk, several Sumner County respondents did not explicitly use the term environment but associated the meaning of risk with HFDD impact on their surroundings. In Barber, Sumner, and Woodward counties, some respondents explained the meaning of risk in terms of harm to themselves or others. Only two participants, from Harper and Noble county, said it was difficult to tell the meaning of risk as it is a very broad term. Because of insufficient data at this point, definitive generalizations about spatial patterns cannot be asserted: there are simply some hints at spatial variation.

From data gathered on the regional meanings of risk, results are consistent with the ideas that a layperson's risk meanings consist of qualitative assessments but lacks numerical data (Cutter 1993) and that risk meanings are subjective and linked to the understanding of individuals' immediate surroundings (Bunting and Guelke 1979, Jacquet and Stedman 2014). Data from this study support implications that risk meanings do have spatial and temporal dynamicity (risk meanings change from place to place over time), with the caveat that the available data do not prove particular associations.

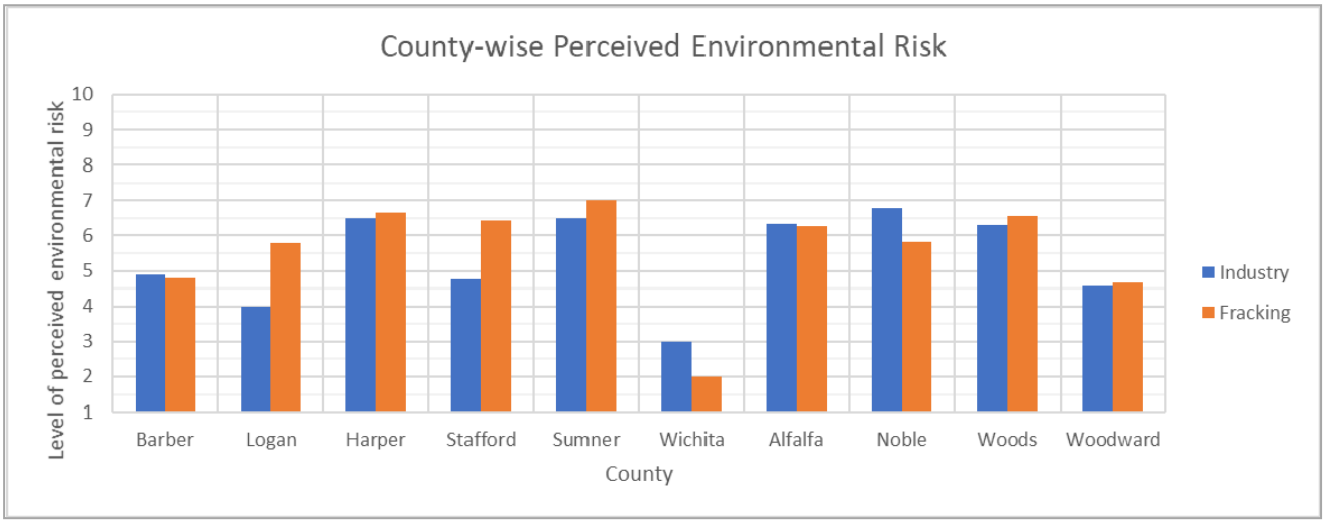
6.5.2 Variations in Perceived Risk Associated with HFDD

Risk perception refers to an individual's views about the risk involved in a situation (Wen, 2015). Environmental risk perception, as considered here, is the risk that individuals perceive about their immediate and distant surroundings or environment. I have assumed here

that individuals apply the same logic for definitions of risk and environmental risk. With respect to the level of environmental risk from the oil and gas industry and hydraulic fracturing, respondents were expected to have high levels of perceived risk. Perceived risk was expected to be higher for fracking, in particular, due to media attention to increased frequency of earthquakes and possible negative environmental impacts (e.g., water quality) linked with the activity.

For levels of environmental risk perceived for the oil and gas industry and fracking, the sample average turned out as expected: 5.81 and 6.10 respectively on a scale of 10. As for comparison of state averages, Kansas response averages bore similarity to the sample average (4.9 and 5.5 on a scale of 10). Oklahoma responses showed similar levels of perceived environmental risk for both oil and gas industry and fracking (6 and 5.8 on a scale of 10). Kansas respondents perceived a higher risk with fracking compared to Oklahoma respondents, who perceived higher risk with oil and gas industry. To assess variation in perceived risk of HFDD between affected communities, averages of perceived environmental risk associated with the oil and gas industry and with fracking are shown in Figure 6.2.

Figure 6.2. Perceived environmental risk by county.



To understand and interpret county-wise variations, Johnson and Covello's (1987) community member dichotomy is useful. According to Johnson and Covello (1987), community members can be divided into two groups: minimalists and maximalists. Minimalists tend to deny or minimize an existing problem (to be dismissive of the seriousness) while maximalists believe risks are substantial and more extensive than officially acknowledged. In their study, Johnson and Covello (1987) found that age and composition of households were important predictors of these groups. For instance, older respondents without children at home, links with oil and gas industry as their primary source of income, socially isolated, individuals with attitude of let-things-take- their- own-turn tended to be more likely minimalists. Younger respondents and those who were young parents with close links to other young families tended to be maximalists. In this study, the average age of respondents was about 64 years and given that these were rural folks (not necessarily isolated), I expected my respondents to be minimalists, meaning to have lower perceived environmental risks than the sample's average. I did not find any clear distinction of such a trend in state sample averages. For both oil and gas industry and fracking, environmental perceived risk was higher than 5 on a scale of 10. In case of state averages, Kansas showed a minimalistic trend for the oil and gas industry-related risk perception, but Oklahoma registered risk perceptions above 5 for both oil and gas industry and fracking.

At the county level, I observed variations in levels of perceived environmental risk. Risk perceptions by non-experts are intuitive judgements (Slovic 2000). Scholars increasingly recognize that subjective judgements, expressed as affect or affective imagery, reflect not only likelihood of impact occurring from industrial operation but also its consequences and its social, psychological, moral, and cultural considerations (Boudet et al. 2014). Affect can orient researchers to better understand influences of risk perception and benefits of industrial activities

(Boudet et al. 2014). In the questionnaire, I asked respondents to recognize three "top of mind" associations with fracking. To understand county-level variations, I used affective imagery in addition to self-reported level of perceived risk, as laypersons tended to use subjective images more than objective facts (Bunting and Guelke 1979).

As expected, affective associations comprised a mixture of positive and negative imagery. Broadly speaking, positive imagery included economic benefits, such as job creation and wealth gathered from land leasing. Negative images included earthquakes, damage to property and reduced environmental quality. While exploring these associations, some affective relations were specific to fracking, but some associations proved more applicable to oil and gas industrial operations, not just fracking. For instance, earthquakes were specifically related to fracking, but economic boom or revenue was linked with fossil fuel industrial operations in the community, including growth of allied activities. I tried to detect patterns in affective imagery and see if they could elaborate varied levels of perceived environmental risk.

The respondents' most frequent affective imagery with fracking was earthquakes, which was common in all 10 counties. However, differences in topical categories could be discerned between counties. For instance, Barber county (KS) respondents talked most about economic benefits (cost, profit, income, money, new jobs) from industrial activity. Noble county (OK) respondents identified, along with earthquakes, land use change, property damage, loud noise, smoke, and trucks with industrial activity. Sumner county (KS) respondents mentioned water concerns and property infringement, along with earthquakes. Only Logan (KS) and Barber county (KS) respondents (one each) talked about energy independence for the U.S. and reduced foreign involvement. Barber county respondents noted below average perceived environmental

risk for both industry and fracking. Noble and Sumner county, however, both registered higher than average perceived environmental risk for industry and fracking.

I was intrigued by the recurring earthquake topic. When seismic activity is caused by human activity, such as HFDD development, it is called induced seismicity. In the early 2000s, increases in the number of earthquakes in the vicinity of oil and gas development and production sites intensified concern for communities where these activities were taking place, and concerns were voiced in Oklahoma, Arkansas, Ohio, Colorado, and Texas (Buchanan et al. 2015). For 2013, about three years after HFDD development in the area, Buchanan et al. 2015 also reported increased frequency of earthquakes in south-central Kansas. Most of these earthquakes were linked to wastewater injection into disposal wells in deep and confined porous rocks. At that time, however, Buchanan et al. (2015) maintained that "Linking a specific earthquake to a specific human activity, such as wastewater disposal at a single well, is difficult." Nevertheless, "…the established pattern of increased earthquake activity over time indicated a correlation between human activity and seismic events."

Survey data for this study were collected in 2017 and 2018. By that time, community members might have experienced significant number of felt earthquakes. For the period of January 1, 2014, to December 31, 2018, U.S. Geological Survey (USGS) records showed 553 felt earthquakes (those above 3.5 magnitude on Richter scale and felt by several people), with 50 recorded in Kansas (majority of them in South-central Kansas) and 503 in Oklahoma.

During interviews, one key informant in Harper county mentioned installation of seismographs in private homes to monitor seismic activity. During my scoping trip, another informant mentioned use of a cell phone app to track earthquakes in the area. When HFDD development crossed Oklahoma border into Kansas, first in Barber and Harper and then Sumner

county, significant increases in earthquake activity in south-central Kansas became evident (see Buchanan et al. 2015). A Sumner county key informant mentioned change in earthquake insurance clauses for community members, as HFDD activity increased along the border of Kansas and Oklahoma. Thus, respondents' identification of earthquake as affective imagery of HFDD activity was expected. The USGS also released the following figure (6.3) showing increased felt earthquakes in the central U.S. A total of 3642 earthquakes above 3.0 magnitude on the Richter scale were recorded from 2009-2019.

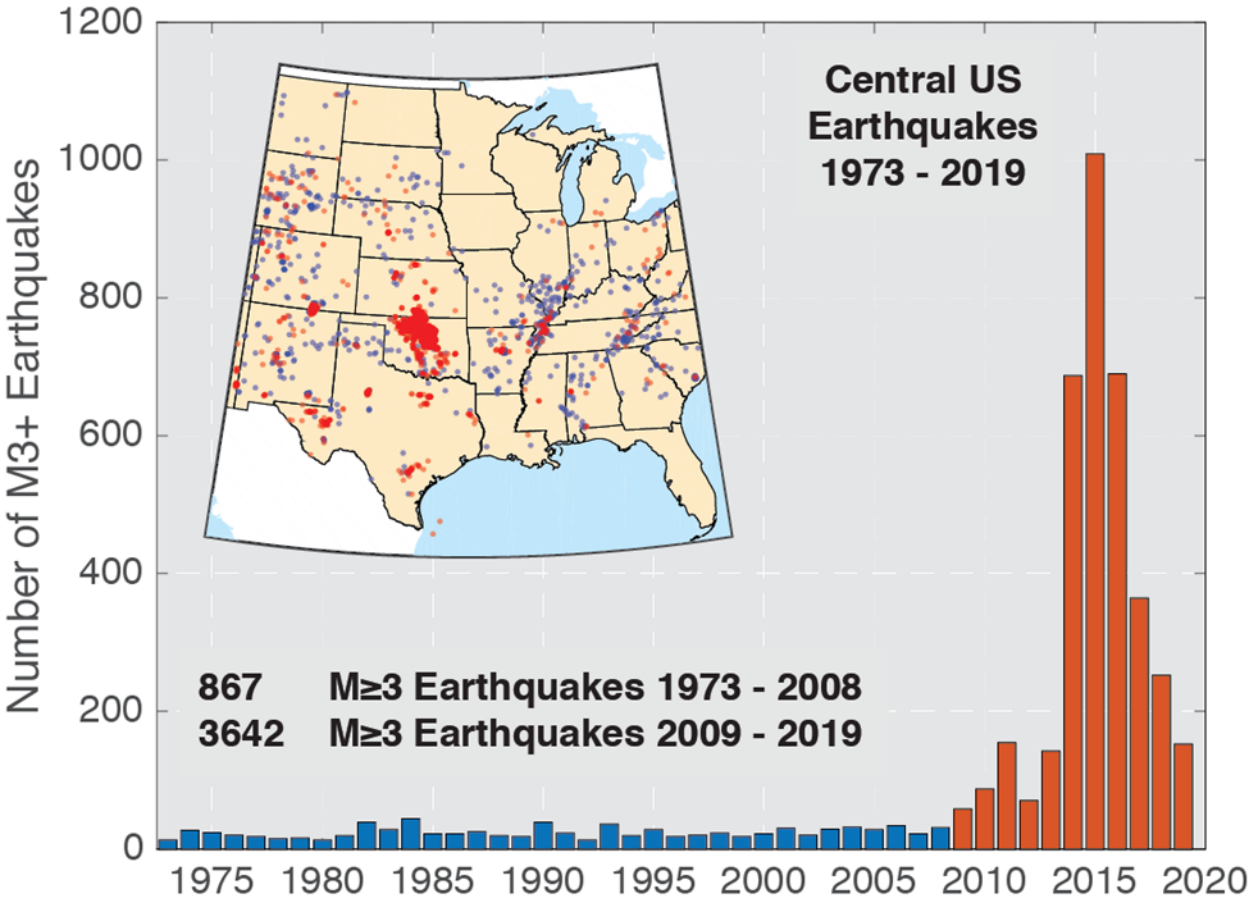


Figure 6.3. Central U.S. Earthquakes 1973 – 2019.
Source: U.S. Geological Survey (https://www.usgs.gov/media/images/increasing-rate-earthquakes-beginning-2009)

To get further clarifications on county variations in perceived environmental risk, I asked public officials the possible reasons for observed levels. They suggested two factors: the experience and length of association with oil and gas industry. This seemed to be a recurring theme of public officials for most explanations. In Harper (Kansas) and Woodward county (Oklahoma), key contact interviewees particularly mentioned these factors. For instance, Woodward county community members already knew about industrial working and its dynamic nature, because of the county's historical association with fossil fuel industry. Since Oklahoma had longer association with contemporary oil and gas industrial dynamics, its communities were better adjusted to the industrial ebbs and flows. Kansas communities, although familiar with conventional oil and gas industry for some time, were undergoing their first experience with a contemporary oil boom and bust. For example, Sumner county is adjacent to Harper county, one of the highest activity counties in Kansas. Although Sumner county did not have actual drilling, when Harper County experienced the boom, Sumner county saw an increase in earthquakes and truck traffic. Harper county residents also witnessed an increase in crime and bar fights, though officials assured they could handle it.

Thus, even though the counties fell in the same MLP geographical region, variation existed between communities in the level of risk perceived. Appropriately, the first clue to understand this variation lies in exploration of affective imagery. Based on county interaction and experience with industrial activity, the affective imagery varied. Public officials provided further explanation for the variation citing two factors: the experience and length of association with industrial dynamics. Both these helped explain variations in environmental risk perception. In my next section, I further explore the factors related to HFDD risk perceptions.

6.5.3 Factors Associated with HFDD Risk Perception

Many factors influence how individuals, groups and society view risk and render judgement on whether the risk is acceptable or not (Cutter 1993). As Cutter (1993) points out, some of these factors are biases associated with study design, individual's personality and socio-cultural factors, while others are experience, culture, environmental philosophy, demographic factors, distance from the activity, perception-behavior linkages and the issue's politicization. Whatever the factor maybe, one fundamental difference remains: public and experts view risks differently. Even within the two groups, public and experts, professional training, values, beliefs and norms, source of information and trust in information affect perceptions of risk. People respond to hazards according to level of risk perceived and the level of risk they perceive depends on how they think about the hazard and organize the available information (Peters and Slovic 1996). Building on Fitchen, Heath, and Fessenden-Raden (1987), I argue that perception of risk is a socially constructed complex process, dynamic, and impacted by local context, including community politics, economics, media, and social interaction. In this section, I divide the factors into five categories: awareness and knowledge, community experience, source of information and trust, perceived benefits and drawbacks and worldviews, and discuss their relationship with perceived environmental risk.

Awareness, Knowledge and Perceived Risk

A plurality of respondents agreed that their communities had enough knowledge and information to let fossil fuel companies continue their activities. In all the conducted interviews, this sentiment resonated. Survey respondents and interview participants agreed that as knowledge increased, perceived risk decreased. In other words, we fear unknown risks (Boudet et al 2013) and oppose the source of the risk. Hydraulic fracturing with directional drilling is

newer technology with potential conflicts over the impacts of its activities and distribution of risks and benefits (Boudet et al. 2014). Hence, it was logical that more than 50 percent of respondents, based on the definition provided to them, opposed fracking. Thus, in essence, the more we know (or think we know) about technology, the less we fear its implementation.

At the same time, interestingly, the more we know about technology, the more likely we are to introduce bias about the estimation and believability of risks (Cutter 1993). Psychology uses Knowledge Theory to explain personal biases. According to this theory, based on what we know or learn about technology and associated risk, we form the basis for technical or rational approach to decision-making (Cutter 1993). People underestimate those risks they are more familiar with or those they can control. Thus, familiarity with the industry and its operations plays a key role in low risk perception. Familiarity comes with experience, which comes with association with the industry long enough to understand its ebbs and flows. For instance, when asked about affective imagery of fracking, one respondent from Woodward county wrote, "*forever, not, new.*" Interviewees in Woodward justified the statement by acknowledging their county's long association with and understanding of industrial dynamics. In Sumner and Harper counties in Kansas, unfamiliarity triggered high risk perception. Here, a few public officials mentioned the issue of unfamiliarity with contemporary oil and gas industry's demands and working.

Several respondents reported having some knowledge about fracking, but when asked about what type of drilling (horizontal, vertical, slant) was happening on their land or around them, 70 percent of respondents were unsure. For this gap, a possible explanation might be that most respondents had not leased their land to any oil or gas company. Hence, the information might not have been available to them. Research shows that individuals who gain benefit or

profit from an activity are more likely to support that activity and perceive lower level of risk (Janmaimool and Watanabe 2014).

During interviews, only one public official said he had leased land to oil and gas company and was also doing a side business with the industry. As this was common knowledge in the community, several community members contacted him to ask about leasing price. The official, however, stressed that he had to disconnect the two roles, one as public official and another as business owner, and very clearly stated who was giving the information. Since this individual was a longtime resident involved in both roles, I considered both his experience and information reliable.

Community Experience and Perceived Risk

Place-based meanings explore how individuals and groups perceive and value their natural and social environments (Jacquet and Stedman 2014). Although, different people have different senses of place and community, levels of attachment vary, as both meaning and importance are subjective outcomes of an individual's experience and interaction with that place. How an individual develops a sense of community depends on four components: membership (sense of belonging), influence (ability to influence and be influenced by the community), fulfilment of needs (supportive and shared values), and shared emotional connection with community members (Ferrari 2013). These factors manifest themselves through an individual's interactions in and with community activities.

Industrial developments can disrupt places and place-based identities. Jacquet and Stedman (2013) assert that disruption of place-based identity can be traumatic and stressful for community members if a large portion of their own identity or personality comes from place-based identity. The topic of place-based identities is mostly studied in instances of forced-

migrations or displacements (Jacquet and Stedman 2014) but not for risk perception and risk analysis framework. Wetherholt (2016) found that a strong sense of community spirit stems from higher participation in community activities, taking leadership roles in the community, positive effects of a community's physical environment, stronger feelings of belonging and safety in the community.

A plurality of the respondents noted they sometimes participated in the community and though their community's visual appearance was average. They cherished high feelings about safety, community spirit, community's physical appearance and local environment. Respondents had lived in their community typically for more than three decades. The safer and more belonging the respondents felt in their community, the less environmental risk they perceived. Similarly, as community spirit and appreciation of visual appearance grew, perceived environmental risk was reduced. Rural communities nurture deeper social ties. These ties equip community members with coping mechanisms against negative effects of any calamity, natural or technological (Ferrari 2013). Only local natural environment showed a positive correlation with perceived environmental risk. As appreciation for the local natural environment increased, environmental risk perception also grew. Unlike Wetherholt's (2016) findings, no correlation existed between perceived environmental risk and community involvement.

Public officials were asked about their experiences with community members participating in various activities. All the interviewees echoed an increasing difficulty in obtaining public participation. While families showed up for school games and took part in recreational activities, very few volunteers invested time for behind-the-scenes work. Stafford county public officials admitted to overusing a handful of volunteers, as other community members showed scant interest in leadership roles.

Given the media's attention to fracking in other parts of the U.S, I was interested in respondents' emotional reactions to the activity occurring in their community. Respondents were asked to rate their feelings about hydraulic fracturing and horizontal drilling. Their answers ranged between concerned to optimistic (Figure 6.2). One in three respondents felt concerned about the use of new technology in their community, while one in four sounded optimistic. Only one in twenty respondents reported "panic" about it. As could be expected, as feelings of uncertainty with fracking increased, risk perception associated with both the oil and gas industry and fracking rose.

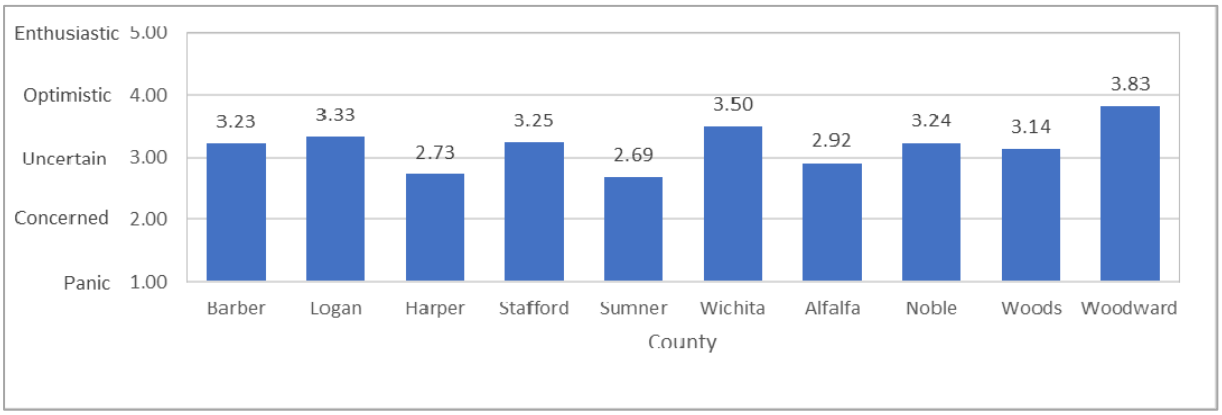


Figure 6.3. Feelings about HFDD activity in communities, by county.

For instance, Sumner county respondents perceived higher than sample's average environmental risk for industry and fracking. Respondents rated their feelings between concerned and uncertain about use of new technology in their community. In Woodward county, with its experience with the fossil fuel industry, respondents felt optimistic about incorporating new technology. Woodward county had lower than sample's average perceived environmental risk for industry and fracking. When asked about what they liked in their community,

respondents cited the community's economic functions, and when queried about the community's appearance, they spoke about community capital and social capital.

Worldviews and Perceived Risks

An individual's worldview is intrinsically linked with images of place and emotional significance attached to them. Worldviews act as a cognitive filter to screen information received through various sources. They are latent predispositions of individuals that can be observed in the form of professed attitudes (Kahan 2012). This means that an individual's worldview will guide risk perception; thus, individuals' fears remain consistent, knowingly or unknowingly, with their life philosophy. This is called as cultural bias. Therefore, there exists a strong correlation between personal bias (risk perception) and ideology (worldview) (Wildavsky and Dake 1990).

For this study, I built on Wildavsky and Dake's (1990) hypothesis on relationships between worldviews and technological risk perceptions. From Boudet et al (2014) study, I modified statements used for four worldviews: egalitarian, heirarchists, individualistic and fatalists. For instance, individualists support self-regulation and bid and bargain with others to attain their personal ambitions; thus, they deem technology as good. Egalitarians reject instructions associated with hierarchy when they perceive it as creating stratification of wealth and power; they fear technology. Hierarchists are comfortable with stratified wealth and power and approve of technology if their experts have given the appropriate safety certifications; they worry more about social deviance and less about technological dangers. Fatalists do not trust experts; they disregard experts' expertise in the field or the technology they support. In this study, I found that individuals with individualistic worldview showed low environmental perceived risk with both the industry and fracking. On the other hand, respondents with

egalitarian worldview displayed higher environmental perceived risk. On a community level, this means that persons with individualistic view will support the use of HFDD technology, while those with egalitarian view will oppose it. My findings are consistent with the previous study conducted by Boudet et al. (2014).

Perceived Benefits, Drawbacks, and Risk Related to Oil and Natural Gas Activity

48 respondents (31 percent) agreed that the benefits for their community from oil and gas would outweigh the downsides. Only 8 percent of respondents did not feel this. There was county-wise variation in perceived benefits, too. Within Kansas, several respondents from Barber, Stafford and Logan county respondents thought the perceived benefits would outweigh risks, whereas Harper, Sumner and Wichita county respondents felt the contrary. In Oklahoma, a majority of Woodward county respondents, too, felt the perceived benefits would outweigh risks. Alfalfa county respondents were divided over the topic, while Noble county respondents were unsure. Woods was the only county where respondents had very definite views about perceived benefits and associated risks, as no respondent voiced 'unsure' response. Pertinently, Alhakami and Slovic (1994, as cited by Peters and Slovic 1996), observed that although there is a positive association between risk and benefits in the world, people perceive an inverse relationship. This means that people see more benefits when risk is low. The current study observed this phenomenon. Respondents perceived lower risks and higher benefits for their community with oil and gas drilling. This was reflected in interviews as well. I had expected some references or examples of accidents in the oilfields, but only one accident was mentioned – severe enough to cause the death of a respondent's family friend (Woodward County).

During the peak of the boom, almost all of the communities witnessed upturns in business. Communities experienced growth in traffic and saw new businesses established in

town. Although local businesses experienced some customer loss, new people came to the community. There was a statistically significant positive relationship between environmental risk perception and traffic increase, local business customer loss and discomfort with new people in the community. As new businesses increased, environmental risk perception decreased. Except for Harper county, no other county expressed discomfort with new faces. With new arrivals, community members had anticipated increases in crime, but local authorities maintained it was not as high as it was perceived.

When asked about the communities' views on benefits and drawbacks, respondents cited job creation, changes in quality of life, increase in noise and worsened air quality. Respondents also believed that any negative impacts of the industrial activity could be fixed. Several respondents admitted, though, that the created jobs were temporary. Consequently, as jobs and quality of life decreased, risk perception with both oil and gas industry and fracking increased. At the same time, as the respondents' perception of noise and air pollution increased, the perceived risk associated with fossil fuel industry and fracking grew. Respondents had hoped that their current concerns about earthquakes, safe water disposal and cautious progress to prevent damage could be handled well. They were not, however, sure whether excessive water use, irreversible damage and preventing fracking close to residential areas was possible.

Trust, News Outlets and Perceived Risk

Trust is an important ingredient of risk management. Trust is defined as the willingness to make oneself vulnerable to another because of expected outcomes (Visschers and Siegrist 2008). Lay people often lack knowledge to make informed decisions. Therefore, they rely on the media, experts, leaders, or the scientific community to obtain their information, and then assume

that they can use the information to make informed decisions. If risks are social constructs, trust is embedded in the social context.

Respondents were given several sources of information and asked to rate their trust in these sources to obtain information about fracking. Federal agencies (Environmental Protection Agency, Department of Energy, and Department of Interior) and local environmental groups proved the least trusted sources of information, while independent researchers, universities, newspapers, state agencies, the oil and gas industry, radio, television, and magazines emerged as more trusted (listed high to low). As people's trust in oil and gas industry and state agencies increased, their perceived risks decreased. Interviews with local officials corroborated this tendency. However, most of the officials, especially extension agents (associated with state universities) pointed out that these trust relations were built on two important factors: personal relationships with community members and community members' perceptions of individuals in official positions as insiders of the community.

The largest number of respondents, 113, identified television as the main source of information for community members. I had assumed that community members would obtain all kinds of news (political, social, industrial) from the same source. It was quite possible, though, that they sought information on a specific topic like oil and gas from a different or more specialized source.

For 87 respondents, social networks, friends, and neighbors emerged the second most mentioned source of information, and local newspapers the third most common source. Given the higher frequency usage of digital and/or print media, I had expected to find higher levels of perceived risks, but there was no correlation. If people had questions about anything specific, they approached public officials. In counties where interviews were held, extension agents

confirmed this. Key informants also pointed out that people informally asked questions and opinions in coffee shops or grocery stores. Between Kansas and Oklahoma, there emerged a major difference in the use of public offices, especially extension offices. Kansas officials noted low frequency of use by community members regarding the oil and gas industry, while Oklahoma officials indicated frequent contacts by members of the public. Community members often contacted extension officers with concerns about environmental issues, such as soil or water quality or earthquakes. They also sometimes informally discussed with extension officers leasing information and rates, but the officers mostly directed them to chamber of commerce or economic development officers. Public officials, especially extension agents, contacted state universities for research-based information or the oil and gas industry for industry-related questions. Again, social capital – feeling of belonging, information from insiders and trust in public officials – helped community members reduce the risk perceived.

Socio-demographically, among age, gender, education, income, marital status, only gender showed significant relationship with perceived environmental risk. Women had higher average perceived environmental risk compared to men.

6.5.4 Identifying Effective Channels for Risk Communication

Risk communication involves exchange of information about the nature, magnitude, significance, and control of a risk (Wen 2015). Communication about hazards and risks is an important aspect of risk management. Risk communication can occur in two manners: one-way risk communication and two-way risk communication. While one-way risk communication focuses on message delivery, two-way risk communication involves feedbacks, inputs and understanding among risk managers and the public. For effective policy planning, researchers

have suggested two-way communication. The choice of the method depends on the goal of communication.

In rural communities, one-way communication focuses on message delivery (Wen 2015), often effected in the form of informational pamphlets and through digital and social media. These generally feature contact information for individuals or agencies for further questions. Two-way communication usually occurs in communities that host town hall meetings or public forums where experts and community members share a common space to interact and public officials hold one-on-one meetings with community members. Two-way communication focuses on feedback, inputs, and information exchange (Wen 2015). To identify effective channels of communication, it is imperative to understand rural demography. While it was unrealistic to expect everyone to receive (or care about) all information, community leaders often attempted to use multiple platforms simultaneously to reach community members.

Community Participation in Public Surveys

Surveys sometimes gather public opinions anonymously, so people can voice their opinions without any inhibitions (Hay 2010). Public officials then analyze this information and again hold meetings to discuss possible solutions. Currently, several counties use social media platforms and local radio stations to reach community's younger members. Public offices also often share email blasts of information. In the hope of reaching community members, public officers employ multiple media avenues.

None of the counties had done an exclusive survey on oil and gas industry. Harper County, however, had done a survey on gauging manufacturers' needs, and Sumner County was a part of a Kansas State University project called First Impressions.

Interviewees raised low participation as a common concern. Possible reasons cited were lack of community investment, skepticism in surveying agency, use of collected data, association with a government body, survey fatigue, and the word "survey" becoming synonymous with waste of time, as outcomes were never shared with the community. The suggested ways to increase response rates included incentives and using a community insider to introduce the researcher to establish the study's authenticity.

When asked about survey participation, a Noble County interviewee said the survey for this study generated a low response rate because of the very term 'survey,' and the association with a state university could have worked against it. The interviewee added that any other term than 'survey' would have been preferable. This latter concern might have arisen out of association of a state university to state government and skepticism over the ultimate use of collected information. Another informant also supported this interpretation. They claimed that sometimes it might be a case of personal skepticism about the use of the collected information. This also reflected indirectly on lack of trust in agencies collecting the information.

Several suggestions about potential changes to improve response rates were made, although these suggestions were no longer applicable to this study. The suggestions included use of a strong cover letter with a personal story to attract people, use of online survey methods and use of multiple platforms and techniques to reach community members. For instance, interviewees suggested use of social media for the young generation, coffee stores for older population and distributing physical copies at grocery stores, as multiple platforms to reach potential participants for survey. To gain access to residents, suggested means also included social media, radio, coffee shops and grocery stores. Interviewees pointed out that they sometimes visited donut shops, used social media, spoke to community members in stores or sent

emails. To reach members of the public, several of these methods were often employed at the same time. Several counties inducted their younger employees to handle social media, as they spoke the language better to connect with community's younger members. Older citizens, however, still preferred office visits and personal communication. If they knew the officers personally and saw them as community insiders, the seniors trusted them more than any other source of information. An extension agent suggested use of a local key person to introduce the surveyor to community to gain people's trust in data gathering, although I had used a variation of this in some locales (writing an article in a local newspaper and asking extension agents to send it through email when print media was not used (e.g., Logan County). A city commissioner linked length of stay in the community with community investment and participation in surveys. Another informant recommended that an incentive to participate in survey would encourage citizens to respond.

A Sumner County interviewee had an interesting spatial explanation about those residents who might participate in the survey and those who might not. He pointed out that Sumner county's northern half was closer to Wichita. The county's this portion served as a bedroom community to the city. Several people worked in Wichita, shopped in Wichita, and only lived in Sumner County. So, these individuals were least likely to be interested in answering surveys about oil and natural gas. On the other hand, Sumner county's southern part was more primary sector-oriented, particularly farming. Thus, the area's farmers more likely leased their land to the oil and natural gas industry and, therefore, were more inclined to take part in such surveys. Additionally, it was noted that residents of the county's southern part might also have been more invested in local development and wellbeing, as they depended more on the community for different socio-economic functions than residents in the county's northern half did.

6.6 Toward Sustainable Rural Communities

Capturing the diversity of rural America is an ongoing research challenge. Historically, rural areas have been perceived as urban residue, as passive entities of growth (Ward and Brown 2009). The way we think about regions in general, and rural areas specifically, reflects our understanding of a place (Isserman 2005). Rurality is often perceived as being synonymous with agriculture, and agricultural policy is often considered as rural policy (Mario 2001). Developing an effective, sustainable economic policy requires an understanding of the region and its characteristics. Local factors, interaction with oil and gas industry, experience, knowledge and awareness all play crucial roles in perceiving risks associated with industrial development.

Rural regions are often perceived as lagging in economic growth, suffering population loss, being filled with low skilled labor, and undergoing overall decline. Mechanization of agriculture meant fewer people were required on the farm, and the average U.S. farm size has increased dramatically. Many rural areas, however, are doing better because of improved transportation and infrastructure, and communication and access to the internet have been attracting people and business. Consequently, social science researchers in advanced economies have realized that rural areas in these economies are different from the generalized picture because of heterogeneous local conditions (Ward and Brown 2009).

Rural areas in different developed nations face different challenges, with some uniqueness at the local level. Overall, however, they are faced with overlapping challenges. Many rural challenges are institutionalized. For instance, Ward and Brown (2008) and Mario (2001) observed that some rural areas face difficulty in establishing the necessary critical mass of facilities, producer services, and investment to support economic development. In the U.S., an increasing awareness of the conventional system's limitations has pushed for new rural

governance (Lu and Jacobs 2013). Ward and Brown (2009) and Mario (2001) suggested a shift from sector-oriented economic development to place or territorial economic development. Since the 1990s, there has been a push for regional governance in planning, cooperation, and development in rural areas. The early 1990s witnessed a renewed interest in regional thinking, not just from economic practitioners but also from community leaders and scholars (Lu 2011). Consequently, instead of, "… large top-down plans, regional initiatives, often grassroots and collaborative efforts, whereby neighboring communities voluntarily form regional alliance based on common issues or challenges…" (Lu 2011, 335) was witnessed.

Since the mid-1990s, for rural economic development, several rural-development scholars have peddled the benefits of governance through regional partnerships that go beyond traditional administrative boundaries (Lu and Jacobs 2013). When regional criteria are applied to collaborate and coordinate, communities with similar regional identities often come together. Regional cooperation among rural communities exists at local levels. During the interviews, several public officials shared examples of regional collaboration. They stressed the importance of sharing information and conducting workshops together. However, officials, and especially community leaders who had been affected by the fossil fuel bust, raised concerns about local competition for limited economic resources.

Often, communities within proximity of each other faced similar challenges. In these cases, joining forces proved a more effective way to handle the costs of public workshops. For instance, during my scoping trips, Harper, Sumner, Barber and Reno counties held a joint informational workshop for community members interested in leasing their land to oil and gas companies. On the administrative side, within a community, public officials worked together to gather research-based information for community members. Economic development officers

often directed queries to extension officers and vice-versa. To get current information, business owners sometimes worked with chamber of commerce and economic development and/or extension officers. Networking and cooperation among public officers' community members aided me (researcher) to schedule interviews for data collection. For instance, in Woodward county, Oklahoma, the extension officer helped me schedule all the interviews. One of the meetings forced two officials to exchange their interview slots at the last minute. The officers coordinated with each other, adjusted their schedules and made sure they kept their appointments with me at the end of the day.

During interviews, I asked officials what they learned from their latest experience of industrial dynamics. Two main topics emerged: education and financial responsibility. According to the key informants, community members who wanted to invest in oil and gas leases needed to know the pro and cons, the expectations, responsibilities and impacts on the community before they signed any documents. For individuals expected to lead the community in the future, current public officials suggested they needed to learn from the current experiences and avoid giving in to the pressure of oil and gas industrial tactics. Brown and Schafft (2011) have advocated for "local communities to be strong and negotiate fair deals with regional, national and/or global actors" (pp223). Public officials strongly emphasized that local leaders needed to put their community's interests first, even if that meant losing economic profit margin. They pointed out that this might seem a huge loss in the beginning, but in the long run, it would be worth the trust and respect the local leaders would earn from the community. Public officials in Harper county, Kansas and Noble county, Oklahoma stressed the following aspects of economic responsibility, as major lessons learnt for their counties: spending the revenues more responsibly, to "save it for the rainy day" or "to not get too excited" with financial opportunities

as they might be short-lived. Other than that, on an individual level, officials also identified education and awareness - legal, financial, and technical - as guidance for the future. Officials from Harper County (one of the worst impacted by the bust) said they would like to learn from other counties with similar experiences about how they managed industrial dynamics. This takes us back to the need for regional collaboration and cooperation. Interviews in Woodward County echoed this sentiment: informants were interested in knowing how people in different places viewed the same problem. They recognized the challenges the county faced; low participation, industrial ebbs and expansions were not unique to their location. They wanted to know how others dealt with these pressures, because they could learn from each other's experiences.

For key informants, the final challenge was acquiring accurate information. Today information is available on several platforms and travels very fast. With the ability to search information on the internet, people rely more on online sources rather than conventional ones, such as extension offices. The first challenge was teaching community members to distinguish between facts and false information. Sometimes untrue information traveled fast through a community via close social networks. If the individual sharing information was from the community, there was a greater tendency to trust that information, although it might not have been factual.

6.7 Summary

Results from this study show that regional meanings of the concept of risk are expressed with a spatial and temporal aspect tied to an individual's experience and interactions with their surroundings. Environmental risk perceptions varied spatially. The reasons for variation differed for different counties. These ranged from experience of community and individuals with the industry, length of association, knowledge, awareness, and community life. Sample

averages for environmental risk perception for both oil and gas industry and fracking stood above 5 on a scale of 10. Trust in agencies also varied. While Federal sources of information and local environmental agencies were deemed the least trusted sources, independent researchers, universities, and newspapers were rated the top three dependable ones. As far as awareness was concerned, most of the respondents had heard about fracking from television news and social networks. Self-reported knowledge on fracking was neither high nor low. Interviews revealed that public officials were considered a trusted source of information. Extension agents in Kansas said they were relatively less used as source, while those in Oklahoma said community members contacted them often. All public officials observed low participation in surveys and in community activities. As it turned out, those involved in the community more likely participated in the mailed survey, but there might have been other factors, too. The common lessons learned from this experience were: better financial management for the future and better and more community awareness programs focusing on legal, technical, and economic aspects of the oil and gas industry. In the next chapter, I summarize this study's major findings and follow up with discussion on further research opportunities.

Chapter 7 - Summary and Conclusions

7.1 Data Gathering

The focal question of this research was "what are the risk perceptions associated with hydraulic fracturing and directional drilling (HFDD) in rural communities within the Mississippian Limestone Play (MLP) region, and how do they vary spatially?" Hence, data collection was designed to address this overarching question, the specific objectives intended to help answer the question, and information related to study area conditions relevant to fossil fuels and perceived risk in the study area.

The oil and natural gas industry is unpredictable and prone to variations in global oil and gas prices as well as domestic supply and demand. The United States uses more energy than it produces domestically. The boom of the early 2000s started in Pennsylvania and expanded to various parts of the country, including the MLP region within Kansas and Oklahoma. This boom emanated from a combination of new technologies, such as hydraulic fracturing and directional drilling. Development of a new extractive industry not only alters land, but also affects individuals and communities that reside in its proximity. Any change in the pattern of economic activity requires the community to adjust and this adjustment takes time. The adjustment period varies from community to community, depending on interaction between industry, community, and individuals. Thus, I was interested in studying risk perceptions of communities with respect to the new HFDD technology.

In August 2014, I began my dissertation research. At that time, both Kansas and Oklahoma were reaping benefits of the 2011 energy boom (Kansas witnessed the boom between 2011 to the end of 2014, while the boom in Oklahoma started between 2007 - 2009, registering

very low production after 2015). Although both Oklahoma and Kansas were familiar with oil and gas industry, use of hydraulic fracturing (fracking) coupled with directional drilling triggered extraction during this period.

In the MLP region within Kansas and Oklahoma, most counties are rural and largely depend on the economy's primary sector, both agricultural and extractive industry. When national and global fossil fuel industrial dynamics trickle down to local level, impacts amplify, owing to socio-economic and cultural setting of rural areas. In communities that largely (and sometimes exclusively) depend on a natural resource, residents develop a unique way of looking at the role the extractive industry plays in their local economy and community (Knight and Bates 1995).

For data gathering, a sequential mixed method approach of mailed questionnaire surveys and in-depth interviews was employed, focused on 10 counties within the Mississippian Limestone Play - a geologically rich oil and gas formation in Kansas and Oklahoma. Six counties in Kansas and four counties in Oklahoma were included, with different levels of oil and gas activity. Questionnaires were mailed questionnaires to a random sample of residents (1000) and 162 usable returns were obtained after repeat mailings following a 'modified Dillman' approach.

Closed-ended questionnaire responses were analyzed for statistical significance using Spearman's rank correlation (r_S). This test helped clarify the relationships of perceived environmental risk of the respondents and different variables. To provide depth to the understanding of responses, open-ended responses were coded in NVivo. After data collection from the mailed questionnaire was complete, three counties in Kansas and two in Oklahoma were chosen for key informant interviews. Interviews were combined with mailed

questionnaires for triangulation of data, interpretation of survey results, and further exploration of local conditions. Results from interviews provided rich qualitative data that triangulated with (supporting) quantitative results and help explain the context behind numerical findings. In the chapter's next section, I summarize this study's major findings. Following this, the challenges of data collection and recommended adjustments are addressed.

7.2 Major Research Findings

This study's results support the idea that regional meanings of the concept of risk are qualitative and vary spatially depending upon an individual's experience and interaction with their surroundings. Expressed meanings of risk encapsulate an underlying spatio-temporality with a concealed emotional reaction. Depending on the individual's nature, the concealed emotional reaction could be optimistic, pessimistic, or neutral. For instance, respondents' local experience with the oil and gas industry and fracking often influenced their meaning of risk. Some respondents expressed risk as a necessary step in the present for a secure or improved future. Such meanings of risk hinted at confidence in technological progress to make industrial procedures safer.

To explicitly state conclusions regarding the study's main question, based on the data gathered here, the risk perceptions associated with hydraulic fracturing and directional drilling in rural communities within the Mississippian Limestone Play region are variable among respondents, but tend to be of relatively minor importance to these residents; indications of spatial variation particularly link to whether a location and its inhabitants of a history of experience with the oil and gas industry, with Oklahoma residents generally perceiving less risk. The study's specific objectives were:

1) To explore regional perceptions of the concept of 'risk;'

2) To assess the variation in perceived environmental risk associated with hydraulic fracturing and directional drilling among affected rural communities in Kansas and Oklahoma; and
3) To identify factors associated with hydraulic fracturing and directional drilling risk perception in the Mississippian Limestone Play region regarding
    a) the oil and gas industry, generally and
    b) hydraulic fracturing and directional drilling risk, specifically.

Keeping in mind that conclusions are based on input from a limited number of residents, results can be suggested for each of these objectives, with the knowledge that assertion of absolute "answers" would not be appropriate based on the available dataset.

7.2.1 Objective 1/regional perceptions of the concept of 'risk'

From the data collected, it appears that important aspects of risk perception in the MLP region include the following:

- Risk meanings consist of qualitative assessments lacking numerical data
- Risk meanings are subjective and linked to the understandings of an individual's immediate surroundings
- Risk meanings have spatial and temporal dynamicity

7.2.2 Objective 2/variations in perceived environmental risk with HFDD

Level of perceived environmental risk varied within the MLP region:

- Kansas response averages bore similarity to the sample average (4.9 and 5.5 on a scale of 10)
- Oklahoma responses showed similar levels of perceived environmental risk for both oil and gas industry and fracking (6 and 5.8 on a scale of 10)

- Interviewees linked experience and length of association with oil and gas industry for the variation in perceived environmental risks

7.2.3 Objective 3/factors associated with risk perception

Sample averages for perceived environmental risk for the oil and gas industry and fracking were 5.81 and 6.1 respectively, on a scale of 1 to 10 with 10 being the highest. Survey analysis indicated county-wise variation in perceived environmental risk related to oil and gas industry and fracking. For every county, reasons for variation were unique. Interviewees explained this variation in perceived environmental risk in terms of knowledge and awareness. Knowledge and awareness create some familiarity with the source of risk, which, in turn, comes with experience of long-term connection with industrial dynamics and trust in local authorities.

The factors potentially affecting HFDD risk perceptions in the MLP were divided into five categories: awareness and knowledge, community experience, sources of information and trust in them, worldviews, perceived benefits, and drawbacks of industrial activities. To assess perceived risks, this study included place-based variables and psychological variables. Inclusion of place-based risk perceptions and social and psychological variables in risk perception analysis not only expands the current body of risk perception studies, but also adds to regional U.S. database of contemporary fossil fuel industrial risk studies.

Several relationships were as one might expect. Awareness of fracking's impacts, such as earthquakes, water usage, disposal of wastewater, damage to communities' social conditions or infrastructure, and fracking near respondents' homes were associated with increased environmental risk perception. When confidence in dealing with negative effects or positive views of the fossil fuel activity increased, environmental risk perception decreased. Respondents

tended to believe that they possessed enough knowledge about drilling to allow companies to continue their local operations.

Similarly, as place-based community experiences, such as safety, community spirit, and feeling of belonging increased, perceived environmental risk decreased. However, community involvement or participation was not a significant factor in increasing or decreasing perceived environmental risk. The length of time spent in the community influenced risk perceptions of the oil and gas industry but not fracking. As length of time of residence increased, fossil fuel industrial risk perception went down. Interviewees explained this relation resulting from trust in local authorities. To manage challenges efficiently, interviewees said that long-time residents asserted confidence in local authorities, by keeping the community's safety and interest before economic gains. Their trust in authorities proved to be a major factor related to perceived environmental risk. Respondents reported increased environmental risk perception when they valued their local natural environment.

As for news outlets, respondents identified television as the most popular source of information, followed by social networks, friends, and neighbors. Frequency of reading newspapers or watching television news did not contribute to either increasing or decreasing perceived environmental risk. As far as trust in source of information was concerned, the oil and gas industry, state agencies, local environmental groups, and magazines emerged as trusted sources for information about the fossil fuel industry. In this context, Extension agents in Kansas claimed they were relatively underutilized as sources for oil and gas-related information, while those in Oklahoma said community members contacted them often.

Worldviews appear to influence risk perception. Respondents with an egalitarian worldview carried a high-risk perception of the oil and gas industry and those with

individualistic worldview harbored lower risk perceptions. Most respondents claimed a conservative political ideology and thus were more likely to support fossil fuel industry (Boudet et al. 2014). As far as perceived risks and benefits were concerned, when respondents perceived more benefits, their perceived environmental risk of both oil and gas industry and fracking reduced. Among the socio-demographic factors: age, gender, education, marital status, and income, women respondents had higher average perceived environmental risk than males.

Interviews with public officials showed that interaction with oil and gas industry, particularly the community's experience with adjusting to industrial ebbs and flows and its length of association with industry, proved important factors in shaping community members' views about industrial activity. The more a community had experience with such ebbs and flows, the less intense any industrial change affected them. For such community, it almost became second nature to go through such changes. For example, while Kansas still struggled to adjust to contemporary oil and gas industrial dynamics, Oklahoma seemed more attuned with the ebbs and flows. Another significant factor was trust. If community members trusted their local officials, they perceived a lower level of risk.

7.3 Scholarly Contributions of This Study

This work contributes to multiple spheres of research. First is inclusion of social and psychological factors in risk perception studies. It is essential to understand social and psychological factors to comprehend community and place-based disruptions. Research on community- and place-based factors can help identify local drivers of perceived risks and, eventually, reasons for support or opposition to new technology (or mitigation of technological effects) in individual communities. It is imperative, therefore, to address and communicate specific risk with community members concerns for future of energy policy, as rising energy

prices, technological innovations and growing populations' energy demands have hastened construction of new energy development projects across the world.

In this research, community members' responses implied an impact of the fossil fuel industry on a community's *socio-cultural fabric* as a source of stress during peak operational months. Members in communities experiencing their first contemporary boom expressed a perceived increase in crime with new people entering their community. They felt that their community's cohesion was being diluted because temporary residents who came with oil companies avoided investing in the community. Moreover, community members believed that new people not only changed the towns' demography but also contributed, albeit unintentionally, to strain between longtime residents and new arrivals. For instance, interviewees pointed out that rising demand for housing and oil workers' ability to pay higher rents had forced some longtime residents to leave town, as they could not afford higher rents. Once the boom busted, though, landlords suffered economic stress because of revenue loss. Additionally, after industrial operations moved out, community's permanent residents were left with a distressed socio-cultural fabric and disturbed economy.

The above conditions (and perceptions) exemplify social disruption theory. While this proved true for communities experiencing their first fossil fuel industry (e.g., Harper County, Kansas), communities with longer familiarity and experience seemed to adjust better to industrial ebbs and flows (e.g. Woodward County Oklahoma). No doubt, the more 'experienced' communities did undergo some disruption, but not to the extreme extent of newly affected places.

The *psychological* element of place-based disruption, too, showed a significant relation to environmental risk perception. Respondents were asked to evaluate their feelings (enthusiastic,

optimistic, uncertain, concerned, panicked) about application of HFDD in their community. This study found that as enthusiasm grew, environmental risk perception decreased. When graphs of environmental risk perception and emotions about new technology were compared at the county level (e.g., Figures 6.2 and 6.3), participants' responses ranged between concern and optimistic. Secondly, communities with higher environmental risk perception expressed more concerns about the technology. Respondents were also asked to identify "three words or terms that come to your mind when you see or hear the term 'fracking'." Building on Boudet et al. (2014), these "top of the mind" associations influence perceptions of risks and benefits and are considered affective imagery. Affective imagery is "broadly construed to include sights, sounds, smell, ideas and words to which positive and negative affect or feeling states have become attached through learning and experience" (Boudet et al. 2014, 59). Several respondents reported negative imagery. The positive responses were centered on economic benefits for the community. These associations are important because they express information that is quickly recalled and used in decision making processes, such as risk associated with industrial activity or support for or opposition to industrial processes.

From the responses, one thing became clear. The challenges that communities face need to be addressed through local collaboration. This is crucial to ensure the communities' sustainable future. At the same time, traditional administration may not provide the best framework, as majority of community challenges are extremely localized and spatially special. Hence, ad-hoc regionalism suggested by Lu (2011), offers a good collaborative way of solving regional challenges. Harper and Stafford county officials in Kansas pointed out some county collaborative efforts, such as workshops organized for members to learn about fossil fuel industry operations. Oklahoma officials, however, did not specifically mention any such efforts.

Kansas initiated such efforts mainly to help community members acquire more knowledge and awareness about the new technology and to familiarize them with industrial knowhow. Oklahoma's longer association, more familiarity and better adjustment ("we are used to this industry") with industrial dynamics probably did not warrant such workshops, or at least was not seen as a need by many respondents and interviewees in the county.

In risk perception studies, use of place-based studies and inclusion of psychological elements linked to environmental factors proposes collaboration between geography's two important subfields: humanistic and behavioral and environmental geography. For robust risk perception assessment in the future, this approach will be beneficial to predict support or opposition to other emerging technologies. It is important to examine place specific studies to understand challenges that plague communities at local level. As communities vary in experience of industrial dynamics and their capabilities to cope with them, spatial knowledge becomes important. Such understanding helps communities cope with disruptions and can better prepare them for similar challenges in the future.

The MLP region within the Great Plains of Kansas and Oklahoma has received little research attention. Thus, my study fills a gap in geographical coverage in risk perception studies in the United States.

7.4 Research Limitations and Recommendations

Research is a process of co-production of knowledge. Knowledge is built in an environment of exchange between researcher and community, which can introduce a range of biases. Multiple identities of individuals are brought to the table and, depending on the situation, one identity overrides the other. For instance, while interviewing one official, my identity as an international student overtook my identity as researcher.

Furthermore, fieldwork in communities affected by resource extraction involves complex interactions between institutional networks, community histories, location of the resource, and researcher positionality (Jenkins et al. 2015). To add to the complexity, economic and social values of a landscape and emotional attachment to place create unique opportunities and challenges for the researcher. In framing social science research, we find ourselves trying to create an unbiased narrative, while attempting, at the same time, to understand our own involvement with the landscape, people, and processes. Thus, it becomes important to reflect critically on the collected data. Understanding how this affects the study and its results forms an important process.

Selection bias may be introduced during the study's design. For instance, the scoping trips I undertook in the early stages of research involved contacting key informants, and I built further networks by snowball sampling. I used these same networks and sources of information for interviews. Thus, my initial information collection in communities depended on informants' knowledge of socio-economic, environmental, and institutional channels of information. I assumed that, based on their membership in community and consideration of 'insider' affiliation, the information key informants shared with me was current.

Participant bias may also occur, and is particularly likely to be an issue with survey work: the individuals who choose to respond may differ from those who do not. Related to selection bias, there is a concern that adequate representation of a population may not be achieved. For respondents of mailed survey, I used stratified random selection, a well-used and accepted technique in mixed method studies. But what people did with the material they received in the mail was beyond my control. I knew that, even with supplying return stamped envelopes, a technique suggested by Dillman (2010) to remove one hurdle in survey participation, people

might choose not to respond. During interviews with public officials, I raised my concern about low public motivation to participate in surveys and asked for possible solutions. They explained that, with random selection there was a chance that the individual contacted could be someone who avoided taking part in community activities, lacked interest in the topic, disapproved of my association with a university or government agency, or was skeptical about the collected data or even had survey fatigue.

Over time, however, respondents recognized that fracking came with its challenges, opportunities, and environmental consequences. While most respondents were unsure about state and federal agencies' extent of regulation, a few explicitly felt that state and federal agencies had overregulated the industry. Such an attitude hinted at fear that agencies' overregulation would cripple economic benefits. This also might have been one the reasons why local antifracking movements were weak and surveys like mine were looked down upon as 'rocking the boat' or 'stirring the pot,' adding to low response rate.

Thus, given the benefit of retrospection now, I would conduct some aspects of the research differently, and such understanding is likely to affect future research. To begin with, awareness of my position in the context of geopolitical rhetorical domestic policy changes would have been helpful. In the future this may help to develop more effective research approaches. For instance, instead of doing mailed questionnaire surveys, in the future I may opt for on-site paper surveys. People were more willing to talk a researcher they had met before. Therefore, if I do similar research in the future, I will ensure that participants can associate a face and voice with the project, rather than just a cover letter. This would mean that contacts would have to be developed and interpretations of results would have to be adjusted.

Additionally, when developing questionnaires or similar tools in the future, I will be even more cognizant of the need to consider the interpretations and reactions of potential respondents related to terminology and research descriptions.

I also came to the realization, though accidentally, that field visits with local experts are particularly informative. Outdoor field visits with extension personnel, for example, provided significantly more information (and sense of place) than most formal office interviews. To the extent possible, I will incorporate such experiences in future research projects, as they can generate detailed, rich, and dense data –even if not all can be summed in words.

7.5 Future Research

The amount of data generated from the survey and interviews undertaken for this research is difficult to describe and analyze here. The qualitative data, particularly, provided an overwhelmingly rich account of local views. Although survey response rates were low, analysis of differences by state, county, or gender may be possible. Longitudinal study in the same area, or development of comparative research in other oil and gas producing parts of the country, may provide deeper understanding of the relationships among places with experience, resource extraction, perceived risk and perceived environmental value. More sophisticated techniques for quantitative data analysis could be applied to these data and/or to further studies for fuller understanding of relationships, such as applying logit regression to better understand relationship between variables and risk perception.

In the later stages of this research, a potential connection between place attachment and risk perceptions appeared as a conceivably important area of study. Further exploration of linkages among emotional bonds with place, risk perceptions, and decision-making have the potential to provide valuable understandings. Here, an interesting question arises: would people

support a particular industry in their community because it gives them economic benefits and also allows them to stay in the place to which they have an emotional bond, or would they prevent any such industrial activity to preserve place characteristics they value?

Each of the three research objectives guiding this project could be taken up as individual research topics with deeper analysis. Moreover, comparative studies of other fracking regions in the U.S. (Marcellus Shale, Bakken Shale, and Barnett Shale regions, e.g.) may help provide a perspective on local challenges and solutions. Similarly, the topic of resource extraction and risk perception can be expanded to examine other types of resource-based communities. Additionally, impacts of boom and bust events can be studied longitudinally by revisiting these communities over time. When the area experiences another boom - interviews hinted at such a possibility – factors that increase (or decrease) community resilience (and ability to best take advantage of changes) might be identified; such information could inform other communities in the face of resource booms.

A case study of Harper County and Sumner County would be fruitful. Harper county was the worst affected by the boom and bust. Compared to Harper County, neighboring Sumner County had relatively less actual drilling but served as a "bedroom" community for oil and gas workers, highlighting the different experiences that may be felt in neighboring counties (or communities) Similarly, studies addressing the differing experiences and perceptions of very rural versus metro-adjacent places with similar environments and resource extraction potentials would aid understanding of the conditions of such places as they are (or are not) influenced by an urban field.

It is essential to study place-specific, long-term impacts of contemporary oil and gas industry in rural communities. This knowledge will help formulate place-based local mitigation

programs for community and economic development. Taking a bottom-up approach will ensure less reliance on external forces for development, and community development will be in tune with local environment and local needs. This research contributes to such understanding in a region that has received little research attention. Indications are that there are varying views of risk related to industry, as well as differing feelings about place, change, and opportunity. Future responses to situations seen as opportunity to some or unacceptable risk by others will be shaped by how communities balance perceptions, values, and responses.

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Appendix A - **Institutional Review Board approval letter for mailed survey**

KANSAS STATE UNIVERSITY | University Research Compliance Office

TO: Dr. Bimal Paul
Geography
121 Seaton Hall

FROM: Rick Scheidt, Chair
Committee on Research Involving Human Subjects

DATE: 02/24/2017

RE: Proposal #8511.1, entitled "Unconventional Oil and Natural Gas Development: A Risk Perceptions and Concern Assessment among Adults in the Mississippian Limestone Play Region."

A MINOR MODIFICATION OF PREVIOUSLY APPROVED PROPOSAL #8511, ENTITLED, "Unconventional Oil and Natural Gas Development: A Risk Perceptions and Concern Assessment among Adults in the Mississippian Limestone Play Region"

The Committee on Research Involving Human Subjects at Kansas State University has approved the proposal identified above as a minor modification of a previously approved proposal, and has determined that it is exempt from further review. This exemption applies only to the most recent proposal currently on file with the IRB. Any additional changes affecting human subjects must be approved by the IRB prior to implementation and may disqualify the proposal from exemption.

Unanticipated adverse events or problems involving risk to subjects or to others must be reported immediately to the IRB Chair, and / or the URCO.

It is important that your human subjects project is consistent with submissions to funding/contract entities. It is your responsibility to initiate notification procedures to any funding/contract entity of changes in your project that affects the use of human subjects.

203 Fairchild Hall, Lower Mezzanine, 1601 Vattier St., Manhattan, KS 66506-1103 | 785-532-3224 | fax: 785-532-3278 | comply@ksu.edu | k-state.edu/research/comply

Appendix B - **Institutional Review Board approval letter for interviews**

KANSAS STATE UNIVERSITY | University Research Compliance Office

TO: Dr. Audrey Joslin
Geography
1004 Seaton Hall

FROM: Rick Scheidt, Chair
Committee on Research Involving Human Subjects

DATE: 12/04/2018

RE: Proposal #8511.2, entitled "Living with Oil and Natural Gas: A risk perception study among adults in Kansas and Oklahoma."

A MINOR MODIFICATION OF PREVIOUSLY APPROVED PROPOSAL #8511.1, ENTITLED, "Living with Oil and Natural Gas: A risk perception study among adults in Kansas and Oklahoma"

The Committee on Research Involving Human Subjects at Kansas State University has approved the proposal identified above as a minor modification of a previously approved proposal, and has determined that it is exempt from further review. This exemption applies only to the most recent proposal currently on file with the IRB. Any additional changes affecting human subjects must be approved by the IRB prior to implementation and may disqualify the proposal from exemption.

Unanticipated adverse events or problems involving risk to subjects or to others must be reported immediately to the IRB Chair, and / or the URCO.

It is important that your human subjects project is consistent with submissions to funding/contract entities. It is your responsibility to initiate notification procedures to any funding/contract entity of changes in your project that affects the use of human subjects.

203 Fairchild Hall, Lower Mezzanine, 1601 Vattier St., Manhattan, KS 66506-1103 | 785-532-3224 | fax: 785-532-3278
comply@k-state.edu | k-state.edu/research/comply

Appendix C - **Study Announcement (Newspaper and County Extension Distribution)**

Kansas State University researchers investigating community opinions on oil and gas development.

Extraction of oil and natural gas has occurred in Kansas for several years, and the energy industry is the 3rd most important economic contributor in the State. The Mississippian Limestone Play (MLP), a porous limestone formation containing oil and natural gas, is found under parts of southern and western Kansas and has been important to energy production.

With horizontal drilling and hydraulic fracturing, there has been a new oil rush in the MLP. An upswing in drilling activity was seen from 2010 to about end of 2014, and its associated industrial establishments have left lasting impacts on local communities.

Researchers from the Department of Geography at the Kansas State University are investigating local opinions about industrial development with a specific focus on the oil and gas industry. The research will contribute to better understanding of how individuals in local communities experience industrial changes, as well as how industrial dynamics affect opinions. It is intended to help bridge gaps between local experiences and government planning.

As a local community member you are invited to take part in our research by participating in a survey. Completing this survey not only helps with the research, but gives you a way to voice your opinion about the energy industry and local activity. Your participation will be held in confidentiality and remain anonymous, and at no point will participants be identified in the reporting or presentation of research results.

Randomly selected houses will receive a survey packet in the beginning of next week. We encourage you to participate in this research. Please complete the survey and mail it back using the self-addressed, self-stamped envelope provided in that packet. The K-State researchers also aim to conduct group discussions and share their results with the community through the extension office in fall or spring of 2017.

Please feel free to contact Dr. Bimal Paul (bkp@ksu.edu) or Avantika Ramekar (avantika@ksu.edu) with any questions.

Appendix D - **First Contact Cover Letter: Kansas**

Living with oil and natural gas: A Risk Perception study among adults in Kansas

Dear Kansas Resident,

You have been randomly selected to participate in a survey gathering local opinions about oil and natural gas industry in Kansas. The survey will arrive by mail in the next few days. Participation is voluntary: you may refuse to participate, you may refuse to answer any particular questions you do not wish to answer, and you may stop participating at any time. This survey strives to understand how individuals in local communities experience industrial changes, as well as how industrial dynamics affect opinions.

This survey will take less than 20 minutes to complete. It will consists of questions on different aspects of your local community: social networks, natural environment, community experience with industrial development and your views about this development near you. All your responses will be confidential and will be shared only between the student and her advisor. We will not identify you in any report or presentation from this research unless indicated otherwise by you by writing a note on or with your returned survey if you wish to give specific responses identified as your own. Your survey packet includes a self-stamped, address envelop for easy return upon completion.

Project Description

This study is being conducted by Avantika Ramekar, a graduate student in the Department of Geography, Kansas State University, as a partial fulfilment of doctoral degree. The study contributes to understanding how individuals in local communities experience industrial changes, as well as how industrial dynamics, life experience, and varied aspects of place (social, personal, environmental and economic) affect their opinions.

Extraction of oil and natural gas has occurred in Kansas for several years, and the energy industry is the third most important economic contributor in the State. With technological advances in directional drilling and hydraulic fracturing, this industry is growing rapidly. Setting up of a new industry not only alters the physical piece of land but also affects the life of individuals and community located in its proximity. Despite of the rapid growth, the exact impacts of this activity on environment and health are not completely understood. This study is planned to help bridge gaps between local experiences and government planning.

Questions or Feedback

For any questions or feedback please contact Avantika Ramekar (avantika@ksu.edu or 8325425311) or Dr. B. K. Paul (bkp@ksu.edu) at 118 Seaton Hall, Department of Geography, Kansas State University, Manhattan 66502.

If you have concerns or complaints about this project, please contact the University Research Compliance Office at 785-532-3224 or fax at 785-532-3278 or by email at comply@k-state.edu.

Avantika Ramekar
PhD Candidate
Kansas State University

Appendix E - **First Contact Cover Letter: Oklahoma**

Living with oil and natural gas: A Risk Perception study among adults in Oklahoma

Dear Oklahoma Resident,

You have been randomly selected to participate in a survey gathering local opinions about oil and natural gas industry in Oklahoma. The survey will arrive by mail in the next few days. Participation is voluntary: you may refuse to participate, you may refuse to answer any particular questions you do not wish to answer, and you may stop participating at any time. This survey strives to understand how individuals in local communities experience industrial changes, as well as how industrial dynamics affect opinions.

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Extraction of oil and natural gas has occurred in Oklahoma for several years, and the energy industry is one of the most important economic contributor in the State. With technological advances in directional drilling and hydraulic fracturing, this industry is growing rapidly. Setting up of a new industry not only alters the physical piece of land but also affects the life of individuals and community located in its proximity. Despite of the rapid growth, the exact impacts of this activity on environment and health are not completely understood. This study is planned to help bridge gaps between local experiences and government planning.

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Avantika Ramekar
PhD Candidate
Kansas State University

Appendix F - **Survey Cover Letter: Kansas**

Living with oil and natural gas: A Risk Perception study among adults in Kansas

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Avantika Ramekar
PhD Candidate and Graduate Research Student
Kansas State University

Appendix G - **Survey Cover Letter: Oklahoma**

Living with oil and natural gas: A Risk Perception study among adults in Oklahoma

Dear Oklahoma Resident,

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Avantika Ramekar
PhD Candidate and Graduate Research Student
Kansas State University

Appendix H - **Survey Instrument**

LIVING WITH OIL AND NATURAL GAS: A RISK PERCEPTION STUDY AMONG ADULTS IN KANSAS

Participation in this study is completely voluntary. Your answers are confidential and will not be reported in a way that can identify you personally unless you indicate a desire to have specific responses identified with your name. You may freely withdraw from this study at any time without repercussions. There are no known or anticipated risks associated with participating in this study. By returning this survey form you are consenting to the inclusion of your answers in this study.

KANSAS STATE UNIVERSITY
Department of Geography

This research explores experiences and opinions of people living in communities in Kansas and Oklahoma related to oil and gas development. The survey will take about 20 minutes to complete. You'll be asked for your own view on topics related to various activity associated with oil and gas development in your community. You may skip questions you don't want to answer and may stop your participation at any time. You are welcome to write extra comments on open space beside any question, or in the space provided at the end. Your responses are anonymous, although if you wish to be identified with any of your responses, you may indicate so.

For the purpose of this survey "oil and gas development" includes all the activities involved in gaining access to, drilling for, extracting, and transporting gas or oil, and disposal of byproducts.

Thank you for sharing your input.

Q1. Based on your experience with oil and gas development in your **community**, please indicate your level of agreement with the following statements:

	Completely agree	Agree	Neither agree nor disagree	Disagree	Completely disagree
Truck traffic has increased significantly in my community	☐	☐	☐	☐	☐
There are many new businesses in the community	☐	☐	☐	☐	☐
Local businesses are losing customers	☐	☐	☐	☐	☐
I see many new faces in my community	☐	☐	☐	☐	☐
New faces make me uncomfortable	☐	☐	☐	☐	☐

Q2. On a 10-point scale (1 being the lowest and 10 being the highest), how much environmental risk do you think is associated with the oil and natural gas industry? (Please circle one number)

1 2 3 4 5 6 7 8 9 10

Q3. How much do you agree with this statement: The benefits my community will get from oil and gas drilling will outweigh the cost the community may have to pay.

- ☐ Completely agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Completely disagree

Q4. Indicate your level of agreement with the following statement: We know enough about oil and gas development to permit companies to continue drilling in our community.

- ☐ Completely agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Completely disagree

Q5. Please list three words or terms that come to your mind when you see or hear the term **'fracking.'**

Q6. Do you have a current lease of any of your land with an oil or gas company?

☐ Yes ☐ No ☐ I don't know

Q7. Will you lease your land to an oil or gas company in the future?

☐ Yes ☐ No ☐ Maybe/not sure

Q8. Which of the following terms best describes how you feel about the recent technological advances in oil and natural gas-drilling techniques (for example, horizontal and fracking) applied in your community? (Please check one box)

Enthusiastic	Optimistic	Uncertain	Concerned	Panicked
☐	☐	☐	☐	☐

If you have any comments please list them below:

Q9. Please evaluate the following statements by checking what you think of each:

	Completely agree	Agree	Neither agree nor disagree	Disagree	Completely disagree
Oil and gas development creates jobs in my community	☐	☐	☐	☐	☐
Oil and gas development will improve the overall quality of life in my community	☐	☐	☐	☐	☐
Oil and gas development is noisy	☐	☐	☐	☐	☐
Any negative impacts of oil and gas development can be fixed	☐	☐	☐	☐	☐
When oil or gas development is going on, the smell or odor of the air near my house bothers me	☐	☐	☐	☐	☐

Q10. Where did you hear about fracking? (You may check multiple items)

- ☐ I have not heard about fracking
- ☐ TV news
- ☐ Radio
- ☐ Newspaper
- ☐ Magazine
- ☐ Friends and neighbors
- ☐ Family
- ☐ Industry
- ☐ Other (please specify) _____

Q11. How much do you know about fracking?

- ☐ Nothing
- ☐ A Little
- ☐ Some
- ☐ A lot
- ☐ I am an expert

Q12. What does the term 'risk' mean to you?

Q13. Based on what you have heard, on a scale of 1 to 10 (1 lowest to 10 highest) how much environmental risk do you think is associated with fracking? (Please circle one number)

1 2 3 4 5 6 7 8 9 10

Q14. Do you know which type(s) of fracking happens on your land or on land around you?

☐ Vertical ☐ Horizontal ☐ Slant ☐ I am not sure

Q15. "Fracking" is a way to extract natural gas and oil from shale rock deep underground. Based on what you have heard or read about fracking, how do you feel about it? (Check one option below.)

☐ Strongly support it
☐ Somewhat support it
☐ Am unsure
☐ Somewhat oppose it
☐ Strongly oppose it

Q16. Based on what you have heard, read or know about fracking please evaluate the following statements: (Please check one box per row)

	Completely agree	Agree	Neither agree nor disagree	Disagree	Completely disagree
Fracking causes earthquakes	☐	☐	☐	☐	☐
Fracking uses too much water	☐	☐	☐	☐	☐
I am concerned about the disposal of fracking waste water	☐	☐	☐	☐	☐
Negative impacts (if any) of fracking in my region can be prevented if it proceeds carefully	☐	☐	☐	☐	☐
I worry there will be a catastrophic accident involving fracking which will cause irreversible damage to my community	☐	☐	☐	☐	☐
Fracking should not be done anywhere near my house	☐	☐	☐	☐	☐

Q17. In a typical week, how many days do you read the **newspaper or news magazines**?

- ☐ Every day
- ☐ At least five days, but not every day
- ☐ Three or four days
- ☐ One or two days
- ☐ No days

Q18. Are there any **newspapers or news magazines** you read regularly? If so, please list them below:

Q19. In a typical week, how often do you watch the **news on TV**?

- ☐ Every day
- ☐ At least five days, but not every day
- ☐ Three or four days
- ☐ One or two days
- ☐ No days

Q20. Are there any **news outlets on TV** you follow regularly? If so, please list them below:

Q21. How much do you trust the following sources for information about fracking?

	Completely	Some	Very Little	No Trust	Unsure
Oil and gas industry	☐	☐	☐	☐	☐
Federal agencies (EPA*, DOE**, DOI***)	☐	☐	☐	☐	☐
State agencies (KCC****)	☐	☐	☐	☐	☐
Universities	☐	☐	☐	☐	☐
Independent researchers	☐	☐	☐	☐	☐
Local environmental groups	☐	☐	☐	☐	☐
Television	☐	☐	☐	☐	☐
Newspapers	☐	☐	☐	☐	☐
Magazines	☐	☐	☐	☐	☐
Radio	☐	☐	☐	☐	☐

**EPA=Environmental Protection Agency; **DOE=Department of Energy; ***DOI= Department of Interior; ****KCC=Kansas Corporation Commission*

Q22. The state government has regulated this source of energy sufficiently:

☐ True ☐ False ☐ Unsure

Q23. The federal government has regulated this source of energy sufficiently:

☐ True ☐ False ☐ Unsure

Q24. Based on your thoughts and experiences, please check one box per statement in the appropriate column.

	Completely agree	Agree	Don't know	Disagree	Completely disagree
At my workplace, everyone's opinion is important to decisions	☐	☐	☐	☐	☐
Firms and institutions should be organized in a way that everybody can influence important decisions.	☐	☐	☐	☐	☐
A person is better off if he or she doesn't trust anyone.	☐	☐	☐	☐	☐
I don't join clubs of any kind.	☐	☐	☐	☐	☐
I would not participate in civil action groups.	☐	☐	☐	☐	☐
Important questions for our society should not be decided by experts but by the people.	☐	☐	☐	☐	☐
My ideal job would be to have my own business.	☐	☐	☐	☐	☐
When I have problems I try to solve them on my own.	☐	☐	☐	☐	☐

Q25. In general, how do you consider your political approach?

Liberal	Somewhat Liberal	Moderate	Somewhat Conservative	Conservative
☐	☐	☐	☐	☐

Q26. How much or how little do you participate in your community?

☐ I do not participate
☐ I rarely participate
☐ I sometimes participate
☐ I frequently participate
☐ I always participate

Q27. When did you move to this community? (Please list year, or year of birth if life-long resident)

Q28. Please describe your community in a few words

Q29. What do you like most about your community?

Q30. How would you evaluate the visual appearance of your community?

- ☐ Very attractive
- ☐ Somewhat attractive
- ☐ Average appearance
- ☐ Not very attractive
- ☐ Not attractive at all

Q31. How safe do you feel in your community?

- ☐ Completely safe
- ☐ Somewhat safe
- ☐ Neither safe nor unsafe
- ☐ Somewhat unsafe
- ☐ Completely unsafe

Q32. Do you agree with this statement: Community spirit is strong here.

- ☐ Completely agree
- ☐ Agree
- ☐ Neither agree or disagree
- ☐ Disagree
- ☐ Completely disagree

Q33. Do you agree with this statement: This community is where I belong.

- ☐ Completely agree
- ☐ Agree
- ☐ Neither agree or disagree
- ☐ Disagree
- ☐ Completely disagree

Q34. How important is the local natural environment to you?

- ☐ Very important
- ☐ Somewhat important
- ☐ Neither important nor unimportant
- ☐ Somewhat unimportant
- ☐ Very unimportant

Q35. Is there anything you would like to change in your community with respect to **fracking**? If so, please list them below.

Q36. In what year were you born?

Q37. What is your gender? ☐ Female ☐ Male

Q38 What is your racial or ethnic identity?

- ☐ White
- ☐ Black
- ☐ Hispanic
- ☐ Asian
- ☐ Native American
- ☐ More than one ethnicity
- ☐ Prefer not to answer

Q39. What is your highest level of education?

- ☐ Less than high school
- ☐ High school or GED equivalent
- ☐ Some college
- ☐ Associate degree
- ☐ Bachelor's degree
- ☐ Graduate degree

Q40. In which industry are you currently employed?

- ☐ Agriculture
- ☐ Oil and gas
- ☐ Meat packing
- ☐ Unemployed
- ☐ Federal/State
- ☐ Education
- ☐ Retired
- ☐ Not formally employed outside home (Student, retail)
- ☐ Other (please specify) _____

Q41. In which income range does your household fall into?

- ☐ Below $10,000
- ☐ $11,000-$30,000
- ☐ $31,000-$50,000
- ☐ $51,000-$70,000
- ☐ Above $70,000
- ☐ Prefer not to answer

Q42. What is your marital status?

- ☐ Single
- ☐ Married
- ☐ Divorced
- ☐ Widowed
- ☐ Domestic partner
- ☐ Prefer not to answer

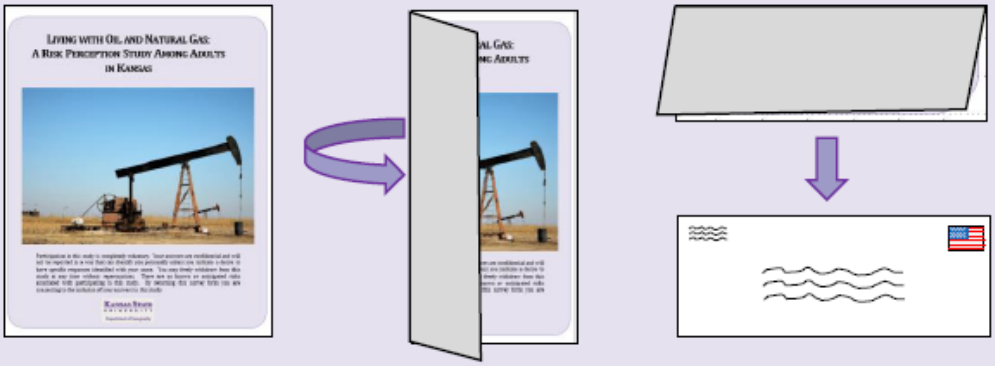
Q43. Which state do you live in?

- ☐ Kansas
- ☐ Oklahoma

Q44. What county do you live in? _____

Q45. Are there any comments you would like to make?

This is the end of the questionnaire. Thank you very much for your time and input in this study. To return your questionnaire, please fold it in half as shown and place it in the included self-addressed stamped envelope for your local mail carrier. Contact information can be located on the back of this questionnaire.



Appendix I - **Follow-up Postcard**

You should have recently received a questionnaire seeking your opinions about oil and natural gas industry in your area. Your name was drawn randomly from a list of households in your county for this survey.

If you have already completed and returned the questionnaire, please accept our sincere thanks. If not, please do so as soon as it is convenient.

If you did not receive a questionnaire, or if it was misplaced, please call me at (832) 542-5311 or send an email to avantika@ksu.edu and we will get another copy in the mail to you right away.

Sincerely,

Avantika Ramekar, Graduate Student Researcher
Department of Geography
Kansas State University
Manhattan, KS 66506

Appendix J - **Second Contact Letter: Kansas**

Living with oil and natural gas: A Risk Perception study among adults in Kansas

Dear Kansas Resident,

You were contacted earlier in summer regarding a survey gathering local opinions about oil and natural gas industry in Kansas. Our records show we have not received a completed survey from you. In case the survey was lost, we are sending you a replacement copy. Participation is voluntary and you may refuse to participate, you may refuse to answer any particular questions you do not wish to answer, and you may stop participating at any time. *We highly encourage you to return completed survey. As a resident of this community, your opinion matters and is important for our study.* This survey is sponsored by the Department of Geography, Kansas State University and it strives to understand how you experience industrial changes in your community and how industrial dynamics affect your opinions.

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Avantika Ramekar
PhD Candidate and Graduate Research Student
Kansas State University

Appendix K - **Second Contact Letter: Oklahoma**

Living with oil and natural gas: A Risk Perception study among adults in Oklahoma

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Project Description

This study is being conducted by Avantika Ramekar, a graduate student in the Department of Geography, Kansas State University, as a partial fulfilment of doctoral degree. The study contributes to understanding how individuals in local communities experience industrial changes, as well as how industrial dynamics, life experience, and varied aspects of place (social, personal, environmental and economic) affect their opinions.

Extraction of oil and natural gas has occurred in Oklahoma for several years, and the energy industry is the one of the most important economic contributor in the State. With technological advances in directional drilling and hydraulic fracturing, this industry is growing rapidly. Setting up of a new industry not only alters the physical piece of land but also affects the life of individuals and community located in its proximity. Despite of the rapid growth, the exact impacts of this activity on environment and health are not completely understood. This study is planned to help bridge gaps between local experiences and government planning.

Questions or Feedback

For any questions or feedback please contact Avantika Ramekar (avantika@ksu.edu or 8325425311) or Dr. B. K. Paul (bkp@ksu.edu) at 118 Seaton Hall, Department of Geography, Kansas State University, Manhattan 66502.

If you have concerns or complaints about this project, please contact the University Research Compliance Office at 785-532-3224 or fax at 785-532-3278 or by email at comply@k-state.edu.

Avantika Ramekar
PhD Candidate and Graduate Research Student
Kansas State University

Appendix L - **Variable Coding**

Q no.	Question	Short Code	Coding	Data Type
1	Based on your experience with oil and gas development in your community, please indicate your level of agreement with the following statements:			
1a	*Truck traffic has increased significantly in my community*	Truck traffic	5= Completely agree 4= Agree 3= Neither agree nor disagree 2= Disagree 1= Completely disagree	Likert Scale: Ordinal Data
1b	*There are many new businesses in the community*	New business		
1c	*Local businesses are losing customers*	Local business customer loss		
1d	*I see many new faces in my community*	New faces		
1e	*New faces make me uncomfortable*	Discomfort with new faces		
2	On a 10-point scale (1 being the lowest and 10 being the highest), how much environmental riskdo you think is associated with the oil and natural gas industry? (Please circle one number)	a. Environmental risk (industry) b. Collapsed Environmental risk (industry)	1 - Low Risk to 10 - High Risk	Likert Scale: Ordinal Data
3	How much do you agree with this statement: The benefits my community will get from oil and gas drilling will outweigh the cost the community may have to pay.	Risk-benefit	5= Completely agree 4= Agree 3= Neither agree nor disagree 2= Disagree 1= Completely disagree	Likert Scale: Ordinal Data
4	Indicate your level of agreement with the following statement: We know enough about oil and gas development to permit companies to continue drilling in our community.	Knowledge & awareness	5= Completely agree 4= Agree 3= Neither agree nor disagree 2= Disagree 1= Completely disagree	Likert Scale: Ordinal Data
5	OPEN ENDED: Please list three words or terms that come to your mind when you see or hear the term ‘fracking’.			
6	Do you have a current lease of any of your land with an oil or gas company?	Current economic benefit	1= Yes 2= No 3= I don't know	Nominal

7	Will you lease your land to an oil or gas company in the future?	Future economic benefit	1= Yes 2= No 3= Maybe/not sure	Nominal
8	Which of the following terms best describes how you feel about the recent technological advances in oil and natural gas-drilling techniques (for example, horizontal and fracking) applied in your community? (Please check one box)	Qualitative assessment	5= Enthusiastic 4= Optimistic 3= Uncertain 2= Concerned 1= Panic	Likert Scale: Ordinal Data
A	OPEN ENDED: If you have any comments please list them below:			
9	Please evaluate the following statements by checking what you think of each:			
9a	*Oil and gas development creates jobs in my community*	Jobs (industry)	5= Completely agree 4= Agree 3= Neither agree nor disagree 2= Disagree 1= Completely disagree	Likert Scale: Ordinal Data
9b	*Oil and gas development will improve the overall quality of life in my community*	QoL (industry)		
9c	*Oil and gas development is noisy*	Noise (industry)		
9d	*Any negative impacts of oil and gas development can be fixed*	Optimism (industry)		
9e	*When oil or gas development is going on, the smell or odor of the air near my house bothers me*	Odor (industry)		
10	Where did you hear about fracking? (you may check multiple items)			
11	How much do you know about fracking?	Self-reported knowledge (fracking)	1= Nothing 2= Little 3= Some 4= A Lot 5= I am an expert	Likert Scale: Ordinal Data
12	OPEN ENDED: What does the term 'risk' mean to you?			
13	Based on what you have heard, on a scale of 1 to 10 (1 lowest to 10 highest) how much environmental risk do you think is associated with fracking? (Please circle one number)	a. Environmental risk (Fracking) b. Collapse Environmental risk (Fracking)	1 Low Risk to 10 High Risk	Likert Scale: Ordinal Data

14	Do you know which type(s) of fracking happens on your land or on land around you?			
15	"Fracking" is a way to extract natural gas and oil from shale rock deep underground. Based on what you have heard or read about fracking, how do you feel about it? (Check one option below.)	Conceptual Clarity (Fracking)	5= Completely agree 4= Agree 3= Neither agree nor disagree 2= Disagree 1= Completely disagree	Likert Scale: Ordinal Data
16	Based on what you have heard, read or know about fracking please evaluate the following statements: (Please check one box per row)			
16 a	*Fracking causes earthquakes*	Earthquakes	5= Completely agree 4= Agree 3= Neither agree nor disagree 2= Disagree 1= Completely disagree	Likert Scale: Ordinal Data
16 b	*Fracking uses too much water*	Water usage		
16 c	*I am concerned about the disposal of fracking waste water*	Wastewater disposal		
16 d	*Negative impacts (if any) of fracking in my region can be prevented if it proceeds carefully*	Caution		
16 e	*I worry there will be a catastrophic accident involving fracking which will cause irreversible damage to my community*	Irreversible damage		
16f	*Fracking should not be done anywhere near my house*	NIMBY		
17	In a typical week, how many days do you read the newspaper or news magazines?	Frequency (Print Media)	5= Everyday 4= at least 5 days, but not everyday 3= 3-4 days 2= one or two days 1= no days	Likert Scale: Ordinal Data
18	OPEN ENDED: Are there any newspapers or news magazines you read regularly? If so, please list them below:			
19	In a typical week, how often do you watch the news on TV?	Frequency (Electronic Media)	5= Everyday 4= at least 5 days, but not everyday 3= 3-4 days 2= one or two days 1= no days	Likert Scale: Ordinal Data

20	OPEN ENDED: Are there any news outlets on TV you follow regularly? If so, please list them below:			
21	How much do you trust the following sources for information about fracking?		5= Completely 4= Some 3= Very Little 2= No Trust 1= Unsure (original coding)	
			5= Completely 4= Some 3= Unsure 2= Very Little 1= No Trust (was recoded to maintain uniformity with other questions by statistical consultant.)	
21 a	*Oil and gas industry*	Industry		Likert Scale: Ordinal Data
21 b	*Federal agencies(EPA*, DOE**, DOI***)*	Federal agencies		
21 c	*State agencies (KCC****)*	State agencies		
21 d	*Universities*	University		
21 e	*Independent researchers*	Independent researchers		
21f	*Local environmental groups*	Environmental groups		
21 g	*Television*	Television		
21 h	*Newspapers*	Newspaper		
21i	*Magazines*	Magazine		
21j	*Radio*	Radio		
22	The state government has regulated this source of energy sufficiently:	State	1= True 2= False 3= Unsure	Nominal
23	The federal government has regulated this source of energy sufficiently:	Federal	1= True 2= False 3= Unsure	Nominal
24	Based on your thoughts and experiences, please check one box per statement in the appropriate column.			
24 a	*At my workplace, everyone's opinion is important to decisions*	Workplace_opinion (E)	5= Completely agree 4= Agree 3= Neither agree nor	Likert Scale: Ordinal

24 b	*Firms and institutions should be organized in a way that everybody can influence important decisions.*	Professional_opinion (E)	disagree 2= Disagree 1= Completely disagree	Data
24 c	*A person is better off if he or she doesn't trust anyone.*	Untrusting (F)		
24 d	*I don't join clubs of any kind.*	NoClubMember (F)		
24 e	*I would not participate in civil action groups.*	NoActionGrp (H)		
24f	*Important questions for our society should not be decided by experts but by the people.*	Expertsnotdecide (H)		
24 g	*My ideal job would be to have my own business.*	BOwneridealjob (I)		
24 h	*When I have problems I try to solve them on my own.*	Selfsolutionto-problems (I)		
25	In general, how do you consider your political approach?	Political inclination	5 = Liberal 4 = Somewhat Liberal 3= Moderate 2 = Somewhat Conservative 1 = Conservative	Nominal
26	How much or how little do you participate in your community?	Participation	1= I do not participate 2= I rarely participate 3= I sometimes participate 4= I frequently participate 5= I always participate	Likert Scale: Ordinal Data
27	Length of residence	27a. Residence years 27b. Grouping residential years		
28	OPEN ENDED: Please describe your community in a few words			
29	OPEN ENDED: What do you like most about your community?			
30	How would you evaluate the visual appearance of your community?	Visual appearance	5 = Very attractive 4 = Somewhat attractive 3 = Average appearance 2 = Not very attractive 1 = Not attractive at all	Likert Scale: Ordinal Data
31	How safe do you feel in your community?	Safety	5= Completely safe 4= Somewhat safe 3= Neither safe nor unsafe 2= Somewhat unsafe 1= Completely unsafe	Likert Scale: Ordinal Data

32	Do you agree with this statement: Community spirit is strong here.	SoCommunity	5= Completely agree 4= Agree 3= Neither agree nor disagree 2= Disagree 1= Completely disagree	Likert Scale: Ordinal Data
33	Do you agree with this statement: This community is where I belong.	PA	5= Completely agree 4= Agree 3= Neither agree nor disagree 2= Disagree 1= Completely disagree	Likert Scale: Ordinal Data
34	How important is the local natural environment to you?	Local Environment	5= Very important 4= Somewhat important 3= Neither important nor unimportant 2= Somewhat unimportant 1= Very unimportant	Likert Scale: Ordinal Data
35	OPEN ENDED: Is there anything you would like to change in your community with respect to fracking? If so, please list them below.			
36	In what year were you born?	Age group	Age Calculated and Categorized	Nominal
37	What is your gender?	Gender	1= Female 2= Male	Nominal
38	What is your racial or ethnic identity?	Race	1= White 2= Black 3= Hispanic 4= Asian 5= Native American 6= More than one ethnicity 7= Prefer not to answer	Nominal
39	What is your highest level of education?	Education	1= Less than high school 2= High school or GED equivalent 3= Some college 4= Associate degree 5= Bachelor's degree 6= Graduate degree	Nominal
40	In which industry are you currently employed?	Employment	1 = Agriculture 2= Federal/State 3= Education 4= Oil and gas 5= Meat packing 6= Retired	Nominal

			7= Not formally employed outside home (Student, retail) 8= Unemployed	
41	In which income range does your household fall into?	Income	1= Below $10,000 2= $11,000-$30,000 3= $31,000-$50,000 4= $51,000-$70,000 5= Above $70,000 6= Prefer not to answer	Nominal
42	What is your marital status	Marital Status	1= Single 2= Married 3= Divorced 4= Widowed 5= Domestic partner 6= Prefer not to answer	Nominal
43	Which state do you live in?	State	1= Kansas 2= Oklahoma	Nominal
44	Which County do you live in?			Nominal
45	OPEN ENDED: Are there any comments you would like to make?			

Appendix M - **Spearman Correlations between Different Variables and Perceived Environmental Risk**

Env'tl risk perception and factors	Q no.	Variable	Number of responses	ϒs Industry	Probability (Industrial)	ϒs Fracking	Probability (Fracking)
Awareness and Knowledge	Q4	Enough knowledge to drill	151	-0.73	<.0001	-0.79	<.0001
	Q11	Self-reported knowledge	157	0.08	0.3077	-0.09	0.2884
	Q15	Definition of fracking-support or oppose	159	-0.69	<.0001	-0.78	<.0001
	Q16 a	Earthquakes	158	0.62	<.0001	0.74	<.0001
	b	Water usage	157	0.54	<.0001	0.63	<.0001
	c	Wastewater disposal	157	0.62	<.0001	0.63	<.0001
	d	Caution	158	-0.58	<.0001	-0.58	<.0001
	e	Irreversible damage	158	0.68	<.0001	0.72	<.0001
	f	NIMBY	158	0.64	<.0001	0.72	<.0001
Community experience	Q26	Participation	158	-0.12	0.1591	-0.01	0.9124
	Q27	Residential length	167	-0.21	0.0107	-0.12	0.1376
	Q30	Visual appearance	157	-0.19	0.0219	-0.13	0.1060
	Q31	Safety	159	-0.29	0.0003	-0.22	0.0073
	Q32	Community Spirit	159	-0.18	0.0247	-0.22	0.0061
	Q33	Belonging	159	-0.23	0.0053	-0.19	0.0204
	Q34	Local natural environment	152	0.16	0.0608	0.19	0.0213
	Q17	Newspaper frequency	159	0.07	0.4040	0.08	0.3481
News Trust	Q19	News frequency	159	-0.13	0.1266	-0.08	0.3217
	Q21 a	O & G	157	-0.57	<.0001	-0.57	<.0001
	b	Federal	156	-0.03	0.7393	0.12	0.1576
Trust Regulation	c	State	158	-0.24	0.0029	-0.16	0.0491
	d	University	158	0.12	0.1350	0.15	0.0674
	e	Independent researchers	156	0.12	0.1324	0.11	0.1800
	f	Local	158	0.20	0.0151	0.27	0.0009

		Environmental Groups					
	g	TV	157	0.09	0.2714	0.22	0.0055
	h	Newspaper	155	0.11	0.1749	0.19	0.0189
	i	Magazine	154	0.18	0.0319	0.28	0.0006
	j	Radio	152	0.12	0.1537	0.16	0.0547
Worldviews	Q24 E	Egalitarian	149	-0.07	0.4004	-0.03	0.7051
	E	Egalitarian	156	0.18	0.0321	0.20	0.0122
Worldviews Political View Perceived benefits and drawbacks	F	Fatalist	157	0.11	0.1702	0.12	0.1465
	F	Fatalist	157	0.03	0.7602	-0.06	0.4936
	H	Hierarchists	156	-0.14	0.0978	-0.13	0.1260
	H	Hierarchists	156	0.13	0.1097	0.02	0.8005
	I	Individualistic	153	-0.30	0.0003	-0.29	0.0004
	I	Individualistic	158	0.01	0.9192	-0.07	0.4031
	Q25	Political approach	157	0.28	0.0006	0.35	<0.0001
	Q1 a	Truck traffic	155	0.26	0.0011	0.16	0.0520
	b	New business	156	-0.21	0.0105	-0.26	0.0013
	c	Local business losing customers	154	0.23	0.0052	0.18	0.0317
	d	New faces	154	0.07	0.4219	0.01	0.9173
	e	Discomfort with new faces	152	0.21	0.0113	0.20	0.0129
	Q3	Benefits outweigh risks	155	-0.62	<.0001	-0.61	<0.0001
	Q9 a	Creates jobs	156	-0.40	<.0001	-0.44	<.0001
	b	Quality of life	158	-0.59	<.0001	-0.59	<.0001
	c	Noisy	158	0.26	0.0016	0.19	0.0203
	d	Negative impacts	156	-0.41	<.0001	-0.44	<.0001
	e	Smell	156	0.43	<.0001	0.45	<.0001
Qualitative assessment	Q8	Feeling about HFDD in their community	153	-0.70	<.0001	-0.76	<.0001

Appendix N - **Interview Informed Consent: Kansas**

Living with Oil and Gas Development in Kansas

A Risk Perception Study among Adults

Consent for participation in Research Interview

Project name: Living with Oil and Natural Gas: A Risk Perception Study Among Adults in Kansas and Oklahoma

Funded by: Department of Geography, Kansas State University

Research Investigator: A. A. Ramekar (Graduate student)

Academic advisors: Dr. Lisa M. B. Harrington & Dr. Audrey A. Joslin

Purpose of the Research Project:
This study is being conducted by Avantika Ramekar, a graduate student in the Department of Geography, Kansas State University, as a partial fulfilment of requirement for the doctoral degree. The study will contribute to understanding of how individuals in local communities' experience industrial changes, as well as how industrial dynamics, life experience, and varied aspects of place (social, personal, environmental, and economic) affect their opinions.

Project description:
Extraction of oil and natural gas has occurred in Kansas for several years, and the energy industry is the third most important economic contributor in the state. With technological advances in directional drilling and hydraulic fracturing, this industry is rapidly growing in Kansas. The breadth impacts of this activity on the environment and human well-being are not completely understood. Moreover, the frequent changes in oil and gas prices make the stability of such a development challenging. This research is intended to help bridge gaps between local experiences and planning. A mailed survey has been completed, and this component of the research seeks to further explore some of those results by discussions with knowledgeable local representatives. You will be contacted later so that you can approve or modify transcripts of this interview, and to clarify any content we may have questions about.

Project procedures:
You have been asked to participate in this interview due to your knowledge and experience about this community. The Institutional Review Board (IRB) of Kansas State University requires interviewees to explicitly agree to being interviewed and know how the information contained in their interview will be used. The interview will take 30-45 mins. We do not anticipate that there are any risks associated with your participation, but you have the right to stop the interview or withdraw from the research at any time.

Questions or Feedback:
For any questions or feedback please contact Avantika Ramekar (avantika@ksu.edu or 8325425311) or Audrey Joslin (ajoslin@ksu.edu) at 1002 Seaton Hall, Department of Geography, Kansas State University, Manhattan 66502.

For any further concerns or clarifications about your rights as a participant you may contact the University Research Compliance Office at 785-532-3224 or fax at 785-532-3278 or by email at: comply@k-state.edu

Please indicate your approval of audio recording to ensure accuracy in reporting:

I do agree to audio recording ☐.

I do not agree to audio recording and prefer that information be recorded in note form by the researcher ☐.

Your signature below confirms your understanding of the study and agreement to participate. Please note there are two potential signature lines, and sign the appropriate one based on the level of identity protection you desire in written and oral reporting of the research project.

_____
Printed Name

Reporting may identify me by my professional role and county

(Specify role, such as planner or Extension agent: _____):

_____ _____
Participant's Signature **Date**

Reporting may NOT identify me by my professional role and county, but must be further generalized:

_____ _____
Participant's Signature **Date**

_____ _____
Researcher's Signature **Date**

Copies: *Once this has been signed by all parties the participant should receive a copy of the signed and dated participant consent form, and the information sheet. A copy of the signed and dated consent form should be placed in the main project file which must be kept in a secure location.*

Appendix O - **Interview Informed Consent: Oklahoma**

Living with Oil and Gas Development in Oklahoma

A Risk Perception Study among Adults

Consent for participation in Research Interview

Project name: Living with Oil and Natural Gas: A Risk Perception Study Among Adults in Kansas and Oklahoma

Funded by: Department of Geography, Kansas State University

Research Investigator: A. A. Ramekar (Graduate student)

Academic advisors: Dr. Lisa M. B. Harrington & Dr. Audrey A. Joslin

Purpose of the Research Project:
This study is being conducted by Avantika Ramekar, a graduate student in the Department of Geography, Kansas State University, as a partial fulfilment of requirement for the doctoral degree. The study will contribute to understanding of how individuals in local communities' experience industrial changes, as well as how industrial dynamics, life experience, and varied aspects of place (social, personal, environmental, and economic) affect their opinions.

Project description:
Extraction of oil and natural gas has occurred in Oklahoma for several years, and the energy industry is one of the most important economic contributors in the state. With technological advances in directional drilling and hydraulic fracturing, this industry is rapidly growing in the region. The breadth impacts of this activity on the environment and human well-being are not completely understood. Moreover, the frequent changes in oil and gas prices make the stability of such a development challenging. This research is intended to help bridge gaps between local experiences and planning. A mailed survey has been completed, and this component of the research seeks to further explore some of those results by discussions with knowledgeable local representatives. You will be contacted later so that you can approve or modify transcripts of this interview, and to clarify any content we may have questions about.

Project procedures:
You have been asked to participate in this interview due to your knowledge and experience about this community. The Institutional Review Board (IRB) of Kansas State University requires interviewees to explicitly agree to being interviewed and know how the information contained in their interview will be used. The interview will take 30-45 mins. We do not anticipate that there are any risks associated with your participation, but you have the right to stop the interview or withdraw from the research at any time.

Questions or Feedback:
For any questions or feedback please contact Avantika Ramekar (avantika@ksu.edu or 832542531) or Audrey Joslin (ajoslin@ksu.edu) at 1002 Seaton Hall, Department of Geography, Kansas State University, Manhattan 66502.

For any further concerns or clarifications about your rights as a participant you may contact the University Research Compliance Office at 785-532-3224 or fax at 785-532-3278 or by email at: comply@k-state.edu

Please indicate your approval of audio recording to ensure accuracy in reporting:

I do agree to audio recording ☐.

I do not agree to audio recording and prefer that information be recorded in note form by the researcher ☐.

Your signature below confirms your understanding of the study and agreement to participate. Please note there are two potential signature lines, and sign the appropriate one based on the level of identity protection you desire in written and oral reporting of the research project.

_____
Printed Name

Reporting may identify me by my professional role and county

(Specify role, such as planner or Extension agent: _____):

_____ _____
Participant's Signature **Date**

Reporting may NOT identify me by my professional role and county, but must be further generalized:

_____ _____
Participant's Signature **Date**

_____ _____
Researcher's Signature **Date**

Copies: *Once this has been signed by all parties the participant should receive a copy of the signed and dated participant consent form, and the information sheet. A copy of the signed and dated consent form should be placed in the main project file which must be kept in a secure location.*

Appendix P - **Interview Guiding Questions**

Interview Questions for Key personnel		
Topic	**Questions**	**Probes**
Introduction	1. Explanation of research project and consent to interviews	Ice-breaker, understand the position of the interviewee
	2. How long have you been in this community?	
	3. Can you tell me a little about your role [as _____]? How long have you been in this position?	
Role of office in community	4. How is your office involved with the community? esp. with respect to decision-making process	Understanding the role of the office in the community and its working: context
	5. What challenges have you faced working in the community, and how did you deal with them?	
	6. What are the main concerns you have had to deal with, with respect to this industry	
Community Involvement	7. Are there any citizen groups that were particularly involved in either supporting or protesting fracking in and around the county?	Evaluating the community's involvement and citizen action groups
	8. Do you find it hard to engage/involve certain groups?	
	9. What changes has the oil and gas industry brought to the community?	
People in small communities are particularly devoted to community affairs. Despite this, when asked to participate in surveys, I found that this county had _____ (high/low/medium) participation rate.	10. What motivates people to take part in (or ignore) such surveys?	
	11. Have there been other such attempts to gather public opinion? (if yes: by whom?)	
	12. What do you think contributes to people feeling the activity safe or unsafe?	
Trust	13. How would you describe your office's relationship with the community?	Determine if and how trust is built in the community and with how much success
	14. What sources of information do people generally trust for getting oil and gas industry news/updates?	Gauge if trust has been built between the office and the community to get oil and natural gas information.
Communicating Risk/ Information	15. How is information about the oil and natural gas industry communicated to the community?	Strategies for different types, catered to different type of audience?
What type of information is given to the community, lay v/s expert language	16. What kind of information is communicated to the community?	Legal, environmental, economic
	17. How does your office deal with unknown or ambiguous information regarding oil and gas industry?	
	18. Are there differences in how community members and experts talk about things with each other? [Do they try to communicate using different terminology?]	Expert V/s Lay, Conflicts and agreements
	19. Are there any differences in how your office and the overall community see risk?	Communication gaps