ADIYANA SHARAG-ELDIN, Ph.D. (December 2019) GEOGRAPHY

THE ROLE OF GEOGRAPHY SPACE AND PLACE IN SOCIAL MEDIA COMMUNICATION: TWO CASE STUDIES OF POLICY PERSPECTIVES (197 PP)

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The study of how space and place in geography intersect with social policy is still nascent but developing rapidly. As two exemplars of the potential that such research proffers, the objective of this research is to integrate the research collected during recent studies of fracking and the death penalty. The primary disciplinary value of this review is to demonstrate the spatial value of communication and social media studies. This study adopted a communication-based theoretical framework as a lens to guide methodological choices in analyzing public perceptions. The social media application from Twitter was used as the engine to capture opinions of social media users engaging public controversies. This review locates connections in the literature between geographers/spatial scientists and communication media theorists.

Keywords: fracking; death penalty; geography; space; place; social media; communication.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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CHAPTER 1: INTRODUCTION

1.1. Background

The use of the Internet became critical to many research fields in the early 1990s when user graphical interfaces of computer software became widely available and commercial interests were allowed to participate (Abbate, 1999; Castells, 2003). The Internet is capable of integrating modes of communication and forms of content, especially in testing social phenomena using diffusion of technology and its media effects (Dimaggio, Hargittai, Neuman, & Robinson, 2001).

The Internet as defined in this study is the electronic communication network that connects people to other individuals or organizations globally through computers and other mobile digital devices, allowing person-to-person communication and diffusing information (Castells et al., 2007). According to a recent survey by Live Internet Stats (Internet Users, 2016), the total world users of the Internet increased by 900% from the year 2000 to 2016. Proportional to the total population, China and India were ranked as the top two countries on the list while the United States ranked third.

In the US, approximately 89% of the population has access to the Internet. The rate of population's access to Internet shows a sharper increase compared to annual population growth (Internet Users, 2016). Internet usage is ubiquitous, especially in the United States where eight in ten people now go online regularly. In particular, the Internet has become a heavily used source for global news and information (Spence et al., 2006). Majority of Internet users are population

groups between 20 to 40 years of age (Zukowski & Brown, 2007). The number of consumers using the web in a year as news sources increased from 24% to 40%, overtaking the 35% news readers who rely on newspapers (Kohut & Remez, 2008).

As mobile devices such as smartphones and tablet computers become universal, the rapid increase in mobile data traffic has been experiencing an unprecedented tenfold annual increase (Choi et al., 2011). Furthermore, the digital lifestyle has evolved into a multi-device experience, with mobile devices playing a prominent role (Buyya & Dastjerdi, 2016).

One of the most popular uses of the Internet is in the electronic communication in a format of mobile text messages that are using Email and social media applications (Wellman & Haythornthwaite, 2002). Social media applications allow users to gain access to and rapidly diffuse information from (or around a specific location) and at a given moment for a related issue around the world.

The concepts behind social media networks are not new. Communicating, connecting, and developing relationships with one another is an intrinsic and adaptive component of human evolution. Online social media are complementing, and in some cases replacing, person-to-person social interactions and redefining the diffusion of information (Ratkiewicz et al., 2011). Such digital technologies have brought to us a new momentum for the users to make connections with other users of the Internet, particularly with homophilous network groups and users. Internet users may choose from a wide variety of the networking program applications appropriate for their activities (Kaplan & Haenlein, 2010). One of the more common social media program applications involves microblogging activities (i.e., Twitter, Snapchat, Instagram,

Pinterest) for sharing communication and information (Westerman, Spence, & Van Der Heide, 2012).

Microblogging is an increasingly popular form of communication on the web. It allows users to broadcast brief text updates of events or personal thoughts/opinions to the public or a selected group of contacts. The launch of Twitter in October 2006 was a revolutionary form of social media medium of communication (Bollen, Mao, & Pepe, 2011). The Twitter company has experienced a rapid global growth (Haustein et al., 2016). It is currently one of the world's dominating social media platforms that allow users to express their thoughts in a brief message. A Twitter user can create a short profile for self-introduction and choose a unique Twitter user's identification or alias.

The study by Bollen, et al. (2011) revealed that most posted tweets include daily chatter, informal conversations, information sharing, and news reporting. Although representing a broad spectrum of communicative uses, microblog posts in Twitter, commonly known as tweets, are less than 140 characters in length. Thus, they are extremely short in comparison to regular blog posts. Such communications offer several advantages for both user and researcher purposes. First, the Twitter network program provides information on the number of tweets user's followers and the number of people the user follows. Second, although most Twitter users are likely to think they are communicating exclusively to their followers, their communications are public domain.

Another advantage of Twitter is the ability of the program to track phrases, words in hashtags that are most popular and posted under the title "trending topics." The hashtag convention allows users to search for the word contained in tweets that feature a specific

character. Hashtags are denoted by special characters such as "#" for hashtags; "@RT" for retweeting other users' messages or @reply for replying to a particular user. These characters "#" and "@" allow senders to direct public messages to specific users or to other users that already follow the senders or to tweet users (Bruns, 2012). The most retweeted posts are about breaking news. The news media such as @CNN, @NBCNews, and @BBCWorld joined Twitter since the beginning of the Twitter operation. News stories are sometimes posted on Twitter before the news broadcasted on television as live breaking news (Kwak et al., 2010a).

The popularity of Twitter began to plateau in the third quarter of 2016, but it continues to offer significant opportunities for researchers to study human social behavior (Zhang, Zhao, & Xu, 2016). The advantage of Twitter is the option to collect the tweets the available Application Programming Interface (API) that allows users to access Twitter data. Users choose among various kinds of hashtags, and these hashtags often reflect communication representing actual human activities. The principle of homophily (i.e., similarity) facilitates the tendencies of people to interact and communicate their interests continuously with one another in ways that reveal significant patterns of human behavior patterns and activities. Intuitively, small units of characters in a text, short phrases, and "memes" act as signatures of the topics and events that propagate and diffuse over the web, from mainstream media to blogs, and vice versa (Leskovec et al., 2007). Such words or video clips should have an attracting expression in social media to reveal, instigate, and catch public attention. Examples for such phrases can be 'Brexit', 'Gangnam-style', 'death_penalty', or 'fracking.'

When words or images are forwarded, replied to, or retweeted to other users in high frequencies, they become memes. Richard Dawkins created the word meme from a Greek word

"Mimeme" to refer to small cultural units of transmission, analogous to genes, which are spread by copying or imitating the original phrases or words (Dawkins, 1976). He described a meme as 'a unit of cultural imitation' (Grafen & Ridley, 2007). A meme is defined here as a unit of information that is spread (i.e., reproduced with some degree of fidelity, or diffused) from person-to-person in a high frequency through a social network. Once a meme is identified, it can be used to classify different types of social phenomena (Kwak et al., 2010a). Most memes go only retweeted once or twice in a social network. However, memes that are spread widely can be said to be "viral" in their diffusion pattern (Weng et al., 2012). Virality is a communication phenomenon in which thousands to millions share a meme over a relatively brief interval of time (Stroud et al., 2015).

Memetics has the potential to represent a primary unit and the process of social change (Johnson, 2007). The functional utility of memetics provides a productive theoretical challenge as well as being used as a methodological tool (Spitzberg, 2014). This study applies memetics in communication theory and geography to explore the meme's function as a productive concept for the analysis of a contemporary phenomenon: specifically, "fracking", "death_penalty."

I am using the meme from a hashtag word "#fracking" in the first case study to track the public opinion on the fracking phenomenon in Ohio, and "#death_penalty" in another case study to investigate the opinion of the American people on the capital punishment. For the death penalty research, I used the hashtag "death_penalty" to capture people's opinion on the practice of sentencing capital punishment with lethal injections or electric chair executions in major states.

The word “fracking” generally carries negative connotations related to environmental destruction and health issues. This word is popular to use by anti-fracking activists, or fracktivists (Rabalais, 2015). In contrast, the supporters for fracking prefer to use other terms such as “natural gas,” “natgas,” “shale oil,” and “shale gas” (Dyni, 2003). For coding purposes in this study, I used “+”, or a “plus sign”, for all statements supporting fracking, a “-“, or a “negative sign”, for all statements condemning fracking (“-1 “), and zero (“0”) for all other neutral or unrelated text comments to fracking. Users’ attributes in this study range from political groups and individuals with strong political agendas to citizens with marginal views. The majority of Twitter users who expressed their opinions related to fracking may be influenced by direct exposure of fracking practices or spread the news to each other through the social media communication (Watts & Dodds, 2007). There are many modes of communication about public policy, but tweets may provide at least one potentially indication or bellwether of public sentiment, and a potential politically mobilizing force of social influence.

According to early founders of communication theory, Elihu Katz and Paul Lazarfeld (Katz & Lazarsfeld, 1955a), a small minority of “opinion leaders” (actors) act as intermediaries between the media and the majority of societies (Elihu Katz & Lazarsfeld, 1955a). This study focuses on the analysis of the opinion leaders’ roles in meme diffusion in attempting to influence public opinions on the fracking phenomenon. According to Cha et al. (2010), a small number of opinion leaders can be identified based on their viral campaign that reaches a broad audience (Cha, Haddadi, Benevenuto, & Gummadi, 2010). In a digitally networked society, the social power of opinion leaders is primarily exercised by and through Internet networks (Castells, 2011). These networks are avenues through which opinion leaders can exert influence through

forums and opportunities for interaction with other social network users (Everett M. Rogers, 1983).

In this research, I apply the multi-level communication framework theory that is called the Multilevel Model of Meme Diffusion (M^3D) (Spitzberg, 2014) to explain the role of actors in meme diffusion. There are two case studies presented in this research, the main work of research is concerning with the fracking operation in the United States. The second case study is the analysis of public perception on the death penalty. Both case studies apply the M^3D model as a conceptual framework of adaptive social features in dynamic networks through which memes propagate (Figure 1.1). The model hierarchically organizes five levels of factors predicted to influence meme diffusion, ranging from elements of the meme-level or message itself, the actor-level, the social network level, the societal-level, and the geotechnical-level. In this perspective, diverse sets of actors (the social network term for opinion leaders), can arise at the individual level (e.g., celebrities, politicians, etc.), the social network level (e.g., liaisons, high centrality actors), groups or institutions (e.g., news media networks, governments agencies), and geotechnical (e.g., infrastructure technology, proximity influences) in predicting public opinion diffusion related to human interaction and environmental concerns (Spitzberg, 2014).

This study adopts the M^3D theory as one of the methods for analyzing the role of actors that influence public opinions through meme diffusion over fracking controversy. In general, actors who are competent, credible, attractive, and have the ability to produce memes are likely to be replicated widely (Spitzberg, 2006). The M^3D theory suggests that the popularity of actors is one of the major factors in the process of diffusion as shown in a theoretical framework in Figure 1.1 As an example for the actor's role in influencing public opinion, I used the public

reaction from the movie "Gasland" (Fox, 2010). The director, Josh Fox and his company, the Fox Company LLC, featured a landowner who had flammable tap water. The image of flammable tap water was very striking to the audience, as seen in Figure 1.1, showed a contaminated tap water that was on fire. This image is reflecting one of the meme-level features of M^3D—distinctiveness. This image also sends a warning message that fracking could cause an environmental hazard (thereby capitalizing on another M^3D level of societal groups and frames already in place seeking to influence public sentiments and policies regarding energy and the environment). In this case, the actor created the word #fracking as a set of dangerous activities that relate to ecological disasters.

In contrast, the supporters for fracking are led by different actors identified commonly as the natural gas and oil companies, Marcellus and Utica shale gas companies, government officials, and some political figures who prefer to use different sets of keywords for hashtags (such as #natural_gas, #natgas, and #shale_oil). The supporters for fracking generally avoid using the word *"fracking"* since the word has taken on a negative connotation (Rabalais, 2015). In this case, I distinguished the texts by words and phrases chosen by the tweeters based on the hashtags and the articulation of the text messages posted on Twitter. Stakeholders (Ladd, 2013) and other actors can influence human consciousness by the transfer of communication in social networks. The more popular an actor is at attracting an audience in the social network, the more power can be wielded in meme diffusion (Wellman & Haythornthwaite, 2002; Zhao, 2006).

The second case study, which was on the death penalty, was triggered by the event when the State of Nebraska repealed the capital punishment in May 2015. This decision was challenged by supporters for the death penalty who initiated to collect signatures for ballots to

reinstate the death penalty in the November 2016 election (Connor & Chuck, 2015). This study analyzes the opinions from the tweets posted in Nebraska from 19 May 2015 to 31 December 2015, using the hashtag #death_penalty. This study also analyzes the geographic distribution of opinions on death penalty. Figure 1. 1 Flammable tap water from fracking contaminated water meme

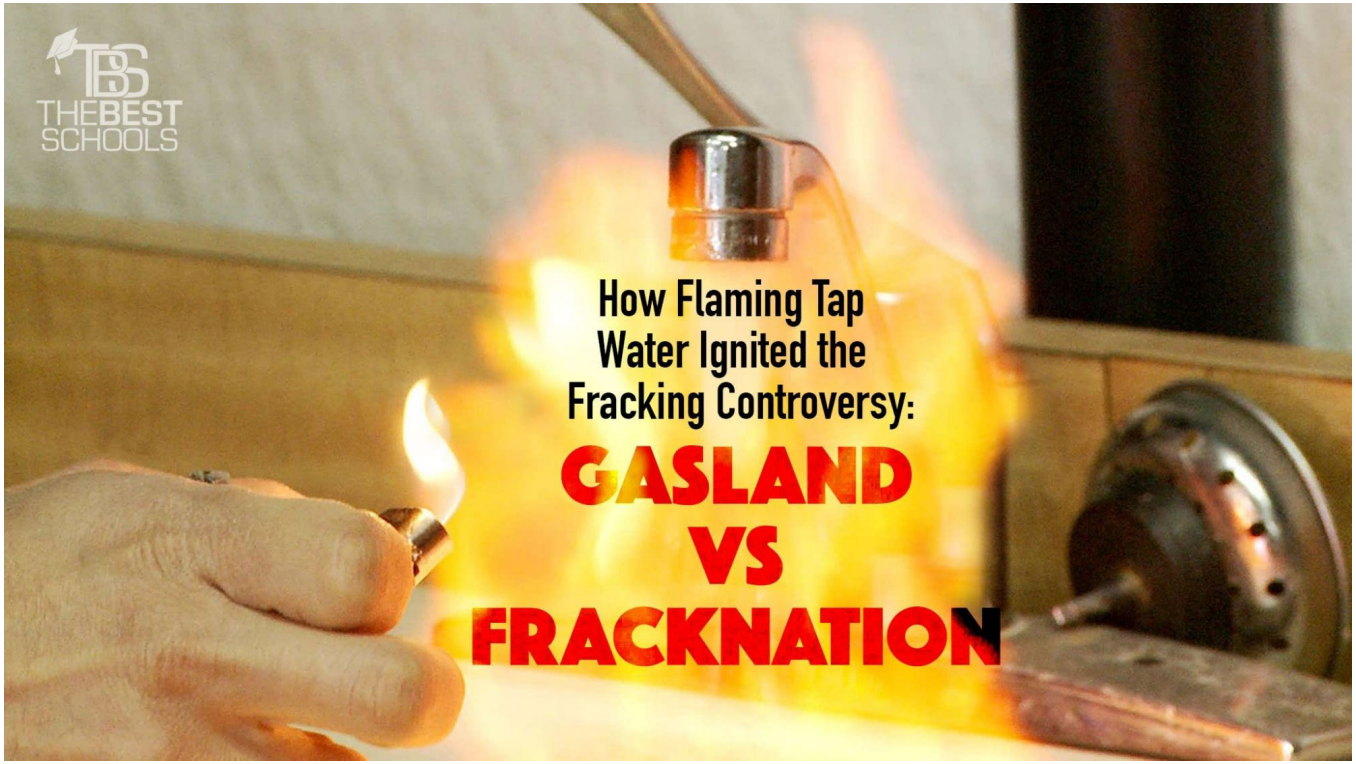

Figure 1.1 Flammable Tap Water from a Faucet ignited by a Lighter

Source: https://res.cloudinary.com/highereducation/image/upload/c_fill,f_auto,fl_lossy,q_auto/v1/TheBestSchools.org/gasland-vs-fracknation.jpg

A theory integrated into the M^3D is the framing theory (Entman, 1993), which is applied mostly to the Meme Level and the societal level. When oil companies spent millions on ad campaigns to frame themselves as environmental stewards, they were framing the fracking issue without saying a word specifically about fracking. On the other hands, actor popularity operated primarily at the Source Level. However, it has implications for the structural and subjective social network levels—highly credible actors are often at highly central positions of social networks, and often attract like-minded adherents through subjective homophily influences.

A frame is a context in which a message is presented in Figure 1.2 in the next page. The M^3D framework shows the hierarchical ranking of the memetic objects as (a) meme: the nature of the meme itself; (b) actors: characteristics of individual or groups/institutions who created the meme; (c) social networks: acceptability of the individual or groups in social network to introduce the meme; (d) institutions (State or Local Government): contextual and societal features that shape the microlevel process of meme diffusion; (e) externalities: geospatial, technical, and external factor to establish the outcome of the meme (Dinh, Lao, & Skurka, 2016; Spitzberg, 2014). For example, on the fracking case study, fracking operations can be presented as a source for economic benefit or as environmental degradation (Jill E. Hopke & Simis, 2017; Hough, 2015; Williams, Macnaghten, Davis, Curtis, et al., 2015).

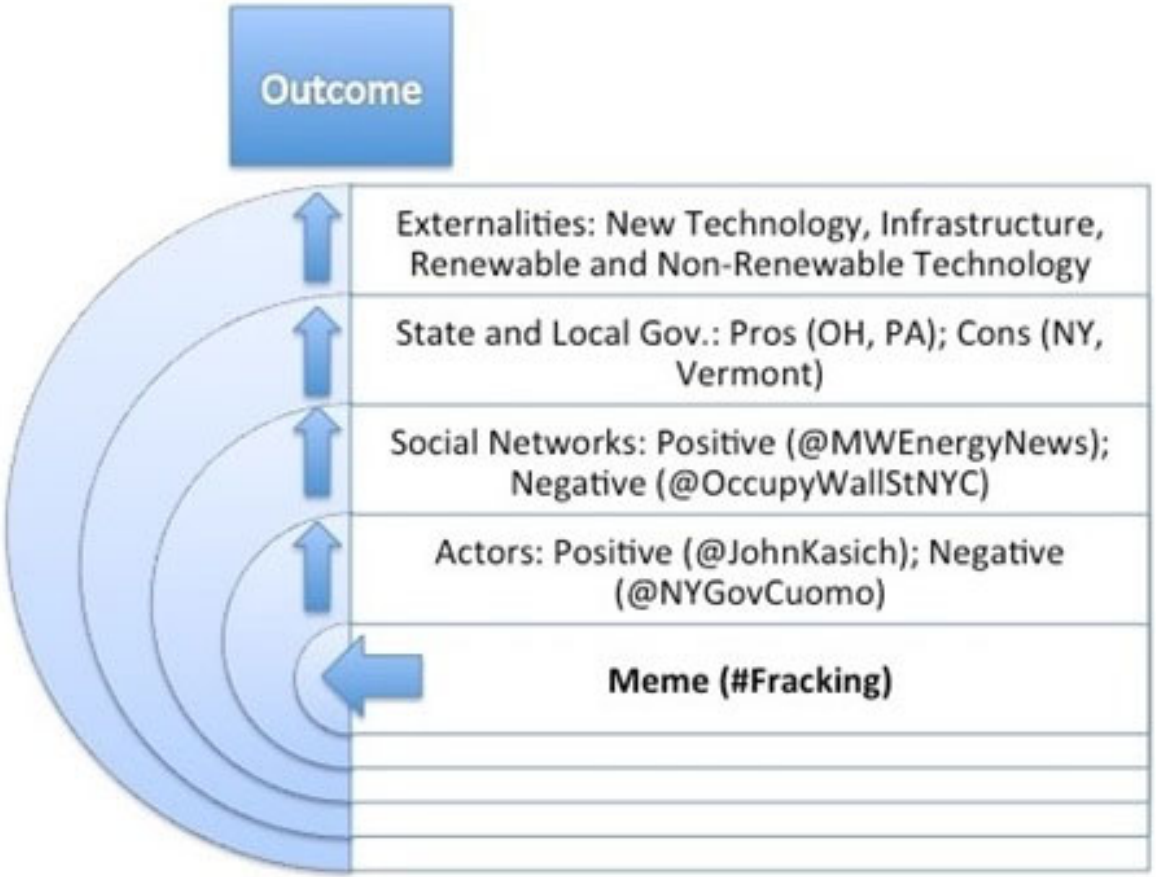

Figure 1.2 Application of the M³D Communication Theory Framework

M^3D theory also incorporates innovation diffusion theories to describe the velocity and span of meme spreading in any given population. In this way, social media provide near real-time access to monitoring and registering social opinion trends. This method integrates the fields of geography (Adams & Jansson, 2012) and computer-mediated communication technology (Spitzberg, 2006) to predict how social phenomena change and evolve (Spitzberg, 2014). The advantage of using Twitter data is the ability of tweets to provide information with georeferenced and time-stamped information that supports the application of geographic information systems (GIS) as planning and decision-making tools (Andrienko et al., 2013). The connection between the communication technology and geographical spatial-temporal theory through social media data attributes will be described in the next chapter.

Although in past decades, social media digital data were still relatively unfamiliar and infrequently used in research methods, many contemporary studies have applied social media data in a variety of contexts (Barnes & Lescault, 2012; Siverman, 2016), including topics related to emergency disasters (Gao, 2011; Mills et al., 2008), political revolutions of the Arab uprisings (Khazraee & Unsworth, 2012; Spitzberg et al., 2013), and public controversies (Johnson, 2007; Spitzberg, 2014).

The fracking phenomenon represents an important context for social measurement of diffusion given its intersection of environmental, public health, economic, and political pressures (Cotton, 2015; Hough, 2015). In this case study, the public controversy captured in social media is the topic of analysis in tracking the meme diffusion by opinion leaders. The supporters or pro-fracking groups argued that fracking generated jobs and increases the supply of natural gas oil (Shafiee & Topal, 2009) that led to economic growth (Boudet et al., 2014). On the other hand,

the opponents for fracking, or anti-fracking groups, had focused their campaigns on the impact of drinking water contamination (Osborn, Vengosh, Warner, Jackson, & Pearson, 2011) and earthquake activities (Ellsworth, 2013; Skoumal, Brudzinski, & Currie, 2015; Q. Wang, Chen, Jha, & Rogers, 2014). Public debates on fracking are likely to be waged in part through social media, and a better understanding of such processes may significantly advance public and policy insights into the phenomenon (Sadasivam, 2014).

The natural gas and oil industry have been in active operation since the 1850s with the discovery of oil in Pennsylvania that changed the economic development in the Midwest of the United States (Hughes, Dudley, 1993). However, the exploration of natural gas using a method of horizontal fracking the earth's shale started only in the early 2010s (Rinfret, Cook, & Pautz, 2014). As with most significant environmental issues, geography plays a significant role in public reaction (Dokshin, 2016). The geographic locations of this case study will take place in the contiguous United States, with attentions on some areas with direct involvement with the fracking operation, such as:

- St. Tammany Parish in Louisiana (Rabalais, 2015)
- Kern County, CA (Onishi, 2014; Rowe, Klocek, & Garcia, 2016)
- South Central Oklahoma Oil Province (Ramsey, 2014)
- Washington County, Pennsylvania (Baen, 2008; Lokke, Kolbert, & Berman, 2011; Meng, 2015)
- Texas (Rahm, 2011)
- West Virginia (Higginbotham, Pellillo, Gurley-Calvez, & Witt, 2010)
- New York (Christopherson, 2011)
- Eastern Ohio (Weinstein & Partridge, 2011)

Each of these locations has a different characteristic and attitude toward fracking captured from the public opinions posted on Twitter. For example, in Youngstown, a rural community in Ohio, the community embraced fracking as a way to support their economy through the expectation of job creation (Zremsky, 2014). On the contrary, the City of Athens, Ohio, a small university college town community, approximately 200 miles from Youngstown, resisted fracking, prohibiting it within their city boundary (Arenschield, 2014). Such geospatial differences proffer a unique perspective until now, largely ignored by social media analyses on the topic of fracking (J. E. Hopke & Simis, 2016). To the extent that former Speaker of the House of Representatives, Tip O'Neill was correct, that "all politics is local," the geospatial dimension of policy-oriented social media was essential (Krause et al., 2014; Obach, 2015; Pearce, Holmberg, Hellsten, & Nerlich, 2014; Vasi, Walker, Johnson, & Tan, 2015).

The objective of this research is to integrate the data collected from social media Twitter during recent studies of fracking and the death penalty. The popularity of global web technology and digital media creates new opportunities for networking power dominated by actors (Castells, 2009). Actors exercise influence on human interests through their norms of social media inclusion and exclusion. The role of actors used by the political parties in the presidential campaign sought to diffuse their political agendas through the social media and traditional media of radio and television (Tumasjan, Sprenger, Sandner, & Welpe, 2010).

The use of microblogging messages posted by actors has been shown to be a valid indicator of human emotion expressed in Twitter messages, in at least some contexts. Research indicates that public moods tend to correspond to public events (Bollen et al., 2011). An analysis of the Twitter actors over fracking sentiment demonstrates close correspondence of the

individual's attitude supporting or opposing fracking (Mahmud & Gao, 2014), which found that Twitter account users' messages related to "fracking" corresponded to the users' sentiment strength. In their study, Mahmud & Gao found positive correlations between sentiment polarity and retweet rates. This indicates that followers who express similar sentiment of the hashtag are also more likely to retweet messages generated by the actor.

The data collected via using Twitter API contains recoverable online conversations, information sharing forums, news commentary broadcasts, and social media news circulation. This study utilizes the feature of "retweeting" (@RT) and hashtags (#) as simple yet powerful mechanisms to detect information diffusion through data mining. Twitter is an ideal platform for users to spread not only information in general but also awareness of environmental phenomena. Twitter and other social media applications are used as propaganda machines to seek public agreement with particular causes, as well as to reinforce certain political opinions or values in general (Stieglitz & Dang-Xuan, 2011), and fracking in particular (J. E. Hopke & Simis, 2016; Jill E Hopke, 2015; Pearce et al., 2014).

I use public profiling method developed by (Longley, Adnan, & Lansley, 2015) to analyze the characteristics of the individual actors (Longley & Adnan, 2016). This method uses the geo-temporal Twitter demographic to develop the relationship between Twitter users and their surrounding demographic environment. Once an actor is identified by username, age, gender, geographic location, and time-stamped and occupation, it is analyzed for the stance of the actor's text messages and their target audience.

1.2. Research Objectives

In responding to the research topic, the overreaching goal of this dissertation is to contribute to the epistemology of how information and ideas posted by social media users spread over time and space. Such knowledge can be used in social research.

In this context, the research questions are identified in two research topics:

RQ1: What is the role of geography in the process of disseminating social media information?

RQ2: How can the influence of posted messages in social media affect the state's policy on controversial public debates?

To answer the first research question (RQ1), two different case studies are presented to analyze the process of information diffusion from the hashtag keywords captured from Twitter. The second research question (RQ2) is presented in the spatial statistical distribution of each case studies to test the spatial autocorrelation in the state levels.

Scholars have sought to expand the use and the mining of social media data on a variety of research topics (Earl & Kimport, 2008; Spitzberg, 2014). As the size and complexity of datasets become increasingly overwhelming, specific data analysis and visualization approaches have become necessary to focus on a particular topic of research. The social media platform such as Twitter offers sources of "big-data" through which theories of computer-mediated communication can be tested (Dinh, Luo, & Skurka, 2016).

1.3. Dissertation Synopsis

After this overall introduction in this chapter, this dissertation is structured with three individual but interrelated research articles (chapter 3, 4, and 5). A conclusion chapter with summaries and discussions of future works is given as Chapter 6. The remainder of this dissertation is organized as follows.

Chapter 2: Literature Review and Methodology

This chapter explains inter-relationship between communication field and geography. Communication theory and geography are two academic disciplines that share a border where interdisciplinary activities constitute fecund opportunities at their intersections (Adams & Jansson, 2012). Lefebvre (1974) revealed the connection between communication theory and in his significant definition of space and time. In his book, Lefebvre suggested the 'representation of space,' or the social space of communication, is occupied by artists, writers, and philosophers. Today, the space of communication shared by the Internet bloggers, celebrities, and political figures.

This chapter also explains the theoretical framework and the methodology as applied in this research. An adaptation of the framework from communication theory is used to track the replication of memes with the specific hashtags commonly mentioned by the social media users. The first study on fracking uses the hashtag "#fracking" to capture the public posted twitter. The death penalty case study uses hashtag "#death_penalty" to track the public opinion on the death penalty.

Chapter 3: The role of space and time in social media communication: two case studies of policy perspectives

This chapter presents two case studies that explain the role of geography's space and time (spatiotemporal geography) in social media communication. The social media application from Twitter is used as the engine to capture opinions of social media users engaging public controversies. This review locates connections in the literature between geographers, spatial scientists and communication media theorists.

Chapter 4: Multilevel model of meme diffusion of fracking through Twitter

This chapter explains the adaptation of the communication framework theory M^3D in human geography in an empirical case study of the fracking controversy. This case study integrates the fields of geography and computer-mediated communication technology to account for social processes.

Chapter 5: Analyzing public opinions on death penalty abolishment

The objective chapter is to demonstrate that an Internet-based study using social media data can be used to analyze and predict social processes engaging with phenomena in real space. The M^3D theory integrates the fields of geography and computer-mediated communication technology to explain and predict public opinion on the death penalty.

Chapter 6: Findings and conclusions

After addressing the theoretical and broader contributions from the three research articles, this last chapter concludes the research by presenting findings and outlining some directions for prospective future research in the domain of geography and social media.

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CHAPTER 2: CONNECTING COMMUNICATION THEORY AND GEOGRAPHY

2.1. Research Background

Communication theory and geography are two academic disciplines that share a border where interdisciplinary activities constitute fecund opportunities at their intersections (Adams & Jansson, 2012). Lefebvre revealed the connection between communication theory and in his significant definition of space and time (Lefebvre, 1974). In his book, Lefebvre suggested the 'representation of space,' or the social space of communication, is occupied by artists, writers, and philosophers. Today, the space of communication shared by the Internet bloggers, celebrities, and political figures.

Another geographer Adams and Jansson (2012) argued that the social space of communication represents places in media as abstract, theoretical, and production-oriented spaces involving the formal plans and abstract blueprints of powerful actors whose formalizations of space control actions. Similarly, Yi-Fu Tuan, a human geographer, argued that space and place are virtual areas we come to know and visualize instead of being at a fixed location (Tuan, 1977). ''Place'', according to Tuan, captures the idea of deeply layered subjective experience grounded in the particularity of local conditions and discourses, whereas ''space'' implies potential as well as the actual movement of bodies, goods, capital, information, and communication (Edwards & Usher, 2000a).

This study connects multiple disciplines, including Geography, Geology, Sociology, and Communication. The link to geography is focused on human geography with special emphasize on the traditional role of communication in exerting and legitimizing political and economic power at various scales on the fundamental concept of space and mobility (Harvey, 1992; Sassen, 1991, 2005; Scott, 2011). Communication and geography theories are co-evolving that account for the role of mediated communication in society (Couldry & Hepp, 2013; Hampton & Ling, 2013; Spitzberg, 2014). Developments in social media communication, Internet technology and computer applications in the social media make online data mining possible. These developments represent a breakthrough for Internet users, including access to data in real-time and worldwide coverage. Such data have been used in the emergency disaster response (Comfort, Oh, Ertan, & Scheinert, 2010; Curtis, Mills, & Leitner, 2007), social movements (Earl & Kimport, 2008; Nagel et al., 2013), and terrorism studies (H. Chen, Reid, Sinai, Silke, & Ganor, 2008).

In another development in computer technology, Internet access and social media support the general public as a platform for expressing an individual's opinion. Media-based research on environmental issues has followed the same path as that of communication research and technology (A. Hansen, 1993). The controversial issue of fracking in the political agenda serves as an exemplary canvas upon which public attitudes are written in online and social media messaging and other traditional news media (Grubert, 2016; Jill E Hopke, 2015; Hough, 2015; Pearce et al., 2014; Williams, Macnaghten, Davis, & Curtis, 2015).

Recent studies found that social media may influence personal opinions and may also represent public perceptions on social issues (Büscher, 2016; Lineman, Do, Kim, & Joo, 2015;

Mohammadi, Wang, & Taylor, 2016). Most opinions do not appear to be formed in a purely rational process. Some studies found that people formed and expressed their opinions of friends or opinion leaders such as prominent people, celebrities or politicians (Ledbetter & Redd, 2016; McCormick, 2016; Nisbett & DeWalt, 2016). Such prominent people or groups of people with large numbers of followers are labeled "actor(s)" in social media. According to Noelle-Neumann (1974), people learn about public opinions from media coverage especially when the news contain contradictions or ambivalent information (Noelle-Newman, 1974).

This study analyzes the public perceptions about fracking issues with a focus on the level of support or opposition from people whose lives are affected by fracking operations (Charles Davis & Fisk, 2014). The use of hydraulic fracking technology uses high-pressure water and chemicals to crack shale and pressure the trapped gas and oil deposits into extractable form. The resulting toxic wastewater has to be sequestered, and this sequestration usually involves the injection of the water into the earth. Fracking has increased the domestic production of natural gas and jobs over the past few years (Shafiee & Topal, 2009). However, it has become an increasingly controversial debate and resulted in public concerns about the drilling impacts on environmental quality and public health (J. E. Hopke & Simis, 2016; Pearce et al., 2014; Simonelli, 2014; Williams, Macnaghten, Davis, & Curtis, 2015; Williams, Macnaghten, Davis, Curtis, et al., 2015).

The opponents for fracking, or anti-fracking groups, have focused their campaign on environmental impacts, public health, and earthquakes problems. Some studies showed that fracking is linked to drinking water contamination and earthquakes incidents (Durfee, 2014; Mitka, 2012; Myers, 2012; Osborn et al., 2011). The massive operation of fracking requires

staggering two to four million gallons of water for a single lateral well, and 15,000 to 60,000 gallons of chemicals. This quantity of water is multiplied by the number of wells drilled at one site to sum up the amount of water required for a given operation. Transporting both the liquids to be injected and extracted involves fleets of tanker trucks and large storage containers (C. Mooney, 2011). In the United States, fracking is prohibited in three states, New York, i.e., Delaware, and Vermont, due to the risk of contaminated drinking water (Boersma & Johnson, 2012).

On the other side of this controversy, a media campaign has been devoted to cover both the economic benefits of fracking and its cleaner technology in comparison to coal-based industries (J. M. Jones & Ones, 2016; Kiger, 2014). State policymakers and shareholders have attempted to reconcile drilling practices with oil and gas statutes that were enacted before the emergence of environmental policy concerns (Charles Davis & Fisk, 2014; Fisk, Davis, & Cole, 2017).

Several studies have begun to investigate the economic impact of fracking. At the beginning of the 2010s, in a depressed economy like Ohio during the recession years, economic development and job creation from shale exploration and production were considered a significant employment opportunity. Research indicates Ohio will need to continue to make economic reforms if it is to prosper in the long term because no one industry—in this case, energy development—can be its long-term savior (Weinstein & Partridge, 2011).

Other studies have examined employment growth generated by the Utica shale well drilling (Hill & Kinahan, 2013), and the job prospect of shale development in Ohio. In 2014, the development of the Utica shale formation was estimated to have contributed almost $5 billion to

the gross state domestic product (A. R. Thomas, Lendel, Hill, Southgate, & Chase, 2012). Findings from the Ohio study estimated the fracking industry would employ 1,500 jobs for engineers and architects and 1,000 jobs for environmental technicians.

Research estimates that mining counties have had considerably faster growth in per-capita income relative to those in comparable non-drilling jurisdictions. The income and benefit came from royalties or lease payments and the high wages in the industry. In manufacturing-heavy states like Ohio, the unemployment rate shrank from above the national average in most years, to a point below the national average in August 2012 (7.2% vs. 8.3%) (Throupe, Simons, & Mao, 2013). This study estimated the Marcellus and Utica Shale plant would create 40,000 jobs and $14 billion in tax spending for the next four years statewide (Weinstein & Partridge, 2011).

Other fracking-related studies in Ohio focused on earthquake incidents that were induced by hydraulic fracturing in Poland Township, Mahoning County, Ohio. This study identified approximately over 70 earthquakes with magnitudes between 1 and 3 on the Richter scale in the area that occurred between March 4 and 12, 2014 (Skoumal, Brudzinski, Currie, & Levy, 2014). In another study, the same authors mentioned a series of earthquakes in Youngstown in 2011 with a magnitude of 3 on the Richter scale. This series was correlated with a large amount of wastewater injection in a well located approximately 18 km to the northwest of Youngstown (Skoumal et al., 2015). It should also be noted that there are other series of earthquakes attributed to fracking operations in Mahoning County, Ohio (Holtkamp, Brudzinski, & Currie, 2015; J.-W. Kim, 2006; Zoback & Gorelick, 2012).

Given the intersection of environmental, economic, and political interests in the fracking issue, this study focuses on the role of opinion leaders, stakeholders, or actors in indexing public opinion. The actors are identified from the hashtag keywords that distinguish the actors as either pro-fracking (#natural-gas, # shale-oil) or anti-fracking (#fracking). The pro-fracking groups include the individuals or groups associated with the government, regional economic development, and natural gas and oil companies. The anti-fracking groups consist of environmentally concerned groups, universities, and research groups. The research design of this study and its methodology are explained in the next section.

2.2. Research Design

This study applies a quantitative research method to respond to qualitative data input in examining topics in social media controversies. The initial data collection process started in November 2015 by collecting Twitter data with hashtags #fracking. The fracking database was accumulated from the raw tweet data with over 56,000 data points. For the death penalty case study, the data with hashtag #death penalty was provided by the Department of Geography at San Diego State University through a collaboration with the Department of Geography at Kent State University. The Death penalty data points contain a big data with 586,945 geocoded data recorded from 5/19/2015 to 12/31/2015.

The next step in the study is coding the database using familiar words or phrases to identify the tweet users' opinions regarding the fracking debate. In the next step, I focus on the group of tweets with a large number of retweets (RT @) and tweets sent by the same users (i.e., identified by the same @username). This grouping of tweets is a preliminary step to identify the actors or opinion leaders and their account profile data information. The next step, I use a

sentiment analysis to describe the users' opinion, sentiment, and subjectivity posted in the subjectivity in the text as a direct response to fracking interest (Kumar & Sebastian, 2012; Pang & Lee, 2008).

Figure 2.1. shows the process flow chart of data analysis from the gathering of the initial tweets raw data as public information to compiling it into the database. The next process is to sort the data and code the texts based on the words mentioned in the texts. Then, I develop and use Python programs to identify usernames and user locations. The data points with it longitude and latitude information are then uploaded to GIS program to map the locations of the user accounts that posted the tweets. I use spatial analysis and statistical analysis to check the imbedded relationships between the observed data and current policies in the United States.

2.3. Data Collection

The primary source of data for this dissertation research was Twitter data related to fracking, and their environmental issues from the period of November 2015. The database contains over 20,000 data points with the study area covering the contiguous United States. The data mining procedure uses Twitter API with hashtags #fracking that were geocoded using user's profile. Table 2.1 shows an example for data summary from the preliminary data downloads from November 2015 to November 2018.

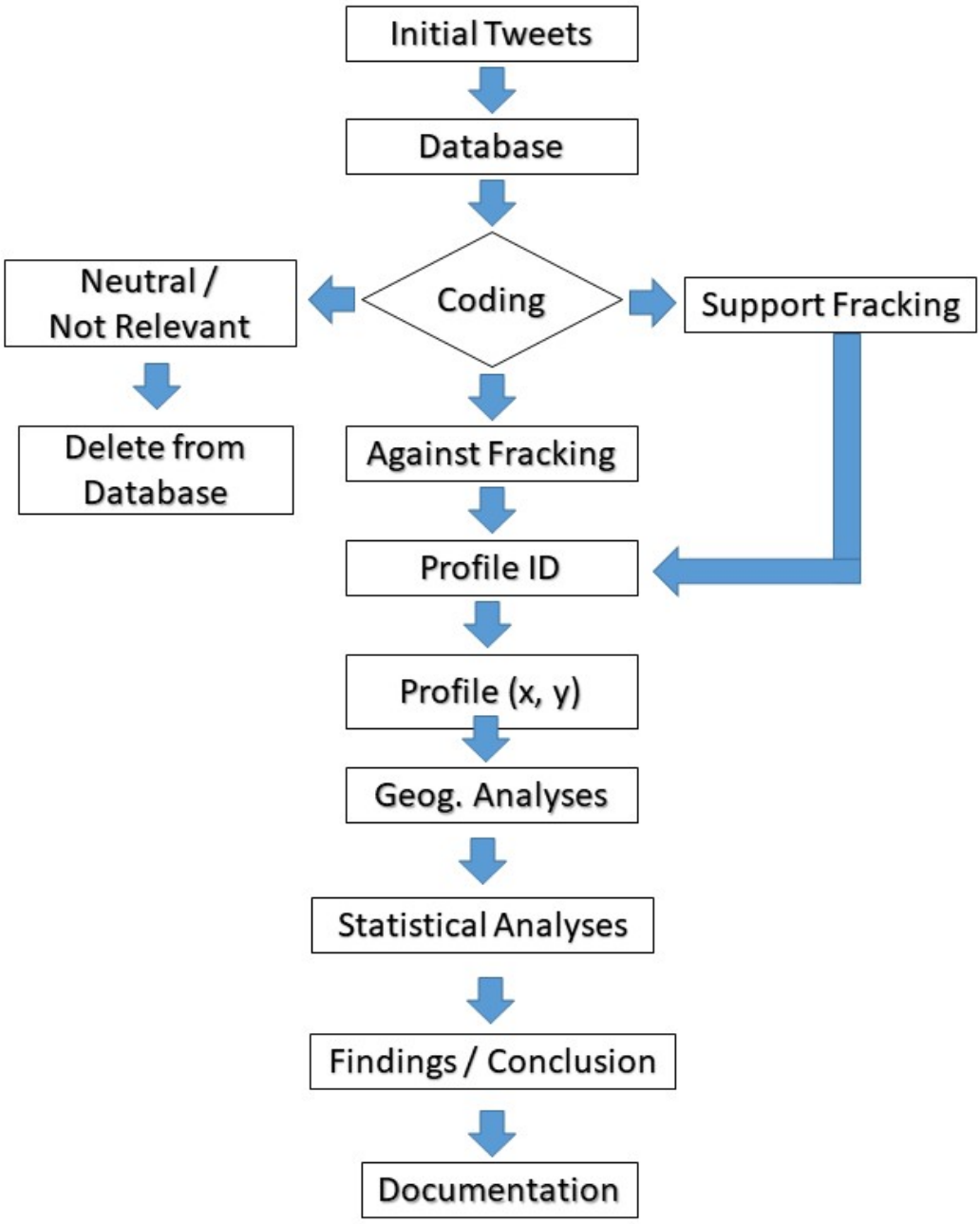

Figure 2.1 Flowchart of Data Analysis Process

Table 2.1 Example of Actors and News Media Twitter Users

Date (the posted time)	4/11/2015	11/12/2015	11/2/2015
Username	Ian Somerhalder	Cher	NBC News
Twitter Username	@iansomerhalder	@cher	@NBCNews
Occupation/Status Org.	Actor	Actress	News Media
Number of Tweets/Retweets	953	476	210
Community affected	St. Tammany, LA	Oklahoma	Generic
Support Fracking	No	No	No
Against Fracking	Yes	Yes	No
Economic benefit	No	No	No
Jobs creation	No	No	No
Energy sources	No	No	No
Earthquakes	No	Yes	No
Groundwater	No	No	No
Methane	No	No	No
Health hazard	No	No	No

The first batch of data collected in the first week of November 2015 contains over 56,000 worldwide tweets, using a hashtag #fracking. From these tweets, I identified 34,000, or 60%, of the entire data set as forwarded tweets or retweeted (RT @) information from other users. The information of an actor is included on Twitter as the user profile with information and identification of Twitter's users.

Table 2.2 shows some examples of actors' identification ranked by the numbers of retweeted messages captured from the first batch. In this study, I identified the retweets from the database and computed how many times each tweet was retweeted. The list in Table 2.2 showed the current descriptions of selected tweet users whose posted tweets with #fracking have been retweeted more than a hundred times for further analysis (this information was updated in September 2018).

Table 2.2 Actors Description and Number of Followers

User ID	Retweets #	Description	#Followers
@iansomerhalder	868	Ian Somerhalder, a celebrity, actor, model, director	7,308,661
@ourcarbon	706	Tim Ream, an individual blogger	8,444
@Frack_Off	641	Organization of Extreme Energy Action Network against shale gas/oil	18,554
@Frackfreemps	490	Politically neutral volunteer promoting #frackfree #UK	9,627
@cher	445	Cher is a celebrity, singer, actress	3,453,750
@AustralisTerry	336	Australis Terry is a blogger from Queensland, Australia who is against fracking	7,144
@TXsharon	317	TXsharon is an individual blogger from North Texas	6,787
@adamjohnsonNYC	262	Adam Johnson a blogger and writer from New York City	73,249
@NBCNews	260	NBC News media	6,117,376
@Earthjustice	244	Earth Justice is Lawyers Organization against fracking	143,820
@MrTopple	239	Steve Topple, a journalist from East England, ultra-left and sectarian	27,905
@MarkRuffallo	221	Mark Ruffalo, a celebrity, movie and TV star	3,983,634
@SierraClub	209	The Sierra Club environmental organization founded in 1892	331,790
@billmckibben	203	Bill McKibben, an author, environmentalist, same writer for @350	276,543
@frackfree_eu	203	Group of bloggers from Brussels, Belgium, sharing fracking news	7,309
@350	181	350 dot org, Global management organization	344,490
@chesterChron	174	Chester Chronical, new media in UK	55,531

An example for the relationship between Twitter users and actors is visualized in Gephi as shown in Figure 2.2 below. Gephi is a social network analysis tool that uses visualization to define the digital humanities relationship (Grandjean, 2016). I used a Gephi graph to visualize the relationship between Twitter users and the actors. The network datasets consist of two components:

1) *node data*: a list of all actors and tweet users in the database, and

2*) edge data*: a list of the relationship between actors and tweet users. The connection is drawn as direct lines between the Twitter users as Followers of Actors and the Actors through the Retweet messages (captured with the symbol @RT).

In Figure 2.2, the Gephi network shows the ranking of most retweeted messages by the largest font size. The larger the font, the more an actor is followed, and messages posted by this actor are retweeted by others as listed in Table 2.2.

After the actors are identified, coding of the text messages posted in the tweets allow me to determine whether the actor posits an anti-fracking or a pro-fracking stance. This coding task requires familiarity with popular actor phrases that are employed to attract social media audiences. Every set of hashtags is expected to represent different sets of actors, so each hashtag is likely to have a different set of familiar phrases and text messages (Jill E. Hopke & Simis, 2017). The text messages in Figure 2.2 show the relationship between Actors and their followers from Gephi application with data downloaded using hashtag #fracking.

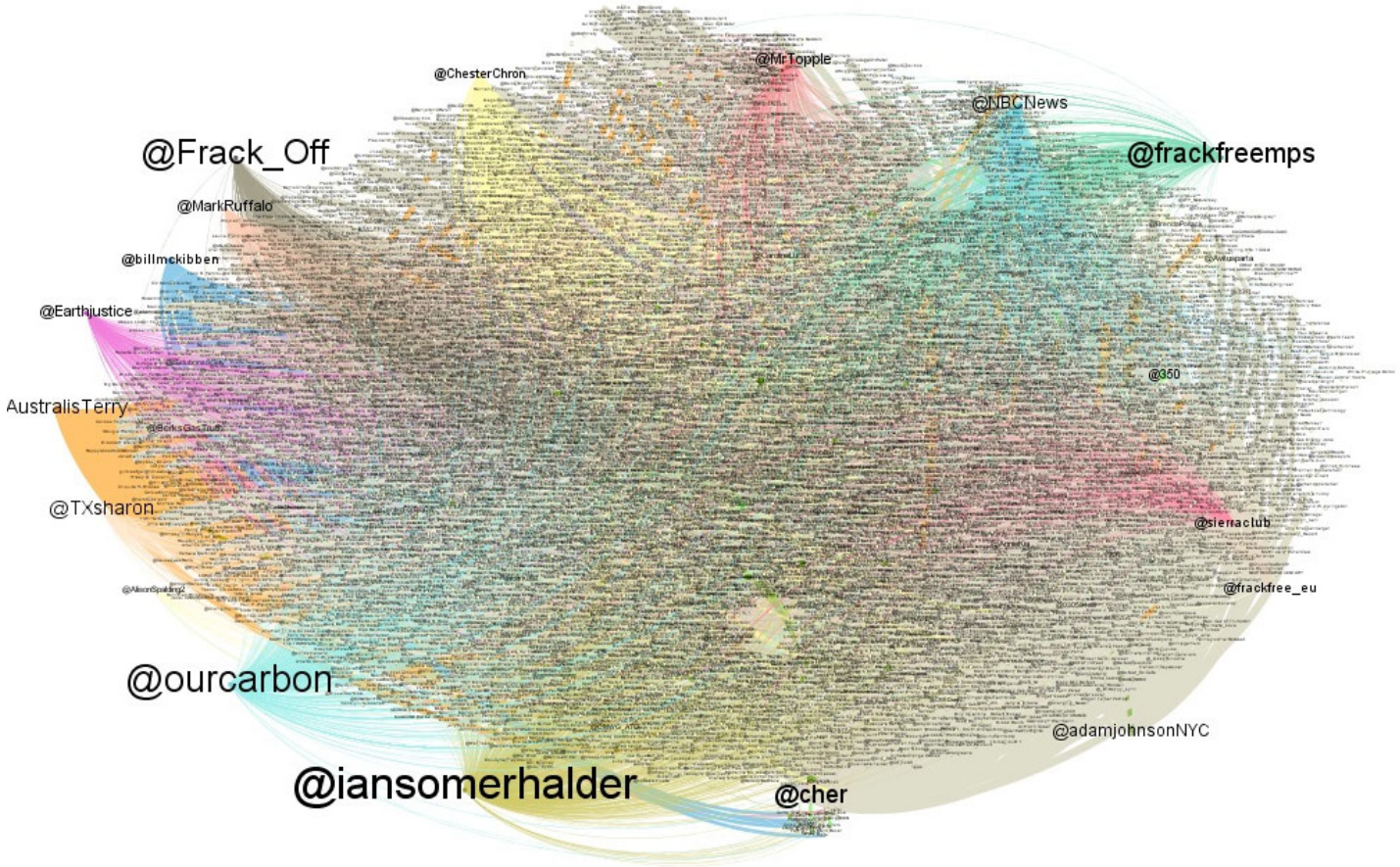

Figure 2.2 Relationship between Actors and Followers in Gephi Graph

The data profiling process uses the same approach as that was used by Longley and Adnan (2016) in their study on geo-temporal Twitter demographics in urban area in London. This method supports the application of demographic classification to characterize the links between actors who are also Twitter users and varying locations of posted tweets across the United States. These analyses reveal messages from distinct groups of actors and identify groups of Twitter users who followed these actors. The role of these actors in influencing public opinions through social media could be one of the major factors influencing forthcoming fracking trends and policies in the US.

2.4. Social Media Data Mining

As a preparation for this study, I have downloaded weekly information from Twitter since November 2015. With Twitter, specific words associated with fracking were used to download the tweet texts (@fracking, @shale_oil, @natural_gas). Although the datasets using @shale_oil and @natural_gas were not part of the analysis in this study, these datasets can be used for future research. Twitter also provides records of location and time. The location from where the text was uploaded is available in x and y coordinates for each posted text, which enables visual mapping of tweets. Furthermore, tweets record timestamps so that time series analyses can be conducted.

The purpose of using social media data collection is to gather large numbers of public opinions posted from Twitter from states in the U.S. to allow comparisons between states. Also, the analysis examines the significant groups and opinion leaders using the most re-tweeted texts signs (@RT) and the Twitter users with the most viral messages (more than 100 posted

messages). An opinion leader plays an essential role as the opinion brokers who carries information across the social boundaries between groups (Ronald S. Burt, 1999; Cha et al., 2010). For future research, the author would like to contact these opinion leaders for interview to calibrate the finding of the research.

The text data was coded based on certain key words that represent individual views on fracking. The texts were coded with positive (+1) signs to represent support for fracking, negative (-1) signs for anti-fracking texts, and zero (0) for representing neutral statements.

The disadvantage of using social media data is the lack of an individual's emotion such as fear or hope related to the fracking experience that is not written in the texts. Social media data does not provide information for us to study the community awareness of environmental impacts. However, social media data supports this study through background opinion of the general public views on fracking issues in the U.S.

My contribution to the literature on social media information diffusion as from this study is threefold: (1) this study provides a partial test of theory in the domain of the relationship between social media and public policy, (2) this study tests whether the opinion leaders would influence public opinion and local and state policy on fracking, and (3) this study documents fractious public views on the fracking phenomenon.

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CHAPER 3: THE ROLE OF SPACE AND PLACE IN SOCIAL MEDIA COMMUNICATION[1]

3.1. Research Background

The technological innovations in communication have historically outpaced the theoretical frameworks formulated to account for the effects of such innovations. Nevertheless, communication theory has co-evolved with such advances in general, and in particular in regard to smartphone technology (Zheng & Ni, 2006). Smartphones are a ubiquitous device for conducting social media network interaction (Bik & Goldstein, 2013) and have become essential in people's lives (Stieglitz, Bunker, Mirbabaie, & Ehnis, 2018). Smartphones continue to expand their market and have yet to reach saturation in the population (IDC Media Center, 2017). The conjunction of mobile phone technology with the Global Positioning Satellite technologies allows geographers and social scientists to track both the approximate location and specific time of communication data sources, and increasingly, the real-time intersections and interactions of people using such technologies (Yang et al., 2016).

The development of digital technology brings a new momentum and access for researchers to georeferenced data embedded in social media (Clodoveu Davis, Pappa, de Oliveira, & Arcanjo, 2011; Gazzard, 2011; Kotzias, Lappas, & Gunopulos, 2016; Shaw, Tsou, &

[1] This chapter is based on Adiyana Sharag-Eldin, Ye, X, Spitzberg, B., & Tsou, M.-H., (2019*),* The Role of Space and Place in Social Media Communication: Two Case Studies of Policy Perspectives. *Journal of Computational Science* published online: 17 May 2019.

Ye, 2016; Tsou et al., 2013). This social media connection makes it possible to link an Internet user with other users of the Internet within homophilous network groups. Internet users may choose from a variety of networking program applications appropriate for their activities (Kaplan & Haenlein, 2010). Social media program applications also provide the affordance of microblogging (i.e., Twitter, Snapchat, Pinterest, Instagram) for sharing communication and information (Westerman et al., 2012). The access to proximity and co-location information has become part of the "geospatial revolution" (Downs, 2014) that is both reflecting and altering people's sense of their place (Erickson, 2010; Q. Jones et al., 2008) in their social and geographic spaces (Mesch, Talmud, & Quan-Haase, 2012).

An increasingly popular mode of web-based communication is microblogging. It allows users to broadcast brief text updates to the public or to a selected group of contacts. The launch of Twitter in October 2006 represented a revolutionary form of communication in social media (Bollen et al., 2011). Microblog posts on Twitter, commonly known as tweets, being at less than 280 characters (originally 140), are very brief in comparison to ordinary blog posts. Twitter is currently one of the world's major social media platforms that allows users to express their thoughts publicly in brief messages (The Statistics Portal, 2017).

Twitter experienced global rapid growth since it was founded in 2006 (Haustein et al., 2016). A Twitter user can create a brief profile and choose a unique Twitter user's identification or alias. The Twitter network program provides information of the number of the Twitter user's followers and the number of people the user follows on Twitter. Most posted tweets consist of daily routine interactions, informal conversations, information sharing, and the reporting of news (Bollen et al., 2011). However, these posted tweets also include users' opinions, especially the

messages from individuals who post their opinions on controversial topics (Neubaum & Krämer, 2017; Shah et al., 2017). Such opinions are often signaled by the Twitter convention of hashtags, which are originated and assigned to such posts by their sender(s) and can be publicly downloaded and searched by researchers. The two exemplary controversial issues of fracking and capital punishment illustrate the value of such analytic methods (Bollen et al., 2011).

In the studies reported here, user participation ranged from concerned individuals to organized political groups, either of which may display attitudes ranging from marginally attitude views to strong political agendas. The majority of individuals may be influenced by direct exposure to fracking activities or their state's policy on the death penalty, and such individuals might differentially diffuse such news to each other through social media communication (Watts & Dodds, 2007).

According to classical mediated communication theory, a relatively small proportion of "opinion leaders" (actors) function as crucial intermediaries between the media and the majority of society (Elihu Katz & Lazarsfeld, 1955a). As such, viral campaigns can reach wide audiences by identifying and persuading a relatively small number of opinion leaders (Cha et al., 2010). In contemporary developed societies, social power is exercised substantially by and through social networks (Castells, 2011). These networks are avenues through which opinion leaders, or influentials (Watts & Dodds, 2007), can exert influence since they provide forums and opportunities for interaction with other users of the social network (Rice, 2017; Everett M. Rogers, 1983), especially when linking otherwise less homophilous groups (R S Burt, 2005; Ronald S Burt, 1992; Carpenter, Boster, Kotowski, & Day, 2015). This research utilized opinion leaders as the leading informer in the diffusion of messages to influence public opinion on social

phenomena. Newer theoretical developments propose that opinion expression in social media may actually drive news as much or more as the media drive social opinion diffusion (Shah et al., 2017).

3.2. The Role of Space and Place in Communication Theories

Communication and Geography are two traditional, relatively separate, academic fields. These fields, however, share and overlap at certain borders where interdisciplinary activities constitute fecund intersections (Adams & Jansson, 2012). The earliest intersections between geography and communication theory were articulated by scholars who were involved in the study of place-names and dialect of geography in the first half of the 1900s (Feipel, 1925; Mcjimsey, 1940; McMillan, 1949; Robert J. Menner, 1950; Robwer J. Menner, 1933; C. K. Thomas, 1947). Afterward in the 1960s, Rogers & Havens (1962), Lefebvre (2014), Katz and Hägerstrand (1966) conceptualized a theory of innovation diffusion, followed soon after by Lefebvre in the 1970s with his significant definition of space and time (Hägerstrand, 1965; Lefebvre, 1974). In the 1960s, sociologists such as Durkheim proposed theoretical analogues such as 'social space' (Nahemow & Lawton, 1975; Shields, 2006), while Lefebvre suggested the *'representation of space'* (i.e., the social space constructed through communication) is occupied by artists, authors, and philosophers. In contemporary society, these spaces of communication are also shared, occupied and co-created by Internet bloggers, celebrities, entrepreneurs, and political figures (Lasorsa, Lewis, & Holton, 2012).

More recently, the geographer Adams (2010) and Adams & Jansson (2012) argued that mediated communication reflects a social space comprised of abstract, theoretical, and production-oriented space. This social space involves the co-construction, representation and

formalization of powerful actors' formal plans and abstract blueprints that influence social action (Adams, 2010; Adams & Jansson, 2012). This argument is parallel to Tuan's (1977) earlier conceptualization of place and space as ephemeral or virtual areas rather than fixed locations (Tuan, 1977). *'Place'* represents a complexly layered subjective experience that is grounded in local discourses and conditions. In contrast, *'space'* reflects actual and potential movements of bodies, entities, information, and communication (Edwards & Usher, 2000a). It can be conceptualized in regard to 'personal space' (Baldasarre & Feller, 1975; Felipe & Sommer, 1966; Hall et al., 1968a; Mazur, 1977) or proximity (Menne, Joy M. Cadiz; Sinnett, 1971; Sussman & Rosenfeld, 1982; Tesch, 1979). The intersection of language, thought, space and time continue to provide an important location for theoretical development (Núñez & Cooperrider, 2013; Pollio, Jensen, & O'Neil, 2014).

The study of communication geography has allowed focus upon the various means through which political and economic power are legitimized through communication, which establishes boundaries of space and time of various scales of space and mobility in society (Castells, 2011; Dodge, 2008; Harvey, 1992; Sassen, 1991, 1994; Scott, 2011). Traditional communication theory has generally presumed rather than theoretically specified the central roles of place and space in human interaction, but as attention to mediated communication has increased, so has the development of communication theory (Couldry & Hepp, 2013; Hampton & Ling, 2013; O'Sullivan & Carr, 2018; Spitzberg, 2014). The contributions from the communication discipline are strongly indicated in studies by Chong and Druckman's focus on framing of opinion in a competitive elite environment (Chong & Druckman, 2007b, 2007a), Dodge's (Dodge, 2008) inquiry into the prevention of chronic violence in American Youth, or Castells' (Castells, 2011) examination of the need for violence and intimidation to shape

collective minds, all of which illustrate the heuristic value of integrating communication theory with human geography.

Developments in the internet, social media, and their computer applications have enabled widespread explorations of online data mining in investigating the various intersections of space and place. Among some of the more notable achievements have been in such applied contexts as social movements (Foust & Hoyt, 2018; Momeni, 2017; Owen, 2017), emergency disaster response (J. Kim & Hastak, 2018; Panteras & Cervone, 2018; Z. Wang & Ye, 2018), and terrorism (H. Chen et al., 2008; Ferrara, 2017; Kwon, Chadha, & Pellizzaro, 2017). One of the most opportune applications of such communication technologies is in the surveillance of public opinion. In particular, for example, media-related research on environmental issues and climate change have followed the same path as communication research and technology (Ford et al., 2016; Lineman et al., 2015; Moulton & Schramm, 2017).

The multilevel model of meme diffusion (M^3D) is a communication framework theory about networked messaging developed by Spitzberg (2014). The M^3D model identifies a variety of constructs to account for the influence of the diffusion and replication of memes through messages that transfer cultural information from individual-to-individuals and from individuals-to-groups (Spitzberg, 2014). Memes are the cultural analogue to genes, referring to any replicable messages that transfer cultural information from individual-to-individual (Dawkins, 1976). The word “meme” is widely used in social media to describe a unit of information that spreads through person-to-person communication in social networks. Once a meme is identified, it can facilitate classification of different types of social processes (Kwak, Lee, Park, & Moon, 2010b). Meme theory also suggests that imbedded in viral messages is the framing of positive and negative opinions regarding issues, which must compete with other memes in the

communication ecosystem. The informational ecosystem is also an analogue for biological ecosystems in which any given organism (and its genes) must compete for resources; memes, in contrast, compete for attention in contexts in which counter-frames and other memes compete for this attention (Spitzberg, 2014).

Implicit in the M^3D theoretical analogy to ecosystems is the assumption that top predators, or influentials, would have disproportionate impact on that system's dynamics. These impacts tend to occur in two forms: objective and subjective. The objective impact of influentials in social networks occurs because of their structural interconnectedness and numbers of followers, which make them important conduits in diffusing information to the rest of the informational ecosystem. The subjective impact is that, the broader social network views influentials as homophilous and aspirational. That is, people tend to affiliate and link with others with similar attitudes, and they want to communicate with those who are most influential and have the highest status in their social networks. M^3D also proposes that several geotechnical factors influence the diffusion of communications in such social networks, including geospatial proximity, which facilitates homophily and reduces the friction of distance, even in cyberspace (Han, Tsou, & Clarke, 2018). Furthermore, a reasonable extension of M^3D is that "local" sense of place, city, and state boundaries, major newsworthy economic investments such as fracking, and local political movements such as ecological resistance or death penalty resistance would signal homophilous activity in the diffusion of social media activity relevant to such factors.

Scholarship in the communication discipline is progressing in the surveillance (Coscia, 2018; Shabunina & Pasi, 2018; Zhang et al., 2016; Zubiaga, Spina, Martinez, & Fresno, 2015) and taxonomic classification of memes in cyberspace (Segev, Nissenbaum, Stolero, & Shifman, 2015; Wiggins & Bowers, 2015; Zubiaga et al., 2015). The application of communication theory

to social media memes was used to trace the source of public opinion in both cases of fracking practices and the death penalty policy in a manner that illuminates human geography.

3.2.1. Case Study 1: The Death Penalty Abolishment and Reinstated in Nebraska

In the United States, the capital punishment is supported by over three quarters of Republicans, yet is opposed by the majority of Democrats (Berman, 2015). The majority of American citizens support the death penalty, although the level of support has been falling consistently for two decades (Jones, 2017; Oliphant, 2016). According to the quarterly report by the Criminal Justice Project, as of July 2017 there were a total of 1,455 executions since capital punishment was reinstated in in the United States in 1976. The total numbers of death row inmates known to the NAACP Legal Defense and Educational Fund (LDF) was 2,817 as of 2017 (Fins, 2017).

Currently, the death penalty is legal in 30 states and illegal in 20 states and DC as shown in Figure 3.1. The Death Penalty Information Center (DPIC) reported the status of the five states with Gubernatorial moratoria on capital punishment: California (2019), Colorado (2013), Pennsylvania (2015), Washington (2014), and Oregon (2011) (Arango, 2019; Death_Penalty_Information_Center, 2016; ProCong.org, 2016).

Other socio-political research in multiple disciplines demonstrates geographic variations in support for the death penalty. Some examples include studies by Soss et al. (2003), who question White's support of the death penalty (Soss, Langbein, & Metelko, 2003); another study by Cassell (2008) compiled cases of capital punishment in California (Cassell, 2008). Thus far, the Nebraska abolishment and repeal of capital punishment appears not to have been investigated

in an academic journal, despite widespread interest revealed in the social media (R. Berman, 2015; Connor & Chuck, 2015).

According to a sociological theoretical framework, the political decision-making that drives policy in regard to death penalty legislation is based more on concerns about public opinion majorities rather than the morality of the policy per se (C. Z. Mooney & Lee, 1999). The M^3D framework theory proposes that such opinion spreads less because of the moral or political perspectives expressed in such memes, and instead due to the novelty or informational utility of such messages, the status of the source of such memes, and the facility of the social networks into which the memes are diffusing. In other words, it is the extent to which the messages agree with one's own perspective, or can be incorporated into one's own opinion, that facilitates diffusion within social networks. Furthermore, given the adage that "all politics is local," M^3D anticipates geospatial locale will be reflected in such diffusion processes.

Such networks can be approximated by identifying the opinion content of certain policy agendas. The authors collected public opinion from the Twitter API to investigate the degree to which Twitter traffic reflects death penalty policies. The data were downloaded using the hashtag "#death_penalty" as the keyword to capture the different opinions on the capital punishment. The tweets compiled ranged from data downloaded between May 27 to December 31, 2015, with approximately 389,800 data points of geotagged tweets as shown in Figure 3.1.

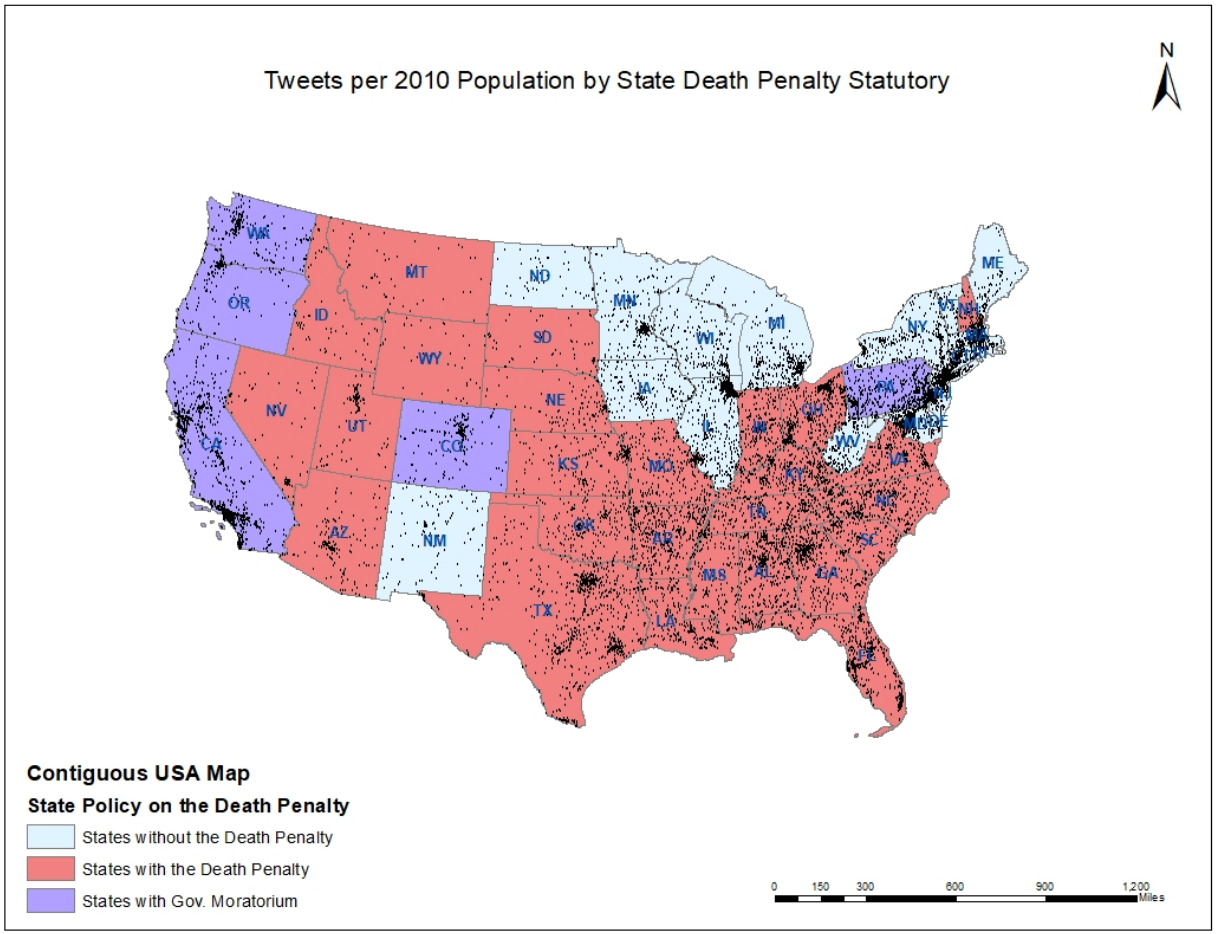

Figure 3.1 Death Penalty Statutory by States Normalized by 2010 Population

The test messages in the tweets data were sorted and classified using sentiments words to distinguish the difference in opinions. For example, there is a strong opinion on the Boston bomber that triggers the tweets for supporting the death penalty. Thus, the words related to "Boston", "Tsarnaev", and "bomber" were classified in the category of Pro-Death Penalty (Pro DP = 0). On the other side, the words related to "Nebraska", "First conservative state", "banned" were put into the category of "Against Death Penalty" (Against DP = 1). From the 380K data points, only one-third of the text mentioned the words that are captured in the sentiments table. The rest of the tweets are irrelevant and neutral without expressing any sentiments. The list of sentiments words related to this research is available in the Table 3.2.

The state's policy on the death penalty also put into two categories, the states with support to the death penalty or "States with DP" in red polygons (with DP = 0), and states with moratorium and states with banned on the death penalty is in category "States without DP" in light blue and purple polygons (without DP = 1).

Using the sentiment analysis, the authors performed the Chi-Square statistical analysis to test the relationships between the two categories of support and against the death penalty in two different groups of states, the states with the support of death penalty and the state with a ban on the death penalty.

The null hypothesis is there is no statistically significant relationship in the opinion of the death penalty between the states with the moratorium and banned on the death penalty and the states supporting the death penalty. The alternative hypothesis is that there is a statistically significant relationship. between the state with the banned on the death penalty and the states with support on the death penalty.

From the calculations, we found a total of 39,000 tweets from the states without the death penalty with the opinion against the death penalty is 26,700 tweets and the opinion supporting the death penalty is 12,300 tweets. From the states with support of the death penalty, we found a total of 51,700 tweets where 36,700 tweets are against the death penalty and the 15,000 tweets supporting the death penalty.

The results of Chi-square test shown in Table 3.1 below:

Table 3.1 Chi-Square Statistics Test Results

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	72.823[a]	1	.000		
Continuity Correction [b]	72.698	1	.000		
Likelihood Ratio	72.671	1	.000		
Fisher's Exact Test				.000	.000
N of Valid Cases	90780				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 11740.21.

b. Computed only for a 2x2 table

The probability is $p=0.000$ that is smaller than $\alpha=0.05$, which means that there is a statistically significant difference between the states with death penalty moratorium and those states that supporting the death penalty with regard to their population sentiments on the death penalty.

Another test performed in this study to investigate the social media representation of capital punishment using public opinion on the death penalty captured in Twitter. The M^3D framework theory proposes that memes such as Twitter messages that refer to sensitizing issues for any given social network will activate cascading diffusion of such memes throughout the broader media ecosystem, and that this diffusion process will reflect geospatial gradients based on local boundaries and proximity. Thus, the research questions focused on the reciprocal relationship between the State and the users of social media (shown in Figure 3.2).

(RQ_1): Are the states with policies that regulate capital punishment will be reflected in social media (i.e., Twitter) by significant moral sentiments and opinions of their citizens?

(RQ_2): Are Twitter users who posted their tweets on social media are influenced by their geographically bounded state policy on the death penalty?

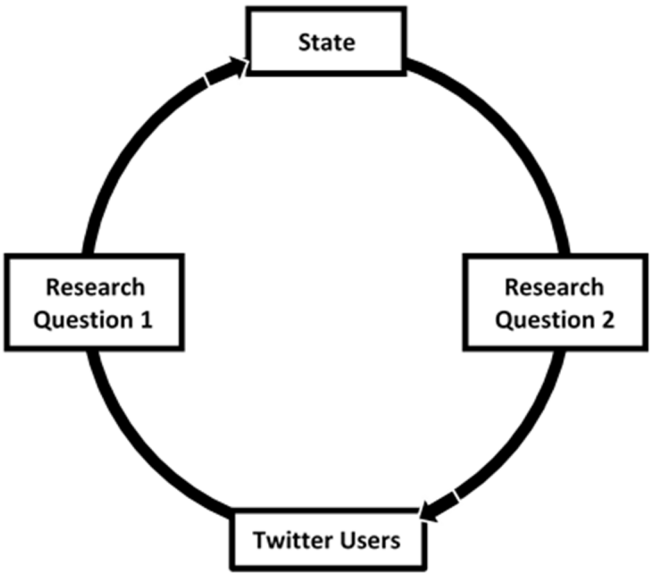

Figure 3.2 Research Scope Diagram

Figure 3.2 diagram shows the inter-related connectivity between the State as policymakers and the Twitter Users as the representative of public perceptions. Research Question 1 (RQ_1) is drawn as the first arrow on the left reflecting the influence of public opinion over the death penalty that motivates the decision on the death penalty at the state levels. Research Question 2 (RQ_2) is drawn as the second arrow representing the connection between the state's policy on the death penalty that triggers public reaction to accept or to oppose the policy.

Using geography spatial analysis, the author wants to prove the connection between the state policy of the death penalty and the state's public perception on the death penalty. From the mapping of geotagged tweets shown in Figure 3.1 (shown in the previous page), the authors analyzed the spatial distribution to verify if there were some clusters formed in the neighboring states. GeoDa program, a free-and open source software program, was applied to detect the connections between the states in connection to the geotagged spatial distribution (Anselin,

Syabri, & Kho, 2006). The findings from spatial analysis showed a positive spatial autocorrelation with the value of Moran's I of 0.145 (Figure 3.3).

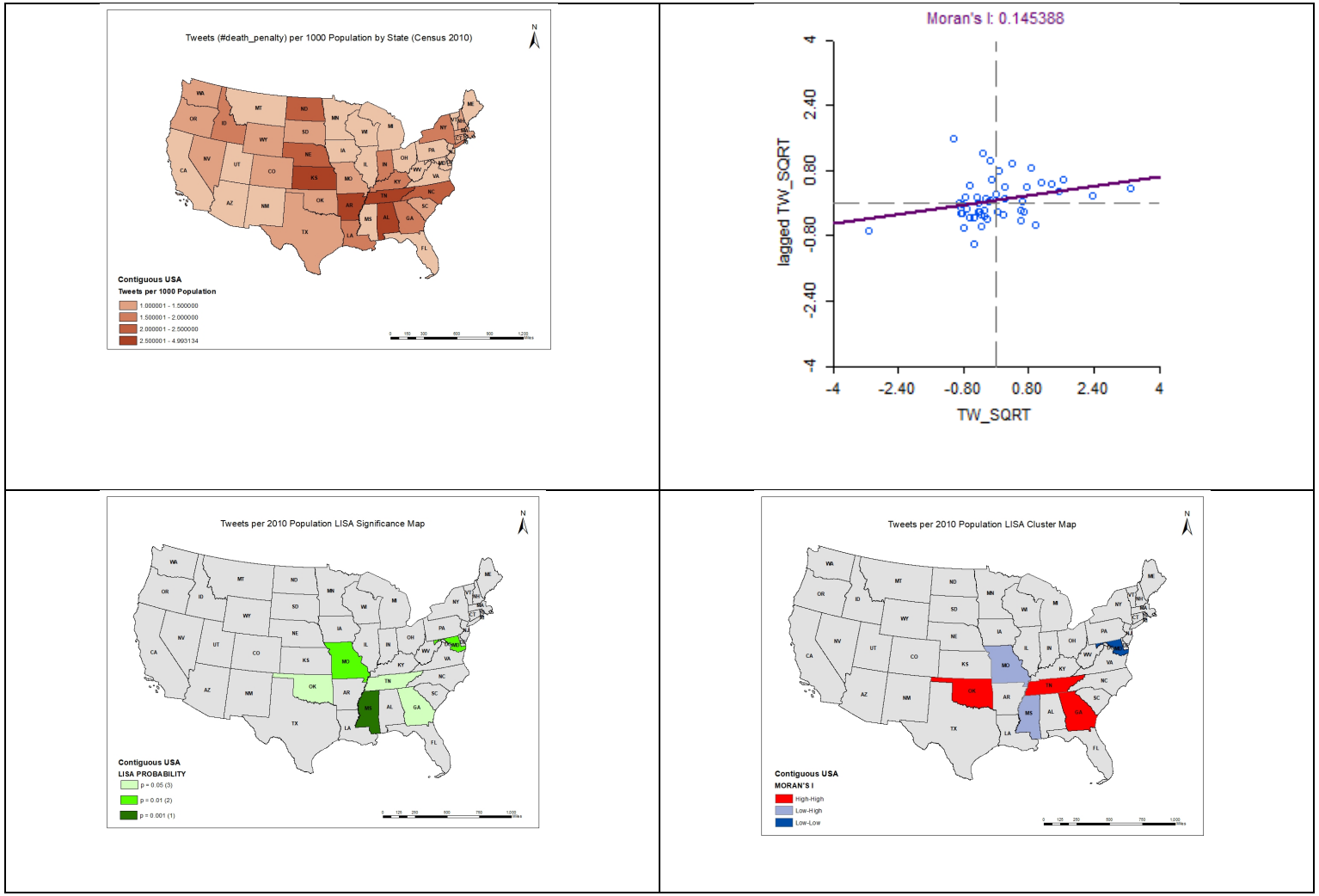

Figure 3.3 Spatial Analysis using GeoDa

The maps in Figure 3.3 show the results of spatial analysis using GeoDa. The first map on the upper-left corner is the density of geotagged tweets per 1000 Population by State (data from the US Bureau of Census 2010). The second graph on the upper-right corner shows the results from GeoDa. The analysis detected an autocorrelation within the data points (states). The third map on the lower-left corner displays the significance of Local Indicators of Spatial Association (LISA), which provides information of identifiable clusters in the data points.

The fourth map in Figure 3.3 shows cluster and outlier analysis based on high value and low value of tweets. The GeoDa result shows some states with High-High (HH) clustering locations that includes Oklahoma, Tennessee, and Georgia. The HH clustering indicates there are positive local spatial autocorrelation clusters located in these three states. These states are surrounded by neighboring states with a high density of tweets per 1000 population. With the spatial correlation analysis, we can prove there is a statistically significant relationship within the neighboring states of Oklahoma, Tennessee, and Georgia with high numbers of tweets mentioned the keyword #death_penalty.

The Low-High location indicates negative local spatial autocorrelation or spatial outliers (Anselin, 1995). In Figure 3.3, the states with Low-High (LH) spatial outliers are represented by two states: Missouri and Mississippi with light blue color. In this case, Missouri and Mississippi are the outliers of LISA probability shows low values surrounded by high values in the neighboring states. This result is supporting the finding in the above paragraph, there is a significant cluster of a high value of posted tweets on the death penalty in the Southern United States except for Missouri and Mississippi that shows lower values of probability compares to its neighboring states.

On the contrary with High-High values (HH), the Low-Low values (LL) indicates a cluster of low values surrounded wish statistically significant LISA probability of low values in the neighboring states. In Figure 3.3, the LL cluster of low values is represented by only one state, Maryland. This result shows that in the neighboring states of Maryland, tweeter users are less likely to post tweets on the death penalty compares to the tweet users in the Southern part of the United States.

The cluster and outlier analysis distinguish between a statistically significant cluster of high value (HH), cluster of low values (LL), and the outliers in which a low value is surrounded by primarily high value (LH). The results from the above GeoDa analysis is consistent with the first map on the upper-left corner of Figure 3.3 (the spatial analysis map in the previous two pages) revealing a dark brown color for Oklahoma, Tennessee, and Georgia. The tweeter users in the Southern part of the United States or informally called the Bible Belt region (including Oklahoma, Tennessee, and Georgia) posted their perception on the death penalty significantly in higher tweets per capita compares to other regions in the United States.

The findings of this research suggest the following conclusions:

1) The clusters of states with high rates of tweets per population are located in the states that maintain capital punishment. These states are located in the colloquially named “Bible Belt” region of the US, known for its religiously grounded political conservatism. Such a pattern of data suggests that religion either has a direct influence on geography of moral policy-based opinions (in this case, regarding the death penalty), or at least that religion is correlated with geospatially clustering of political attitudes and beliefs. Consistent with RQ_1, social media do appear to reflect moral reactions to public policy, illustrated by views expressed in regard to capital punishment policy.

2) In regard to RQ_2, there is a low level of correlation between the states' death penalty policies and the number of posted tweets in each state. The GeoDa Moran's I positive auto-correlation value of 0.145388 means there are some clusters of states with a similar density of tweets per state population in the study area. In other words, the results from the spatial statistical analysis indicate that some states that keep the death penalty have the same users' sentiment of expressing opinions in social media. Visual inspection confirms that the majority of the tweets opine against the death penalty. Thus, contrary to RQ_2, the spatial analysis indicates that the Twitter users who posted their tweets on social media were not influenced by the geographically bounded State policy on the death penalty.

Another study of the death penalty targeted a particular State (Xinyue Ye, Sharag-Eldin, Spitzberg, & Wu, 2018). The State of Nebraska experienced the abolishment of the death penalty in 2015 (Berman, 2015). However, a year later, the citizens of Nebraska voted overwhelmingly to reinstate the death penalty and nullify the historic 2015 vote by the State Legislature (Hammel, 2016). Nebraska's abolishment of the death penalty in 2015 was apparently caused by an economic issue rather than moral issue. The debate in the Nebraska legislative forum concluded that the lethal injections serum to perform executions was too expensive for the state to uphold (R. Berman, 2015).

The statewide campaign in Nebraska launched by the pro-death penalty supporters was led by Governor Pete Ricketts. The Governor and his family donated $400,000 to the campaign to reinstate the death penalty (Payton, 2016). Since the primary articulated decision to abolish the death penalty in 2015 was based more on economic rather than moral criteria, supporters of the death penalty tried to raise money for the state to afford lethal injections drugs (J. Duggan,

2015). The Governor of Nebraska had already been discussing the possibility of changing Nebraska's lethal injection protocol. Despite nationwide support for a ban the capital punishment, the voters in Nebraska handed back the option of lethal injections and voted to reintroduce the death penalty on the November 2016 election day (Hammel, 2016).

From these data points, the word "Nebraska" were added to separate a specific case related to Nebraska's abolishment of its death penalty, in comparison to the national data in the present study. Approximately a total of 10,500 tweets from the entire database were selected with the hashtag "#death_penalty" and "Nebraska".

During Nebraska's abolishment of the death penalty in 2015, the news diffused extensively due to the unexpected reactions of the repeal of the death penalty from a conservative state, although the establishments of a major political party and religious leaders were both in favor of keeping the death penalty. The viral message was illustrated by the Associated Press on May 27, 2015:

"Nebraska on Wednesday became the first conservative state in more than four decades to repeal the death penalty" (R. Berman, 2015).

The rapid, extensive and global diffusion of such news is considered an example of meme diffusion due to its viral effect. Memes represent a mechanism of cultural transfer, but memes sometimes go "viral," such that they reveal rapid social sharing across a wide range and depth (Nahon & Hemsley, 2013) Thus, all viral social media are memetic, but not all memes go viral. All diffusion and viral events (i.e., retweets) imply influence, but influence is not isomorphic with persuasion (Pentland, 2010), which would imply a transfer of attitude change in the direction of directed social media message views. Some memes may not mean the same thing

for the people who send them around (Stroud et al., 2015), and forwarding a tweet does not equate with agreement or a modification of belief.

Despite some contrast and similarity between the memetics application in communication theory and geography, this study explored the meme's function as a productive concept for the analysis of a contemporary phenomenon. The interconnectivity between communication and geography require renewed attention to the need for cross-disciplinary theory and research in these disciplines.

This study of the death penalty assessed public opinion on the controversial issues of capital punishment. It offers new insights into the influence of communication technology as a tool to represent and potentially predict social phenomena in general, and the formation of a particular policy. Pursuing these public opinion exchanges will assist in the early detection of social and political processes related to public opinion formation and their roles in influencing criminal justice and human rights.

3.2.2. Case Study 2: The Fracking controversy

The development of fracking procedures to extract natural gas instigated a controversy that represents a particular intersection between public opinion and political agendas. The political debate surrounding fracking represents an exemplary public policy issue upon which social attitudes are written both in traditional news media as well as online and social media messaging (Xinyue Ye, Li, Sharag-Eldin, Tsou, & Spitzberg, 2017). The impact of Internet technology and social media communications reflect, influence and form personal perceptions and opinions on social issues directly and indirectly (Flanagin, 2017; Haenschen, 2016; J. J. Jones, Bond, Bakshy, Eckles, & Fowler, 2017).

In developing opinions, people often do not use their rationality to form their own views or decisions, especially in regard to environmental awareness (Kollmuss & Agyeman, 2002). Most people express their opinions by adopting or expressing the opinions of other people or those of opinion leaders as social 'actors'. Such actors consist of celebrities (movie actors and singers), prominent people, public figures, politicians, and religious leaders. These actors have the ability to influence the opinion of their followers and diffuse political agendas through social media (Chen, 2016; Coscia, 2018; Downing, 2008). The news contains public controversy become popular on the media coverage (Glynn, Hayes, & Shanahan, 1997; Noelle-Newman, 1974; Preiss, Gayle, Burrell, Allen, & Bryant, 2007).

The controversy surrounding fracking can at least be traced in large part to the release of the movie *Gasland* in 2010. This documentary by Josh Fox on the societal and environmental effects of fracking was widely noted as revealing potential hazards of fracking (Fox, 2010; Wood, 2012). The opponents of fracking have focused their campaigns on environmental problems, public health concerns and earthquakes (Simonelli, 2014; Skoumal et al., 2015). Some studies have also linked the fracking process to drinking water contamination (Boersma & Johnson, 2012; Hilson, 2015; Throupe et al., 2013) due to the massive amounts of water required for fracking operations. Since *Gasland,* the public debate on fracking has represented a sensitive issue in US Presidential administration's policies. On July 2017, the Trump administration announced an intent to roll back fracking protections from Federal lands (Milman, 2017). According to Samuel Kernell (1997) in his book, *Going Public*, the direct support from the American public is often bypassed by Congress (Kernell, 2007).

According to Johnson and Boersma (2012), the operation of fracking requires 2 to 4 million gallons of water and 15,000 to 60,000 gallons of chemicals for a single lateral well. This massive amount of water is multiplied by the numbers of gas wells at every site (Boersma & Johnson, 2012). In addition, the transportation of wastewater from the drilling sites to the designated injection well pits is another risk an environmental disaster waiting to happen (Cusick, 2014; Whitacre, 2013). Transporting of the waste liquids from the fracking wells requires a fleet of trucks and large underground injection wells with full Federal requirements. Due in part to such risks and complications, three states in the United States (New York, Vermont, Maryland) and some local governments ban fracking or have imposed a moratorium within their jurisdictions (Carroll, 2014; Wines, 2016).

Another environmental impact related to fracking involves earthquake incidents related to hydraulic fracturing in certain locations such as Youngstown, Ohio and in south-central Oklahoma. One study identified 77 earthquakes with a magnitude of 1 to 3 on the Richter scale near Youngstown, OH (Holtkamp et al., 2015; Skoumal et al., 2015). Some studies focused on the injection-induced earthquakes in Oklahoma as part of the process required to stimulate the production from dense shale formations, or by disposal of wastewater associated with hydraulic fracking (Ellsworth, 2013; Holland, 2013; Keranen, Savage, Abers, & Cochran, 2013).

On the other side in this controversy, there are some substantial media campaigns to promote fracking, primarily supported by the oil and gas industry, state policymakers and shareholders. The content of such campaigns by fracking supporters tends to include the economic benefits and cleaner technology compared to coal, as well as the potential for reduced national dependency on imported oil (Charles Davis & Fisk, 2014; Kiger, 2014). There is

evidence that the contemporary administration and policymakers have consistently downplayed the role of the oil and gas industry in order to reconcile the drilling practices with fossil fuel policies enacted prior to the emergence of more pressing environmental policy concerns (Milman, 2016; Yu, 2017).

During the recession, in the beginning of 2010s, in a depressed economy state, Ohio, was desperately in need of a stimulus to its economic development from the jobs promised by shale oil exploration in east Ohio. A study by Weinstein and Partridge (2011) argued that the energy development industry from a natural gas exploration in eastern Ohio would serve as a reliable economic engine for the whole State (Weinstein & Partridge, 2011). Another study by Hill and Kinahan (2013) study supported the same kind of economic development (Hill & Kinahan, 2013). A study by Thomas et al. (2012) predicted the employment growth generated by the Utica Shale company would generate 1,000 jobs for engineering and 1,000 jobs for environmental technicians in 2014. The estimated Gross Domestic Product (GDP) from the gas and oil industry was expected to represent $54.9 billion dollars (Thomas, Lendel, Hill, Southgate, & Chase, 2012).

The polarized opinions reflected in social media regarding fracking demonstrated that the public has difficulty in formulating rational behavior or opinion regarding complex public policy (Meegoda, Rudy, Zou, & Agbakpe, 2017). In such cases, the public is likely to rely more on social media to gauge, influence and form personal opinions on social issues (Flanagin, 2017; Haenschen, 2016; Jones et al., 2017). In such complex public policy issues, people tend to depend on the opinion leaders who can be trusted to serve to validate self-opinion formation (Sharag-Eldin, Ye, & Spitzberg, 2018).

The current study downloaded tweets with the hashtag "fracking" from 1/1/2017 to 1/1/2018, returning over 15,000 data points as public reactions within the contiguous United States. The tweets were geographically tagged with the longitude and latitude of the coordinate system based on the users' IP address. The public reactions were captured in the posted Twitter and arrayed on a time-series graph as the spikes between mid-July to early August 2017 (see Figure 3.4). The majority of tweets compiled on July 2017 contain various messages about the threat of fracking operations on the environment, especially on the water supplies. The following texts are examples from the tweets posted in mid-July 2017:

- Trump administration to overturn fracking controls on public land
- RT @RobertKennedyJr: Stop Dumping Offshore Fracking Waste into the Gulf of Mexico
- @RT_America: Sediments downstream from one treatment plant contain about 200 times the level of #radium found upstream
- RT @SafetyPinDaily: Fracking can contaminate rivers and lakes with radioactive material, study finds
- RT @RoseAnnDeMoro: Wastewater produced by #fracking contaminates waterways with radioactive waste and hormone-affecting chemicals
- RT @cleantechnica: Wastewater from Fracking Pollutes Pennsylvania
- RT @3DTruth: Penn State finds PA river dumped with treated fracking water just 14% below the level to qualify as radioactive waste.

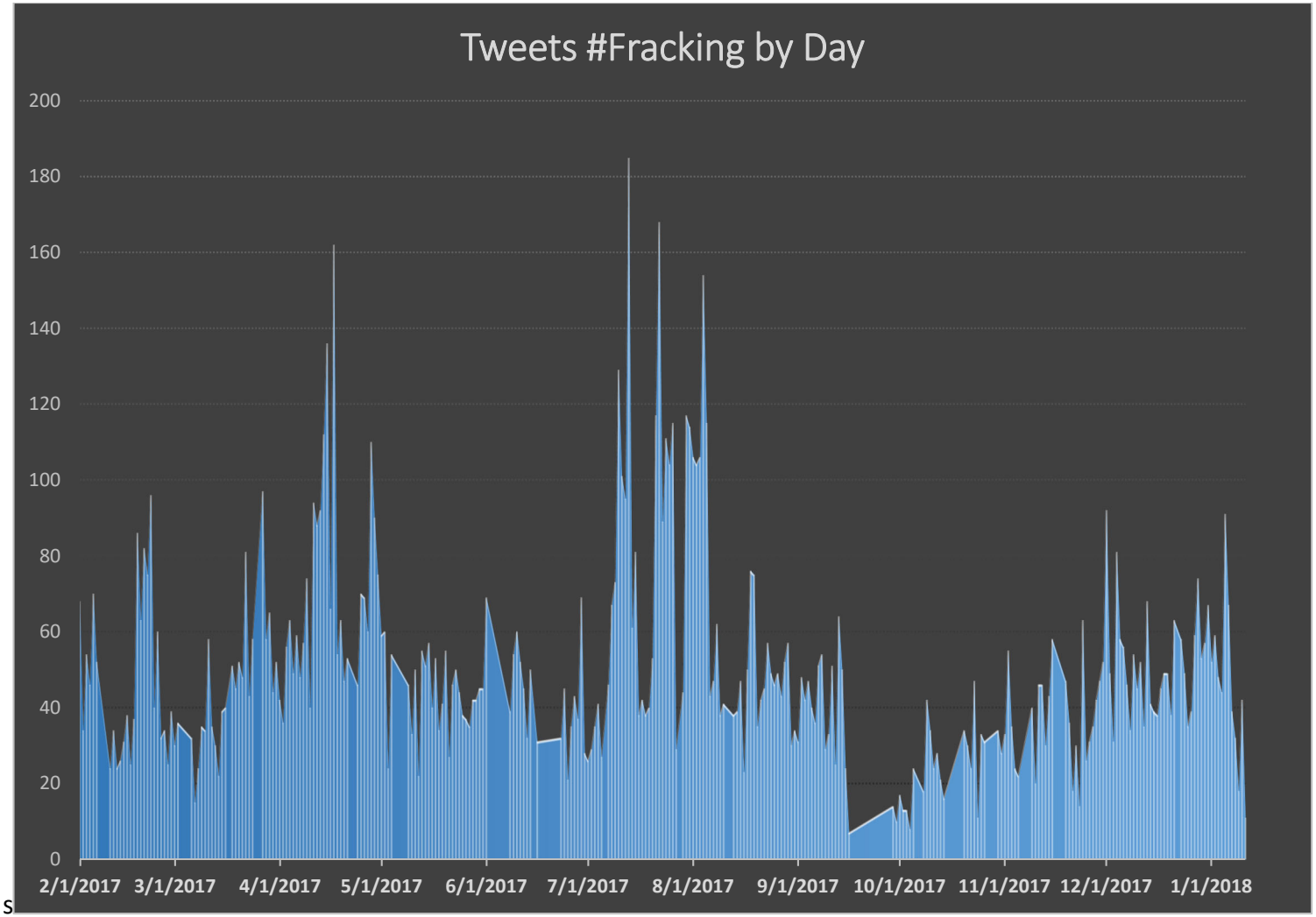

Figure 3.4 Numbers of Tweets with Hashtag Fracking in Time Series Graph

Figure 3.4. shows the spike of tweets between July and August 2017 as reactions to the Trump Administration policy on cancelling the fracking regulation that was previously forced by the Obama administration. The spike shows concentration of posted tweets produced by Twitter users as reaction to the changes policy by the Administration. The intensity of protest coverage and discussion on fracking operation has risen since the beginning of the sworn of the new President. It's an open question whether this is a coincidence or if the many national protest movements are linked by some common factors (Fisher, 2012).

Although the areas that cover the shale deposits of natural gas only covers 22% of the contiguous U.S., the posted tweets as public reactions on fracking show up everywhere across the U.S., not just the areas directly affected by fracking. The map in Figure 3.5 shows the posted tweets overlaid upon the areas with shale deposits. This map also displays the public concern of fracking operations reflected through posted tweets beyond the areas with direct impact from fracking.

The density of posted tweets is concentrated in the urban areas such as Seattle, San Francisco Bay Area, Los Angeles-San Diego in the West Coast. From New York City, Boston, Philadelphia and Washington DC in the East Coast as seen in Figure 3.5 below. This finding is consistent with the previous study using a smaller sample size (Xinyue Ye et al., 2017).

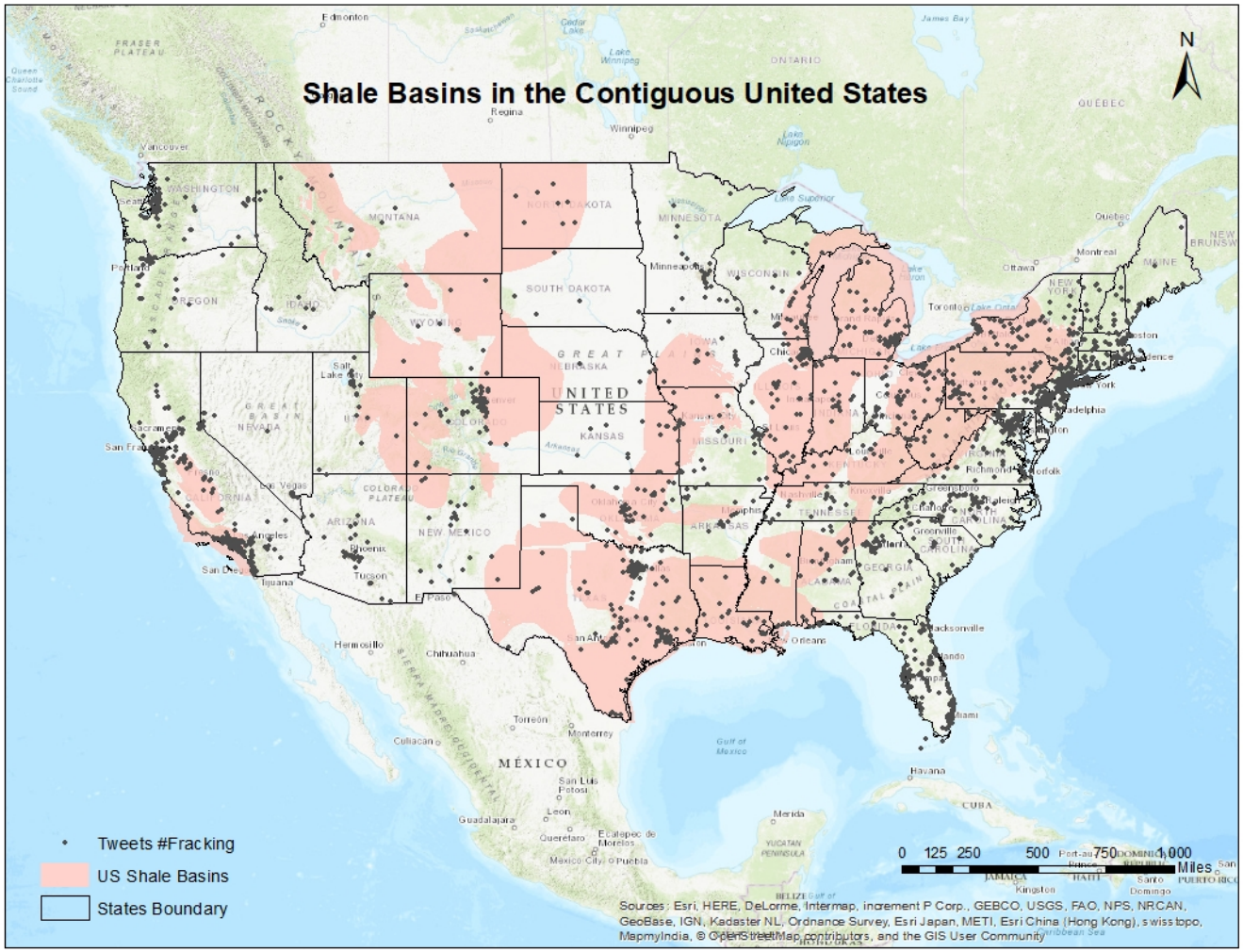

Figure 3.5 Map of Shale Basins Locations in the 48-Lower States

In the previous study, which used social media with the hashtag "Fracking," we found a significant role for opinion leaders (or 'actors'), led by movie actors/actresses from Hollywood, California expressing opinions about the danger of fracking. The tweets from these actors were diffused faster compared to other news media due to their popularity and ability to capture large numbers of followers. Some studies have found that well-educated actors have important influence within mainstream media, not only in the spreading of political opinions, but also through discussing these opinions with other users (Tumasjan et al., 2010). There is some representation of Hollywood actors with anti-fracking agenda captured in this study. They are:

- Cher messages on the earthquakes in Oklahoma became viral and repeated over 500 times
- Ian Somerhalder concerns on St. Tammany Parrish in Louisiana as one of the fracking destinations was retweeted for 900 times
- Mark Ruffalo sent many messages to ban fracking in various locations in the US

On the state level, the public opinion reflected in the tweets was more focused on the internal problems of the respective states. In California, for example, the majority of the tweet messages retrieved were anti-fracking, emphasizing mostly concerns about water contamination, water preservation and climate change. New York was one of the states with a statewide fracking ban. However, the majority of tweets posted from New York state were sent by the Environment Group, which warned the Government about the danger of fracking practices. In Ohio most of the public opinion on fracking was focused on its environmental hazards, especially related to major earthquakes near Youngstown. Large numbers of tweets from Ohio and Pennsylvania showed public dissatisfaction with the local township policy that accepted fracking within its jurisdictions.

One drawback of this study using social media as a tool to capture public opinions is the biases in data sample. The concentration of posted tweet messages represents only urban areas, especially concentrated within the states with advanced technology and large populations of well-educated occupants (M. Duggan, Ellison, Lampe, Lenhart, & Madden, 2015; Greenwood, Perrin, & Duggan, 2016; Xinyue Ye, Dang, Lee, Tsou, & Chen, 2018). The spatial distribution of posted tweets with hashtag #fracking is showed in Figure 3.6.

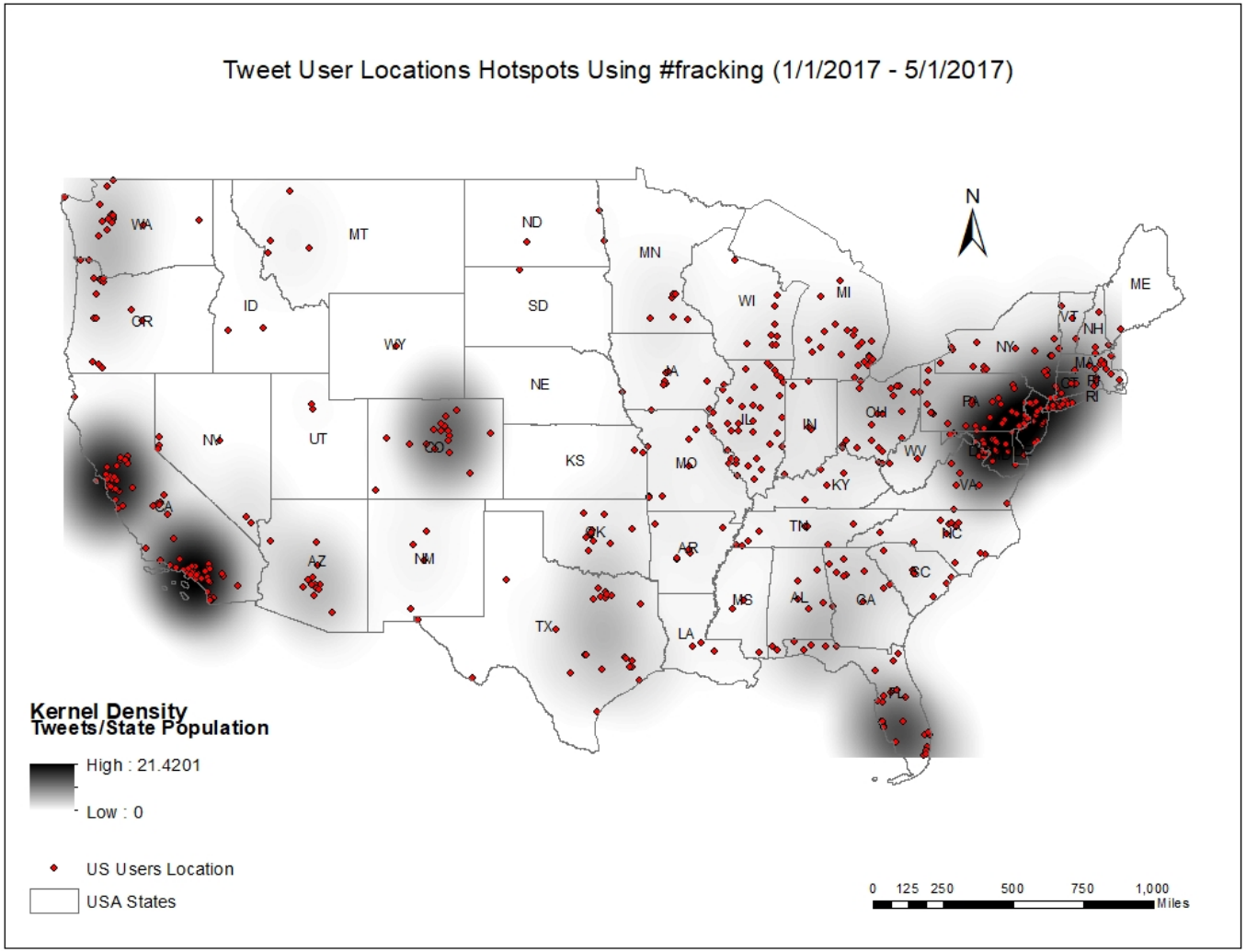

Figure 3 6 Hotspot Maps with High Concentration of Tweets using #Fracking

The above Figure 3.6 showed the clusters of posted tweets (normalized with total population from Census 2010). The concentration of Twitter users who posted their opinion on fracking are in California (S.F. Bay Area, Los Angeles-San Diego areas), Colorado, Florida, and the East-Coast urban areas.

The contribution of this fracking study on the integrated communication and geography theories demonstrate that the M^3D framework theory from communication is applicable as a general theory, especially in human geography. This communication framework theory anticipates that people and their opinions cluster in ways that reveal and reflect their geospatial locality, in this case, regarding their views regarding fracking operations. The objective of this study was to investigate the role of opinion leaders in influencing public opinion. These inquiries provided a window within which the formation of local and state energy policy could be understood.

3.3. Limitations in the research method

This review of the literature on the integration of communication theory and geography was limited by certain factors. The first was the limited number and adaptation of keywords used as a search parameter for searching tweets. For the fracking study, the word "fracking" was used as the key element of Twitter's Application Programming Interface (API). Fracking is a term used more by anti-fracking groups, whereas proponents tend to use the terms "shale-oil" and "natural-gas" in their social media. The inherent keyword bias is likely to have overrepresented one user group's sentiments. In the case of the death penalty study (see case study #1), the keyword used in this study was "death_penalty," which may have also reflected similar biases

relative to alternative terms such as “execution,” “death_sentence” and “capital punishment” (Tess, 2013).

A second limitation is the availability of tweets with geotagged data. Only a small proportion of Twitter users activate their GPS location on their smart phones. Geographically annotated social media is extremely valuable for modern information retrieval. However, researchers can only access publicly visible data, because the trend shows social media users rarely publish location information for privacy issues (Compton, Jurgens, & Allen, 2014). Therefore, the number of tweets with geotagged information captured in these studies is very low, representing approximately 1 to 5 tweets per week for U.S. Twitter users (Issa, Tsou, Nara, & Spitzberg, 2017). This limitation was adjusted for by using the “User Location” in the tweets attribute to estimate user location (Chandra, Khan, & Muhaya, 2011). The exact degree of error in this interpolation of location is not known.

A third limitation is that the M^3D is an evolving theoretical model, and its predictive status is still relatively nascent. Several of its potentially relevant variables were not examined in this particular study, such as social network structure of the communication, the rates of diffusion, the specific message features that facilitated diffusion of opinions on the death penalty or fracking, and so forth. Continued work on M^3D will pursue a more propositional and predictive model as empirical research continues to inform the theory’s content.

The fourth limitation is the interactions of robotic technology used by humans to multiply the posted tweets for individual or groups benefit. Using sentiment analysis in Case study 1, the authors were able to isolate a third of the tweets to get information related to a pre-prepared list

of words. The other two-thirds of unused tweets were irrelevant to the research topic. The authors will apply the sentiment analysis for future research on public perception of fracking.

3.4. Conclusion

This article offers a selective literature review based on case studies of social phenomena using public perception data derived from social media. The first study analyzed public reactions to Nebraska's abolishment of the death penalty in 2015, which was subsequently repealed in 2016. This study focused on the moral perspectives expressed in social media regarding the value of capital punishment. The second study was on fracking operations in the United States that triggered political debates from supporters and opponents. Both studies utilized public perception data from Twitter, and contained recoverable online conversation information, news commentary broadcasts, sharing forums, and social media news circulation. Both studies applied the multilevel model of meme diffusion (M^3D) as a communication perspective that accommodates the relationships between communication and human geography (Spitzberg, 2014). Meme source, space and place play a significant role in the diffusion of opinions in social media, and reveal local, regional, and state-level differences that are sensitive to events in real space. Much work still needs to be done to specify the interrelationships among these factors and will require disciplinary contributions from multiple fields (Tsou 2015). The presence of social media communication creates a new method for conducting geography research by collecting public perceptions from the publicly accessible Twitter communications. An ample collection of literature review was compiled in and stored in Mendeley reference management software.

The studies synopsized here were grounded in the two disciplines of Geography and Communication. These two social scientific fields are connected by the human activities to

communicate using social media. As communication technologies advance and are more ubiquitous in adoption, they will continue to demonstrate the necessity of integrating communication theory and human geography to understand the complex human dynamics of complex social issues.

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Table 3 2 List of Sentiment Words

List Word	Sentiments	List Word	Sentiments
bomber	Pro DP = 0	abolish	Against DP = 1
Boston	Pro DP = 0	against death penalty	Against DP = 1
Christopher Monfort	Pro DP = 0	amnesty	Against DP = 1
Conservative states	Pro DP = 0	anti DP	Against DP = 1
convict	Pro DP = 0	banned/bans	Against DP = 1
criminal	Pro DP = 0	black	Against DP = 1
favor of DP	Pro DP = 0	Cairo	Against DP = 1
federal	Pro DP = 0	Chambers	Against DP = 1
House	Pro DP = 0	China/Chinese	Against DP = 1
incest	Pro DP = 0	Christian teaching	Against DP = 1
indicted	Pro DP = 0	Clinton	Against DP = 1
kill	Pro DP = 0	conservative	Against DP = 1
murder	Pro DP = 0	costs more	Against DP = 1
Nigeria	Pro DP = 0	Egypt	Against DP = 1
prison	Pro DP = 0	Ernie Chambers	Against DP = 1
prosecutor	Pro DP = 0	execute	Against DP = 1
punish	Pro DP = 0	First conservative state	Against DP = 1
rapist	Pro DP = 0	jail	Against DP = 1
repeal	Pro DP = 0	justice	Against DP = 1
seek DP	Pro DP = 0	mentally ill	Against DP = 1
support	Pro DP = 0	moratorium	Against DP = 1
supports of DP	Pro DP = 0	Morsi	Against DP = 1
terrorist	Pro DP = 0	Mursi	Against DP = 1
Trump	Pro DP = 0	Nebraska	Against DP = 1
Tsarnaev	Pro DP = 0	Obama	Against DP = 1
War	Pro DP = 0	overturn death penalty	Against DP = 1
		Pakistan	Against DP = 1
		petition	Against DP = 1
		problems with DP	Against DP = 1
		Sanders	Against DP = 1
		Saudi	Against DP = 1
		Scalia	Against DP = 1
		sentence	Against DP = 1
		Sudan	Against DP = 1
		suspend	Against DP = 1
		woman	Against DP = 1
		wrongfully accused	Against DP = 1

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CHAPTER 4: MULTILEVEL MODEL OF MEME DIFFUSION OF FRACKING DEBATE TRHOUGH TWITTER[2]

4.1. Introduction to M^{3}D Model

The recent identification of potentially extensive shale-gas resources within the United States has generated mixed public and political responses. The purpose of this study is to apply the Multilevel Model of Meme Diffusion (M^{3}D) in an empirical case study of the fracking controversy. This analysis supports the heuristic value of the M^{3}D and the value of digital technologies as indexes of controversial opinions, showing the potential of monitoring and registering social opinion trends with geospatially sensitive methods. This study integrates the fields of geography and computer-mediated communication technology to account for social processes.

4.2. Background of Methodology in the Fracking Case Study

The development of unconventional sources of oil and natural gas in the US via hydraulic fracturing or fracking has created a controversy in public perception. This study captures series of tweets that mentioned the hash-tagged fracking and keywords of selected US states (Pennsylvania, Ohio, New York and California) in social media. Pennsylvania and Ohio largely

[2] This chapter is based on Sharag-Eldin, A., Ye, X., & Spitzberg, B. (2018). Multilevel model of meme diffusion of fracking through Twitter. *Chinese Sociological Dialogue, 3(1), 17-43*.

welcomed fracking, whereas New York banned fracking and California was ambivalent regarding fracking.

A meme is an analog of genes in biology; that is, a meme is any replicable message that spreads information or culture from person to person (Chesterman, 2016). An internet meme may take the form of an image, hyperlink, video, website, or hashtag. It may be just a word or phrase, including an intentional misspelling. For example, based on the Twitter search engine, the word "fracking" has a relatively specific referent and is tweeted and retweeted frequently (type #fracking). An advantage of using Twitter is the ability to track phrases, words in hashtags that are most mentioned and posted under the title of "trending topics". The hashtag convention allows users and researchers to search for a word contained in tweets that features a specific phrase or character such as "#" for hashtags. One theoretical approach to viewing the role of such technologies in the evolution of social and community attitudes is the multidimensional model of meme diffusion (M^3D), which provides an integrative framework for explaining such communication dynamics (Spitzberg, 2014).

4.3. Fracking as a "meme" in social media

The hashtag fracking (#fracking) was used in this project to track the Twitter message using the same hashtag. Some of the messages identified also represented viral words repeated by anti-fracking supporters. A meme is defined here as a unit of information that is spread (i.e. reproduced with some degree of fidelity or diffused) from person-to-person through a social network. Once a meme is identified, it can be used to classify different types of social phenomena (Kwak et al., 2010b). Most memes go only one or two steps or nodes in a social network, but memes that are spread widely can be said to be "viral" in their diffusion pattern

(Weng et al., 2012). Virality is a communication phenomenon in which thousands to millions share a meme over a relatively brief interval of time (Stroud et al., 2015).

The hashtag fracking was used to capture the viral messages related to anti-fracking sentiments sent by prominent actors or opinion leaders. The anti-fracking groups in the social media prefer to identify their messages using the hashtag fracking (#fracking). The support groups for fracking use other hashtags such as natural gas (#natural-gas) or shale oil (#shale-oil). Fracking memes can be identified as messages sent by an individual actor and then retweeted by many subsequent Twitter users. Examples of the memes identified in this study include:

> @iansomerhalder: There will BE NO #FRACKING in ST. Tammany Parish. Reelect Jake Groby to the Parish Council so we are safe.
>
> @cher: OKLAHOMA, NOW THE EARTHQUAKE CAPITAL OF THE WORLD, THANKS 2 FRACKING
>
> @MarkRuffalo: EPA science advisors say agency's claim of no 'widespread, systemic' #fracking water contamination is wrong
>
> @MarkRuffalo: Next up, stop fracking on Federal Lands. Citing Climate Change, Obama Rejects Construction of Keystone XL Oil Pipeline.

4.4. Public debate on fracking

Fracking is a drilling technique used in the oil extraction industry to stimulate the production of oil and natural gas after a well has been drilled. The drilling process is a combination of the conventional vertical drilling and the horizontal drilling technique to increase exploration and development of natural gas production. Pressurized liquids are injected into shale deposits, fracturing and releasing gas and oil deposits. Such displacement liquids are extracted and must subsequently be sequestered in ancillary locations, typically by injecting such

toxic liquid byproducts into subterranean deposits. This process gives access to harder-to-reach deposits and allows drilling (and fracking) in several directions from a single well (Gaswirth, Marra, & Cook, 2013). Fracking creates several social, environmental and economic challenges for host communities. Fossil fuel and energy-based companies see vast economic opportunity in such operations, but environmental groups envision vast ecological risks. The potential impacts of fracking are creating sharp tensions between stakeholders over the costs and benefits of drilling within the communities (Finewood & Stroup, 2012). Studies of the physical impacts of fracking should be expanded to address communities' concerns (Lave & Lutz, 2014).

The recent identification of potentially extensive shale gas resources within the United States has generated mixed public and political responses. On the one hand, there were those who claimed that the commercial development of these resources could play a major role in the nation's future energy mix, thereby reducing dependency on foreign sources of energy and stimulating investments in new jobs and businesses. On the other hand, some community groups have been campaigning to oppose future fracking due to a range of environmental and societal concerns (P. Jones, Hillier, & Comfort, 2015; Krupnick & Kopp, 2014). The community groups often felt caught in the middle of the public debate and were expected to be active in expressing their messages through individual beliefs whether to support or oppose the political agendas. The controversial issue of fracking in the political agenda will serve as an exemplary canvas upon which public attitudes were written in online and social media messaging and other traditional news media (J. E. Hopke & Simis, 2016; Jill E Hopke, 2015).

4.5. Literature review

This study combines three traditionally separate academic disciplines – communication, geology, and geography – that share a border where interdisciplinary activities constitute furtive movements at the territories (Adams & Jansson, 2012). The connection between communication theory and geography was first revealed by Hägerstrand in his publication on the Aspects of the Spatial Structure of Social Communication and the Diffusion of Information (Hägerstrand, 1965), and soon afterward Lefebvre in his significant definition of space and time (Lefebvre, 1974). Lefebvre suggested the 'representation of space' or the social space of communication is occupied by artists, writers, and philosophers. The space of communication is also shared by the internet bloggers, celebrities, and political figures.

Adams and Jansson (2012) argued that the social spaces of mediated communication reflects an abstract, theoretical, and production-oriented space involving the co-creation and representation of formal plans and abstract blueprints of powerful actors whose formalizations of space influence social action (Adams & Jansson, 2012). This comports with Tuan's (1977) conceptualization of space and place as virtual areas we come to know and visualize instead of being a fixed location (Tuan, 1977). ''Place'' in Tuan's definition captures the idea of deeply layered subjective experience grounded in the particularity of local conditions and discourses, whereas ''space'' implies potential as well as the actual movement of bodies, goods, capital, information, and communication (Edwards & Usher, 2000b).

Geographers have focused on the traditional role of communication in exerting and legitimizing political and economic power at various scales on the fundamental concept of space and mobility that is addressed in communication geography (Harvey, 1990; Sassen, 1991, 1994;

Scott, 2011). However, communication theory has been slow to incorporate place and space as central dimensions of human interaction, but as attention to mediated communication has increased, so has the development of communication theory (Couldry & Hepp, 2013; Hampton & Ling, 2013; Spitzberg, 2014).

Developments in social media communication, internet technology and their computer applications make it possible to employ online data mining in exploring these intersections of place and space. In scholarly research, such data have been used in understanding emergency disaster response (Comfort et al., 2010; Curtis et al., 2007), social movements (Earl & Kimport, 2008; Nagel et al., 2013), and terrorism (H. Chen et al., 2008).

One of the most opportune applications of such communication technologies is in the surveillance of public opinion. In particular, the media related research on environmental issues has followed the same path as communication research and technology (A. Hansen, 1993). The controversial issue of fracking represents an intersection of public opinion and political agendas and will serve here as an exemplary canvas upon which public attitudes are written in online and social media messaging and other traditional news media. Social media communications reflect, influence and form personal perceptions and opinions on social issues (Gunther, 1998; Spitzberg, 2006). In developing an opinion, people often do not use rationality to form their own opinions or make their decisions. People often express the opinions of friends or those of opinion leaders or social "actors" who consist of prominent people, celebrities or politicians. People learn about public opinions from media coverage, especially when the news contains contradictory information (Noelle-Newman, 1974).

This study analyzes the public perceptions toward fracking issues with a focus on the level of support or opposition from people whose lives are affected by fracking operations (Charles Davis & Fisk, 2014). Although hydraulic fracking technology relying on high-pressure water and chemicals has increased the domestic production of natural gas and consequent jobs over the past few years (Shafiee & Topal, 2009), it has become an increasingly controversial debate with rising public concerns about the drilling impacts on environmental quality and public health (Simonelli, 2014).

The opponents of fracking or anti-fracking groups have focused their campaigns on the problems of environmental impacts, public health, and earthquake. Some studies indicated that fracking is linked to drinking water contamination and earthquakes (Durfee, 2014; Mitka, 2012; Myers, 2012; Osborn et al., 2011). The massive operation of fracking requires a staggering two to four million gallons of water for a single lateral, as well as 15,000 to 60,000 gallons of chemicals. These quantities of water are multiplied by the number of wells drilled at any given site. Transporting the liquids involves fleets of tanker trucks and large storage containers (C. Mooney, 2011). In the US, fracking was disallowed in three states – New York, Vermont, and Maryland – due to the risk of contaminated drinking water (Boersma & Johnson, 2012).

On the other side of this controversy, a substantial media campaign has been devoted to covering both the economic aspects of fracking-related issues and cleaner technology in comparison to the coal industry (Kiger, 2014). In addition, state policy makers and shareholders have attempted to reconcile the drilling practices with oil and gas statutes that were enacted before the emergence of environmental policy concerns (Charles Davis & Fisk, 2014). In the beginning of the 2010s, in a depressed economy like Ohio's during the recession years,

economic development and job creation from shale exploration and production were considered vital to stimulating employment opportunities. At least one study suggested that Ohio would need to continue to make economic reforms if it were to prosper in the long term, given that no one industry – in this case, energy development – could adequately serve as a reliable long-term economic engine (Weinstein & Partridge, 2011).

Research has examined both statewide and local economic effects of fracking activity. For example, one study emphasized the employment growth generated by the Utica shale wells drilling (Hill & Kinahan, 2013). Another study team investigated the statewide job prospects of shale development in Ohio. Findings from this study estimated the fracking industry would generate 1,500 jobs for engineers and architects and 1,000 jobs for environmental technicians by 2014. The total of the state's Gross Domestic Product (GDP) was expected to increase by $4.9 billion in 2014 from the development of the Utica shale formation (A. R. Thomas et al., 2012).

A recent study estimated that the mining counties in Ohio had considerably faster per-capita income growth compared to their non-drilling peer counties. The income and benefits came from royalties or lease payments and the high wages in the industry. In manufacturing-heavy states like Ohio, the unemployment rate shrank from above the national average in most years (8.3%) to a point below the national average in August 2012 (7.2%) (Throupe et al., 2013). This study estimated the Marcellus and Utica shale plant would create 40,000 jobs and $14 billion in tax spending for the next four years statewide (Weinstein & Partridge, 2011).

Other fracking-related studies in Ohio focused on earthquake incidents related to hydraulic fracturing. One study identified 77 earthquakes with magnitudes approximately 1 to 3 Richter scale in Poland Township, Mahoning County, Ohio that occurred between 4 and 12

March 2014 (Holtkamp et al., 2015; Zoback & Gorelick, 2012). In another study, the same authors identified a series of earthquakes in Youngstown in 2011 with a magnitude of 3 Richter scale. These incidents were correlated with a large amount of wastewater injection into the well located approximately 18 km to the northwest (Skoumal et al., 2015).

Given polarized opinions and research on the social utility of fracking, the public at large may find it difficult to formulate a rational or objective opinion regarding public policy. As such, it is expected that with complex public policy issues such as fracking, people may rely substantially on public opinion leaders, and further, that the social media presence of these leaders may well serve as accurate signals of the status of public opinion. In this study, theses opinion leading social actors are identified from the hashtag keywords that distinguish the actors as pro-fracking (#natural-gas, #natgas, # shale-oil) or anti-fracking (#fracking). The pro-fracking groups included the individuals or groups associated with the government, regional economic development, and natural gas and oil companies. The anti-fracking groups consisted of the environmentally concerned groups, university, and research groups.

The contribution of this study will be a surveillance of public opinion(s) on the public policy of fracking in four U.S. states facing the gas boom with all its positive and negative impacts. In addition, this study aims to examine the role that opinion leaders play in signaling or influencing public opinion. Such inquiries provide implications for the formation of local and state energy policy.

4.6. Conceptual framework

This paper employs the meme diffusion model on public perceptions represented by the social groups as a reaction on fracking. The use of social media is the key to testing the power of

communication technology as a tool to predict social phenomena. Social media supports "backchannel" communications, allowing for wide-scale interaction that can be collectively resourceful, self-policing, and generative of information that is otherwise hard to obtain (Sutton, Palen, & Shklovski, 2008). Tracking these message exchanges will assist in the early detection of economic and social activity related to the growth of the oil and gas industries in Ohio and some other states as a study comparison.

Memes emerge in two typical ways – evememic (event-based) messages arise when events in the world elicit similar symbolic and visual representations of those events across communicators (e.g. tweets, emails, and images associated with a tremblor or earthquake), whereas etymemic (text-based) messages arise from texts that are replicated and evolve as they are adapted across communicators (e.g. the image of tap water on fire as a sign of gas pollution of groundwater supply). Polymemic episodes represent a linkage of evememic and etymemic episodes, which occur when events generate memes that then take on a life of their own through memetic diffusion and evolution (Spitzberg, 2014).

M^3D proposes that memes propagate more rapidly, more extensively, or more influentially based on five levels of predictive factors: meme level, source level, social network levels, societal level, and geotechnical levels (shown in Figure 1.2 in Chapter 1). For example, memes, such as tweets, are more likely to diffuse extensively to the extent they provide novel information (meme level), derive from a more credible or popular author (source level), enter an internally homophilous group with heterogeneous boundaries (social network level), encounter minimal competition from other groups' memes (society level), in a context of high technological capacity (geotechnical level).

In any analysis of memetic episodes, the most basic level of analysis is the meme itself. Thus, the first level of M^3D is the meme level—some messages are more memorable, replicable, stimulating, and persuasive than other messages. Messages can be designed in an infinite variety of ways, and some message designs are more influential than others, whether face-to-face or in more mass communication contexts. In a complex public policy context, social media memes have the potential for mass diffusion and subtle systemic reflections of, and effects on, public opinion (Heylighen & Chilens, 2009). One common message design element that facilitates message influence and replication is the hashtag. The user of a hashtag word expects the word to be repeated and replicated across the social media. In this study, I used the hashtag word "fracking" (#fracking) as the signal seed for replication.

Memes originate from actors communicating, and therefore the next level of the M^3D theory is the actor, or source, level. In general, actors who are competent, credible, and popular are capable of producing memes that are likely to be replicated widely (Spitzberg, 2006). According to early founders of communication theory, a small minority of "opinion leaders" (actors) act as intermediaries between the media and the majority of societies (Elihu Katz & Lazarsfeld, 1955b). Although social media may be altering, or in some cases delimiting the role of the opinion leader, the status and popularity of highly influential actors are still important factors in the process of meme diffusion. These actors may dominate any given network of interaction on a given topic.

We sorted the retweeted messages and grouped the texts by username to identify the most popular actors whose messages were retweeted multiple times by other users. For example, from all the tweets in the dataset with hashtags fracking, there are 46% retweeted text messages

(identified with the sign RT @). The highest number of retweeted messages was posted by @iansomerhalder for 874 tweets or 3.39% of the selected retweeted messages (a total of 25,779 tweets). The second highest number of retweets was sent by @cher with 446 text messages that were retweeted 446 times (1.73% of all retweeted messages). Third place was @MarkRuffalo with 2.7 million followers, who posted various tweets with anti-fracking messages.

The next level of the M^3D theory represents the social networks through which memes propagate. The subjective and the objective or structural features of social networks may provide some memes with a better set of affinity paths than other memes (Iribarren & Moro, 2009). Some research indicates that memes diffuse better with a sender who has many friends (Kee, Sparks, Struppa, & Mannucci, 2013), especially within homophilous network groups. The example of social networks that are positively disposed and supportive of fracking activities include groups such as the natural gas and oil companies ExxonMobil and Chesapeake Energy.

Furthermore, certain evememic processes may facilitate the formation of homophilous groups. For example, the movie Gasland (Fox, 2010) promoted an activist awareness of the environmental hazards of fracking. In contrast, opponent groups with homophilous but negative dispositions include groups such as the EPA, environmental activists' groups, and landowners at risk of having their property fouled by such industry. Although earlier studies showed that landowners received royalties as an indirect benefit, reflected as "shale gas has been a terrific boon", there have also been counter arguments that a boomtown was unsuitable to live in because of unmanaged growth (Sovacool, 2014; K. Thomas & Kinnaman, 2011).

At the geotechnical level of the M^3D model, the state level of communications of pros (support) and cons (opposed) regarding fracking should reflect geospatial and political influences

over fracking related communications. For example, New York state has already banned fracking (Tran, 2014), and some counties in California have banned fracking as well (Boudet et al., 2014). Given active movements to ban fracking statewide in California, we captured over 560 text messages from California expressing tweeters' opinions against fracking. Less wealthy states like Ohio and Pennsylvania, however, have facilitated the fracking industry due to the promise of job creation and economic development. Other states, such as Oklahoma, has been considering regulating fracking due to escalated earthquake activities associated with fracking operations. These geospatial distinctions will often also reflect political differences, as California and New York are majority Democrat, and Ohio and Pennsylvania are typically more Republican or swing states.

The M^3D framework theory anticipates that external factors at the geographic, technical, and infrastructure levels also play a significant role in how memes diffuse. The geospatial locality of fracking operations is likely to interact with proximity dynamics of social networks and neighborhoods, from the personal level to the state level of meme diffusion. Fracking operations clearly involve geospatially clustered areas and occur in spaces that vary in their online and social media demographics and political leanings. The government support in each state is likely to predict the dominant valence of online communication content on fracking, although protest and resistance communication often goes to where the problem is, as with oil pipeline protests. Specifically, in conservative political states, in which the political parties and government officials support the installation of extensive fracking industry, memes are likely to reflect highly polarized social networks that evoke the passions of the opposition campaigns. In contrast, in states that have effectively banned fracking or that face no prospect of fracking, the states would show a relatively less randomized distribution of memes.

4.7. Methodology

Twitter data were downloaded with a keyword #fracking. The hashtag fracking (#fracking) captured tweets worldwide; however, the study area in this research analyzed four states inside the contiguous United States as case studies. I used the keywords of state names mentioned in the texts as a proxy to relate to the groups of tweet users that mention the state names during the posting of their opinion of fracking. For geographic information, I used the geotagged information and the Twitter users' location to identify the longitude and latitude of tweet users (Ajao, Hong, & Weiru Liu, 2015). Ajao, et al. (2015) suggested that these two methods (with geotagged and user's location-based data) can be used in location inference technique. However, the proportion of geotagged tweets is very few, less than 1% of total tweets (Cheng, Caverlee, & Lee, 2010). In this study, I used the users' locations uploaded to the Geographic Information System (GIS) to analyze the relationship of tweet users' locations, their opinions on fracking and the state's policy on fracking.

The data were appended to a spreadsheet for the text sorting purpose. Tweets supportive of fracking were coded (+1), tweets opposing fracking were coded (-1), and tweets reflecting a neutral opinion, or no opinion or text unrelated to fracking, were coded as (0). The scope of the study in this paper included four states: Ohio, Pennsylvania, New York, and California. The fracking activities were still in active operation in Ohio and Pennsylvania, whereas New York and California had banned, or appeared poised to ban, fracking. New York is the second state after Vermont to ban fracking (Tran, 2014). In March 2017, Maryland became the third state to ban fracking (Witte, 2017).

In this study, we developed a coding system using the type of interaction that occurred in the dataset. There are two ways of grouping the tweet texts:

1) Coding using username: finding the highest numbers of tweets by username and user id (user identification numbers)
2) Coding using retweeted messages: finding the most retweeted text messages ("RT @").

4.8. Coding Using Username

The username appears as the first field of Twitter attributes in the dataset, and contains unique alphabetic combinations chosen by the user to log in to the program. The user's name was ranked to select the highest numbers of tweets posted by an individual or group of people belonging to an affiliated institution who are actively sending messages related to fracking. The same username usually has the same user ID if the person uses the same account on Twitter. From the dataset, we found that the highest username posted the same tweets more than 1,000 times, using the message that was originally posted in @Pinterest. I reviewed the posted time that shows that the tweets were sent between split seconds (0:00:00) and 0.02 seconds (0:00:02). Based on the timestamp on posting over thousands of tweets in two days, perhaps the users utilized a robotic electronic device. However, it is outside the study boundary to analyze the probability of robotic technology used on Twitter. Since this message was for marketing purposes and not related to public perception, we put this username under "unrelated" group and deleted from the analysis.

In another example for coding with username, we found an individual with a common username (for example, @JohnDoe, the original name is not mentioned to protect users' privacy) who posted over 1000 tweets to various mentioned names (@ username). After we followed this

Twitter user and rechecked with Google search, we found that he was using the tweets for marketing purposes related to his company. I collected these unrelated tweets and excluded the text from the analysis.

4.9. Coding Using Retweeted Messages

This second group of coding using retweeted messages is an effective selection method of coding compared to the first group (using user_name) because most of the retweeted messages had already been chosen by the Twitter users to represent the fracking debate suitable to represent the sender's opinion. The "RT@" signs means the source of the tweet has been retweeted by another tweet user who is attracted to the message from the original tweeter (Hermida, Lewis, & Zamith, 2014). Some of the original messages have been retweeted more than 500 times in one week of the tweet download cycle. These retweeted messages were grouped based on the username mentioned after the "RT" sign (RT @username). The identification of the retweeted users includes: the affiliated group they represent (i.e. support of fracking groups, anti-fracking groups), the organization represented by the account (environmental group, natural gas industry), the mainstream media organization, political actors, and independent bloggers (Heaivilin, Gerbert, Page, & Gibbs, 2011).

Finally, for coding purposes in this study, we used a "plus 1 sign" for all statements supporting fracking ("+1"), a "negative 1 sign" for all statements condemning fracking ("-1"), and zero ("0") for all other neutral or unrelated text comments on fracking. This method for manual coding has been applied for sentiment analysis in social media communication (Stieglitz & Dang-Xuan, 2011).

I analyzed the data based on the specific condition of the fracking operation. Ohio and Pennsylvania were analyzed and compared together since these two states are in an ongoing heated debate regarding fracking operations. New York and California were analyzed separately due to the different policies applied for fracking. New York has already banned fracking, whereas although not prohibited at the state level, the majority of cities and counties in California oppose fracking. These four states, therefore, offered a potentially varied set of contextual applications of M^3D theory. Scholars have sought to expand the use of social media data on a variety of research topics (Earl & Kimport, 2008; Spitzberg, 2014). As the size and complexity of datasets become increasingly overwhelming, data analysis and visualization have become necessary to focus on a specific topic of research.

4.10. Data Collection and Analysis

The data for this study were downloaded from Twitter, a popular social networking and micro-blogging internet application that allows users to post and read short messages, limited to 140 characters. The data downloaded through the key elements of Twitter's Application Programming Interface (API) allowed the Twitter users to search and capture certain keywords at no cost (Yin et al., 2015). The authors used the users' locations and keywords of state names mentioned in the texts as a proxy to relate to the groups of Twitter users that mention the state names during the posting of their opinion of fracking.

4.10.1. Case studies of public perceptions of fracking captured in tweets from selected states

According to the US Gallup poll, the opposition to fracking in the US rose to 51% in 2016 from 40% in 2015 (Swift, 2016). However, the public perception comparison from state to state produces different results. A report by the National Surveys on Energy and Environment

(NSEE) found that the public perceptions in Pennsylvania were more favorable to fracking compared to those in New York. The NSEE survey results reported that the majority of Pennsylvanians (54%) supported the extraction of shale gas in their state, while only 29% of New Yorkers supported this form of drilling within their state borders (Brown, Hartman, Boric, Rabe, & Ivacko, 2013). Historically, hydraulic fracturing has been used in Pennsylvania since the 1960s and horizontal drilling techniques were first used in the 1920s. In this sense neither are "new" techniques. However, neither was sufficiently developed until the last decade for large-scale use, in tandem with deep shale formations such as the Marcellus (Pifer, 2012). Ohio has been active in drilling for natural gas after the governor permitted it in 2011.

In New York State, natural gas fracking has been banned since February 2013 by Governor Andrew Cuomo. In December 2014, New York's Court of Appeal by a 5–2 vote upheld the lower court decision supporting the fracking ban imposed by Dryden and Middlefield. By then approximately 170 communities had enacted the ban. Right after the court decision Governor Cuomo finally imposed a permanent moratorium (Morris, 2015).

In California, fracking bans were passed for only two counties, San Benito and Mendocino. Such a ban failed to pass in Santa Barbara County. Although anti-fracking voters and environmentalists are very active in pursuing a fracking ban, Governor Jerry Brown rejected a statewide fracking ban in California. From most tweets in each state, we predicted that California would follow New York in the statewide ban on fracking. The process of analyzing the data is a manual calculation, due to the sensitivity of interpreting public perceptions. For future work, I suggest combining the manual processing with the Natural Language Processing

(NLP) to select words to accurately reflect public perceptions. Table 4.1 below shows an example of ranking perceptions into attributes.

Table 4.1 shows the manual coding applied in the fracking study based on the text posted in each posted Tweeters with a fracking hashtag. The coding for the support of fracking (+1) or the anti-fracking tweets was based on the list of words posted such as “waste” (-1) because this is the word commonly used for the anti-fracking group to spread the fear of fracking feeling among public.

Table 4.1 Sample of Tweets Texts with Coding to Reflect Public Opinion

Text	Support	Oppose	Neutral
"Ohio Study Finds More Costs than Benefits in Shale Gas Drilling" #fracking @conway_joanEHE @MDSenate @LarryHogan =>http://t.co/kXoeFACU1h		-1	
#Ohio businesses pick apart Kasichâ€™s tax proposals http://t.co/wSJsJEZNWY via @DispatchAlerts #taxes #fracking		-1	
@Chesapeake Testing Waterless #Fracking at Ohio Well http://t.co/UujIHfCvDK #Shale			0
@Chesapeake testing waterless #fracking at Ohio well http://t.co/3DHhG3QgYj			0
Activist organizations file motion to stop "unregulated" disposal of #fracking waste in #Ohio. http://t.co/NWjjCYqkGQ		-1	
After court decisions in Ohio and Pennsylvania, #fracking is becoming a "shale of two cities." http://t.co/GVgDAveSiN @buchanannews	1		
Another #Ohio #fracking ban bites the dust @ellengilmer http://t.co/HW0ysiadjn	1		
Damn: Ohio judge says cities have to allow #fracking inside city limits. It's going to take a state law change. http://t.co/dTRQ78pKEp		-1	

4.10.2. Pennsylvania public perceptions on fracking

Approximately 400 tweets mentioned the keyword Pennsylvania in the text. We targeted this group to represent the tweets from the state of Pennsylvania, which has experienced fracking operations longer than Ohio. The public perceptions in Pennsylvania are similar to the worldwide reaction. The tweets from Pennsylvania, a state with a long history of fossil fuels production, showed the majority of tweeters were opposed to fracking (79%), a drastic comparison compared to the supporters of fracking who represent only 7% of the state of Pennsylvania in social media opinion. The comparison of the four states' results is presented in Table 4.2 below.

Table 4.2 Public Perception of Fracking in PA, OH, NY, and CA

	Pennsylvania		**Ohio**		**New York**		**California**	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Supported	27	7%	235	34%	27	5%	67	5%
Neutral	54	14%	189	27%	301	59%	727	51%
Opposed	297	79%	267	39%	184	36%	623	44%
	378	100%	691	100%	512	100%	1,417	100%

Table 4.2 shows that Ohio has a large support of fracking (34%) compares to the other three states. There is an expectation that the fracking operations will lift up the state's economy from long devastation of economic crisis due to job loss in the auto and steel industry.

From the Pennsylvania Twitter data, we identified the actor usernames with the most retweeted texts. The influential persons or actors are the most popular people in the social media; they might be celebrities, public figures, political parties, or the news media (online news, television and radio station). The list of major influentials in Pennsylvania, Ohio, New York and California tweets captured with #fracking is displayed in Table 4.3.

Table 4.3 Major Actors in Twitter with Hashtags (#fracking)

Pennsylvania Supporter Major Actors	**Ohio** Supporter Major Actors	**New York** Supporter Major Actors	**California** Supporter Major Actors
@EIDMarcellus	@EIDMarcellus	@CuomoWatch	@EnergyInDepth
@MarcellusGas	@EnergyNation		@ruairimckiernan
@MarcellusShale	@EnviroEdgeNews		
@Shale_Advocates	@FrackNation		
@ShaleGasNow	@JohnKasich		
@Tri_State_Shale	@MWEnergynews		
	@OccupyYtown		
	@realDonaldTrump		
	@shalegasnow		
	@YoungBLKRepub		
Opposition Actors	Opposition Actors	Opposition Actors	Opposition Actors
@katiervalentine	@ConCitOhio	@BerksGasTruth	@350
@Newsweek	@EarthWorks	@DOC NYCfest	@LoveLeitrim
@nytimes	@ksecus	@EcoWatch	@ourcarbon
@OccupyYtown	@Montel_Williams	@MFG.com	
@PublicHerald	@OccupyYtown	@MikeBloomberg	
	@OhioEnviro	@OccupyWallStNYC	
	@OhioGreenParty	@WAMCRadio	
	@ourcarbon		
	@StopFrackingOH		
Neutral Actors	Neutral Actors	Neutral Actors	Neutral Actors
@amaditalks	@ballotpedia	@adamjohnsonNYC	@JerryBrownGov
@cleveland_news	@cleveland_news	@AlterNet	@NewsbyMeredith
@FracTracker	@FracTracker	@EcoWatch	
@KeystoneReport	@KeystoneReport	@nytimes	
@marcellusminutes	@marcellusminutes		
@PetroChase	@OhioEnviro		
@Publici	@OhioEPA		
	@PetroChase		
	@PolitiFact		
	@Publici		
	@WSJ		

The major concerns regarding fracking operations in Pennsylvania refer to environmental and health hazards, most of which point to water contamination (72.05%). Another major concern is policy related to some townships that face votes to allow fracking for economic reasons. The detailed categories of all concerns related to fracking in the four states are listed in Table 4.4 below.

Table 4.4 List of Public Concerns related to the Fracking Operations

Pennsylvania	Total Tweets	Percent
Water Contamination	214	72.05%
Township policy on fracking	38	12.79%
Pipeline	14	4.71%
Radioactive and pollution	7	2.36%
Health Hazard	7	2.36%
Generic warning on Fracking	7	2.36%
Environmental Hazard	10	3.37%
Total Oppositions	297	100.00%

Ohio	Total Tweets	Percent
GOP Campaign about Fracking	136	50.94%
National Forest Destruction	42	15.73%
Earthquakes	24	8.99%
Pipeline and Injection wells	16	5.99%
Environmental pollution	15	5.62%
Water Contamination	14	5.24%
Generic warning on Fracking	11	4.12%
Township allows fracking	9	3.37%
Total Oppositions	267	100.00%

New York	Total Tweets	Percent
Protest to Government	91	49.46%
Protest by Environment Group	69	37.50%
Climate change	4	2.17%
Miscellaneous	20	10.87%
Total Oppositions	184	100.00%

California	Total Tweets	Percent
Water Contamination	227	36.44%
Concerned re: Kern County	193	30.98%
Protest via Hollywood actors	66	10.59%
Protest to Government policy	65	10.43%
Protest via religious leaders	62	9.95%
Miscellaneous	8	1.28%
Climate concerned	2	0.32%
Total Oppositions	623	100.00%

Table 4.4 above shows that people from a different state have their own concern about fracking. The most common concerns are the worries about water pollution environmental and water pollution. The tweets from California and Pennsylvania expressed most of their concerned-on water contamination.

The supporters of fracking consist of some natural gas and oil companies, which posted only 7% of the total tweets in Pennsylvania. The influence of the fracking industry on social media does not appear sufficiently large to attract public notice. However, their advertisements on public television and radio got increasingly intense. The North Fayette-based Marcellus Shale Coalition started a statewide advertising campaign aimed at promoting and rebranding gas extraction. Michael Pavone, the CEO of Harrisburg-based advertisement firm Pavone, previewed the campaign and said the coalition, a lobbyist and trade group, contracted to produce the ads and keep airing them through the following summer's state budget negotiations (Conti, 2014). A pro-fracking group reserved 323 TV ad spots at a cost of more than $299,000 for the nine weeks leading up to the November election at a Denver station (Fish, 2014).

The fracking opponents are mostly bloggers who retweeted their negative news from New York-based newspapers. New York state banned fracking in 2010 (Hoye, 2010), and the news agencies with headquarters in New York tend to reflect positions consistent with the state policy against allowing fracking.

The neutral group posted about 14.3% of the total tweets in Pennsylvania. The actors in this neutral group were mostly newspapers and journalism bloggers. The tweets were largely announcements of policy related to fracking activities. This group did not post any opinions of support for, nor opposition to, fracking.

4.10.3. Ohio public perceptions on fracking

The Ohio tweets revealed completely different results from the Pennsylvania tweets. From approximately 700 tweets, the public opinion in Ohio was divided almost equally among the three groups Figure 4.1 below. The support of fracking in Ohio was enhanced due to the 2016 GOP presidential election debates. In particular, the comments from Donald Trump and Governor John Kasich mentioned the prospect of job creation and economic development as a result of fracking operations in Ohio.

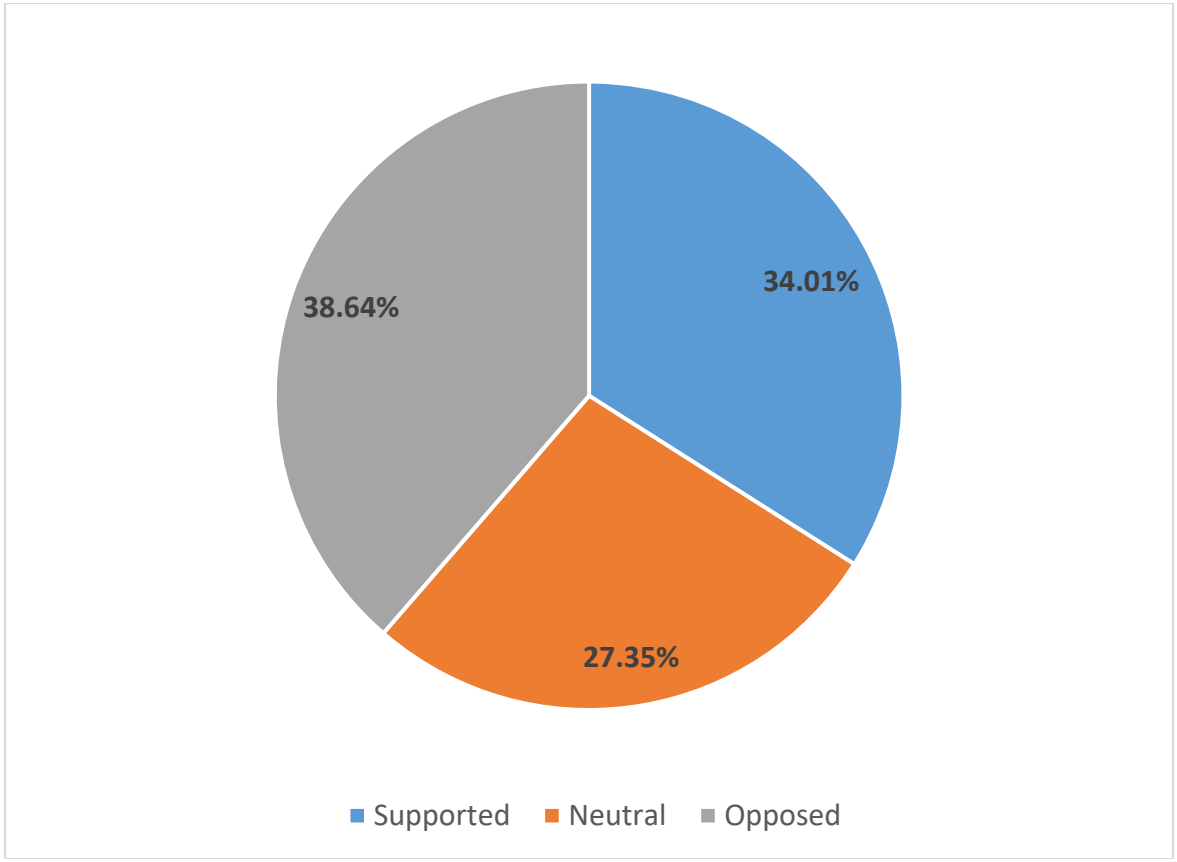

Figure 4.1 Percentage of Public Opinion in Ohio Fracking Debate

The main fracking concern in Ohio was the fact that the federal government proposed fracking in Ohio's national forest. The Bureau of Land Management (BLM) was considering allowing fracking in Wayne National Forest (50.94%). This concern was related to the GOP debate that was used as a counterargument by the opposition to frack. The opposition retweeted that statements by Donald Trump and John Kasich were untrue.

Public debate in the city of Youngstown resulted in extensively tweeted public opinions. Youngstown's citizens voted 'no' for the fifth time to a ban on fracking. Although there were some earthquakes near Youngstown commonly attributed to wastewater injection from fracking disposal wells, the voters still believed that natural gas fracking operations would bring back jobs to this shrinking city.

In summary, in the state of Ohio, without taking the political debate into consideration, the major concern in Ohio was the expansion of fracking sites into the national forest. Another concern in Ohio is the occurrences of earthquakes related to the injection well from fracking backflow of water.

4.10.4. Comparison between Ohio and Pennsylvania of public perceptions on fracking

Comparison of the two states of Ohio and Pennsylvania showed the different ranks of concerns about fracking operations in public opinion. Compared to Ohio, Pennsylvania has decades of experience in dealing with fracking. Pennsylvania communities were worried about the water contamination hazard. In Ohio, people were worried about the expansion of the fracking operation to allow drilling in the national forest. The next public concern in Ohio was the recent earthquakes triggered near fracking sites.

4.10.5. New York public perceptions on fracking

In New York state, the fracking opponents were mostly bloggers who retweeted their negative news about fracking from New York-based newspapers. New York state was considering a ban on fracking since 2010 (Esch, 2010). Finally, fracking was officially banned by Cuomo's administration because of concerns over health risks. After the ban on fracking in New York state, there were not many supportive opinions for fracking, as only 5 percent of tweets supported fracking in the entire Twitter dataset (see Table 4.2). The majority sources of retweeted texts were posted from liberal news media such as The New York Times and The Wall Street Journal. The news media outlets were not inclined toward clear support or opposition to fracking. The most retweeted fracking news from New York state was from The New York Times, The Wall Street Journal, and Newsweek.

The only major supporter of fracking was the "Cuomo Watch" group that had its own political agenda as posted in its Twitter profile as "Dedicated to documenting why some believe an out of touch Gov. Cuomo needs to go". Their tweets were not pro-fracking, but this group posted slogans to challenge Cuomo's fracking policy.

The list of most frequently tweeted concerns posted in New York state can be categorized into the following: (1) messages intended for a government body, and (2) fracking protests from the radical opposition and environmental activist groups that retweeted their messages from the same source by the username Occupy Wall Street NYC.

4.10.6. California public perceptions on fracking

California was in the process of banning fracking from the state. The majority of the opposition to fracking was comprised by the environmental activists and the global

environmental protection groups seeking to persuade the governor to ban fracking. Governor Jerry Brown was an active tweeter, and although his tweets were generally neutral, he invoked his executive right to say no to banning fracking. Only 5% of the total tweets from Californians supported fracking, in comparison to 44% of the total tweets that were opposed to fracking (see Table 4.2).

The proportion of public opinion in California was similar to the proportion in New York. In both states, the percentage of people supporting fracking was only 5%, with the rest divided between neutral and opposed to fracking, although the percentage of those who were opposed to fracking was slightly smaller than those who are neutral.

The supporting actors for fracking mostly represented the shale oil industry and their tweets that were retweeted by other bloggers. The Governor of California had the highest proportion of followers (over a million), but the tweets were mostly neutral. The opposition actors were nominated by environmental groups and climate concern groups. The major concern in California referred to water contamination from the wastewater during the fracking process. The second major concern was in Kern County, a major fracking site in California (showed in Table 4.4).

4.10.7. Comparison between New York and California of public perceptions on fracking

The rank of public concerns about fracking operations in New York and California were not similar. This represents a potential bias in social media, as people may diminish their tweeting once they like the status quo. Therefore, comparison between these two states does not provide a good match. New York state had already banned fracking, so the public did not post major concerns regarding fracking on Twitter. The public showed they were concerned about

climate change more than fracking. The negative opinions regarding fracking were mostly posted by environmental activist groups and anti-government protesters.

In contrast, the public opinions in California were still in the process of informing the Governor of California regarding a fracking ban. The majority concern was the water contamination from the fracking process as California grappled with a drought. Another concern was concentrated in or around Kern County, where major fracking operations were occurring. Hollywood actors and religious leaders also played influential roles in directing and reflecting public opinions about anti-fracking actions. Surprisingly, given current political context, climate change was the least frequent concern expressed in tweets.

4.11. M^{3}D Model Applications

The first hypothesis in this study predicted that the popularity of a meme depends on the popularity of some individual actors and group of actors or organizations that play a significant role in meme diffusion. These influentials could be personal figures, politicians, religious figures, or celebrities such as Hollywood and TV actors. The actors could also include organizations that are supporters of fracking like the Marcellus group, Shale Nations, and Energy News. The opposition actors in organization groups include environmental activists, the Green party, government opposition parties, and groups with aligned objectives. The Twitter data collected in this study found that hypothesis #1 was supported: memes diffuse more extensively based on the popularity of influentials. The actors in meme diffusion were divided into two categories:

- Individual actor
- Group actor

4.11.1. Individual actor

The individual actor is a public figure with a popular Twitter account, followed by over a million followers. Examples of individual influentials are governors, senators, presidential candidates and other political figures. The news from the actor is retweeted by regular bloggers through meme diffusion. Table 4.5 below, displays a list of the most popular actors in the social media captured in this study. At the top of the list were Donald Trump and Hillary Clinton, each with 5 million followers (at the time of the analysis). The tweets reflected public opinion at a scale that public opinion surveys often cannot represent.

Table 4.5 Most Popular Actors in the Fracking Debate

Tweet Username	Real Name	State	Follows	Followers*	Description
Most Popular Individual Actors in the Social Media					
@realDonaldTrump	Donald Trump	NY	48	4,983,480	The official Twitter profile for Donald Trump
@HillaryClinton	Hillary Clinton	NY	518	4,948,051	Wife, mom, grandma, women+kids advocate, FLOTUS, Senator, SecState, hair icon, pantsuit aficionado, 2016 presidential candidate
@MikeBloomberg	Michael Bloomberg	NY	324	1,086,095	Entrepreneur, Philanthropist, and Three-term mayor of New York City
@JerryBrownGov	Jerry Brown	CA	29	1,051,011	Jerry Brown, Governor of California
Most Popular Group of Actors in the Social Media					
@350	350 dot org	CA	19,520	272,875	Join a global movement that's inspiring the world to rise to the challenge of the climate crisis. 350=safe upper limit of CO2 in atmosphere.
@PolitiFact	PolitiFact	OH	4,517	233,012	The editors and reporters of PolitiFact, an independent fact-checking journalism website.

@OccupyWallStNYC	Occupy Wall Street NYC	NY	7,196	198,554	Occupying Wall Street since Sep 17, 2011. Standing with the global #Occupy movement.
AlterNet	AlterNet	NY	17,104	104,389	AlterNet is a progressive news magazine and online
Most Popular News Media in the Social Media					
@nytimes	New York Times	NY	987	22,325,832	Where the conversation begins. Follow for breaking news, special reports, RTs of our journalists and more
@WSJ	Wall Street Journal	NY	1,024	8,339,358	Wall Street Journal Breaking news and features from the WSJ Tweets
@Newsweek	Newsweek	NY	3	2,726,943	Newsweek, Stay relevant

*) numbers of followers taken during the time of the research

4.11.2. Group actor

A group actor is a tweet username that represents a group of people with the same political affiliation, or a tweet username belonging to a business entity. The tweets under these usernames reflect the group messages to the government or to the general public. The group actor is commonly used by those who support, are neutral or are opposed to fracking. Table 5.4 shows a sample of the most popular group actors captured in this study. The second hypothesis of the M^3D predicted the influence of the social media networks in diffusing memes. We found support for hypothesis #2. The social network reflected a substantial influence on public opinions, as indicated by the numbers of retweeted news (@RT) tweets that originated from news media. Among the top news media captured in this study were The New York Times, Wall Street Journal, and Newsweek. The Occupy Wall Street movement was one of the internet newsgroups with a radical view that was opposed to government policies.

The newspapers on Twitter have had large numbers of followers since they joined Twitter in 2007. The top newspaper on the list was The New York Times (NYT) with more than 2.6 million followers, followed by The Wall Street Journal with 465,000 followers (Porter, 2010). News organizations may not always be first to publish the news, but their agendas and discussions continue to shape conversations around major news stories (Newman, 2011). The NYT tweets tend toward an anti-fracking stance, consistent with the state's ban on fracking.

The third hypothesis predicted a role for government policy to influence meme diffusion. We found support for hypothesis #3. At the state level, government policy had a substantial influence on meme diffusion. The fracking ban in New York state appeared to have reduced the anti-fracking tweets (only 36% opposed) compared to Pennsylvania, where fracking was

operating, and 79% of tweets opposed fracking. Ohio's government had high expectations for fracking to boost its economic development. Public opinions were divided almost equally into supportive, neutral, and opposed sentiments. In contrast, the majority of California communities opposed fracking, although the Governor had not decided to ban fracking by the end of data collection. The majority of anti-fracking tweets represented messages seeking to persuade the Governor (Gov. Jerry Brown, at the time of this study) to ban fracking, although California state still permits regulated fracking.

Geotechnical factors such as technological penetration of the population to localizable clusters of tweets require large data to investigate the influence of meme diffusion. It may be possible, for example, to correlate state population levels of wireless subscriptions, the internet, and broadband penetration, and digital divide features to tweet diffusion. Further, if "all politics are local," then tweet sentiments may aggregate in geospatially specific ways based on proximity to fracking sites, and based on socio-economic concerns (e.g., unemployment) vis-a`-vis more socioeconomically privileged concerns (e.g., environment). The renewable resources from solar power, biomass energy, and wind turbines are still very expensive compared to fossil fuel energy. Although there are some tweet users from the oil industry captured in the study (@EnergyNation, @EnergyinDepth), none of the tweets that came from the alternative energy industry (@Solar Power, @Wind Energy) mentioned the word #fracking in their Twitter accounts.

4.12. Summary

The objective of this study is to use public opinions expressed through tweets to test certain general-level parameters of the M^3D model, and to investigate meme diffusion as a

window into public engagement with policy-based issues. The M^3D model anticipates that a meme has the ability to replicate and the social network may provide some memes with better paths than other memes. The M^3D proposes that the diffusion of some memes will be influenced by highly centralized influentials such as news media and state or local government policy, as well as external geotechnical factors. I tested the influence of each of several major actors and actor groups by state levels. I found that the candidates for the 2016 US presidential election represent disproportionate sources for the diffusion of memes on a relatively narrow topic (Hillary Clinton's name was mentioned in 656 tweets; Donald Trump's in 325 tweets).

The news media have joined the social media as registered users since Twitter was created in 2006. The tweets from the traditional news media have been retweeted (a total of 2825 tweets were retweeted from newspapers, magazines and TV media). The newspaper with the largest number of followers is the New York Times, followed by the Wall Street Journal. The newspapers and television are still the largest news generators that are retweeted by bloggers.

Another relevant aspect uncovered in this study is the relative weakness of signals in Twitter data when focusing on highly specific policies. The keywords fell far short in capturing the posted texts by Twitter users who used particularly idiosyncratic or colloquial terms (Hirschberg & Manning, 2015). For example, the users' name for @OccupyYtown posted opinions from both supporters of fracking and anti-fracking groups. This actor may represent a weak tie. Weak ties represent a node one step or link removed from another node. According to Mark Granovetter, a sociologist who invented his theory on "the weak ties", "the strength of ties should follow the definition of a combination of the amount of emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie" (Granovetter, 1973).

Weak ties are often the ties that bridge critical structural holes or information gaps across social networks.

Research is only beginning to comprehend the theoretical role that weak ties play in the diffusion of information in social media (Ahn & Park, 2015; Grabowicz et al., 2012; Luarn & Chiu, 2013; Shi, Rui, & Whinston, 2014). Advanced natural language processing (NLP) tools are needed to accompany the pre-selection of keywords in tweets. NLP will help the data screening by identifying which concepts a word or phrase represents and demonstrates how to link those concepts together in a meaningful way (Jain, Doan, & Gravano, 2008).

Another suggestion for future research is to add the Artificial Intelligent (AI) approach to allow recognition of difficult pattern of computer-based data. AI contributes to the velocity data by facilitating rapid computer-based decisions that lead to other decisions (O'Leary, 2013).

Government policy can influence public opinion in at least two obvious ways: a) to legitimize fracking in communities by institutionalizing and regulating fracking operations, or b) to severely restrict or prohibit fracking. In Ohio, political officials were campaigning for fracking companies with the promise of job creation and economic development. Public opinions are mixed between pro-fracking and anti-fracking, with some neutral views in the middle. In contrast with New York state, the Governor of New York banned fracking in 2014. Public opinion on anti-fracking was subdued (36%) compared to the neighboring state of Pennsylvania where 79% of total tweets opposed fracking. In California, only two counties banned fracking, although the governor refused to ban fracking. In California, 44% of the tweets were anti-fracking, citing concerns over water in a time of drought and the hazards to drinking water, wildlife, and earthquake risks.

An important implication of this research is that such opinion profiles were possible without the need of expensive or time-consuming public opinion polling. As the validity of polls on political issues are increasingly under scrutiny for their validity, social media may provide an important insight into unedited spontaneous public opinion on important policy issues. The multilevel model of meme diffusion provided an integrative framework within which several relatively intuitive predictions could be examined in the context of the social media surrounding a diverse societal controversy. Future refinements of the theory will need to develop riskier hypotheses if the model is going to result in a predictive rather than an explanatory approach. Such refinements will need to integrate social network theory, information and diffusion theories, communication theory, and geospatial theories of human activity.

There are nevertheless important limitations to reliance on social media as a proxy for public opinion. In this study, there were not enough data to investigate the roles of geotechnical external factors such as technological penetration of the population to localizable clusters of tweets. Geotechnical factors in this case study might have included population demographics affecting the adoption of Twitter (which is a more millennial generation medium), the concentration of major media outlets, urban versus rural divisions that index political ideologies, and perhaps even neighboring state politics or shared urban metropolitan areas. Future research will need to utilize several software packages and datasets to examine research purposes. Nevertheless, this study discovers that Twitter data offer research opportunities for geographers to analyze human activities and communications (Issa, 2016).

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The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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CHAPTER 5: ANALIZING PUBLIC OPINIONS ON THE DEATH PENALTY ABOLISHMENT[3]

5.1. Background Research

A meme consists of any words or images in a text that can be replicated across communicators in the exchange of information. This study tests the Multilevel Model of Meme Diffusion (M^3D) in a case study in the digital electronic technology that captures the controversial opinions regarding death penalty abolishment in Nebraska. The objective is to demonstrate that an internet-based study using social media data can be used to analyze and predict social processes engaging with phenomena in real space. The authors utilize the meme death_penalty in Twitter texts to predict public perception of death penalty abolishment in Nebraska. The M^3D theory integrates the fields of geography and computer-mediated communication technology to explain and predict public opinion on the death penalty.

The death penalty, or capital punishment, has been reinstated in the United States since 1976 (Dezhbakhsh & Shepherd, 2006). In 2015, approximately 30 inmates were executed by six US states (Florida, Georgia, Missouri, Oklahoma, Virginia, and Texas) and 2984 were waiting on death row (Death_Penalty_Information_Center, 2016). Capital punishment has been declining, and is geospatially highly concentrated (Garrett, Jakubow, & Desai, 2017). During this data collection, in May 2015, Nebraska became the first conservative state in more than for

[3] This chapter is based on Ye, X., Sharag-Eldin, A., Spitzberg, B., & Wu, L. (2018). Analyzing public opinions on death penalty abolishment. *Chinese Sociology Dialogue 31(1) 53-75.*

decades to repeal its death penalty option (R. Berman, 2015). Since 1972, most American citizens have supported the death penalty, although the level of support has been falling consistently for two decades (Hood & Hoyle, 2015; J. M. Jones, 2017; Oliphant, 2016; Pew Research Center, 2015). Capital punishment is supported by more than three-quarters of Republicans, but it is opposed by the majority of Democrats (M. Berman, 2015b). Rather than rely on self-report surveys, this study investigates social media representations of capital punishment. Public opinion on the death penalty was captured in tweets compiled from 27 May to 31 December 2015, with approximately 389,800 geotagged tweets.

The development of communication theory has evolved rapidly in conjunction with the advancement in information technology. This study aims to test a new perspective toward "meme diffusion" as a technique to explain and predict social phenomena (Spitzberg, 2014). The model is explored by using online data mining applications in collecting conversations of social groups as reactions to the prospect of the abolishment of the death penalty in Nebraska. In this application, the issue of the death penalty as a controversial political agenda serves as an exemplary cyberspace canvas upon which public attitudes are expressed in online and social media messaging.

The purpose of this study is to assess public opinion on the abolishment of the death penalty to predict whether it will be abolished or reinstated in Nebraska. The use of social media offers new insights into testing the power of communication technology as a tool to predict social phenomena in general, and policy formation. Tracking these message exchanges will assist in the early detection of social phenomena related to public opinion regarding criminal justice and human rights. This study evaluates the application of the meme diffusion model to public

reactions represented by social media groups as a reaction to the repeal of capital punishment in Nebraska.

5.2. Conceptual framework

The conceptual framework in this study is adopted from the M^3D framework developed by Spitzberg (2014) with slight modification to fit this case study (Figure 1.2 in Chapter 2). The word "meme" was developed by Dawkins in his book The Selfish Gene (Dawkins, 1976). According to Dawkins, memes defined as cultural units of transmission, analogous to genes that spread from person to person by copying or imitation (Shifman, 2013). Spitzberg in his article about the meme diffusion (Spitzberg, 2014) argued, in this digital era, the term "memes" emerges in two typical ways— evememic (event-based) messages arise when events in the world elicit topically and group-based symbolic and visual representations of those events across communicators (e.g., tweets, emails, and images from a new year's eve crowd experience), whereas etymemic (text-based) messages arise from texts that are replicated and evolve as they are adapted across communicators (e.g., the " " equal sign in the US expressing agreement with gay marriage). Polymemic episodes occur as etymemic—evememic reciprocities, in which events generate memes, which then take on a life of their own through memetic diffusion and evolution, and/or when those memes generate activity in cyberspace that evokes real space behaviors. For example, a measles outbreak might evoke social media panic, which results in political pressure for passing stricter mandatory vaccination policies. Conversely, social media may stimulate a flash mob, which evokes violent confrontations with police, which stimulate waves of social media diffusion of the event and further public reactions.

M^3D proposes five macro-levels of factors influencing meme diffusion outcomes, within which the model organizes almost 40 micro-level variables. While no study is likely to be able to operationalize the entire model contents, the macro-levels provide a useful heuristic for isolating certain variables in any given research project. In any analysis of memetic episodes, the highest macro-level of analysis is the meme itself. Thus, the first level of M^3D hierarchy level is the meme level given the fact that a meme has the potential for replication and transfer of information. In this study, the authors used the hashtag term death penalty (#death_penalty) as a seed for replication under the expectation that it would be the most inclusive and integrating meme representing public sentiments regarding capital punishment. Individual conversations are ephemeral, but digital memes such as hashtags enable the diffusion of sentiment and influence through communication, especially for an issue that has a specific term for a vast and complex set of processes (Heylighen & Chilens, 2009). The hashtag phrase is expected to be repeated and replicated across the social media.

Memes originate from actors communicating, and therefore, the next level of the M^3D theory is the actor or source. In general, actors who are more competent, credible, and popular are more capable of producing memes likely to be replicated widely (Spitzberg, 2006). The status and popularity of the actor are important factors in the process of diffusion. For example, I know more about the death penalty after reading the news about an inmate, Ms. Kelly Gissendaner, who was executed in Georgia in September 2015 (Fins, 2015). Ms. Gissendaner was the first woman executed in the state of Georgia in 70 years (Baker, 2015). Another example is the media exposure surrounding a series of contemporary “botched” and questionable actual and attempted executions (Gill, 2017). Media consumers may be more influenced by certain spokespersons or pundits than others, and such influentials may dominate any given network of

interactions on a given topic. The more the communication technologies support or maintain a social network, the more potential there is for both the technologies and the social network to facilitate meme diffusion (Wellman & Haythornthwaite, 2002; Zhao, 2006).

The next macro-level of the M^3D theory represents the social networks through which memes propagate (Xinyue Ye, Sharag-Eldin, Spitzberg, & Tsou, 2018). Social media memes are units of information that spread from person to person through the internet and social network (Kwak et al., 2010b). Certain features of social networks may provide some memes with better affinity paths for diffusion than other memes (Iribarren & Moro, 2009). For example, some research indicates that memes diffuse better with a sender who has many friends (Kee et al., 2013), especially within homophilous network groups. Examples of social networks that are supportive of death penalties include groups of terrorist victims. In contrast, opponent groups with likeminded attitudes toward abolishing capital punishment include Amnesty International and the National Coalition to Abolish the Death Penalty (NCADP).

In the theoretical metaphor of M^3D, each meme enters an informational ecosystem, in which it competes for attention relative to other memes in general (i.e., the overall attention available relative to all the memes seeking such attention) and memetic predators, or counter-frames that reflect memes generated by a network in direct opposition to a given meme. Thus, when a meme proposes a sentiment toward the death penalty, it not only has to compete for attention in a crowded cyberspace of attentional resources, it may also draw direct attack by users and groups in networks seeking to extinguish or 'out-voice' such memes.

Some memes find either favorable or unfavorable resources when societal macrolevel factors or institutions seek to either amplify or silence such memes. Thus, some relatively local

memes find purchase in the glare of national media institutions or organized campaigns, whereas the vast majority of memes fail to propagate beyond their initial receiver for lack of institutional broadcast pathways. Societal experiences, such as disease outbreaks (e.g., measles, Ebola) or terrorist events (e.g., Paris attacks), provide an information ecology readied for the emergence of more collective attention to certain memes relative to others.

In this study, this macro-level was influenced when the Nebraska repeal of capital punishment was challenged by supporters of the death penalty. The citizens of Nebraska signed up to collect signatures for the ballot to reinstate the death penalty in the November 2016 election. This study analyzes the opinions from the tweets posted in Nebraska from 19 May 2015 to 31 December 2015. The data collected from Twitter API contains recoverable online conversations, information sharing forums, news commentary broadcasts, and social media news circulation. This study will utilize the feature of "retweeting" (@RT) and hashtags (#) as simple yet powerful mechanisms to detect information diffusion through data mining. This study also examines the geographic distributions of opinions on the death penalty including the probability of pros (support) and cons (opposed) by states using tweets data as input indicators.

In May 2015, the state of Nebraska banned the death penalty. The reactions to this event were captured for all the 50 states, with the highest geotagged tweets from Nebraska (1,315 tweets), New York (993 tweets), California (816 tweets), and Washington DC (553 tweets). Although the large numbers of tweets posted from Washington DC do not represent the residents of Washington DC, the tweets were sent by Twitter users who work in the adjacent areas around Washington DC. The fact that state-level local groups often have their lobbying groups and political representatives headquartered in DC is a socio-geographic parameter when examining

policy-based issues. More specifically, on policy-related issues to which lobbying groups and politicians are sensitive, it should be expected that Washington DC will reveal geospatial concentrations of social media traffic on such issues, even when the jurisdictional legislation is located over a thousand miles away.

As a default prediction, the status quo government policy on the death penalty in any given state is likely to predict the dominant valence of online communication content on the death penalty. Specifically, in politically conservative states, in which the political party and religious leaders support the installation of the death penalty, memes are likely to reflect highly polarized social networks that evoke the passions of the opposition campaigns. In contrast, in states that have effectively banned the death penalty or that face no prospect of the death penalty, there should be a relatively more randomized distribution of memes. Similarly, the greater the majority of the Democratic or Republican primary state-level officeholders, and the longer those majorities have been in place, the more asymmetric (i.e., disproportionate) the meme sentiments will be in that state in favor of the legislation's status quo. Exceptions to this default prediction are likely to arise when specific legislative options (such as laws or propositions) elicit social movements and campaigns that may provide more voice for change in the status quo.

Furthermore, even when the "red state/blue state" divergences are clear, within such states the dueling nature of social media may heighten the salience of the topic in general, amplifying and polarizing the dominant sentiment. In the M^3D invocation of Wilson and Wilson's (2007) axiom, "Selfishness beats altruism within groups. Altruistic groups beat selfish groups. Everything else is commentary"(Wilson & Wilson, 2007, p. 71) developed this axiom based on Darwin's original insight and development, reviewed in his book Descent of Man

(Darwin, 1888). Selfish individuals might out-compete the altruists within the groups, but internally the altruistic groups are the one who beat the selfish group. The axiom by Wilson and Wilson is applicable in the context of social media. The polarized debates may well activate internal cohesion among the groups and energize social media campaigns that result in even more dominant and organized social media landscapes in the evolutionary war of the memes. Among the implications of this axiom, therefore, is that within relatively homogenous groups, there are likely to be opinion leaders competing for status, but the more collaborative these competing voices are overall, the more influential or dominant that group will be relative to other groups. In network structures, dominant networks would reveal complex structures with dominant nodes within the network but a high density of interconnectedness within that network or clique.

At the community levels, the demographic diversity may affect significant differences between "pro" and "con" groups and some "neutral" groups; for example, the urban-rural differences and some racial-ethnic differences would probably correlate statistically in supporting or opposing the death penalty. Another example for the state level, Texas, which has a majority of its population belonging to the Republican Party, would have a broad majority in the pro-death penalty (pro-DP). However, its urban areas such as Austin, Dallas, and Houston would probably be much more balanced, or even more Democratic or anti-DP in sentiment, due to the high proportion of black populations in those cities.

In contrast, California, for example, will be broadly more anti-DP overall because it is so solidly Democratic, even though it still allows the death penalty. There are 743 death row inmates in California. However, depending on the topic and uniquely homogeneous

communities, the decision of “pro” or “con” in the death penalty varies by individuals in the community. For example, the Catholic communities may be anti-DP, but may not be very interconnected or embedded within the more politically active (i.e., lobbying) communities.

Finally, M^3D anticipates that external factors at the geotechnical macro-level also play a significant role in how memes diffuse. The geospatial locality of death penalty opinions is likely to interact with proximity dynamics of social networks and neighborhoods, from the personal level to the state level of meme diffusion. Death penalty opinion is geospatially clustered in ways that reflect population and political topographies and occur in spaces that vary in their online and social media demographics and political leanings. The death penalty events in Nebraska offer a potentially varied set of contextual applications of M^3D theory.

5.3. Literature review

Communication and geography are two academic disciplines that share a border where interdisciplinary activities constitute liminal movements in both their territories and boundaries (Adams & Jansson, 2012). The social scientific study of the use of space and communication, or proxemics, dates back to the 1960s (Forston & Larson, 1968; Hall, 1963; Hall et al., 1968b). The connection between communication theory and geography was first revealed by Ha¨gerstrand in his publication “Innovation diffusion as a spatial process”, based on his doctoral thesis in (Hägerstrand, 1968). He defined the diffusion of innovation as a function of social communication. Ha¨gerstrand also introduced the time and space model, which included features such as a space-time path and a space-time prism that was the beginning of the time geography studies (Kraak, 2003). Throughout the years the Hägerstrand model has been applied and improved to understand movements through space (Gale, 1972; Hägerstrand, 1970).

In another development related to communication and human geography, Lefebvre introduced the concepts of the right to the city and the production of social space (Lefebvre, 1974). Lefebvre suggested that representation of space as the social space of communication is occupied by artists, writers, and philosophers. In today's context, the space of communication is also shared by internet bloggers, celebrities, political figures, and virtual relationships.

Another geographer, Adams, conceptualized the social space of communication as the abstract, theoretical, and production-oriented spaces involving the formal plans and abstract blueprints of powerful actors whose formalizations of space control actions (Adams & Jansson, 2012). This statement is supported by Yi-Fu Tuan, a human geographer who argued that space and place are virtual areas I come to know and visualize instead of being a fixed location (Tuan, 1977). Place captures the idea of deeply layered subjective experience grounded in the particularity of local conditions and discourses, whereas space implies potential as well as actual movement of bodies, goods, capital, information, and communication (Edwards & Usher, 2000b).

Geographers have focused on the traditional role of communication in exerting and legitimizing political and economic power at various scales in the fundamental concept of space and mobility that is addressed in communication geography (Harvey, 1992; Sassen, 1991, 2005; van der Hulst, 2011). Efforts are progressing in theorizing the role of geospatial factors in mediated communication (Couldry & Hepp, 2013; Hampton & Ling, 2013; Spitzberg, 2014).

There are promising developments in social media communication with the advancement of internet technology and its computer applications in the social media that make online data mining possible (Xinyue Ye, Li, Yang, & Qin, 2016). These new developments represent a

breakthrough for internet users, marketing experts and researchers in their access to data in real-time and global coverage (Xinyue Ye & He, 2016). Research is capitalizing on social media data in understanding emergency disaster response (Comfort et al., 2010; Curtis et al., 2007), social movements (Earl & Kimport, 2008; Nagel et al., 2013), terrorism (Hsinchun Chen, Reid, Sinai, Silke, & Ganor, 2008), and environmental issues (A. Hansen, 1993). Recent studies have found that social media both reveal and represent sources of the influence on personal opinions (Gunther, 1998; Spitzberg, 2006). According to Noelle-Neumann, people learn about public opinion from media coverage, especially when the news contains a contradiction (Noelle-Newman, 1974). In today's information society, these media are increasingly both mass and social in transmission and influence.

Given this rationale, I focus on the role of opinion leaders or actors who influence the public using their media power. The research question is to what extent M^3D accounts for the meme diffusion patterns of social media messages related to death penalty abolishment. The actors are identified from keywords that distinguish the actors as supporters of the death penalty (appeal, ballot, referendum, pro-death penalty, etc.) or antagonists of the death penalty (abolish, repeal, reject, brute). The list of chosen words is shown in Table 5.3. Among the pro-death penalty groups are included the individuals or group(s) associated with the government, families of terrorist victims, and conservative groups. In contrast, the anti-death penalty groups consist of amnesty groups, liberal groups, and groups of lawyers. Given the intersections of communication and geography available in the social media context, I examine the following research questions.

5.4. Methodology and data preparation

This study adopted mixed quantitative and qualitative methods to examine the death penalty controversy. The data were collected with the free version of Twitter API with hashtag #death_penalty, as mentioned in the Conceptual Framework section. The objective of data collection using Twitter was to capture a large data corpus and to identify the viral messages among the text messages.

The initial data were appended in a spreadsheet for the text sorting purpose. After the Twitter download, the data were analyzed based on the specific event(s) of the death penalty. The event that stirred the most salient Twitter reactions in Nebraska was the proposal to repeal the death penalty in Nebraska, representing 10,500 Twitter users. Since this study focuses on this episode in Nebraska, other high-profile events mentioning the death penalty messages are excluded, including the death penalty for ex-Egyptian president Mohamed Morsi, death penalty and executions in Saudi Arabia, and the death penalty for the Boston Bomber.

The next step was coding the database using familiar words or phrases to identify the Twitter users' opinions on the death penalty debate. R-programming was used to create word-clouds of the most popular words posted in the initial database (O'Sullivan & Perry, 2013; Waller, Gotway, Walter, & Gotway, 2004). The words in the word-clouds were used to identify the opinions reflected by the tweet. The coding of the tweet users' opinions will be explained in the data preparation section.

The text messages were sorted, coded and ranked to generate a list of words and phrases that could be interpreted as supportive of the death penalty as an extreme method of capital punishment (coded as +1), or words and phrases with sentiments toward banning or abolishing

the death penalty (coded as -1). Tweets with unrelated or neutral messages that were nevertheless captured with the hashtag “death penalty” were coded as 0 and discarded from the process.

After coding the text messages, the next step was to group the tweets based on large numbers of repeated texts, retweets (RT@) and mention name (@) sent by the same users. This grouping of the tweets was a preliminary step to identify the names of the opinion leaders or actors and their Tweet account profile data information. To understand the diffusion of the keyword “death penalty,” the texts from the opinion leaders, or “actors”, were examined separately. In general, Twitter uses the retweeted messages with the symbol “RT@”. The retweeted messages are messages originating from a certain actor or actors captured by the followers and then retweeted in the social media (Cha et al., 2010). From the M^3D perspective, every retweet verifies the message as a meme replication and represents an index of social influence in a diffusion adoption process.

The groups of high-volume tweets sent out by the same usernames were sorted and identified separately. Another group of tweets containing most retweeted messages were analyzed separately using NodeXL to visualize the direction of relationship between the news creators (or those whose tweets were retweeted by other users) and the regular Twitter users. The NodeXL methods followed the examples in Hansen et al. (D. L. Hansen, Shneiderman, & Smith, 2010).

Data preparation involved downloading Twitter data with the keyword #death_ penalty from 27 May 2015 to 31 December 2015. The data download resulted in a sample of 389,800 worldwide geotagged tweets. From the geographic locations and timestamps obtained in the data, tweet data point locations were assigned to their respective states. For the geographical map

limitations, data assigned as originating in Alaska and Hawaii were omitted in this study. The data were sorted using the daily time series to show the peak of daily tweets captured during the study period (Figure 5.1.)

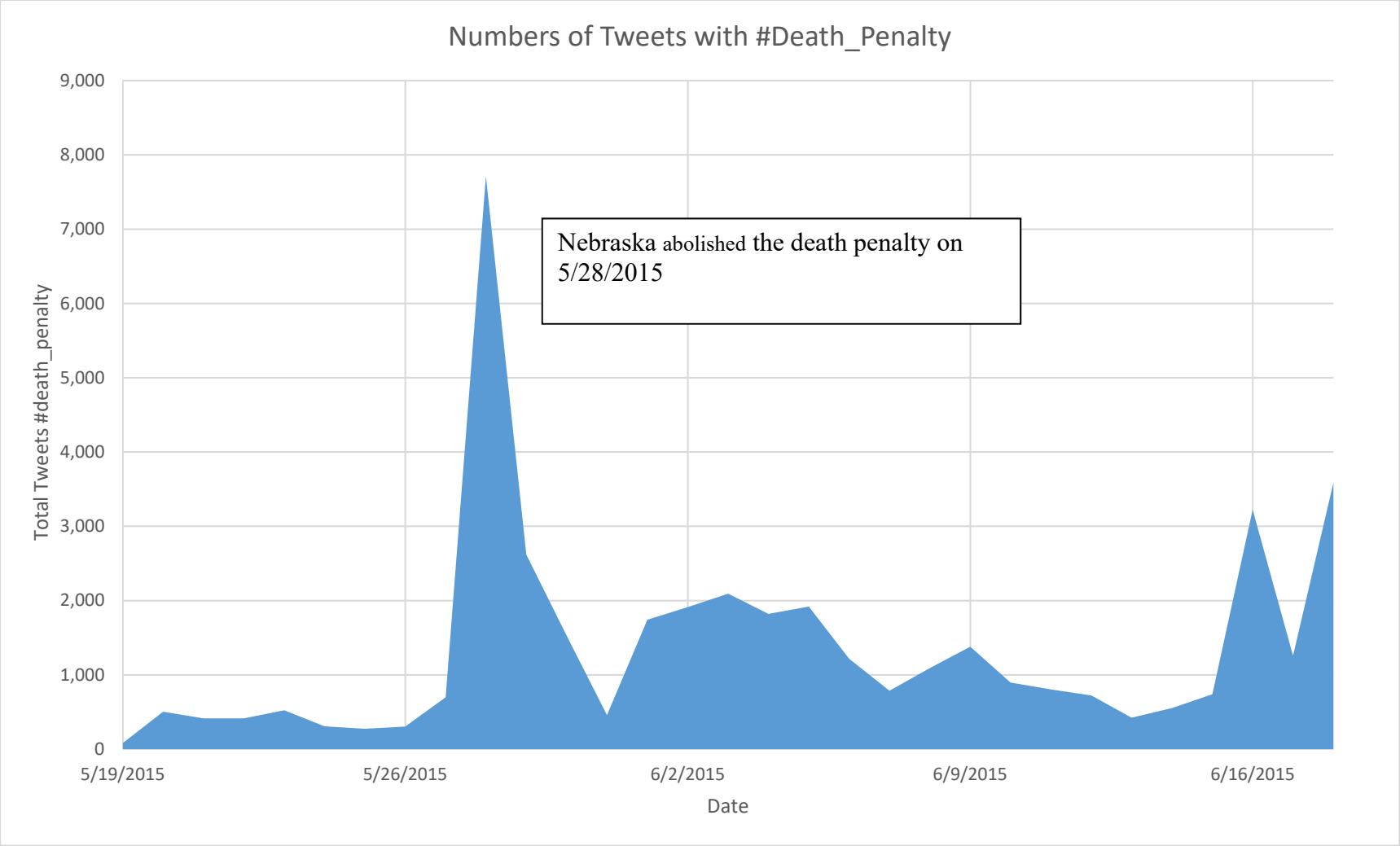

Figure 5.1 Public Opinion on the Death Penalty Debates in Time Series Graph

The first step of data analysis is to sort all data points based on timestamps to identify the events resulting in the most tweets, or the underlying meaning of peaks in Twitter activity. The time series chart in Figure 5.1 showed the highest peak or spike of tweets on 28 May 2015. This peak was triggered by the memes related to the abolishment of the death penalty in Nebraska ("Nebraska abolished the death penalty"). The meme was retweeted and replicated over 10,500 times during the study period due to the abnormality of Nebraska as a conservative state abolish the death penalty. A point raised during my defense discussion by Dr. Scott Sheridan of my committee member argued if the ban on the death penalty enforces in California it may not trigger the spike. As I mentioned earlier, the intensity of the tweets depends on people's perception of the news and information they read from the media. The news receives newsworthiness if it is covering uncommon events (Lundman, 2003).

The reaction to executions in the Islamic countries (Saudi Arabia, Pakistan, Iran, Bangladesh, Sudan) is another major topic that triggered public opinions. The list of public reactions to events related to the death penalty captured in the geotagged tweets data is shown in Table 5.1. According to Human Rights Watch and Amnesty International, from the hundreds of people on death row from various nations, over 175 people were executed from 1 January to 31 December 2015 (The Guardian Staff, 2015).

In this study, I captured the highest numbers of tweets that mentioned the combination of keywords using hashtags of "death penalty" and the name of the state "Nebraska" to compile the US public reaction to the abolishment of the death penalty in Nebraska at the time. Most tweets were posted from Nebraska with 1,315 tweets, followed by New York (993 tweets), and then California (816 tweets). The list of the highest 20 states in response to Nebraska's repeal

decision is shown in Table 5.2. A list of words used in this study to identify the “pros” and “cons” of “death penalty” is listed in Table 5.3.

Table 5.1 showed the most striking topic at the time of this research was when the state of Nebraska abolished the death penalty. This posted tweet is reaction follows by the breaking news circulating in the international broadcast regarding the death penalty in Saudi Arabia.

The list of public perception in the US linked to the Nebraska abolishment of the death penalty is shown in Table 5.2 in the next page.

Table 5.2 shows the hierarchical list of states based on the number of tweets posted related to the State of Nebraska abolishment on the death penalty. The highest number of tweets were posted from the state of Nebraska due to controversies of “pros” and “cons” of the death penalty and how the political, social value, traditions and religious norms affected public perception to deal with the death penalty.

Table 5.1 List of the Most Mentioned Topics related to the Death Penalty

	Number
Nebraska abolishes death penalty	10,504
Death penalty in Saudi Arabia	10,379
Dr. Mohamed Morsi death penalty	6,706
Death penalty in Iran	4,782
Tsarnaev Boston Bomber sentencing	4,483
Death penalty in Pakistan	2,877
Death penalty in Sudan	2,256
Death penalty in China	1,505
Death penalty in Nigeria	941
Death penalty in Bangladesh	832

Table 5.2 Number of Tweets mentioned the death penalty in Nebraska by States

STATE	# TWEETS	PERCENT
Nebraska	1,315	12.52%
New York	993	9.45%
California	816	7.77%
District of Columbia	553	5.26%
Georgia	522	4.97%
Indiana	520	4.95%
North Carolina	514	4.89%
Texas	434	4.13%
Florida	380	3.62%
Kansas	352	3.35%
Alabama	318	3.03%
Illinois	289	2.75%
Arkansas	288	2.74%
Ohio	222	2.11%
Pennsylvania	215	2.05%
Massachusetts	201	1.91%
Missouri	183	1.74%
Michigan	172	1.64%
Louisiana	170	1.62%
Tennessee	167	1.59%
Kentucky	132	1.26%
Arizona	131	1.25%
Washington	131	1.25%
South Carolina	128	1.22%
Connecticut	116	1.10%
Wisconsin	112	1.07%
Colorado	106	1.01%
New Jersey	105	1.00%
Iowa	100	0.95%
Virginia	92	0.88%

The next step is to identify the opinion leaders as an indicator of the source of meme diffusion among the tweet users. Katz and Lazarsfeld (Elihu Katz & Lazarsfeld, 1955b) demonstrated that information is disseminated through opinion leaders rather directly from mass media. To understand the diffusion of the key term "death penalty," the texts from the opinion leaders, or "actors," were grouped and examined separately. I identified the opinion leaders using the retweeted messages. The Twitter users whose messages were retweeted the most may be an indicator of opinion leaders. The retweeted messages with the symbol @RT are the messages originated from a certain actor or actors captured by their followers and then retweeted in the social media.

From the M^3D perspective, every retweet both verifies the message as a meme replication but also represents an index of social influence in a diffusion adoption process. Internet memes depend on collective creation, circulation, and transformation. The memes are multimodal texts that facilitate participation by re-appropriation, by balancing a fixed premise with novel expression (Milner, 2016). This study traced the repeated phrases that were circulated among the tweet users that originated from the opinion leaders. The following table 5.3 shows the list of words used for coding purposes. The support of the death penalty is coded as "+1" while the anti-death penalty is coded as "-1".

Table 5.3 List of Words captured in Texts with #Death_Penalty

Support of DP	Oppose of DP
appeal	abolish
back	against
ballot	ban
for death	capital punishment
GOP	challenge
need	conservative
news	cost
not over	destroy
on hold	dump
oppose	end
petition	expensive
poll	executive
referendum	fall out
reinstate	first
Republican	give up
restore	get rid
reverse	kill
save	nixed
signature	no need
support	outlaw
undo	override
vote	overturn

In order to visualize the connection between the opinion leaders and their followers, I used NodeXL, a product of Microsoft associated with Excel. From a total of 10,500 tweets related to the abolishment of the death penalty in Nebraska, approximately half of the text messages (5,400 tweets) were retweets. NodeXL was used to create clusters of the 20 most retweeted text messages that originated from actors or opinion leaders with large numbers of followers. Multi-scale layout algorithms were chosen to achieve an aesthetic visualization of undirected graphs with curved edges. The algorithm is capable of drawing graphs of large-sized data sets. For example, the algorithm achieved optimal drawings using the Harel-Koren Fast Multiplex layout to find clusters in the network that have the same attributes in the settings (D. L. Hansen et al., 2010). Figure 5.2 shows an example of actors (in larger vertices) such as, EJUSA, NE4PublicSafety, and CCATDP, etc. links to other visually grouped of followers in the smaller vertices.

Figure 5.2 shows the relationship between the "Actors" or "Influencer" of the death penalty in grey lines connected to their followers. The connections is not only one-to-one link but also one-to-many, as the actors meme were re-tweeted by many Twitter users.

The public reactions on Nebraska abolishment of the death penalty is presented on Figure 5.3 in the next page shows the chart of public opinion by selected states based on the list of the highest states in response to Nebraska's abolishment of capital punishment (as listed in Table 5.2.) The first column in Figure 5.3 shows the state of Nebraska's social media zeitgeist with 658 tweets of support for the death penalty versus 421 tweets opposed to the death penalty.

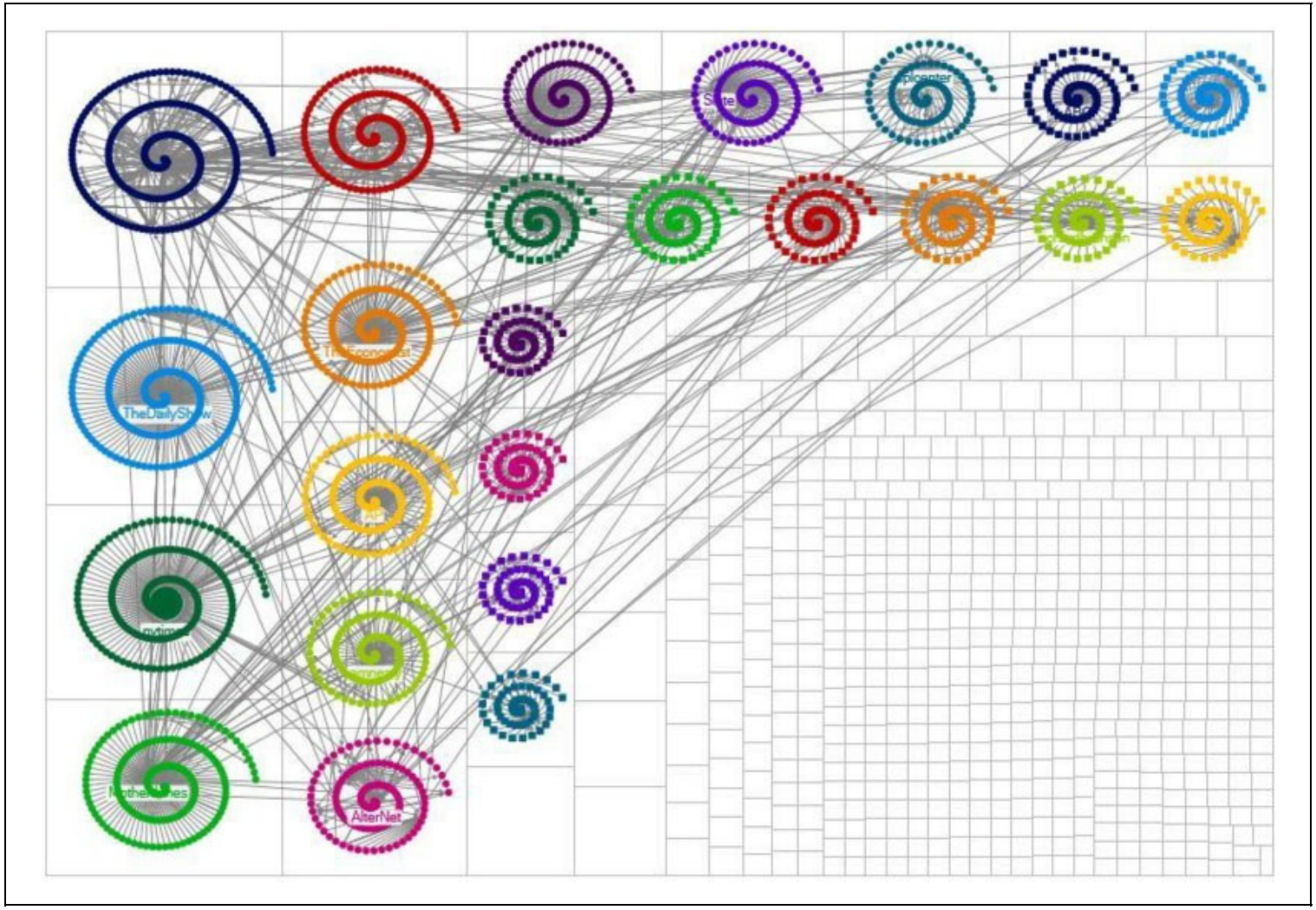

Figure 5.2 NodeXL Individual Actors and Group Actors Twitter Users

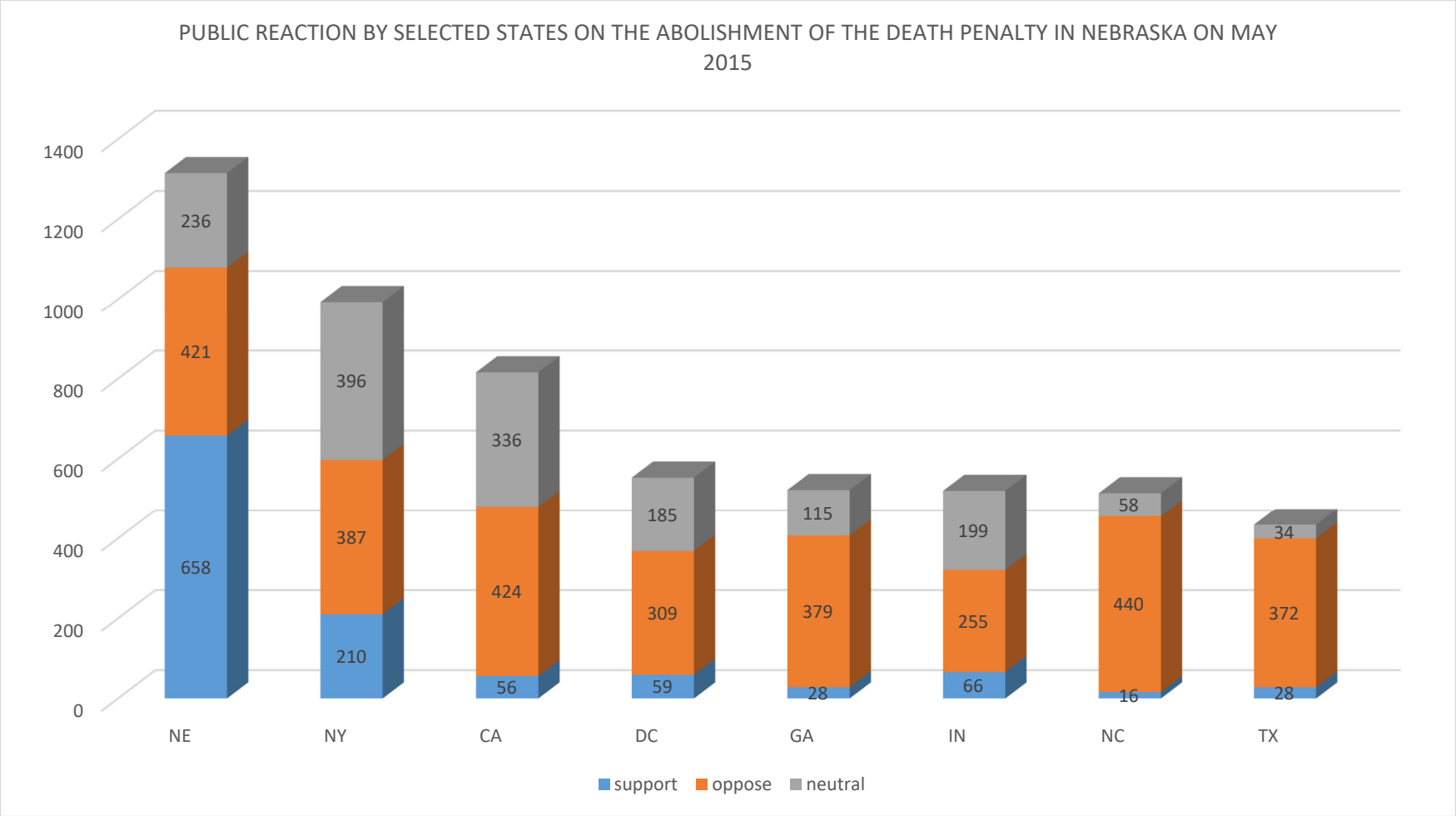

Figure 5 3 Public Opinion on Nebraska Abolishment of the Death Penalty

5.5. Findings

The information from NodeXL represents the relationship between regular or frequent tweeters and their group relationships. After setting up the groups, actors' usernames were traced in Twitter to interpret which categories of the M^3D model were represented. This process led to the following initial results:

- Individual actors consisting of movie stars, entrepreneurs, and politicians with between 2 million and 7 million followers diffused memes more extensively than typical Twitter users. The sample of actors is listed in the following Table 5.4. below. One group of actors belongs to media businesses or political affiliations, which have larger numbers of followers than individual actors (up to 15 million followers). This information supports the second hierarchy of M^3D, that the more popular the actor initiating the meme (i.e., the more influential the source, vis-a`-vis the average individual actor), the more widely the meme diffuses.

- The news agencies and social media applications revealed their own social networks. Their representations in meme diffusion were many times more extensive than the individual and group actors, presumably because such organizations often have the responsibility or task of diffusing newsworthy issues and have the collective resources to repeat and reinforce such diffusion processes. The sizes of their follower networks collectively represent 15 million to 30 million people. This finding supports the third level of M^3D, in which social network structures moderate public opinions reflected in meme diffusion patterns.

- The abolishment of capital punishment in Nebraska is a government action. The influence of the government actions in this sensitive issue stirred up reactions in public opinion, reflecting peak social media reactions to real space events. This supported the fourth level in the M^3D societal entities such as government institutions and policies moderating the diffusion of the memes to citizens.

- The above three points in the findings indicate that the hierarchical levels of the M^3D, from actors to social networks to societal groups (i.e., state or government institutions), play important roles in the meme diffusion using #death_penalty. Thus, the research question #1 (RQ#1) is affirmed—public opinion on issues such as death penalty legislation, as reflected by memes in social media, can be mapped conceptually and empirically at multiple hierarchical levels of influence.

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Table 5.4 Sample of Actors using #Death_Penalty

RT_User_ID	Username	Group Categories	Status	Followers
@nytimes	The New York Times	Newspaper	News media	26,475,515
@BBCWorld	BBC World	British news	News media	13,962,560
@AP	The Associated Press	News agency	News media	7,412,118
@NBCNews	NBC News Media	US global news media	News media	3,269,288
@TheEconomist	The Economist	News magazine	Group actors	13,773,984
@washingtonpost	Washington Post	News media	Group actors	6,281,852
@ABC	ABC News	TV news	Group actors	5,700,436
@TheDailyShow	The Daily Show	TV show	Group actors	4,169,299
@richardbranson	Richard Branson	Entrepreneur	Individual actors	7,483,001
@MarkRuffalo	Mark Ruffalo	Movie actor, activist	Individual actors	2,370,820
@mattdpearce	Matt Pearce	National reporter	Individual actors	54,558
@NordquistNE	Jeremy Nordquist	Nebraska politician	Individual actors	2,693

In the United States, there is a fluctuating tendency to enforce, and to abolish, the death penalty. Such legislative episodes have been influenced as well by Supreme Court decisions. Michigan was the first state to abolish the death penalty, in 1847. Four other states prohibited the death penalty in 1907 and 1911, and seven more between 1913 and 1918 (Hartung, 1952). Until recently, most Americans did not think much about the possibility that some percentage of people sentenced to death might be innocent (Baumgartner, De Boef, & Boydstun, 2008).

In May 2015, the Nebraska Legislature voted to repeal capital punishment. Nebraska became the first conservative state (J. M. Jones & Ones, 2016) in more than 40 years to abolish the death penalty (Connor & Chuck, 2015). After more than two hours of emotional speeches at the Capitol, the Legislature, by a majority vote that cut across party lines, overrode the governor's veto of the bill repealing the state's death penalty law. After the repeal measure passed, by just enough votes to overcome the governor's veto, dozens of spectators in the balcony burst into applause (Bosman, 2015).

The Nebraska bill's passage was unusual because some states that have abolished capital punishment in recent years are politically inclined toward the Democratic Party. During the last 20 years, numerous empirical studies have concluded that the death penalty has no measurable deterrent effect beyond that of life imprisonment (Baldus & Cole, 1975; Dölling, Entorf, Hermann, & Rupp, 2009; Gerritzen & Kirchgässner, 2013). Nebraska, a Republican state with the majority of its legislative body consisting of people with a conservative view, defied the odds by eliminating capital punishment in 2015. The last conservative state to abolish the death penalty was North Dakota in 1973 (M. Berman, 2015a).

Nebraska's supporters of the death penalty challenged the Nebraska Legislature's decision by collecting signatures of support for the death penalty. They needed 57,000 signatures (or 5% of the state's voters) but collected over twice the number needed (120,479 signatures). Thus, the proposition to repeal the abolishment of the death penalty made it to the ballot for the 2016 election (Bellware, 2015). The decision to revive the death penalty was not necessarily surprising, given that the majority of US citizens still support the death penalty (Cassell, 2008; Soss et al., 2003). In 2017, a Gallup poll on public opinion in the US found that the majority of the general public (55%) was in favor of the death penalty compared to 41% who opposed it. However, support for the death penalty is as low as it has been in the past 40 years (J. M. Jones, 2017). Furthermore, what is true at the national or international level may or may not reveal relevance or influence at the more localized state level.

The tweets collected in this study indicated that the majority of US citizens supported the state of Nebraska's repeal of its capital punishment law. The tweets from Nebraska, however, indicated that over half of tweeting Nebraskans (57% of Nebraska voters) supported the reinstatement of its death penalty. This study also found that some major states showed support of the abolishment of the death penalty in Nebraska (i.e., Texas, Georgia, and North Carolina; see Table 5.2). As an additional triangulation that social media are diagnostic of public opinion, these states also reveal higher execution indexes per capita in the United States (Death Penalty Information Center, 2016), although the tweets also captured a high number of opinions against the death penalty across these states as well. This illustrates that memes compete in contexts in which there are often counter-framed memes, and these competing memeplexes thrust and parry in sometimes symbiotic ways, each side supplying fuel for the other side's reactions and attempts to overcome the competition (Clark, Spitzberg, & Tsou, 2018). However, in the end, it appears

that state governments tend to decide on death penalty policies based on how the majority of the electorate within those states feels.

As predicted by the analysis using Twitter data on death penalty opinion in Nebraska, the voters decided to repeal the ban on capital punishment (Hammel, 2016). The results from the election showed that 61.2% voted to repeal the death penalty ban and 38.8% voted to retain or keep the death penalty prohibition. The results from the election were consistent with posted public opinion in social media, as the majority of Nebraska voters wanted to reinstate capital punishment. The few digit anomalies of the percentages between tweet data results and ballot measure results are possibly caused by the distribution of Twitter users who were skewed toward younger population cohorts (Mislove, Lehmann, Ahn, Onnela, & Rosenquist, 2011). The results from the death penalty vote indicated that social media data were relevant for analyzing social phenomena regarding public policy development. This evidence supports provides an answer to RQ2, that social media data are relevant for analyzing social phenomena.

5.6. Conclusion

Social media processes often foment public attention through both opinion divergence and convergence. Sometimes, social media sometimes also evoke public action and reaction. Such actions and reactions, in turn, result in polymemic feedback loops that activate more social media processes. This study captured public perceptions regarding the abolishment of the death penalty in Nebraska. Although the Legislature and electorate decided to reinstate capital punishment, as of this writing, a large and active contingent of Nebraska citizens are mobilizing once more against the death penalty (e.g., http://nadp.net/; http://retainajustnebraska.com/facts/cost/). Such propositional debates and social movements will

increasingly be resolved in the competitive environment of public attention. Memes, both pro and con, will continue to compete in the informational ecosystem in which they seek compatible environs and a comfortable foothold for the issue species at stake.

The objective of this study was to use public opinions expressed through tweets to test certain macro-level parameters of the M^3D. The M^3D model anticipates that a meme has the potential to replicate, and the social network may provide some memes with better paths than other memes. M^3D proposes that some memes' diffusion levels will be influenced by highly centralized actors such as news media, state or local government policy, as well as external geotechnical factors, ranging from demographics that influence media literacy and engagement, to geospatial factors affecting the liberal—conservative value and belief polarizations.

The study found evidence of the influence of several major actors and actor groups at different state levels. The news media have hybridized social media since Twitter was created in 2006. The tweets from the traditional news media have been retweeted to other groups of media and regular Twitter users. Newspapers have a large number of followers since they joined Twitter in 2007. The top newspapers on the list were the New York Times, with more than 2.6 million followers, followed by the Wall Street Journal, with 465,000 followers (Porter, 2010). News organizations may not always be the first to publish the news, but their agendas and discussions continue to shape conversations around major news stories (Newman, 2011). As agenda setting theory suggests, the content of media may not determine what people think, but they may significantly both influence and reflect what they think about (Vargo, Guo, Gruszczynski, & Wagner, 2017).

In addition to news media, state governments and their decisions can influence public opinion in at least two ways:

a. by instigating religious leaders to engage in social activation to ban the death penalty

b. by restricting the use of lethal drugs in capital punishment.

Such factors may help explain why Georgia and Texas, which have executed the highest number of people since 1976, revealed tweets mostly opposed to the death penalty.

In Nebraska, public opinion was mixed between those in favor of the death penalty and those against it. The analysis of the tweets sample results showed that 57% of the Nebraska population supported the reinstatement of the death penalty, compared to 21% of the population against the death penalty, and 22% with opinions unrelated to the death penalty. The prediction from the findings strongly indicated that the death penalty will be reinstated in Nebraska due to popular vote. On election day in November 2016, Nebraska citizens voted to bring back the death penalty, with 61.2% voting to repeal its abolishment. Thus, the results from the election are consistent with the public opinions posted on Twitter.

In this paper, there were not enough data to investigate the roles of geotechnical external factors such as technological penetration of the population to localizable clusters of tweets. Geotechnical factors in this case study might have included population demographics affecting the adoption of Twitter (which is a "younger generation" medium), the concentration of major media outlets, urban versus rural divisions that index political ideologies, and perhaps even neighboring state politics or shared urban metropolitan areas. Future research will need to utilize several software packages and datasets to examine research how Twitter data offer research opportunities for geographers to analyze human activities and communications (Issa, 2016).

Another possible geotechnical factor would be the proportion of a local population that has directly experienced (been victimized by) violent crime. Cultivation theory research demonstrates that both prior victimization and media consumption tend to disproportionately increase fear of crime, which may be reflected in an evememic cycle of influence (Custers & van den Bulck, 2011; Elchardus, De Groof, & Smits, 2008; Grabe & Drew, 2007). For example, the state of Illinois abolished the death penalty in 2011, after more than a decade of a moratorium on executions out of concern that innocent people could be put to death by a justice system (Corley & NPR, 2011). It would be an important pursuit of this prospect by investigating how the public in Chicago express their opinion about the death penalty after a couple of years of escalating violence and homicide.

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CHAPTER 6: FINDINGS AND CONCLUSION

6.1. Conclusions

This research offers reviews of selected literature based on case studies of social phenomena using public perception data derived from social media. The first case study was on fracking operations in the United States that triggered political debates from supporters and opponents. The second case study analyzed public reactions to Nebraska's abolishment of the death penalty in 2015, which was subsequently repealed in 2016. This study focused on the moral perspectives expressed in social media messages regarding the value of capital punishment. Both studies utilized public perception data from Twitter that contained recoverable online conversation information, news commentary broadcasts, sharing forums, and social media news circulation. The multilevel model of meme diffusion (M^3D) was applied to both studies as a communication perspective that accommodates the relationships between communication and human geography (Spitzberg, 2014). Data input to the studies was downloaded from public domain text messages posted in social media. The data was taken from long period of time to create big-data sources. This past decades, scholars have sought to expand the use of social media data mining in various research topics, especially in social sciences (Earl & Kimport, 2008; Spitzberg, 2014).

Social media processes often stimulate public attention through both opinion divergence and convergence. Sometimes, social media evokes public actions and reactions. Such actions and reactions, in turn, often resulted in polymemic feedback loops that activated more social media processes. Such propositional debates and social movements would increasingly be resolved in the competitive environment of public attention. Memes, both *pro* and *con*, would continue to compete in the informational ecosystem in which they would seek compatible environs and a comfortable foothold for the issue species at stake.

The source, space, and place of a meme play a significant role in the diffusion of opinions in social media, and reveal local, regional, and state-level differences that are sensitive to events in real space. Much work still needs to be done to specify the interrelationships among these factors and will require disciplinary contributions from multiple fields and disciplines (An et al., 2015). With the latest Internet technology, the presence of social media communication creates a new method for conducting geographic research by collecting public perception data from the publicly accessible social media (e.g., Twitter) communications. An ample collection of literature review was compiled in and stored in Mendeley reference management software (Burck, 2005; Heylighen & Chilens, 2009; Mykhalovskiy et al., 2008; Truscott et al., 2010).

The studies synopsized in this dissertation were grounded in two major disciplines, Geography and Communication, with some additional multidisciplinary fields from Geology,

Sociology, Journalism, and Criminology. These natural and social scientific fields are connected by human activities communicating via social media. As communication is a basic necessity for human interaction to express their emotion, communication technologies leap forward to support the basic survival demand (Kock, 2005). Communication technologies will continue to demonstrate the necessity of integrating communication theory and human geography to understand the complex human dynamics of complex social issues.

The contribution of this study is to provide documentation and analysis of the public views for the controversial public debates such as pro-fracking and anti-fracking, support of the death penalty and condemn of the death penalty, These controversial messages could be used as a guideline for decision makers of related policies to decide the prospect of policies in the future. In the case studies, the main component of my research relies on data mining from social media using Twitter text messages. The text messages from the opinion leaders and other Twitter users who posted high numbers of opinion messages related to fracking or the death penalty were examined for different reasons and reactions to the debates from individual and group users. Through these studies, I demonstrated the power of public opinions lead by the opinion leaders that are strong enough to affect the political decisions on certain controversial disputes.

The implication by findings of this research is that such opinion profiles are possible without the need for expensive or time-consuming public opinion polls or traditional surveys and interview methods. As the validity of polls on political issues are increasingly under scrutiny for their validity, social media may provide an important insight into unedited spontaneous public opinions on important policy issues.

This study found evidence for the influence of several major actors with large numbers of followers at different state levels that supports the diffusion of meme or the same message that triggered the tweet users' interests. The tweets from the traditional news media also play a key role as the news have been retweeted to other groups of media and regular Twitter users. The newspapers networks have many followers since they joined Twitter in 2007. The top newspapers on the list were the New York Times, with more than 41.8 million followers, followed by the Wall Street Journal, with 15.9 million followers (Porter, 2010). News organizations may not always be the first to publish the news, but their agendas and discussions are very dynamic and continue to stimulate the conversations around fracking news but not so much on the death penalty issues.

Although the controversial issues of fracking and the death penalty are not the major issues in the debate coverage in the 2016 US Presidential debate or the 2018 US midterm Congregational debates, there has not been any major decisions made on these issues. The coverage of fracking in social media is still on-going in the public debate and the public policy is limited locally to city level (such as those in Athens, Ohio and in Youngstown, Ohio) or state level (such as those in New York State). Similar case with the death penalty coverage that is not a major topic to the news media.

The above two case studies affirmed that the public opinion on issues as reflected by memes in social media can be mapped conceptually and empirically in geography boundary with multiple hierarchical levels of influence. The dynamic communication characteristics of Twitter data offer a great research opportunity for geographers to further examine human activities and communications (Issa et al., 2017). This research proves that geography plays a major role in the

process of disseminating social media information as mentioned in the first research question (RQ1 in Chapter 1)

However, for the second research question (RQ2 in Chapter 1), regarding the power of posted messages in social media that can affect the state's policy on the controversial issues, I found no evidence that the social media has the power to change public policy in the state and national levels (Smith & Ferguson, 2013).

6.2. Limitations in the research method

of the review of literature on the integration of communication theory and geography encountered limitations by certain factors. The first was the limited number and adaptation of keywords used as a search parameter when searching for relevant tweets. For the fracking study, the word "fracking" was used as the key element of Twitter's Application Programming Interface (API). The keyword "death penalty" was the hashtag choice for the death penalty debate. If there were indeed other words used by different groups, the inherent keyword bias is likely to have overrepresented one user group's sentiments. Fracking is a term used more by anti-fracking groups, whereas proponents tend to use the terms "shale-oil" and "natural-gas" in their social media. In the case of the death penalty study (see case study #1), the keyword used in this study was "death_penalty," which may have also reflected similar biases relative to alternative terms such as "execution," "death_sentence" and "capital punishment" (Tess, 2013).

A second limitation is the availability of tweets with geotagged data. There were only a small proportion of Twitter users activate their GPS location on their smart phones. Therefore, the number of tweets with geotagged information captured in these studies is very low, representing approximately 1 to 5 tweets per week for U.S. Twitter users (Issa et al., 2017). This

limitation was adjusted for by using the "User Profile" that include information of "User Location" in the tweets attribute to estimate user location (Chandra et al., 2011). I used the user locations with their proximity based on the Street Centerlines to estimate the locations of the Twitter users. The exact degrees of error in this interpolation of location is not known.

A third limitation is that the M^3D is an evolving theoretical model. Its predictive status is still relatively nascent. Several of its potentially relevant variables were not examined in this particular study, such as social network structure of the communication, the rates of diffusion, the specific message features that facilitated diffusion of opinions on the death penalty or fracking, and so forth. Continued work on M^3D will pursue a more propositional and predictive model as empirical research continues to inform the theory's content.

The fourth limitation is data security and privacy protection. In recent years, these concerns by social media platforms have become ubiquitous and important for social networking and sharing information. How can social media users rely on the safety of individual electronic data and personal data information not to be misused by other parties? According to Chen & Zhao (2012), although cloud computing service providers claimed the security and reliability of their services, the actual deployment of cloud computing services is not as safe and reliable as they claim (D. Chen & Zhao, 2012). This users' concern creates the need to find a security system or protection procedure on personal information data from the third parties without consent.

In 2009, the major cloud computing vendors successively allowed several leaks of information. According to a whistleblower who investigated the Cambridge Analytica for more than a year, the hackers are links to the Brexit Leave campaign in the UK and Team Trump in

the US presidential election (Cadwalladr, 2018). The use of robotic technology (botnet) is another factor that is damaging the research analysis due to data abnormality. The botnet from marketing vendors was detected in my research on fracking case study. Botnets become widespread in wired and wireless networks, whereas the relevant research is still in the initial stage (Xiao, Liu, Ghaboosi, Deng, & Zhang, 2009).

There is also another issue that needs to be considered as a limitation. It is the longevity of the technology to support social media programs and their customers/users. In a capitalist economy, business performance is affected by market orientation, yet there is no limit to the change of technology and human creation to achieve better and more efficient systems. The social networking system that is available in recent years depends on the infrastructure such as Wi-Fi, mobile network, Internet providers, program applications (Twitter, Facebook, Instagram, Snapchat, WhatsApp, etc.), and customers' preference on many choices of programs on the market (Ferrara, Interdonato, & Tagarelli, 2014).

In future work, the author will add posted information from Facebook and Instagram. According to some researchers, Facebook is the largest social network in the current social media applications, especially with the Facebook Messenger, their interactions are more meaningful in social relations (Tidey, 2017).

6.3. Future Works

This dissertation stimulates future research in several domains, some potential research topics as follow.

6.3.1. Validation of public perception on fracking operation in Eastern Ohio communities.

In this future study, I will contact the social media influencers in east Ohio from the list of fracking databases to conduct a personal interview on Skype or face-to-face interview. The objective of this interview is to get their recent perception of fracking in their hometown. The interview results will be compared to the previously posted social network data that were downloaded during the study period for a significant test. There have been few studies to compare the results of public perception data from social media with the survey data (Casler, et al., 2013).

6.3.2. Analysis of Public Perception on Fracking Operations in the United States.

This research is a continuation of fracking analysis as reported in Chapter 4 but it includes the communities where the fracking operation is an on-going activity. Some studies indicate that there are many states and local communities that are not pleased with the fracking operations in their neighborhood (Sangaramoorthy et al., 2016). This phenomenon also captured in this dissertation analysis in chapter 3 and chapter 4.

6.3.3. Empirical Studies on the US Perception on the Death Penalty.

Since the 1990s, there are not many studies to analyze the people's perception on the death penalty, from the judiciary articles in the Google Scholar, I found two articles by Tabak (1998) and Vidmar (1995). Future works are needed to analyze the diffusion of information synthesizing human reactions to crime and punishment that lead to capital punishment.

The same analytical procedures can be used in other case studies with controversial issues or other social phenomena in different countries. The prediction of the validity or successfulness of adopting this method may be different in different countries as the different

levels of use of digital data and different levels of availability of digital social media data decisively define how these studies can be carried out and how valid the findings are.

6.3.4. Contributions of this dissertation to Geography.

The author dedicated this research to Geography on three conceptual claims:

First, I argued that Geography and Communication are interconnected through the social media network. These amalgamated of these two academic fields would be the beginning of a new branch of Geography that would be called Social-Media Geography. The social media networks connecting and developing relationships from one individual with another individual with the same interest as a component of human evolution. The interconnection in social media could be traced using geotagged information from the Users' data (Chandra, Khan, & Muhaya, 2011). This research proves that geography plays a major role in the process of disseminating social media information

Second, I argued that the research method using data download from social media applies to geography research based on public perception. Social media applications such as Twitter, Facebook, Instagram, etc. have been used by Internet users to express their emotions. The posted message is a valid indicator of human emotion that corresponds to public events (Bollen, Mao, & Pepe, 2011). The social media data has geotagged information that can be mapped conceptually and empirically in geography boundary with multiple hierarchical levels of influence. The dynamic communication characteristics of Twitter data offer a great research opportunity for geographers to further examine human activities and communications (Issa, Tsou, Nara, & Spitzberg, 2017).

Third, I argued that the capacity of local influencers is very effective to stir the controversial debates that can affect the government's policy. My analysis challenges assumptions regarding the capacity of influencers to attract the opinion of their followers and diffuse political agendas through social media (Chen, 2016; Coscia, 2018; Downing, 2008). Once the influencer is identified by a username, age, gender, geographic location, and time-stamped and occupation, it is analyzed for the stance of the influencer's text messages and their target audience.

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