Exploring shale activism on Twitter using spatio-temporal Network Analysis.

Varley A[*1], Bartie P[2], Dickie J[1], Ryder S[3], Evensen D[4], Devine-Wright P[3] & Whitmarsh L[5]

[1]Biological and Environmental Science Department, Faculty of Natural Sciences, The University of Stirling, United Kingdom
[2]Computer Sciences, Herriot-Watt, Edinburgh, United Kingdom
[3]Geography, University of Exeter
[4]Politics and International Relations, University of Edinburgh
[5]Psychology, University of Bath

February 13, 2021

Summary

The spatio-temporal response of online communities towards shale gas development ('fracking') across the UK was explored using Twitter network analysis over 2019. For the first half of the year the debate was driven by a well-informed community based primarily in the North of England with a history of shale gas activity. Changes in the political environment in the second half of the year, driven by the general election, saw the co-opting of the online debate at the national scale by three political communities clearly seeking to push their own political agendas.

KEYWORDS: Shale gas development, Spatio-temporal patterns, Network analysis, Twitter

Introduction

UK shale gas development

The US shale boom over the past two decades demonstrated that it was possible to exploit domestic shale reserves for huge profit and at the same time alleviate the reliance on foreign imports and provide improved energy security (Cooper et al., 2016). However, extraction of unconventional hydrocarbons using hydraulic fracturing has caused significant controversy, especially in the UK, as many argue the risks associated with extraction, principally induced seismicity, outweigh the economic benefits (Howarth et al., 2011; Inman, 2016; Lal et al., 2007; Thomas et al., 2017; Vidic et al., 2013). After nearly a decade of faltering development and continued pressure on the government, England followed in the footsteps of the other devolved governments in the UK by implementing a moratorium on shale gas extraction on the 2nd of November 2019 and perhaps signalling the end of shale gas in the UK altogether (Devine Wright et al, in press).

There are significant lessons to be learned from the so called 'shale fail' specifically in monitoring of public opinion towards energy technologies and building of trust at differing spatial scales in an attempt to avoid significant opposition and activism developing (Andersson-Hudson et al., 2016). This is timely particularly with emerging greener technologies having to fill the energy gap given the government's commitment to net zero by 2050 (Committe on Climate Change, 2019).

Twitter network analysis

Social media played a significant role in the development of the opposition shale gas movement within

[*] a.l.varley@stir.ac.uk

the UK (Cooper et al., 2016). It enabled the rapid establishment of local and national groups and gave them a platform to voice ideas and disperse information and was critical in coordinating protests and marches. Tens of thousands of users have become involved in the shale gas debate with wider environmental, social, and political topics often embroiled. Twitter has the third largest user base (16.7 million users) in the UK and unlike most other platforms conveniently allows researchers to collect data on its users.

This study uses retweets and mentions to construct a directional network graph over the course of 2019 to explore how specific communities respond to different political, social and industry events (Doğu, 2020). Moreover, geolocation techniques and sentiment analysis were used to determine spatio-temporal patterns in public discourse.

Methods

Network construction

Over the course of 2019, tweets containing the key terms: 'frack', 'hydraulic frac' and 'shale gas', were collected from the Twitter API with a timestamp and username. Accounts formed the nodes of the network and retweets (i.e. 'RT @username') and mentions (i.e. '@username') were extracted from each tweet's text and used to build a directional network as forward and backward edges, respectively (Figure 1). For example nodes 3 has retweeting node 1 and 4 in separate tweets and mentioned node 11 and 4. Mentions were weighted proportionally to the number of mentions in a tweet (i.e. 4 @ in a tweet would equate to a weight of 0.25). Networks were built in igraph in R (Csardi and Nepusz, 2006).

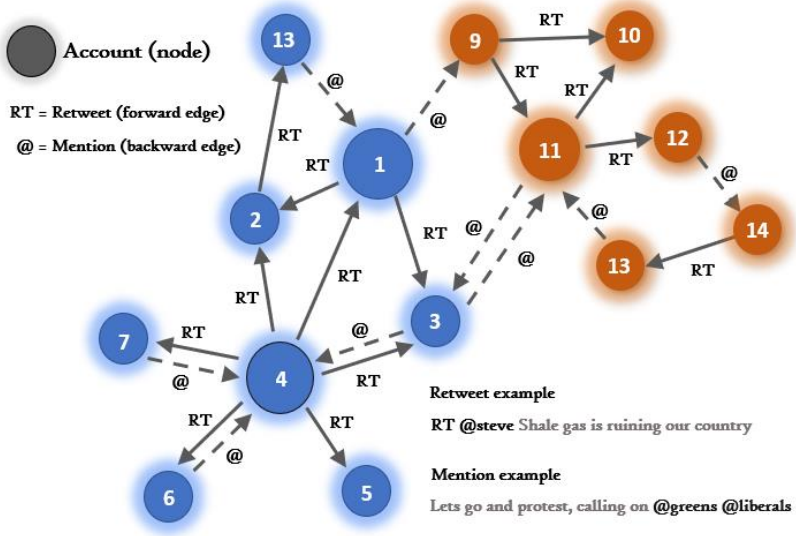

Figure 1. Directional graph of the Twitter Network

Network and text analysis

Each node was assigned a community based on the Walktrap clustering algorithm (Pons and Latapy, 2006) with communities with five or more users being retained. UK tweets were separated from tweets from other English-speaking countries by reviewing the twitter account information of the top 20 users. Tweets were given a sentiment score and hashtags (#) and URLs (https//*) were extracted for later analysis. Term Frequency – inverse Document Frequency (tf-idf) was performed on the largest communities to better understand discourse and motivations of communities over time (Robertson, 2004).

Placing UK users

As the majority of tweets were not geolocated, the OpenStreetMap geocoding API was used to extract geographic coordinates (Eugster and Schlesinger, 2013). Polygons were then retrieved using the reverse geocoding matched with their OpenStreetMap id. Weekly tweet response density maps were then plotted for the UK per community using local authority level polygons. Areas of intersection were calculated and weighted to the number people in the 18-40 age range in the local authority polygon (highest active group of twitter users). For example, Derbyshire overlaps 9 different authorities, therefore a weight of 0.076 would be given to each multiplied by the population of each authority divided by the sum of all overlapped authorities (Figure 2).

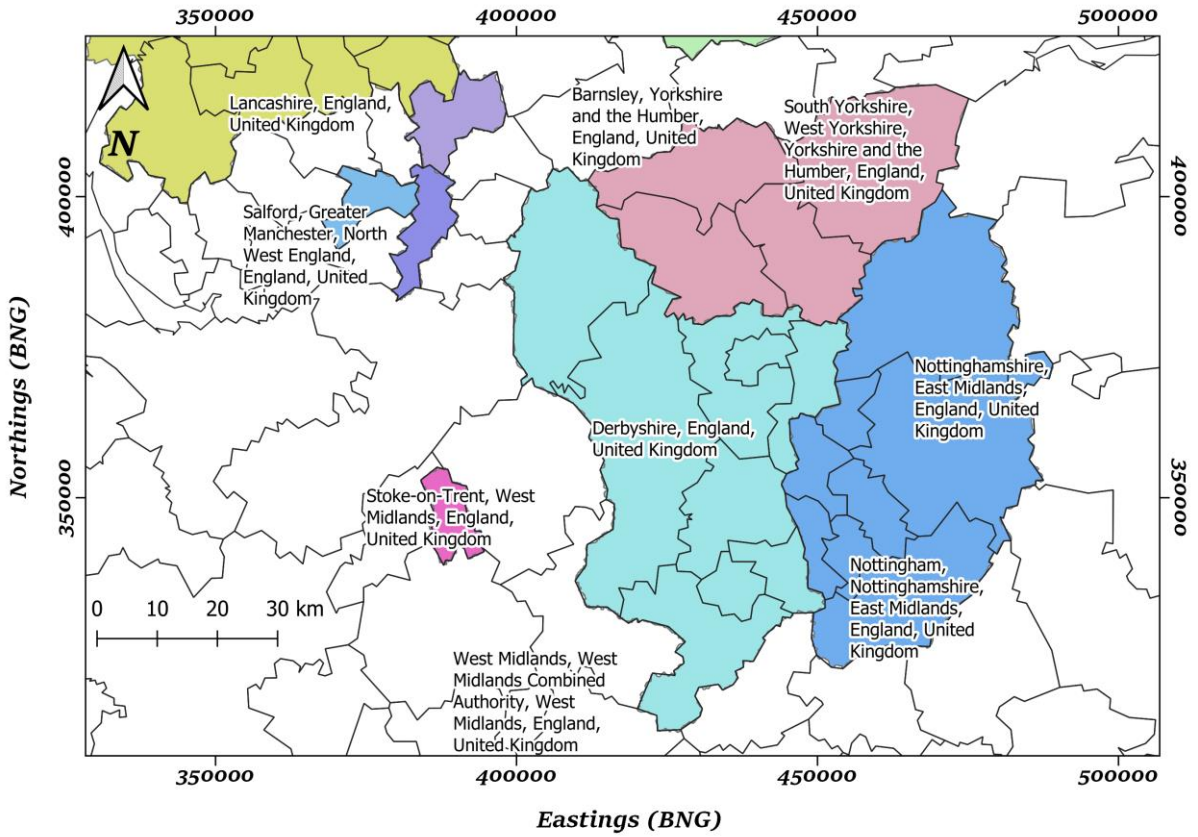

Figure 2. Mapping user locations with local authority polygons.

Results and discussion

Characterising communities

Nineteen UK communities were identified by the Walktrap clustering algorithm making up 37% of the English-speaking world.Interestingly, pro-shale gas groups were largely absent. . Four of the largest communities (>2000 users), cumulatively making up 95% of all UK users, were analysed in greater detail using the hashtags, URLs and tf-idf and given names and descriptions (Table 1)

Table 1. Description of the four main communities within the UK shale gas debate.

ID	Name	Description	Total	Total	Tweets per

			users	tweets	user per month
1	Left of Centre	Labour and Corbyn supporters, environmentalists, anti-conservative government, anti-Liberal Democrat,	2.0E+4	2.2E+5	9.1E-1
4	Anti-shale gas activists	Shale gas informed, environmentalists, protestors, local groups, communities	8.5E+3	1.1E+5	1.0E+0
9	Anti-establishment	No real political affiliation, government sceptics, focussed on scandals and conspiracy theories	2.9E+3	1.4E+4	3.9E-1
10	Pro-Scottish independence	Scottish National Party supporters, pro Scottish independence, anti-Liberal Democrats	2.9E+3	2.4E+4	7.3E-1

The highest level of engagement is seen in the 'Left of centre' and 'Anti-shale gas activists' groups, given they have the highest number of total users, 2.0E+4 and 8.5E+3, and tend to tweet more often about shale gas, 9.1E-1 and 1.0E+0 tweets user^{-1} month^{-1}, respectively. In comparison, the 'Anti-establishment' and 'Pro-Scottish independence' groups had significantly less engagement overall.

The 'anti-shale gas activists' group led the debate in the first half of the year with content directly related to shale gas such as 'the Woodsetts enquiry' and 'the trial of 12 protesters' in June and March, respectively (Figure 3A) and sentiment within this group is high suggesting support for these events (Figure 3C). Eigen centrality scores for this community are also high during this period making them central to the larger debate and in information dispersal across all groups (Figure 3B).

Key political events in the second half of the year, driven by the run up to the general election, sees a switch in the shale gas discourse whereby the other 3 groups particularly the 'Left of centre' group (Figure 3A+B) dominate. For instance, Jo Swinson becoming Liberal Democrat leader and Jeremy Corbyn visiting the Preston New Road site in Lancashire (late July).

Figure 3. 2019 timeseries plots for the communities 1, 4, 9 and 10. A) Proportion of weekly tweets, B) Most influential group and C) Average sentiment over time.

Spatial-temporal distribution of community response

The 'Anti-shale gas activists' group typically had a much stronger response in the North of England in the first half of the year centred around events including the trials of fracking protesters, Tour de Yorkshire protests and the Woodsetts enquiry (Figure 4B). Engagement in the North within this community however diminishes in the second half of the year (Figure 4D). Other groups have a more homogenous spatio-temporal twitter response for example the pro-Scottish independence group is almost exclusively based in Scotland and the Anti-government group has a greater membership in the South East of England. The largest of these groups (Table 1), the 'Left of centre' group, is reasonably homogeneous across the year except around the seismic events occurring at Preston New Road where there is noticeable increase in support in the North West of England (Figure 4C).

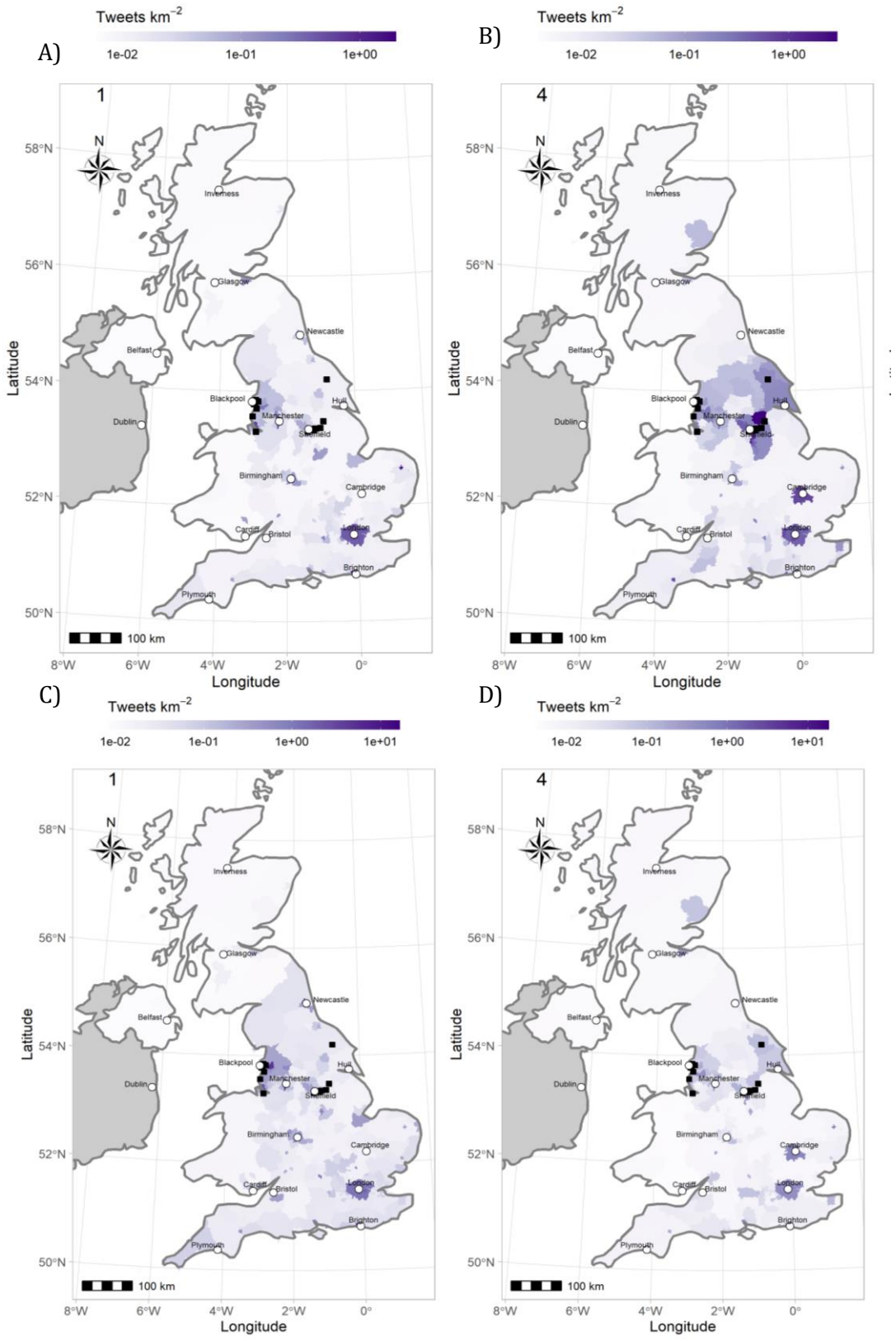

Figure 3. Spatial distributions of tweets for communities 'Left of Centre' (A + C) and Anti-shale gas activists (B + D) in March (A + B) and August (C + D)

Conclusions

Collectively, the evidence suggests a strong support in the North of England by anti-shale gas activists, who are well informed and closely follow industry and political developments associated with the shale gas industry. Engagement from this group falls off in the second half of the year as the shale gas debate becomes increasingly more political and as it is co-opted by the other groups and used in their own political narratives. After this point, discourse also becomes more negative and even the occurrence of the moratorium (2020-11-02) and general election (2020-12-12) do little to change the pattern in opinion suggesting twitter users overall were not convinced that political commitments would bring about real change in shale gas development.

References

Andersson-Hudson, J., Knight, W., Humphrey, M., O'Hara, S., 2016. Exploring support for shale gas extraction in the United Kingdom. Energy Policy 98, 582–589. https://doi.org/10.1016/j.enpol.2016.09.042

Committe on Climate Change, 2019. Net Zero: The UK's contribution to stopping global warming, Committe on Climate Change.

Cooper, J., Stamford, L., Azapagic, A., 2016. Shale Gas: A Review of the Economic, Environmental, and Social Sustainability. Energy Technol. https://doi.org/10.1002/ente.201500464

Csardi, G., Nepusz, T., 2006. The igraph software package for complex network research. InterJournal Complex Syst.

Doğu, B., 2020. Turkey's news media landscape in Twitter: Mapping interconnections among diversity. Journalism 21, 688–706. https://doi.org/10.1177/1464884917713791

Eugster, M.J.A., Schlesinger, T., 2013. Osmar: Openstreetmap and R. R J. https://doi.org/10.32614/rj-2013-005

Howarth, R.W., Ingraffea, A., Engelder, T., 2011. Should fracking stop? Nature. https://doi.org/10.1038/477271a

Inman, M., 2016. Can fracking power Europe? Nature. https://doi.org/10.1038/531022a

Lal, R., Reicosky, D.C., Hanson, J.D., 2007. Evolution of the plow over 10,000 years and the rationale for no-till farming. Soil Tillage Res. 93, 1–12. https://doi.org/10.1016/j.still.2006.11.004

Pons, P., Latapy, M., 2006. Computing communities in large networks using random walks. J. Graph Algorithms Appl. https://doi.org/10.7155/jgaa.00124

Robertson, S., 2004. Understanding inverse document frequency: On theoretical arguments for IDF. J. Doc. https://doi.org/10.1108/00220410410560582

Thomas, M., Partridge, T., Harthorn, B.H., Pidgeon, N., 2017. Deliberating the perceived risks, benefits, and societal implications of shale gas and oil extraction by hydraulic fracturing in the US and UK. Nat. Energy. https://doi.org/10.1038/nenergy.2017.54

Vidic, R.D., Brantley, S.L., Vandenbossche, J.M., Yoxtheimer, D., Abad, J.D., 2013. Impact of shale gas development on regional water quality. Science (80-.). https://doi.org/10.1126/science.1235009

Acknowledgements

This research has been undertaken as part of the ASSIST project funded under NERC & ESRC UK Unconventional Hydrocarbons - NERC NE/R017727/1.

Bibliography

Dr Adam Varley is a research assistant at the University of Stirling in Biological and Environmental Science Department. He conducts research in environmental radioactivity, remote sensing and human geography and has a general enthusiasm for big data and computer programming.

Dr Phil Bartie is an assistant professor in computer science at Heriot-Watt University, where he carries

out research in spatial data science. This ranges from analysing big data to gain a better understanding of space and place, to building contextually aware systems and user interfaces.

Dr Jen Dickie is a lecturer in Environmental Geography at The University of Stirling, specialising in energy geographies. She is an interdisciplinary researcher whose work focuses on understanding the complex socio-environmental interactions of the energy landscape using socio-spatial mix methods.

Dr Stacia Ryder is a Postdoctoral Researcher in the Geography Department at the University of Exeter and a co-founder of the Center for Environmental Justice (Colorado State University). Her work focuses on critical environmental justice, including her upcoming edited volume "Environmental Justice in the Anthropocene: From Unjust Presents to Just Futures."

Dr Darrick Evensen, assistant professor in environmental politics, University of Edinburgh, specialises in public perceptions and reactions to controversial energy, environment, and climate issues. He has published 50+ peer-reviewed articles in this interdisciplinary field; his research is funded by ESRC, NERC, ERC, Norwegian Research Council, and Royal Society of Edinburgh.

Professor Patrick Devine-Wright holds a Chair in Geography at the University of Exeter and conducts research on social-psychological and spatial aspects of energy transitions. He is an IPCC lead author, Chair of the Devon Net Zero Task Force and a top 1% cited scholar for 2019 and 2020 in social science.

Professor Lorraine Whitmarsh is an environmental psychologist, specialising in perceptions and behaviour in relation to climate change, energy and transport, based at the University of Bath. She is Director of the UK Centre for Climate Change and Social Transformations (CAST), and IPCC WGII Lead Author for the Sixth Assessment Report.