ABSTRACT

Title of Document:	THE MARCELLUS SHALE IN MARYLAND AND TWITTER: A MIXED METHODS ANALYSIS OF TWEETS FROM NOVEMBER 2016.
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Social media platforms like Twitter, provide new modes of networked public participation while affording communities a space for identity development and expression. During 2016, Maryland saw increasing interest in and debate around opening the State to hydraulic fracturing. Data collection of relevant tweets occurred throughout November 2016. The final sample of tweets for this period was n=638 stratified across thirteen hashtags. The timing, actors involved and themes of tweets were analyzed using qualitative methods. Frequency analysis showed peaks on November 14, November 18 and November 22. Respectively, peaks corresponded to the release of proposed regulations by the Maryland Department of the Environment, a day of action referred to as #frackfreefriday and an uptick in regulation discussion. Analysis showed individual actors and the hashtag #dontfrackmd contributed the most to the final sample. Further analysis is recommended to understand public perception within the Marcellus Shale region as it pertains to hydraulic fracturing.

THE MARCELLUS SHALE IN MARYLAND AND TWITTER: A MIXED METHODS ANALYSIS OF TWEETS FROM NOVEMBER 2016

By

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Dedication

To my husband, parents, family, and friends: without your love, understanding, listening ear, and unwavering support, I would not have made it through this program.

To my dog Daisy: for staying up with me countless nights so I was not alone while I studied, wrote, analyzed, and worked.

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Chapter 1: Introduction

According to a 2014 study by the Pew Research Institute, 75% of US adults are on social networking sites (Matsa, 2014). One of those sites, Twitter, a microblogging application that limits posts referred to as Tweets, to 140 characters has emerged as a frequented platform for obtaining, sharing, and interacting with news and current events (Aldahawi & Allen, 2013). Twitter first emerged in 2006 and currently boasts a monthly active user count of 310 million with a 500 million additional non-member site visits per month (Smith, 2016). Every day the social network site sees approximately 500 million Tweets. Social media platforms like Twitter provide potential new modes of networked public participation around contested technologies while affording communities a space for identity development and expression (Hopke & Simis, 2015). Opportunities and spaces created by Twitter are of particular importance in the current environment of innovation, development, and democracy. “Science and technology have increasingly higher uncertainty and higher decision stakes, which calls for more democratic processes of development” (Funtowicz & Ravetz, 1993) and “responsible innovation calls for the inclusion of public values relevant to technological development.” (Taebi et. al, 2014). By collecting, analyzing, and reporting, public attitudes expressed on social media scientists can begin to understand the public’s values. Unconventional natural gas extraction, or hydraulic fracturing, is the recent technological advancement of extracting natural gas deposits from underground geological formations through horizontal wells. The technology allows extraction of shale gas from previously unviable reserves (Jackson et al. 2011). The public values surrounding the technology, whether or not to allow it near their

homes and communities and the safety of the technology all vary widely depending on geographic location, political affiliation, age, and other factors (CITE). Our study sets out to begin the process of understanding public attitudes towards hydraulic fracturing in Maryland during a pivotal month of 2016. By answering three specific research questions, we aim to understand better the public perception around hydraulic fracturing in Maryland.

Research Question 1: Who are the main actors engaged on Twitter in conversations surrounding hydraulic fracturing in Maryland?

Research Question 2: What is the main content of tweets around hydraulic fracturing during November 2016 and what is the stance towards hydraulic fracturing?

Research Question 3: What was the temporal distribution and did the frequency change over the course of November?

Chapter 2: Background

Our study focuses on a single geographic region during a single moment in time, November 2016 in Maryland. Our aim is not to argue for or against the industry and its utilization of natural gas as an energy source. Natural gas as an energy source has existed in the United States since around 1800. With the technological advancement of hydraulic fracturing, the energy source that has existed for a few hundred years is experiencing a resurgence. In 2015 alone, natural gas accounted for 33% of the U.S. electrical energy consumption, tied with coal and followed closely by nuclear (20%) with hydrological (6%), renewables (7%), petroleum (1%), and other gases (<1%) producing the remainder of the energy that year (U.S. Energy Information Administration, 2016). The industry is active in certain areas in the United States, (CA, MT, WY, ND, UT, NE, CO, KS, NM, TX, OK, AK, MS, AL, LA, IN, MI, OH, PA, WV, VA), while others banned the practice or instituted a moratorium (NY, MD, counties in MA, NH, VT). Some states, have not made a final decision but are considered to be on the cusp of opening their borders to the industry (NV, IL, NC, FL) (Hirji & Song, 2016). One of the United States largest, the Marcellus Shale formation, extends underground across five states, Pennsylvania, Ohio, West Virginia, New York and Western Maryland (United States Environmental Protection Agency, 2016). At the time of proposal in October 2016, the State of Maryland had an active moratorium on hydraulic fracturing within its borders set to expire in October of 2017 (Johnson & Wiggins, 2015). Maryland has a Republican governor in office who supported the practice as good business with viable reserves in the Western part of the state (Johnson & Wiggins, 2015). With increasing awareness of and debate around whether Maryland should continue

the moratorium, ban the practice entirely, or accept the proposed regulations by the Maryland Department of the Environment and begin approving permits for the hydraulic fracturing in the western region of Maryland (Maryland Department of the Environment, 2011) necessitated a public attitude study. Between the time of proposal and completion of the research study, Maryland experienced a significant political shift towards a ban on the practice. Before these results were released, Maryland signed into law a hydraulic fracturing ban. A brief history of fracking in Maryland through the signing of the most recent legislation follows.

In 2011, then Governor Martin O'Malley (D) signed into law the *Marcellus Shale Safe Drilling Act of 2011* which required an impact assessment and proposed regulations be released and open to public comment before any permits would be approved, with additional pre-permit approval stipulations (Maryland Department of the Environment, 2011) In 2014, the Maryland Institute for Applied Environmental Health published their findings titled *Public Health Impacts of natural Gas Development and Production in the Marcellus Shale in Western Maryland*. The MIAEH study identified environmental public health impacts with high, moderate and low likelihood of occurrence in Western, Maryland if hydraulic fracturing was approved. The following year, in July of 2015 Larry Hogan (R) intentionally took no action thereby allowing the moratorium extension to de-facto become law (Environment - Hydraulic Fracturing, 2015). Over a year later, on November 14, 2016, during sample collection, the Maryland Department of the Environment released proposed regulations for Maryland (Oil and Gas Exploration and Production, 2016, sec. 26.19.01 Oil and Gas Resources). During the 2017 legislative session, HB1325 – *The Oil and Natural Gas Hydraulic Fracturing – Prohibition Bill* passed out of the Maryland House of

Representatives by a veto proof majority on March 10, received public support by Governor Hogan on March 17, and on March 27, the same bill (SB0740) passed out of the Maryland Senate. On April 5, 2017, Governor Larry Hogan signed HB1325 / SB0740 into law officially banning the extractive process of hydraulic fracturing from occurring in Maryland.

Chapter 3: Literature Review

Twitter mining and content analysis for public perception, though less common as it relates to hydraulic fracturing, is an established research focus. Previous studies have looked at the connection between different oil companies and sentient opinion (Aldahawi & Allen, 2013) while others mapped relationship nodes within the context of identity development around communication networks (Edinger, 2010). Others studied public perception and knowledge as it evolved during the 2014 Ebola pandemic (Odlum, 2015; Lazard et. al, 2015).

Through a process of pressurized injection of water, sand and chemicals (fracturing fluid) into rock formations through horizontal wells, unconventional natural gas extraction releases shale gas for collection. The pressurized injection of the fracturing fluid causes the wastewater and gas to return to the surface ("The Process of Hydraulic Fracturing," 2017). Once extracted shale gas is identical to the more commonly and easily extracted conventional natural gas (Finkel, 2011). Attributable to the technological advancements, previously unobtainable and abundant reserves of shale gas have become economically viable to obtain. In the Marcellus Shale alone drilling is expected to generate 300,000 jobs, $6 billion in tax revenue and $25 billion in value added to the economy by 2020 (Rao, 2012; Yergin, 2011; Mazur 2016).

The US Environmental Protection Agency does not regulate the injection of fracturing fluids nor do companies release the proprietary formula of the fluid (Finkel, 2011). Up to seventy percent of the fracturing fluid return to the surface potentially (Finkel, 2011). A 2014 study done by the Maryland Institute for Applied Environmental Health

(MIAEH) in collaboration with the Maryland Department of Health and Mental Hygiene (MDHMH) identified and ranked (from high to low likelihood) possible impacts from hydraulic fracturing in Maryland. Their findings found air quality, healthcare infrastructure, occupational health and the social determinants of health to have a high likelihood of occurrence. Cumulative exposures and risks, flowback and production, water-related and noise were found to have moderately high likelihood of occurrence. Finally, earthquakes were found to have a low likelihood of occurrence (Maryland Institute of Applied Environmental Health, 2014).

Other studies look not only at a specific region like Western Maryland as the 2014 MIEAH study did, but look to the industry practices as a whole and aim to quantify the risks and rewards of the industry. A comprehensive review of the health effects, environmental effects, and social impacts have been previously published (Carpenter, 2016; Vengosh et al 2014; Lave et al, 2014; Merjen &Lee, 2014; and Kreipl et al., 2017) and therefore, only a highlight of specifically relevant studies will be provided here.

Finkel, 2011 found that of the 41 products used in hydraulic fracturing that they studied, 73% had up to 14 different deleterious health outcomes ranging from skin, respiratory irritation to brain, and nervous system impacts. Unconventional natural gas production continues to ramp up but the necessary baseline assessments and research into the practice are not keeping up (Mitka, 2012). In an attempt to combat the lack of information and protect their citizens, many states and communities, including the federal government, have created advisory organizations to determine the risks and produce recommendations. Goldstein (2012) points out however, almost all of these advisory boards are missing representatives from the environmental public health sector. Without

these members on the committees, he notes the impacts to the environmental public health sphere are usually overlooked. Hopke, 2015 has found that the contested nature of hydraulic fracturing comes not only from the technology itself, but also from a lack of consensus regarding what health and environmental threats are of concern and who should be involved in decision making.

Previous research has identified public attitudes, perceptions,, scientific findings, and industry opinions related to hydraulic fracturing both in Maryland, communities across the United States, and the globe (Hopke, 2015; Hopke and Simmis, 2015; Neville, K. and Weinthal E. 2016; Sarge et al., 2015; Williams et al. 2017; Weible, C., 2016). Studies looking at public opinion on fracking found low level of familiarity with the technology resulting in mixed support. Boudet et al. 2014 identified 58% of survey respondents not knowing or being undecided on fracking, 20% being somewhat or strongly opposed, and 22% being somewhat or strongly supportive. Researchers must continue to track the perception before, during, and after development or approval of industries at the community and individual level as people prepare for and react to impacts from the industry (Brasier et al., 2011).

There have been a very limited number twitter analyses as they relate to fracking. One, published in 2015 by Hopke, found significant differences across hashtags surrounding the international day of action against fracking ($X2(df=8, N=64,417) =18,632.95, p=0.000$). Results also showed significant correlation between opinion and hashtags (Cramer's $V=0.380, p=0.000$). Hopke's results highlight the differences that can occur between and across hashtags as individuals express their opinions, attitudes and perceptions on Twitter.

As past research shows political opinions expressed on Twitter have variable focuses across different political groups (Colleoni et al, 2014; Yardi and Boyd, 2010). Identifying discourses across groups improves public health education, decision-making, and risk communication. Odlum (2015) found that Twitter mining proved useful in public health education. Through trend and content analysis authors showed communication stimulated by public concern mirrored the news alerts surrounding the public health issue. "Social media text mining provides a valuable tool that can be used quickly and efficiently to improve public health communication efforts by collecting and identifying prevalent themes of public concern" (Lazard, 2015). Work by Bruns and Burgess in 2012 provided research that shows networked nodes of communication and how information was shared between and within sub-networks on Twitter. One of the less studied areas in the use of Twitter as a measure of public attitudes around fracking forcuses on a specific geographic location. Therefore, our research aims to contribute to the overall science and provide insight into a less studied region as it relates to Twitter and hydraulic fracturing.

Chapter 4: Methods

Sample designation and Data Collection

All fifteen of the data collection phrases and hashtags were selected based on results from multiple sources. The literature provided the initial set of terms. The website Hashtagify.me verified content and hashtags associated with hydraculic fracturing and Maryland. hashtags and phrases without sufficient results from either the literature or hashtagify.me were investigated using Twitter's search bar to determine if the phrase or hashtag was appropriate to include.

Hashtagify.me

Hashtagify.me is an online portal that allows searches for terms and hashtags. The software provides a Twitter search engine whose results are powerful analytics on hashtags associated with content or topics. And provides the most common associated terms, phrases, other hashtags and content.The combination of methodologies resulted in fifteen hashtags and phrases. Justification for each follows below.

Marcellus Maryland, Fracking in Maryland, and MD Fracking

Hashtagify.me provided sufficient evidence to support the inclusion of the term *fracking* in our sample. *Marcellus Maryland, fracking in Maryland* and *MD fracking* were independtly not common enough for hashtagify.me analytics. Independent research combined with knowledge of the content provided justification to add both "*in Maryland"* and "*MD"* to the term fracking in order to focus the scope of tweets on the geographic region of interest. Similarly, *Marcellus Maryland* through independent Twitter search was determined to be a common phrase used around the topic and therefore was included.

natgas and shale

#Natgas and #shale both show up in the literature as hashtags on opposing sides of the fracking debate (Hopke, 2015). Both terms were searched on Hashtagify.me to verify their continued relevance around the topic.

Western md & Western Maryland

The term Maryland was identified as a common phrase for the region through Hashtagify.me searches. *Western md* and *Western Maryland* showed connection to the geographic region of interest. Researchers determined with results from independent searches that including the geographic location of the Marcellus Shale in Maryland was critical to capturing all tweets associated with fracking in Maryland.

Health fracking & Environment fracking

As noted previously, the term fracking was identified as a strong component of the fracking discussion on Twitter. Researchers identified, through their research questions, content topics of interest. The term *health* and the term *environment* were added to the term *fracking* in order to capture all tweets associated not just with fracking but with our content of interest.

#dontfrackmd & #frackmd

Dontfrackmd is a well-known hashtag affiliated with the anti-fracking movement in Maryland. Researchers verified the hashtags relevance via Hashtagify.me. Literature highlighted opposing opinion of fracking utilizing opposing hashtags. Therefore, we independently searched Twitter for *frackmd*. No recent tweets were identified, but researchers determined that inclusion was critical to capturing both sides of the debate around fracking in Maryland.

#banfracking

Banfracking is a known hashtag associated with the anti-fracking movement. Results from Hashtagify.me confirmed the frequency of *banfracking.* Additionally, the term *fracking* was being picked up by other sample terms and *banfracking* would provide some degree of opposing tweets related to fracking.

Fracturing

The term *fracturing* was included based on results from Hashtagify.me and the researcher's knowledge about the content. Though may refer to fracking as such, the real term is hydraulic fracturing. Inclusion of the term fracturing was essential to capture all tweets related to the content regardless of how the user referred to the industry.

Marcellus shale

Marcellus Shale is the name of the natural gas deposit in Maryland. Results from both Hashtagify.me and independent searches on Twitter showed positive connections to the topic area.

Maryland fracking moratorium

Independent Twitter searches returned the phrase *Maryland fracking moratorium* as a phrase used in Twitter discourse around the industry in Maryland. Though Hashtagify.me could not provide analysis due to too few tweets, researchers determined inclusion of term as beneficial to the study.

Tweet Archivist

Once the final term list was identified, a Tweet Archivist account was created. Tweet Archivist is an online software that collects publically available tweets in real time during sample collection. Tweet Archivist generates archives, analyzes and exports the file of

Tweets. Tweet Archivist is a paid subscription. Once all terms were identified, entered into the account, data collection began.

Data Processing

Datasets for each of the fifteen hashtags were downloaded from Tweet Archivist. Next, researchers removed tweets that occurred outside of the period of interest (12:00am November 1, 2016 - 11:59 pm November 30, 2016). Researchers then separated original tweets from retweets in line with the literature. Manual and program assisted classification (SAS 9.4, Cary NC), reduced the sample to the final, content, location and date specific tweets. Manual coding was undertaken first to understand how the topic was referenced in the tweets. All non-Maryland, non-fracking tweets were removed from the original only tweet sample. At this stage, SAS 9.4 was used to index tweets to identify Maryland and fracking only tweets. Researchers, through automated methods, indexed hashtag samples for the following terms: Maryland, MD, md, America, US, and United States. Validation of indexing occurred within hashtag *fracturing*. To minimize classification errors, researchers manually verified all indexed and non-indexed tweets. This validation led to a reprocessing with inclusion of all county and city names in Maryland. Once the final sample (N=638) was compiled, qualitative analysis followed. Qualitative analysis was modeled after the methods of Braun and Clarke (2006).

Qualitative Analysis

Qualitative analysis began with researchers reading the text of each tweet for both content and stance. The tweets were read for main content and classified into the following categories: *activism, economy, environment, health, health and the environment, election or policy, other,* or *no specifics.* Category other was used when more than one main content

was referred to and it was unclear what the primary content was. At the same time, the text of the tweets were classified for overall stance towards fracking. For the stance, researchers used the following four categories: *anti, no stance, other* or *pro. Other* was again used when the answer was ambiguous and researchers could not verify which stance was being taken. *No stance* was used when a tweet included no opinion language and was instead a sharing of information. Distinction was made between an unclear stance (*other)* and a non-existent stance (*no stance*). The third step of analysis required the review and classification of actor type. For this, researchers looked at the twitter handle, name, and profile picture and when necessary bio of the tweeter to identify which of the following categories the tweeter fell under: *Bot / anonymous, community organizations, government individual, industry, non-profit, other, science.* Following actor classification, all handles, names, and link to bios or profile pictures were removed from samples and tweets de-identified in accordance with proposed methodology under our Institutional Review Board application for this research.

Statistics

Indexing for search terms and automated classification were completed within SAS 9.4 (Carey, NC).

Chapter 5: Results

Sample

At time of initial download, the sample size was 216,672 tweets. The sample size was reduced to 45,832 when all tweets outside the period of interest (12:00am November 1 – 11:59pm November 30) were removed. Removal of retweets reduced the sample further to 20,528 tweets. After the last step, removal of non-Maryland, non-fracking tweets, researchers were left with a final sample for analysis of 638 tweets. The final sample represented 0.29% of the initial download, 1.39% of the November only sample, and 3.00% of the retweet removed sample. The only two days within the period of interest without any tweets were November 24 and November 25. The hashtag *natgas* dominated the sample during initial download, November only, and retweet removal. In the final sample, the hashtag *dontfrackmd* was the predominant hashtag representing over 50% of the sample (n=328). Hashtags *frackmd, Marcellus Maryland, Maryland fracking moratorium and environment fracking* represented the least frequent hashtag in the initial download, November only, removal of retweets and final sample respectively. The hashtags, *shale, frackmd, and Marcellus Maryland* had no effective sample size due to inclusion criteria and therefore were not part of the final sample. The final sample was comprised of the following twelve hashtags: *banfracking, dontfrackmd, environment fracking, fracking in Maryland, fracturing, health fracking, Marcellus Maryland, Marcellus shale, Maryland fracking moratorium, mdfracking, natgas, western Maryland and western MD.*

Actor

Within the final sample (N=638), actor type - *individual,* content type – *other* and stance type – *anti* were the most common. All actor types were represented in the final sample with *individual* making up the largest portion and *science* representing the smallest. Figure 4 shows the percentages of the remaining actor categories. No actor type was present in all hashtags. *Individual,* the most common was also present in the most number of hashtags, 10 of the final 12. *Community organizations* was only present in one of the 12 hashtags followed next by *news* and *science* each present in only three hashtags. *Other* and *non-profit* were present in nine and eight hashtags respectively. The following tweets provide examples of tweets from three actor types:

Industry

@UNIT1: Saying YES to #natgas means thousands of good jobs for MD residents. #PipelinesareLifelines https://t.co/xRGLCDGmSG https://t.co/OP9Zdc4tjn

Bot / anonymous

@UNIT2: Among our key findings: The top three shale plays by water use were the Eagle Ford in Texas, Marcellus in... https://t.co/3ULwwfm5O1

Non-profit,

@UNIT3: What is #fracking and why should we #banfracking in Maryland? https://t.co/4q1DR17Ybn #DontFrackMD https://t.co/UxvBZC8Zvk

Content

All content types were represented in the final sample. Figure 6 and 7 highlight the total sample and content stratified by hashtag respectively. *Activism (16%), other (28%) and election or policy (20%),* were the most prevalent content types representing 64% of the

sample combined. *Economy* (2%), *health* (7%), *environment* (8%), *environment and health* (8%), and *no specifics* (11%) make up the remainder of the sample. Hashtags *dontfrackmd* and *md fracking* both had tweets representative of every content type. Content type *other* and *environment* were present in the most number of hashtags, ten and nine, respectively. Both *activism and economy* were centralized around the same three hashtags, *dontfrackmd, fracking in Maryland,* and *md fracking*. The following tweets are examples of four content types:

Economy

@UNIT4: #DontFrackMD Let's train people for #solar jobs instead of #fracking jobs: https://t.co/NxRNL33cBB

Environment

@ UNIT5: Marsha Haley MD on current see-back from #Fracking wells. https://t.co/yzJKjRDAXp

Health

@ UNIT6: @conway_joanEHE No Maryland citizen should be put at risk for cancer. Stand up to oil & gas lobbyists #dontfrackmd

Policy

@UNIT7: Frostburg, MD working away on #fracking ban in city limits and on city-owned land, ban on use of city water, too.https://t.co/0STkv6uOLo

Stance

Our third qualitative classification, *stance* had at least one tweet in each of the four categories. All hashtags except *natgas* had tweets representing *anti*-fracking sentiment. The only hashtags that had *pro*-fracking sentiment were *fracking in Maryland*, *md fracking*

and *natgas*. The *other* stance, reserved for tweets that were inconclusive was present in *fracking in Maryland, md fracking and western md.* With 80.08% of the sample *anti*-fracking sentiment was the most common. *No stance, other* and *pro* represented the remaining sample with 17.08%, 0.78% and 1.25% respectively. Figure 9 shows stance stratified by hashtag. An example of each stance type is highlighted below:

Pro

@UNIT8: Oh my #Grade4Greatness 3,000 jobs a year! In Maryland! #frackingdebate #boom 43% wants to ban fracking? But 57% want it!

Anti

@UNIT9: It's #frackfreefriday tell your local leaders #dontfrackmd

No stance

@UNIT10: #Maryland #fracking opponents push for statewide ban. #energy #naturalgas via @MDDailyRecord https://t.co/VBtY4mBTLZ https://t.co/J38HgjWGbr

Other

@UNIT11: The latest Marcellus Shale Daily! https://t.co/XCO5lGEK0j Thanks to @businessPG #americanenergy

Temporal distribution

The temporal distribution of the data (Figure 1) shows three peaks on November 14, November 18 and November 22. The highest frequency of tweets occurred on November 18. Figure 2 shows the temporal distribution by hashtag. Figure 3 shows the temporal distribution by hashtag without *dontfrackmd*. For both Figure 2 and Figure 3, the three

peaks (November 14, November 18 and November 22) remain visible with delineation of by hashtag representation.

Chapter 6: Discussion

Sample

Our results highlight aspects of public attitudes around hydraulic fracturing in Maryland specifically as it relates to actor type, content focus area, stance and temporal distribution. We expected the large sample size reduction that was described previously and highlighted in Table 1. Our sample phrases and hashtags intentionally collected information related to the industry as a whole not just in Maryland which contributed to a large portion of the sample reduction occurring when the geographic inclusion criteria was applied. Broad search terms meant our initial sample included all Twitter talk around fracking contributing to the large initial sample. Certain hashtags have dual meaning. For example, *fracturing* returned a majority of unrelated injury focused tweets. The *fracturing* sample focused largely on professional athlete and individual injuries. As mentioned previously, the final sample was stratified across twelve of the fifteen hashtags. We did not anticipate that *frackmd* would be excluded from our final sample. Data collection identified older tweets associated with the hashtag but because of the frequency of *dontfrackmd* and other anti-fracking sentiment tweets, we anticipated *frackmd* to be present in our final sample. *Shale* and *Marcellus Maryland* were absent for different reasons. *Shale* because there was no tweet during our period of interest related to fracking in Maryland, it was a failure of the sample to meet the temporal criteria. *Marcellus Maryland* was a failure to meet inclusion criteria related to content. The tweets associated with *Marcellus Maryland* had no tweets pertaining to hydraulic fracturing. We anticipated *Marcellus Maryland* to be a present and

large proportion of the sample because of the name of the shale deposit and geographic location.

Actor

The results for actor type were largely in line with expectations. Although we expected to see more governmental representatives engaging directly in the dialogue and we saw zero, the largest proportion being individuals was expected. Another surprise was that there were tweets by the scientific field. With fracking being such a contested topic, scientists typically do not engage in conversations about industry in order to remain impartial. Classification of actor type proved more difficult than we or the research team - figure out which term you want to use - anticipated. The actor type is based solely on how the individual represents themselves on Twitter. Between their twitter handle, name, profile picture and bio (if all components were used) the exact type – individual or community organization for example – can be difficult to discern. There are nuances both in how people portray themselves and how they want to portray themselves on a social media site that impacts our ability to truly, in one moment capture who they are and who they represent.

Content and stance

The content of tweets provided more insight into how different actor types engaged with the discourse on Twitter. The content of the tweets, though largely anti-fracking, did show some differences between the anti- and pro-fracking sentiments. While making up a much smaller portion of the sample which limits the applicability to the dialogue as a whole, the pro-fracking tweets tended to use harsher terms, more attack language, and put the opposition down. That type of attack language was present in the pro-fracking and other-fracking stances as well, just not in the same proportion as found in the pro-fracking

focused tweets. Also noted in the content of the tweet was an unexpected proportion of tweets referencing a specific policy? Whether the policy was recently proposed or soon to be proposed the engagement that directly corresponded with or about political action, not just the general election was unexpected.

Temporal distribution

As identified previously, Figures 1 – 3 show different iterations of the temporal distribution of the tweets over the course of November. In Figure 1, two of the three major peaks are associated with specific events in Maryland. The first, on November 14 coincides with the release of the MDE proposed regulations for fracking. The second, and largest peak, coincides with the Sierra Club's day of action that used *frackfreefriday* as their collective hashtag and *dontfrackmd* as the secondary hashtag. Finally, the third, and smallest peak was on November 22. Tweets from that day predominantly focus on a call to action around a referendum to ban fracking in Maryland promoted and supported by a non-profit, Chesapeake Climate. The hashtag *dontfrackmd* also represented large portions of the peaks on both the 14 and 18 of November. A final aspect of the temporal distribution to point out is that when stratified by hashtag all three peaks remain visible in the data. The stratification by hashtag and resulting distribution indicates that multiple hashtags engage in the hydraulic fracturing conversation throughout the month.

Comparison to current literature

Comparison of our results to others is limited due to the lack of research studies focused on Twitter and hydraulic fracturing and the differences between Twitter samples for our study and other published studies. However, one of the forefront studies, done by Hopke in 2015 found that the hashtag *natgas* was predominantly anti-fracking while *shale*

was predominantly pro fracking. Again, our sample did not include any tweets from the hashtag *shale* due to the inclusion criteria but we did have five tweets that were from the hashtag *natgas*. Our results, showed *natgas* as the only predominantly pro-fracking hashtag from our sample. This could mean that the way in which specific hashtags are used could have changed since 2015 or that the dialogue around a global day of action, from Hopke 2015 is fundamentally different from the dialogue over the course of a month related to fracking in a specific geographic location.

Banfracking

As expected, *banfracking* had the largest proportion of tweets related to activism as well as a majority of the 48 tweets for this hashtag tweeting at government or famous individuals to try and sway their position. Additionally, media outlets were tweeted at a lot in this hashtag in attempts to share stories and information with a wider audience. Due to this context, it's unsurprising that context around policy, and policy in specific locations within Maryland were common. It is interesting however, that *banfracking* not only doesn't have a peak on the 22 but did not register a single tweet that day. November 22 was a day of increased activism on Twitter around calling for a ban so it is very surprising that only two of the three peaks are present in Figure 10.

Dontfrackmd

As mentioned previously, *dontfrackmd* was the most common hashtag with over 50% of the tweets in the final sample coming from this hashtag alone. The three peaks, are still visible on the temporal distribution (Figure 11) for this hashtag. The content focused predominantly on activism around specific locations or politicians in Maryland. Tweeters using this hashtag also took the time to thank jurisdictions or politicians for supporting a

ban or protecting health, a component of activism lacking from other hashtags. Although the MIAEH study found a low likelihood of earthquakes impacting Maryland should fracking be opened, the study citing the link between earthquakes and fracking in Oklahoma was cited very frequently as a reason to ban the practice in Maryland. This highlights the potential disconnect between research, risk communication and the publics knowledge around what true risks are associated with fracking for them. This hashtag is the only one that has content around the C&O Canal pipeline project.

Environment fracking

Environment fracking only contributed three tweets to the final sample, too small of a sample to draw conclusions, however all three did speak directly on the environmental impacts due to fracking calling for a ban to protect, not health but the environment.

Fracking in Maryland

In addition to having peaks on November 14, 18 and 22, *fracking in Maryland* also shows a peak around November 6. Though unclear what the impetus was for the uptick, there were more discussions on fracking in Maryland specifically in the Frederick area. Tweets from this hashtag also had a high portion of tweeting at politicians but unlike *banfracking* tweets for this phrase also brought in and tweeted at non-profit organizations. With 106 tweets, representing just under 17% of the final sample, *fracking in Maryland* provides an important look into the dialogue around hydraulic fracturing in Maryland during November.

Fracturing

The term fracturing resulted in a majority of tweets related to injuries. However, the final sample included eight tweets from this hashtag and they all focused on either the

environment or a policy decision. Specifically, the implications of and decision by representatives in Frostburg and Hagerstown were highlighted by tweets and utilized the term hydraulic fracturing instead of fracking in their tweets. The tweets were clustered around a five day span of time, from November 10 – 15. Figure 14 shows the temporal distribution of *fracturing.*

Health fracking

Not unpredictably tweets resulting from this phrase during data collection focus on the health effects or potential health effects of hydraulic fracturing. A common health focus of the tweets related to the report of Pennsylvania lawmakers regretting their decision to support hydraulic fracturing in their state because of the health impacts they've seen since opening up PA to fracking. Individuals tweeting about fracking in Maryland were framing this as a precautionary tale that we should learn from our neighbors and listen to them, good bad and ugly regarding fracking and make the best decision for our health. The majority of tweets were centered around the *frackfreefriday* day of action. The *health fracking* phrase made up the majority of the health focused tweets on that day.

Marcellus shale

While the sample size is also too small to draw any significant conclusions, it is worth mentioning that *Marcellus shale* is the only hashtag that mentions Cove Point, MD in their tweets. Additionally, the content focused on the economy as it relates to human wellbeing indicating that those tweeting with the phrase *Marcellus shale* and nothing else are concerned more with the economy than any other content.

Maryland fracking moratorium

The majority of the five tweets were advertising the same specific panel hosted by Johns Hopkins around the Maryland fracking moratorium from an economic, political and societal perspective. The small sample size and predominant, repeated topic limits conclusions for this hashtag. It is interesting to acknowledge that the only tweets associated with this hashtag are related to an event with the term in the title. This indicates either that people are not talking about the moratorium or not using the specific phrase. This is not entirely unexpected since the focus of the dialogue for the other hashtags was on a future fracking ban, not on the active moratorium.

Md fracking

MD fracking represented the largest individual portion of the tweets from the day of proposed regulations release which shows that individuals and others engaged on the topic of fracking around that day were all referring to the topic by addressing fracking in their state, *MD fracking.* It is not unexpected that the day of proposed regulations release would see an uptick in the dialogue around fracking in the State of Maryland. There was also an increase in debates within our sample on whether or not the regulations are strict enough and if there should be a ban or an opening up to the industry. The conversations were engaged and focused on specifics of the regulations as well as an overall look at the risks which was interesting that even with only 140 characters, some individuals managed to speak very specifically about the regulations and their opinions towards them. The secondary peak on November 18 was not necessarily related to the *frackfreefriday* but instead was due to the story of bringing the fracking debate to churches. While it can be inferred that this is part of the larger *frackfreefriday* day of action, the content and actor

type on November 18 within this hashtag was different than either *dontfrackmd* or *fracking in Maryland.*

Natgas

The hashtag *natgas* resulted in five predominantly pro-fracking tweets as outlined above. This was particularly interesting to researchers because it goes against findings in other studies. However, it is critical to note that the sample size is too small to be able to extrapolate to the larger *natgas* discussion. Comparison of how *natgas* is used in Maryland specific tweets to the rest of both the Marcellus Shale region and the larger United States will be an interesting analysis. *Natgas* tweets are also clustered around the November 14 peak, indicating that the majority of tweets were sent on the day of MDE's proposed regulations release, though none of the tweets explicitly mentioned the proposed regulations.

Western Maryland

Like *natgas*, *western Maryland* only had five tweets in the final sample, limiting the analysis on the content, actor and stance. The tweets are not clustered around any one day and instead, are distributed across the first 17 days of the month. Additionally, the majority of tweets focused on the health impacts particularly in Frederick and the implications for the impacts to their communities. Frederick was the most common region of Western Maryland discussed across all hashtags indicating an engaged population regarding the potential for natural gas extraction in their communities.

Western md

The majority of the fifteen tweets attributed to *western md* focused on the comparison of western Maryland to the rest of the state as it relates to their stance on fracking. Some of

the tweets also discussed the impacts of fracking – both positive and negative. Overall, this hashtag seemed to be the most combative and derogatory towards others with opposing positions. One consideration is that those individuals in Western Maryland that stand to benefit from the extraction of the natural gas within the Marcellus Shale feel it is not the right of 'outsiders' so to speak to make the decision that will be impacting them the most. However, without talking to the individuals and identifying why they tweeted the way they did, we are unable to confirm this conclusion.

Our findings show a broad focus on anti-fracking sentiment tweeted by individuals throughout the month with peaks on three days. Based on what we know to have occurred in Maryland since data collection stopped, our analysis aligned with the direction and magnitude of at least the political movement in Maryland. While not all hashtags had sample sizes sufficient to draw conclusions or extrapolate to the larger dialogue within that hashtag, our analysis still highlighted the who and what of tweets related to the fracking conversation in Maryland. It provides the first look and understanding into how to engage with individuals, organizations, industry and the like on social media. If you are looking for individuals focused on or concerned about the health effects related to fracking, search *health fracking* but verify the health effects they are concerned about. Based on our results, you would start with the hashtag *natgas* and go from there. With Twitter's platform utilizing hashtags as a way to connect individuals talking about similar topics, it becomes essential to understand the differences in who and what across hashtags of similar topics, for examples, the fifteen related but different hashtags for fracking in Maryland.

Chapter 7: Conclusion

Strengths

The research undertaken provided an analysis of the entire month of November for fifteen hashtags. Previous studies looked at a few days, or a singular day, but our analysis provided a longer scale look at the dialogue around hydraulic fracturing in Maryland. Additionally, by including fifteen hashtags, some not directly linked to fracking in Maryland but linked to the topic or geographic area, we captured tweets that are omitted from other studies that only utilize one or two hashtags. Another strength of our study is that we classified not just for one factor, but for three. Our analysis shows overall and stratified by all hashtags, the predominant content and stance of the tweet as well as the actor type. This stratification allows for comparisons not only across actor, content or stance, but across hashtags by those topics to identify differences in dialogue by actor, content, stance and specific hashtag or phrase used in the tweet. The analysis provides the first look at public discourse and perception around hydraulic fracturing for a specific geographic area, Maryland. Lastly, the studied collected all publically available tweets using an established and validated collection method, which resulted in our sample being complete for the phrases and hashtags we identified.

Limitations

Our analysis is not without weaknesses. While there are studies highlighting the connection between public perception as expressed on Twitter and the broader public opinion, no study currently exists making that connection in Maryland. Additionally, our hashtags, though not initially recognized as, biased towards anti-fracking sentiment. It was not until data

classification that more pro-fracking hashtags were identified as described in the discussion above. A limitation of the data distribution itself is that by stratifying across as many hashtags as we had, statistical comparison and analysis was limited. Finally, with the qualitative classification as well as the automated indexing, we have risk of classification and omission errors respectively.

Future studies

As mentioned, this study provided the first analysis within the Maryland geographic region around fracking and Twitter. Future studies of this data set will look regionally, to the conversation in and around all the states within the Marcellus Shale reservoir, look at the location the tweet originated from, and the follower count of the tweeter to identify influential actors, hot spot areas, and a regionally analysis of the dialogue. Additional follow up analysis should include temporal analysis looking at how the dialogue changes post-November through, particularly in Maryland, when on April 5, 2017 the ban was signed into law. Hydraulic fracturing is an industry that continues to grow, and researchers should be looking to all possible avenues to understand public perception around hydraulic fracturing (fracking) including future studies both with this dataset and with larger datasets to understand the dialogue in Maryland the Marcellus Shale region as a whole.

Conclusion

The State of Maryland, between the time of proposal for this research and the writing of our analysis, has moved from an active, shortly expiring moratorium on the industry to wide bipartisan support for a full ban on the industry. On April 5, 2017 Governor Larry Hogan signed into law *The Oil and Natural Gas – Hydraulic Fracturing – Prohibition Bill* banning the practice of hydraulic fracturing within Maryland. The extraction of hydraulic

fracturing may now be banned within Maryland, but other stages of the lifecycle of Natural Gas including transport, storage and treatment, still occur within Maryland. Our analysis showed the majority of tweets in the sample we obtained, with the limitations of potential bias as noted above, were in support of a ban on the practice within Maryland. Our results also show the variability in dialogue around and within the topic of hydraulic fracturing in Maryland with the potential to be scaled up to the regional level. Understanding public perception is challenging and a dynamic process. However, our results showed a glimpse into the public attitudes around hydraulic fracturing in Maryland and the majority of tweets in our sample were in agreement with the eventual political decision regarding fracking in Maryland. Understanding public support and opposition is critical for planners (Boudet and Ortolano, 2010), government agencies attempting to establish regulations (New York State Department of Environmental Conservation, 2013) and for researchers, advocates and others interested in communicating potential impacts (Clarke et al., 2015).” Our analysis began to fill the gap of knowledge regarding public attitudes around hydraulic fracturing that existed and continues to exist in Maryland.

Appendix

Table 1: Sample distribution across inclusion criteria

	% of N	**% of n (Nov)**	**% of** no RT
Initial download	100.00%	-	-
November only	21.00%	100.00%	-
No Retweets (RT)	9.00%	45.00%	100.00%
Final Sample	0.29%	1.39%	3.00%

Figure 1: Temporal distribution of Tweet frequency across November

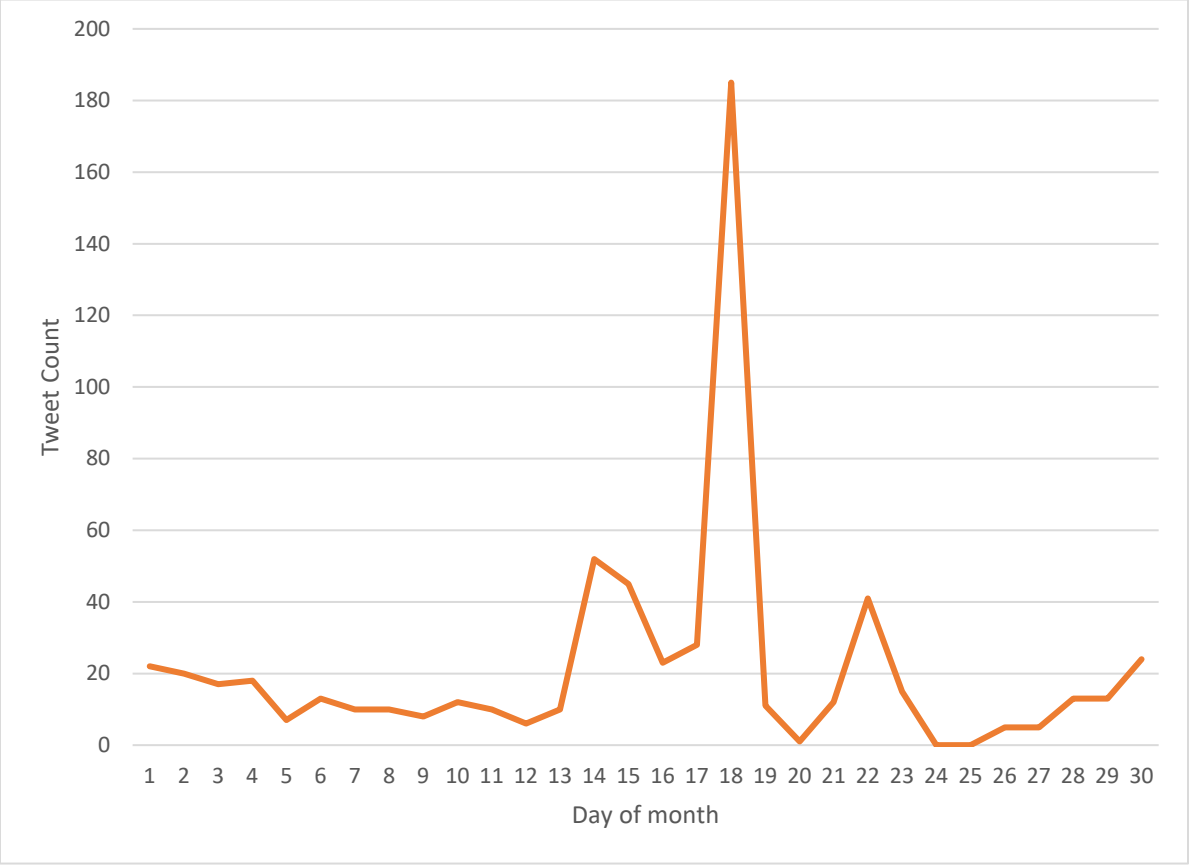


Table 2: Sample frequency distribution by inclusion criteria and hashtag

	Initial Sample (count)	**November Only (count)**	**No Retweets (Count)**	**Final Sample**	
Hashtags				Count	Percent of total
banfracking	27,934	3,329	699	48	7.52%
dontfrackmd	8,425	837	328	328	51.41%
environment fracking	30,346	8,739	2,946	3	0.47%
fracking in maryland	3,915	946	106	106	16.61%
frackmd	0	0	0	0	-
fracturing	39,835	7,745	3,674	8	1.25%
health fracking	20,762	5,692	2,611	13	2.04%
marcellus maryland	701	0	0	0	-
marcellus shale	2,779	504	328	4	0.63%
maryland fracking moratorium	199	8	5	5	0.78%
md fracking	2,574	214	99	98	15.36%
natgas	50,031	12,147	7,193	5	0.78%
shale	20,842	4,309	1,726	0	-
western maryland	3,471	533	380	5	0.78%
western md	4,858	829	433	15	2.35%
Total	216,672	45,832	20,528	638	

Figure 2: Temporal distribution of Tweet frequency stratified by hashtag

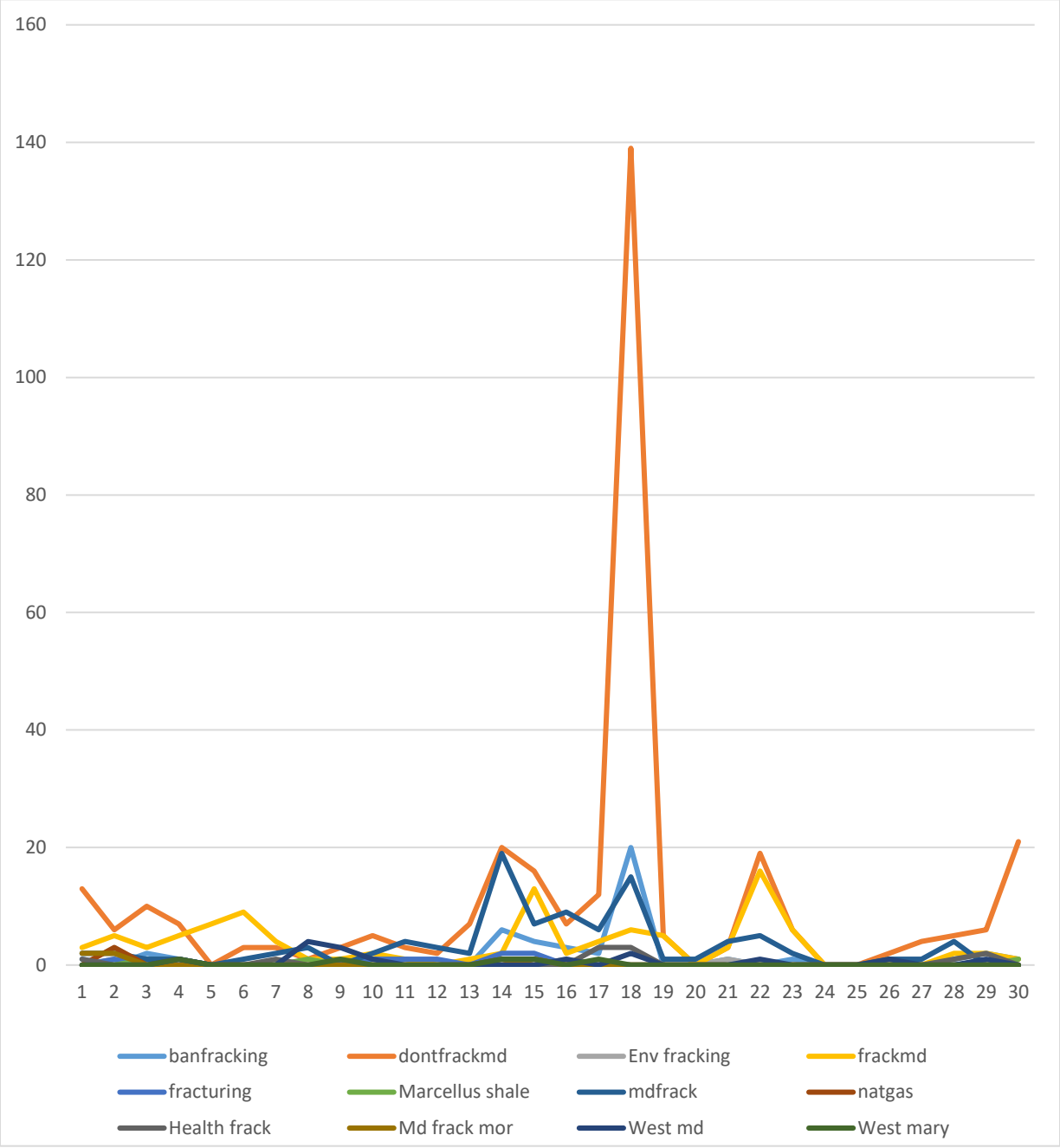


Figure 3: Temporal distribution of Tweet frequency stratified by hashtags excluding dontfrackmd

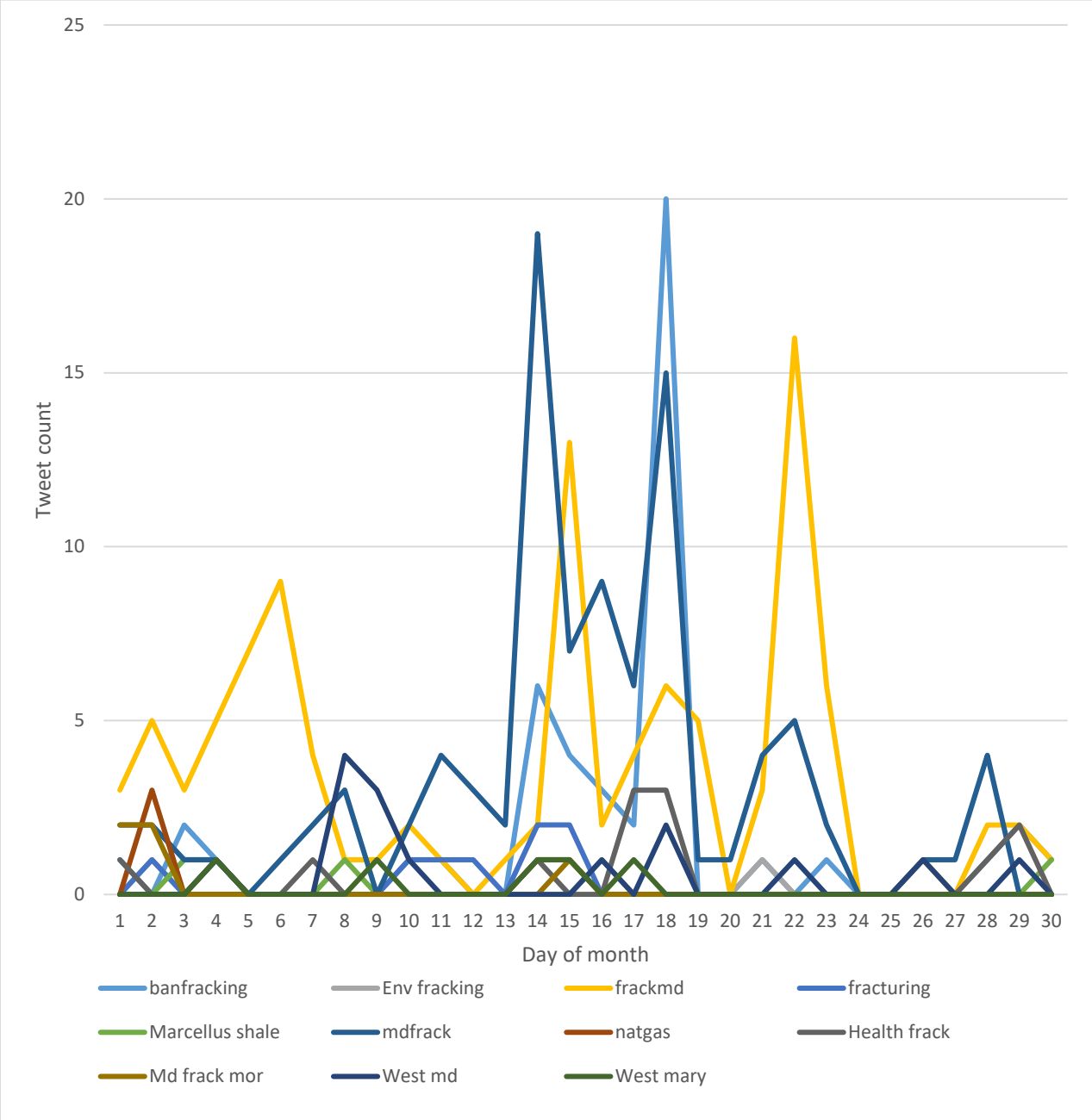


Table 3: Most common actor type, content focus and stance stratified across hashtags

Hashtag	Actor	Content	Stance
banfracking	Non profit	Election or policy	Anti
dontfrackmd	Individual	Election or policy	Anti
Environment fracking	News / Non-profit / Other	Election or policy / Environment / Other	Anti
Fracking in Maryland	Individual	Other	Anti
Fracturing	Individual	Other	Anti / No stance
Health fracking	Non profit	Health	Anti
Marcellus Shale	Individual	Environment	Anti / No stance
Maryland fracking moratorium	Science	Other	Anti
MD Fracking	Individual	Activism	Anti
natgas	Industry	Other	Pro
Western Maryland	Individual	Environment	Anti
Western md	Individual	Election or policy	No stance

Figure 4: Percentage of actor type for full sample

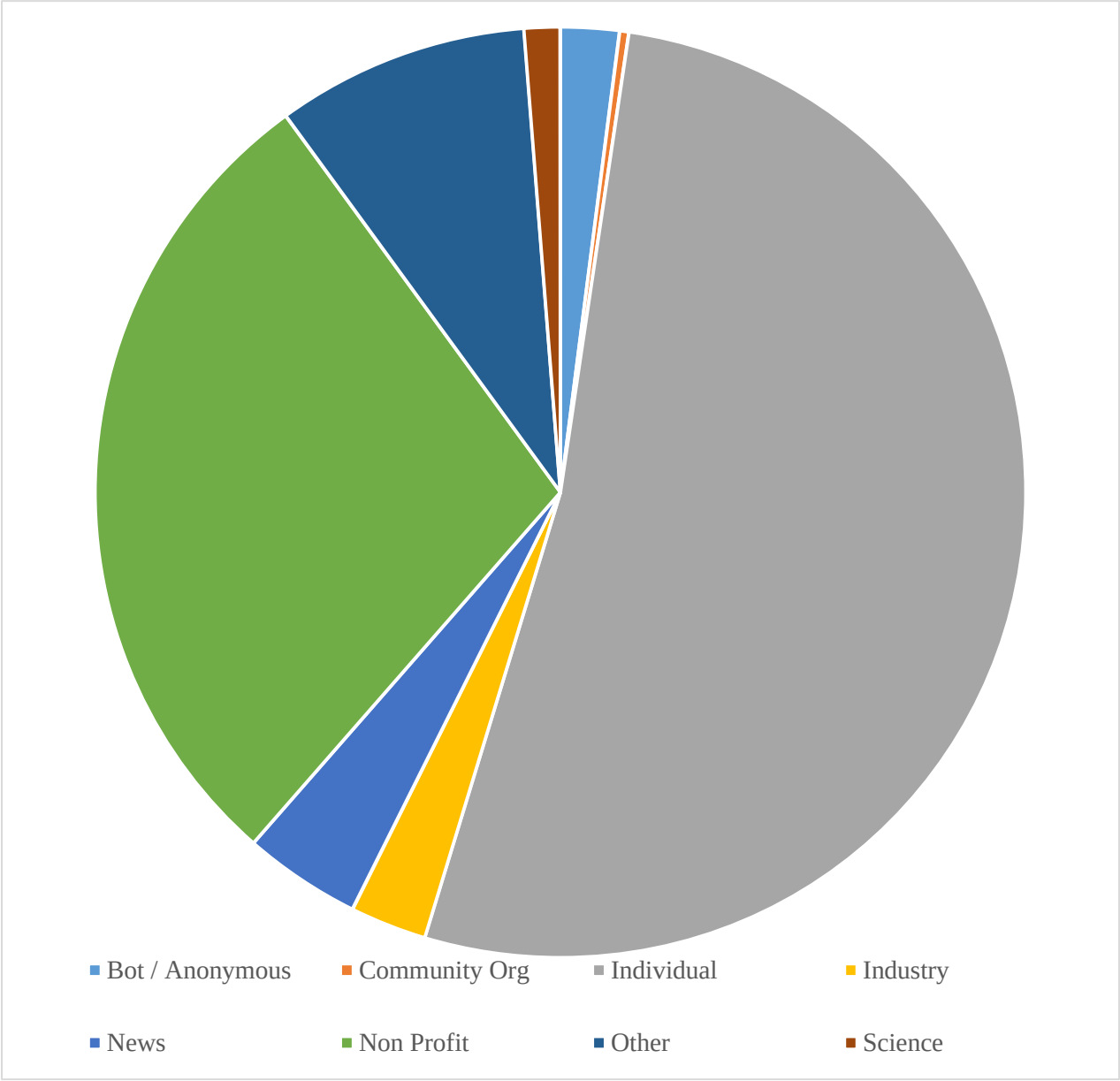


Figure 5: Actor type stratified by hashtag

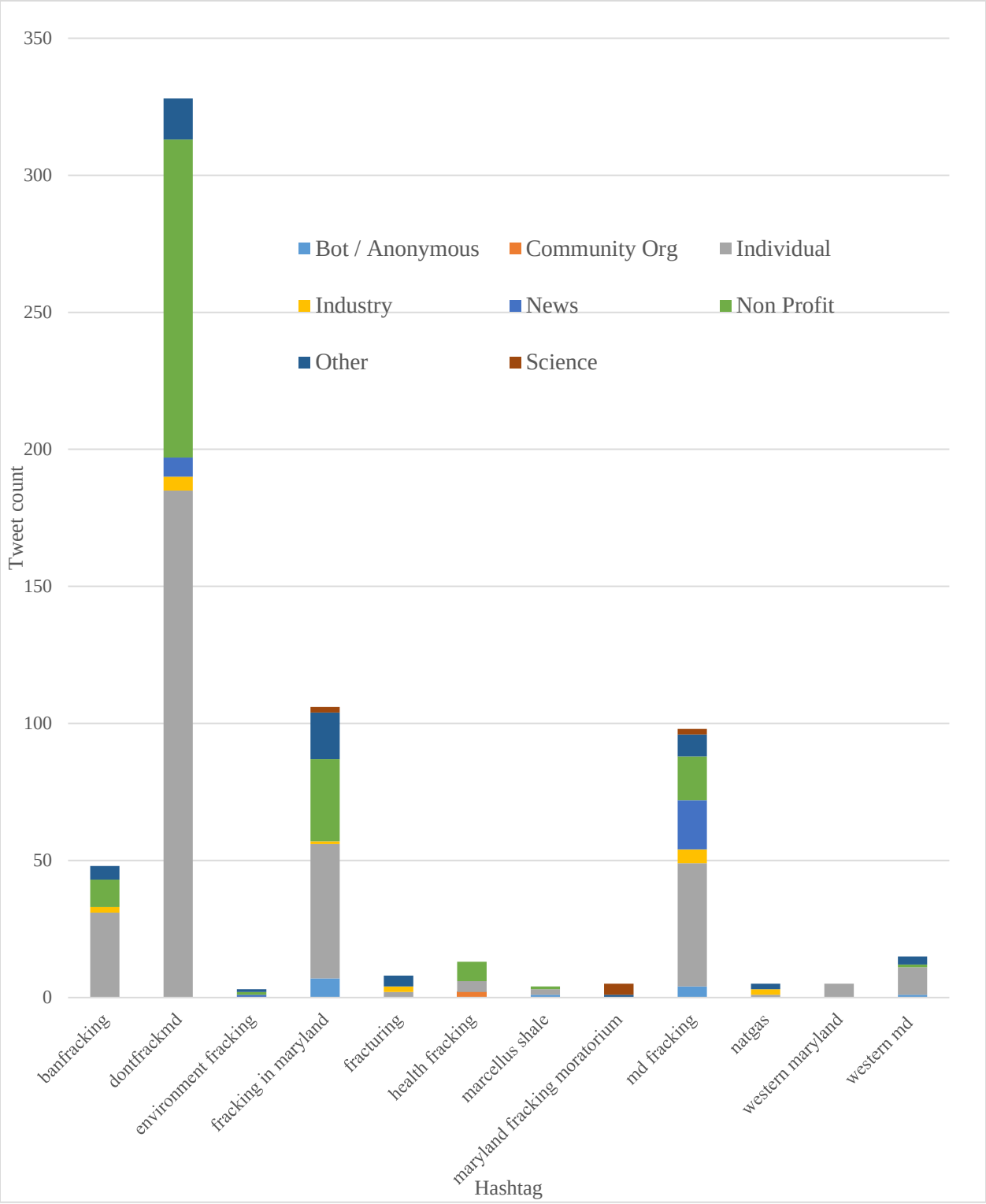


Figure 6: Percentage of content type of full sample

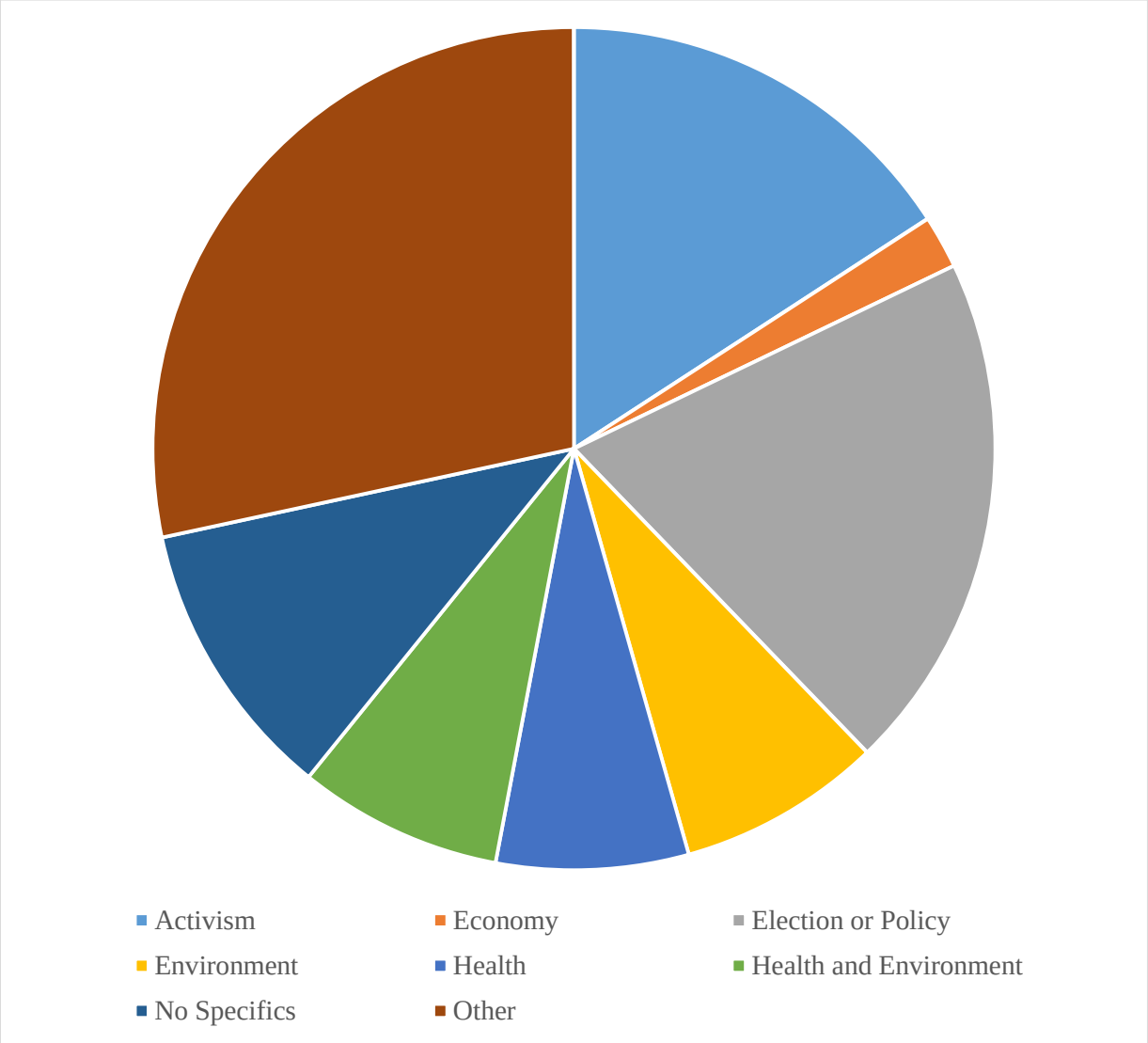


Figure 7: Content type distribution stratified by hashtag

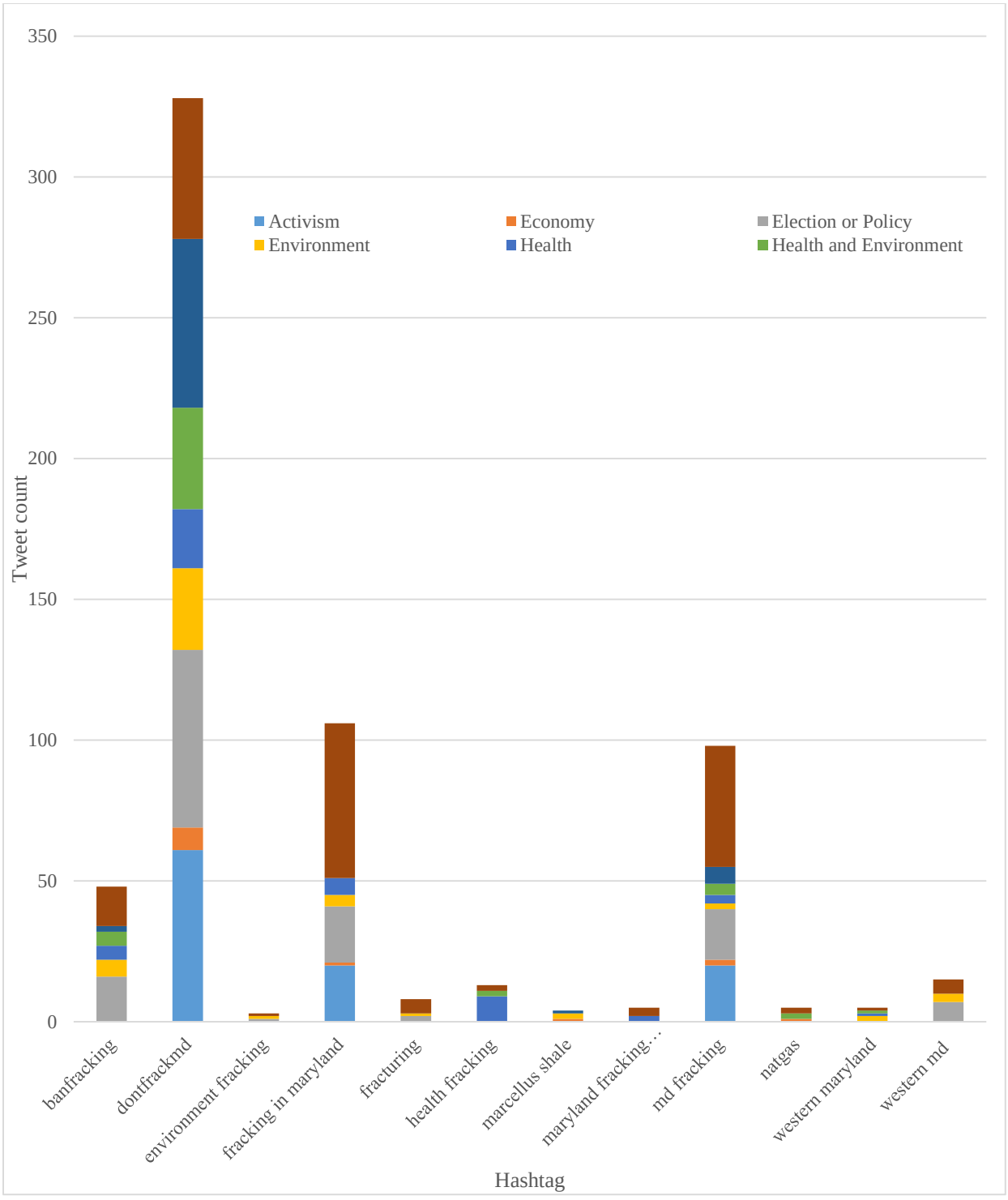


Figure 8: Percent distribution of stance towards hydraulic fracturing

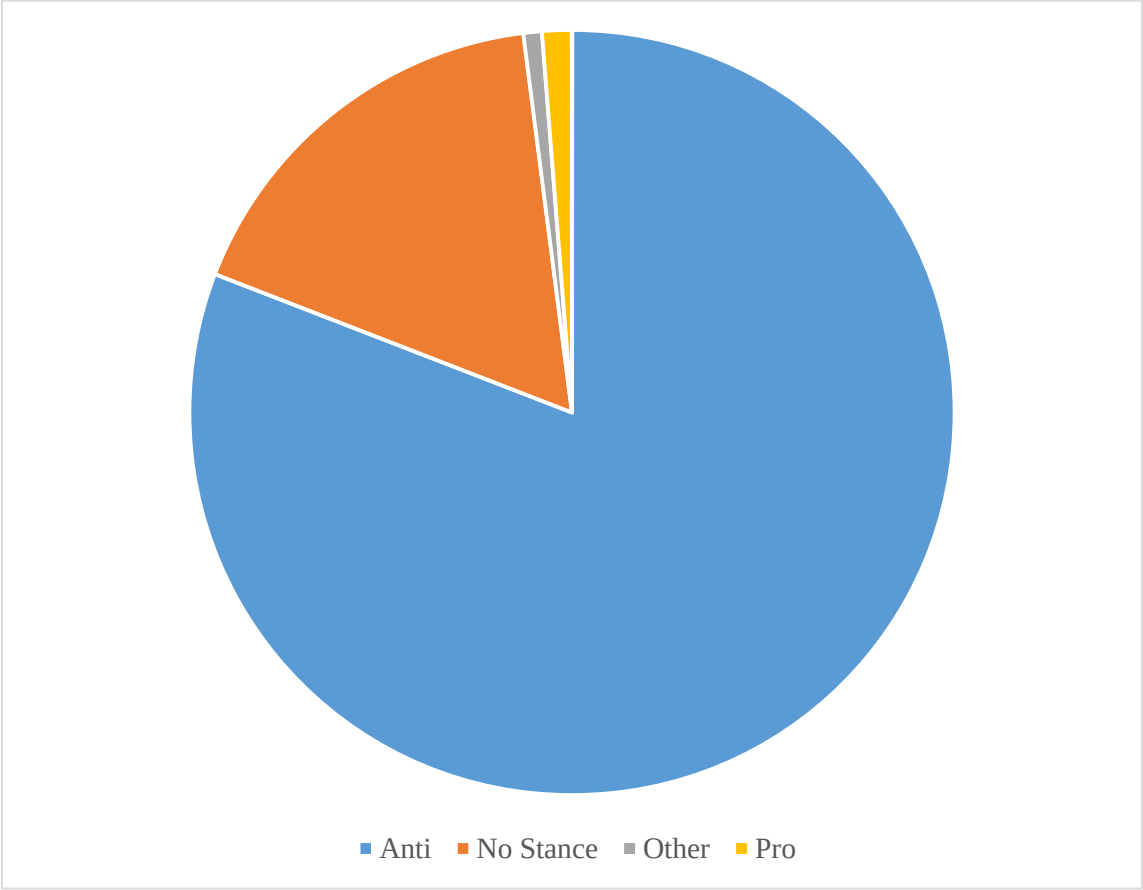


Figure 9: Stance count stratified by hashtag

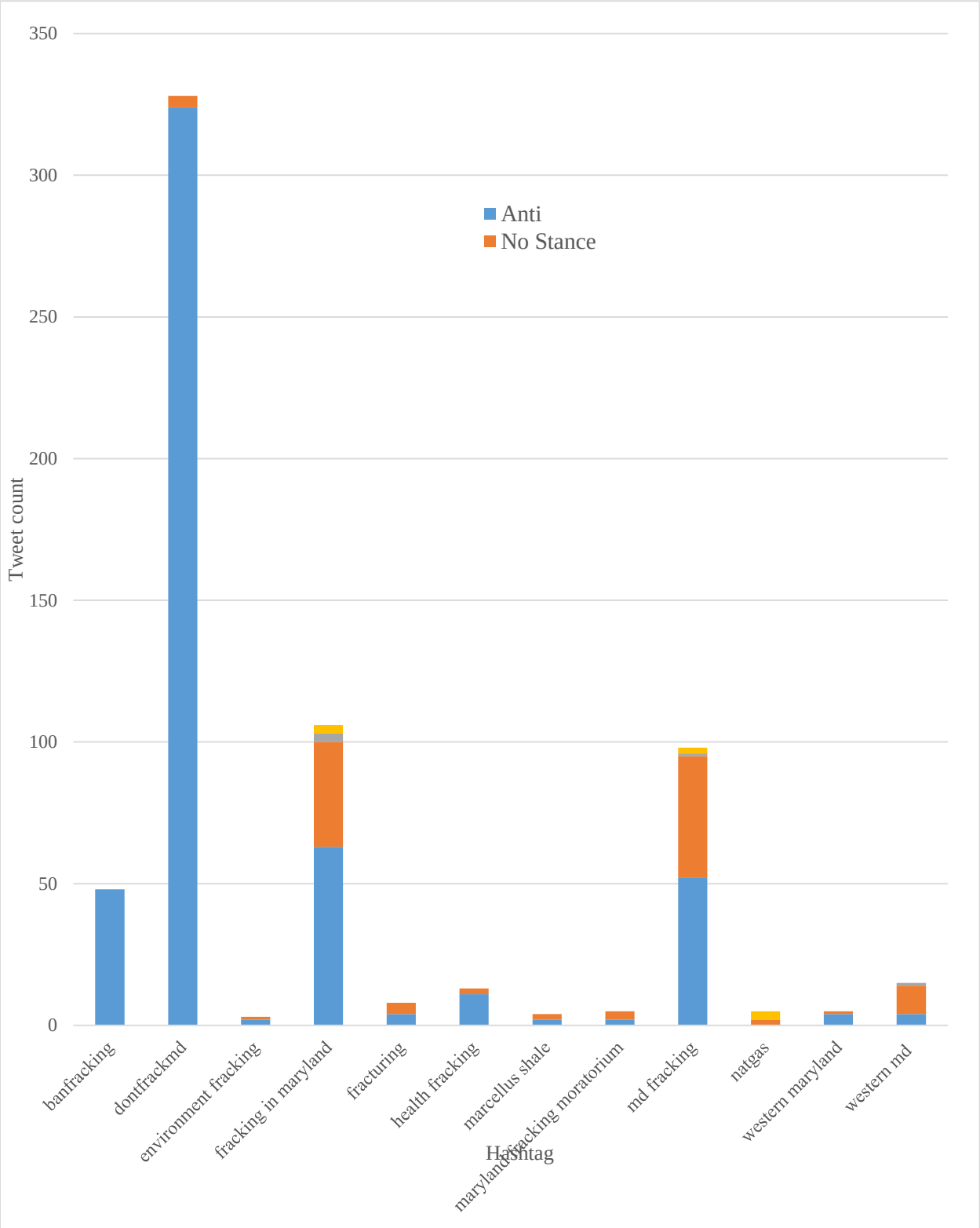


Figure 10: Temporal distribution of hashtag banfracking

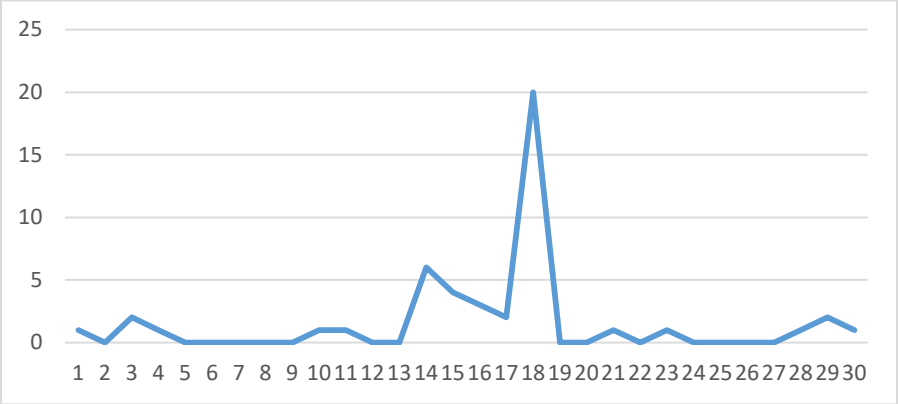


Figure 11: Temporal distribution of hashtag dontfrackmd

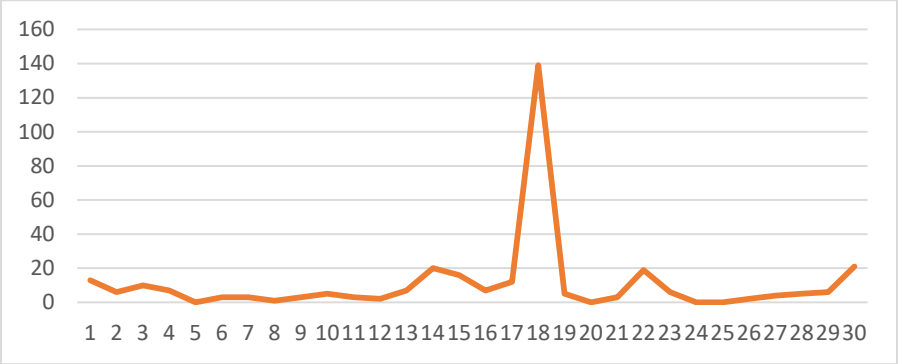


Figure 12: Temporal distribution of hashtag environment fracking

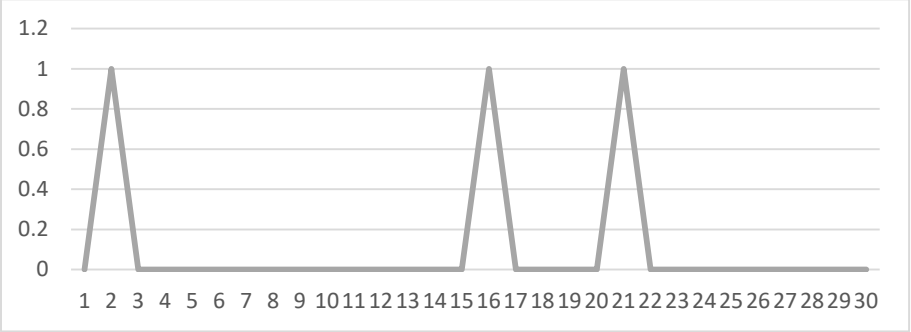


Figure 13: Temporal distribution of hashtag fracking in Maryland

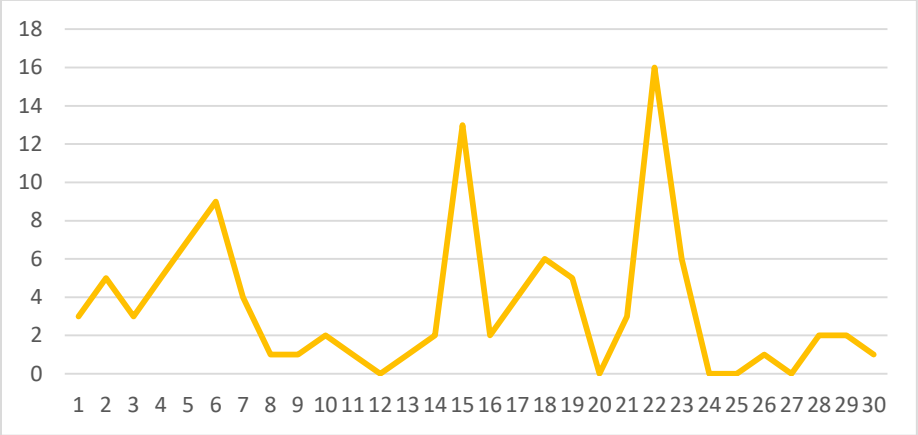


Figure 14: Temporal distribution of hashtag fracturing

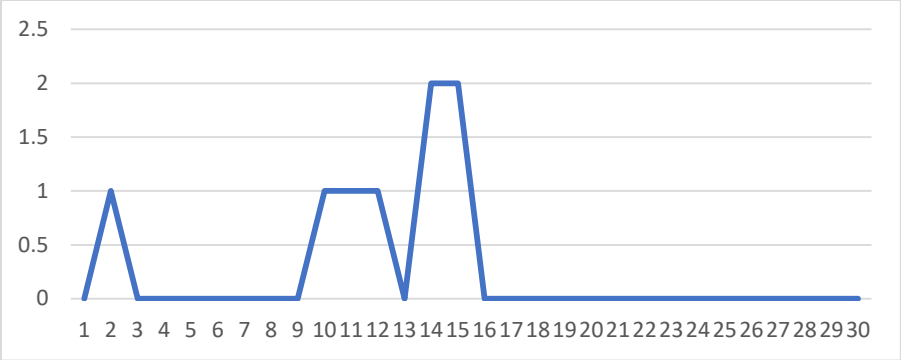


Figure 15: Temporal distribution of hashtag health fracking

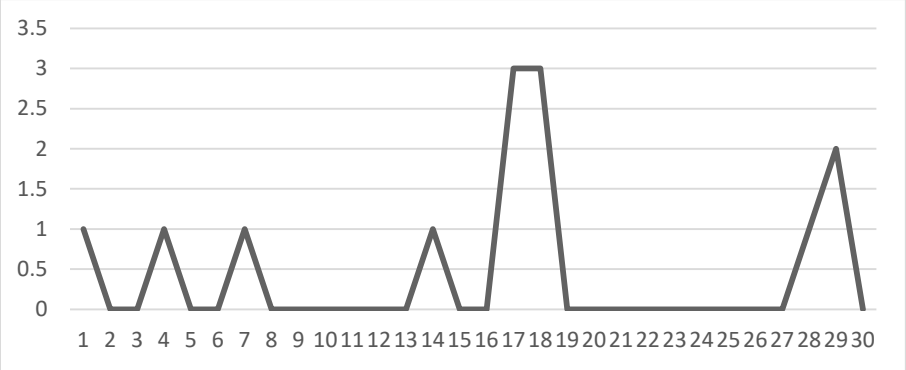


Figure 16: Temporal distribution of hashtag Marcellus Shale

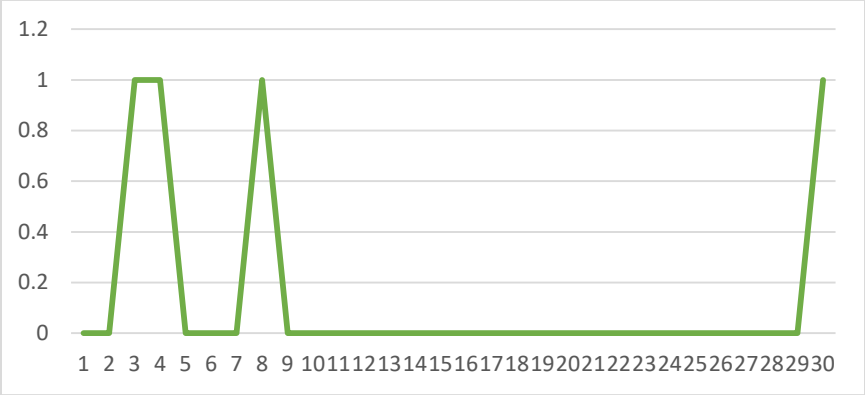


Figure 17: Temporal distribution of hashtag MD fracking moratorium

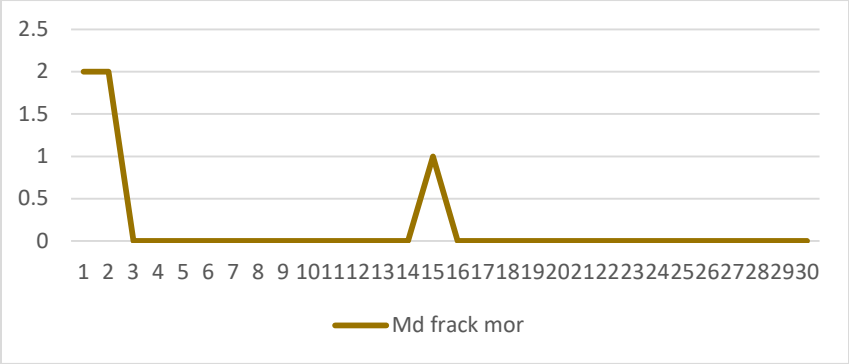


Figure 18: Temporal distribution of hashtag md fracking

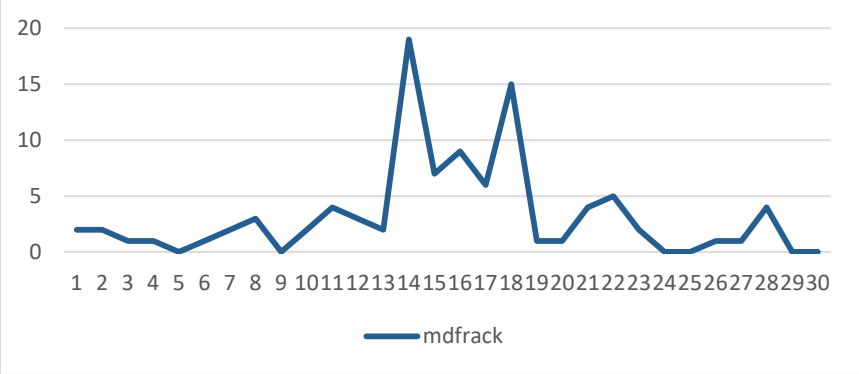


Figure 19: Temporal distribution of hashtag natgas

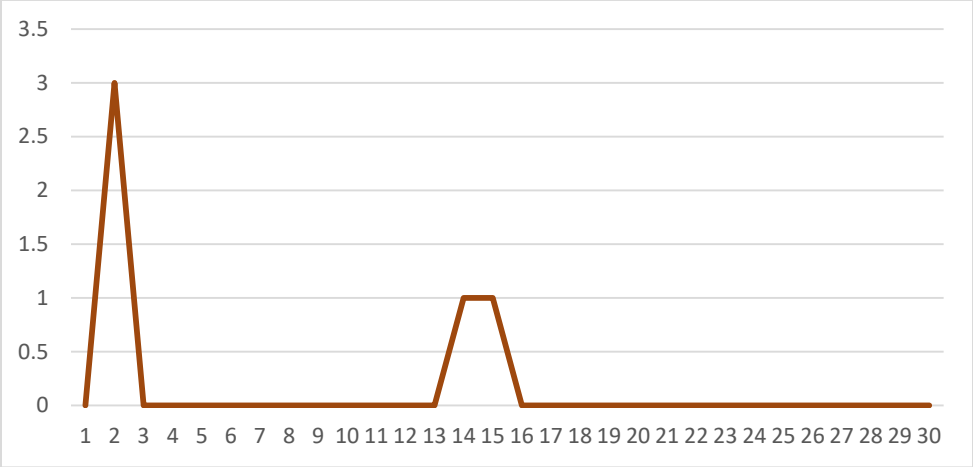


Figure 20: Temporal distribution of hashtag Western Maryland

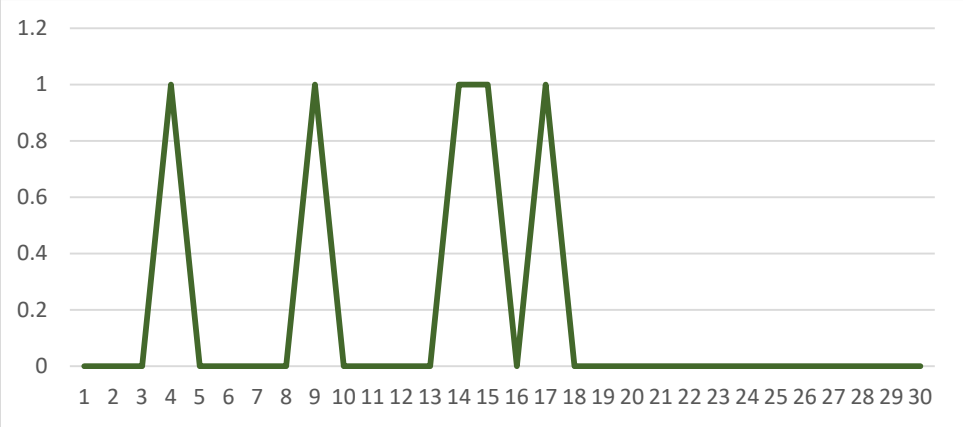
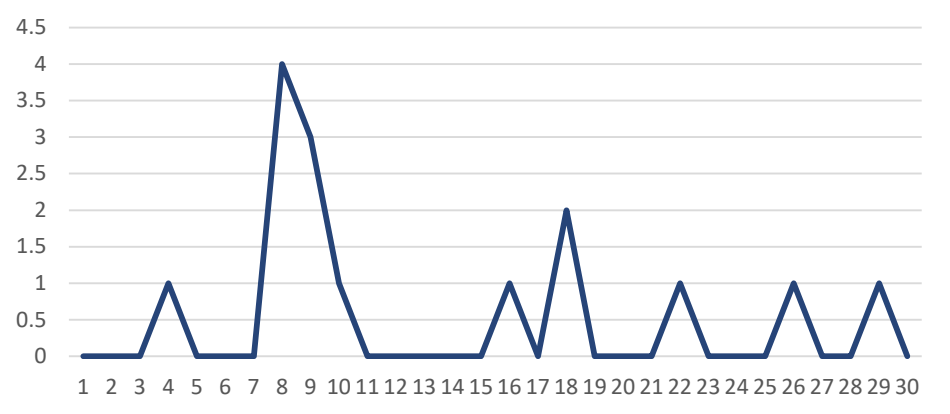


Figure 21: Temporal distribution of hashtag Western MD



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