Social Media during a Sustained Period of Crisis: The Case of the UK Storms

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ABSTRACT

This paper analyses the social media communications surrounding the 2015 - 2016 series of winter storms in the UK. Three storms were selected for analysis over a sustained period of time; these were storms Desmond, Eva and Frank which made landfall within quick succession of one another. In this case study we examine communications relating to multiple hazards which include flooding, evacuation and weather warnings using mainstream media content such as news stories, and online content such as Twitter data. Using a mixed method approach of content analysis combined with the application of a conceptual framework, we present (i.) the network of emergency responders managing events, (ii.) an analysis of crisis communications over time, and (iii.) highlight the barriers posed to effective social media communications during multi-hazard disasters. We conclude by assessing how these barriers may be lessened during prolonged periods of crisis.

Keywords

Social media, disaster management, conceptual framework, emergency coordination, information overload

INTRODUCTION

Social media are increasingly utilised for the dissemination of information throughout all phases of the disaster life cycle (Ruggiero & Vos 2014; Haddow & Haddow 2013; Alexander 2013). Individuals may rely on social media as a source of information required to make personal and complex safety critical decisions during crisis situations (Carver & Turoff 2007). Similarly emergency responders and organisations managing such events may rely on multifaceted networks of skilled individuals, bodies, policies and protocols (Huang et al. 2010). Social media offers a range of supporting features which may reduce risk during crises: real-time monitoring and evaluation can be used for targeted action purposes (Ruggiero & Vos 2014), generalized monitoring and evaluation may support policy-making (Sobkowicz et al. 2012), and as a means to establish situational awareness (Anderson et al. 2014). Specific to disaster management, social media may provide warning systems throughout life cycle phases (Sweta 2014), identify or track potential hazards or problems (Crooks et al. 2013), and strengthen human interaction, coordination and crisis communications (Lindsay 2011).

Using social media as a means to disseminate time-critical information does however face obstacles. Information overload transpires when there are high volumes of accessible information which may not be relevant or useful to individuals or bodies (Bharosa et al. 2009). Often this occurs when information is not entirely related to a specific situation, is not targeted at particular individuals or networks, or is simply outdated, making reliability of sources a problem (Lu & Yang 2011; Westerman et al. 2014). Furthermore, poor communication and uncoordinated dissemination from emergency responders and bodies managing crisis situations may further exacerbate these problems (Shklovski et al. 2008). Despite a rise in global connectivity through developments in technology, such as the World Wide Web, accessibility to social media remains a significant obstacle (Wentz et al. 2014). Factors such as social class, gender, ethnicity, income and geographical location may all impact one's ability to access social media and other online resources (Fothergill et al. 1999; Haddow & Haddow 2013). Analysis of particular social media platforms, predominantly Twitter, are growing in number within the field of disaster management for their ability to disseminate tailored and succinct information rapidly in time-critical situations (David et al. 2016; Hughes & Palen 2010).

In addition to tackling barriers posed by social media there is a growing need to analyse the causes and impacts of high magnitude and multi-hazardous disasters which are becoming more common and devastating than previously expected (Kappes et al. 2012; Kousky 2014; Lung et al. 2013). The term multi-hazardous is applicable to disasters where a combination of hazards occur within quick succession of one another, and in a particular geographical region. The hazards must interact, trigger, exacerbate the effects of, or compound other hazards (UN/ISDR 2009). Such events are likely to increasingly become the focus of disaster management strategies due to underlying or preexisting processes and events such as pollution or climate change (Blaikie et al. 2014). Effective coordination and crisis communications by emergency responders and bodies involved in managing events must be timely, reliable, and uniform in content across multiple social media platforms (St. Denis et al. 2014). A number of recent studies have been conducted which assess social media during such events where platforms can provide new functionality during disasters, for example: using Twitter as a distributed sensing sensor system for hazards (Crooks et al. 2013), using cloud-based systems and cyber-infrastructure to build online communities to cope with disasters (Wan et al. 2014), building Web-based decision support mechanisms (Hadiguna et al. 2014), and the creation of early warning systems which utilise particular social media platforms (Sweta 2014).

This paper contributes to current knowledge by demonstrating the change in Twitter content over a sustained period of crisis that featured multiple disaster events in a bounded geographical region. Unlike similar studies which take into account change in Twitter content throughout the pre-disaster, during, and post-disaster lifecycle phases, this study assesses content throughout the lifecycle phases for three separate storm events during a period of three months (December 2015 until February 2016). This demonstrates that the function of Twitter changed not only over time, but also as a result of multi-hazardous events which were, in some cases, caused or exacerbated by previous hazards. Unlike a majority of similar studies, the Twitter data was compared with information collected from mainstream sources such as newspapers and news broadcasts. This allowed the study to cross-reference events across multiple sources resulting in a clearer analysis that reduced the risk of potential contradictions between online vs. offline information. To demonstrate this the study applies a conceptual framework proposed by Gray et al. (2016) to provide a categorical understanding of the uses and users of Twitter and how this changes over time. This contributes to the field by offering a better understanding of how categorical use of social media is affected by overlapping disaster lifecycles and the presence of multiple hazards which occur within quick succession of one another. The paper concludes with suggestions for the future management of multi-hazard disasters over a sustained period, and identifies steps for data analysis which may further the work presented in this paper.

THE STUDY

Rationale for Analysis

Many studies have demonstrated that Twitter content changes during the disaster lifecycle of a particular event, see for example (Hughes & Palen 2010). However, few have evaluated changes in content during overlapping phases of the disaster lifecycle. In such periods of time, the way in which people engage with social media is blurred (Houston et al. 2012). Someone may be using it to spread early warnings - which is characteristic of the pre-disaster phase (Jin et al. 2011) - whereas another person may be using the same function, at the same time, to get into contact with a loved one – which is characteristic of the post-disaster phase (Simon et al. 2015). Therefore, data sets for each of the storms were collected separately to preserve the information cycle of each disaster. Each data set was later cross-referenced with the others, as well as with the offline information gathered in the form of media updates and news stories.

Storms Desmond, Eva and Frank were the three largest and most destructive storms of the UK winter storm season which featured eleven meteorological events in total. The season began in early November 2015, and dissipated in late March 2016, illustrated in figure 1 below. Each of the selected storms were contained to a relatively small region of northern England which meant that the emergency responders and bodies managing events remained the same throughout this period. Similarly, the populations affected remained unchanged throughout each of the meteorological events making direct comparisons in management and effectiveness more insightful over a sustained period of time.

Background Information

The unusually intense storm season was associated with a strong westerly airflow in the Eastern seaboard of the US. Due to colder ocean temperatures over the North Atlantic a strong temperature gradient formed which strengthened the jet stream and formed rapidly deepening cyclones, such as Storm Frank, Desmond and Eva. The Met office issued warnings for North East England where the storm systems were due to make landfall throughout December, increasing in severity prior to the landfall of storm Desmond. From the December 1st - 4th areas experienced continuous rain which made large expanses of ground saturated, and winds over 70mph, warranting a severe storm hazard to public safety. Following landfall, record rainfall caused further hydrological hazards. Later, the overly saturated ground triggered a major subsidence of land in a wet mass movement hazard, blocking many road and national rail links. Hydrological hazards such as high velocity floodwaters and extreme surface runoff caused infrastructure damage to bridges, roads and pathways resulting in traffic hazards.

Warnings to the public regarding safe movement were issued through multiple media channels which increased after several deaths occurred due to floodwaters. Debris from other hazards swept down river channels with the potential to cause damming, or to harm the surrounding environment. From December 6th - 10th floodwaters submerged one or more floors of more than 1,000 properties, warranting emergency evacuations and rehabilitation. Flooding damaged local electricity suppliers causing a technological hazard where more than 6,000 properties across Cumbria to lose power. Later on in the month severe weather warnings were issued for storm Eva which made landfall on December 23rd and featured winds of 84mph. High rainfall exacerbated flooding caused by storm Desmond and lead to a total of more than 3,000 further power outages. Further disruption was forecast by the arrival of storm Frank, resulting in additional severe flood warnings. The storm made landfall on December 29th causing the collapse of several local bridges, and crippled local transport systems across Cumbria, and in several towns in Scotland. A timeline of events is shown in figure 1 below.

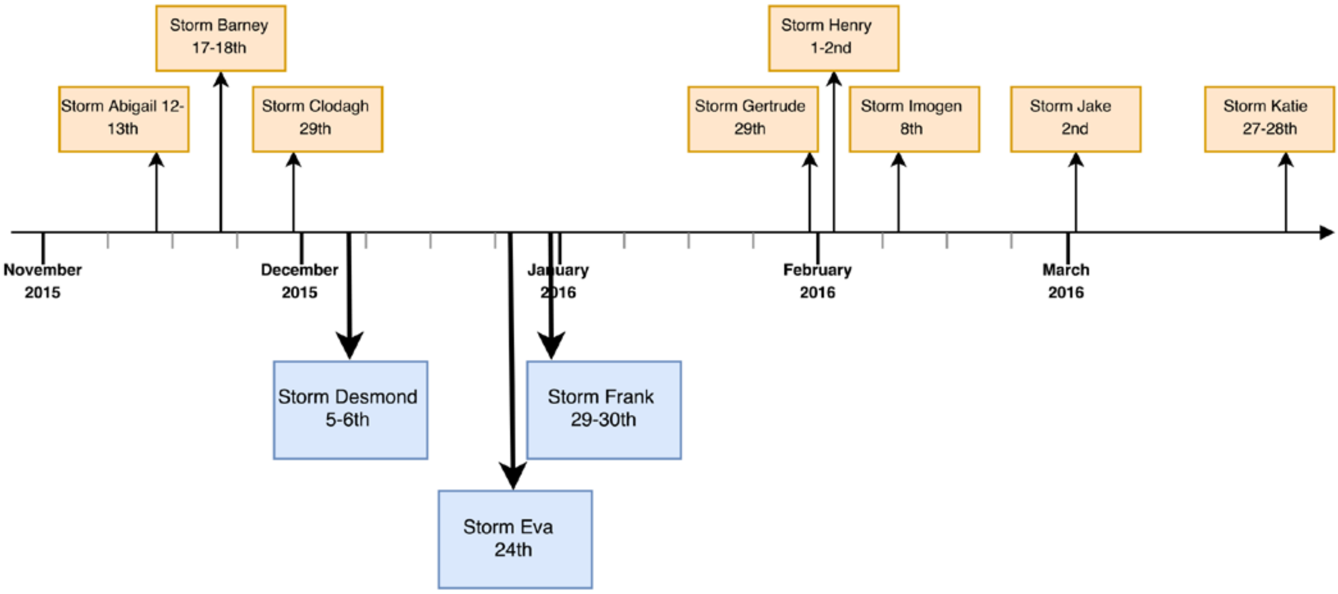


Figure 1. A timeline of the storms which made landfall in the UK from November 2015 – March 2016.

METHOD

Data relating to storms Desmond, Eva and Frank was collected using online content, such as Twitter data and blogs, and mainstream media content, such as news broadcasts. This provided a detailed timeline of events that could be cross-referenced with one-another, resulting in a more accurate understanding of how the offline vs. online events differed during a sustained period of crisis which featured multiple hazards. Content analysis was conducted on Twitter data collected for featuring key terms ("Storm Desmond", "Storm Frank, and "Storm Eva"), as well as the application of a conceptual framework for the classification of the uses and users of social media over time. Each of the methodology sections below are listed in chronological order of their occurrence.

Twitter Data

Twitter data was collected for storms Desmond, Eva and Frank using the Twitter streaming API. This produced roughly 127,000 tweets in total. Tweets were collected for featuring specific terms which are shown in table 1 below. As the collection terms are general it is important to note that the content may be biased towards accounts and individuals who are more heavily using these terms compared to others. This has been addressed in the latter 'Future Work' section.

Table 1. Search terms for tweet collection and number of tweets collected per term.

Search Term	Number of Tweets
Storm Desmond	10,418
Storm Eva	12,835
Storm Frank	105,474

Content Analysis

An infoveillance approach was adopted to track popular terms and hashtags over time (Chan et al. 2013; Pagliari et al. 2016). Between December 2015 and February 2016 tweets were collected into three data bases corresponding to each of the search terms in table 1 above. Tweets were systematically selected for a whole 24-hour period at 7 day intervals for each of the search term data sets, beginning at the pre-disaster phase of storm Desmond (chronologically the first storm selected for analysis, December 2015). These smaller datasets can therefore be considered "sub-samples". This avoids problems with the large size and velocity at which content is created and re-tweeted on Twitter during disasters, while demonstrating content change over the course of three months (Hoeber et al. 2016).

Content analysis was conducted after systematic sampling. This was firstly done automatically by python scripts, and then manually by the researchers which indicated: (i.) the most popular terms and hashtags over time, (ii.) the most active accounts over time with regard to creation of information (for example, new weather warnings), (iii.) the most active accounts in terms of information dissemination (for example, retweeting), and (iv). the nature of crisis communications both between emergency responders and bodies managing the event, as well as between these bodies and the public. Offline content analysis was collected in parallel to the Twitter data from newspapers and updates published by organisations manually. This was used by the researchers to create a timeline of online as well as offline events which could be cross-referenced with one another.

Conceptual Framework Application

Following content analysis, the conceptual framework proposed by Gray et al. (2016) was applied to the systematically sampled data sets to show change in social media content over time. The application of the framework was conducted manually by the researchers in which tweet content was read, and a framework category (or multiple) was assigned to the content. The framework is shown in Table 2 below, and was created by inductively coding a range of disaster management literature from the previous five years to ascertain current uses and trends of social media during crises. This indicated that the uses of social media categorised from literature were present in the data, and showed how they changed in nature throughout a sustained period of crisis.

Table 2. The conceptual framework proposed by Gray et al. (2016) showing the users and uses of social media throughout the disaster lifecycle phases.

Disaster lifecycle phase	The uses of disaster social media
All stages	1. Evaluate the reliability of information 2. Identify and/or contain false information
Pre-event	3. Provide and seek general disaster preparedness information 4. Provide and receive general national and regional disaster warnings
Pre-event → During	5. Detect and warn of disasters and specific hazards locally 6. Identify the differences between actual and potential uses of social media
During event	7. Send and receive requests for help or assistance 8. Inform others about ones condition and location
During → Post-event	9. Provide, receive and analyze big data generated by the event 10. Provide, receive and encourage information sharing in multiple formats 11. Document what is happening during a disaster online and offline 12. Consume or create news coverage of the disaster 13. Provide and receive location based real-time warnings 14. Express public and/or individual emotion or empowerment; reassure others 15. Raise and develop awareness; donate and receive donations; list ways to help or volunteer 16. Seek to inform and support existing disaster management strategies 17. Provide and receive specific disaster response, rescue and evacuation information 18. Seek and assess mental, behavioral and emotional health support 19. Filter, categorize critically analyze information 20. Understanding how online and offline situations differ 21. Provide and receive information regarding disaster response, recovery and rebuilding; tell and hear stories from the disaster 22. Understand how ones access to the Web has had an effect on their experiences
Post-event	23. Discuss socio-political causes, implications and responsibility 24. Re-connect community members 25. Discuss the accessibility of the Web as an intermediary to social media 26. Discuss the accessibility and reliability of specific social media; discuss perceptions
Post-event → Pre-event	27. Consolidate lessons learnt to develop new/improved social media applications

RESULTS: COMMUNICATIONS OVER A SUSTAINED PERIOD OF CRISIS

Content analysis of offline data showed more than 100 agencies created, discussed or disseminated information regarding storms Desmond, Eva and Frank. These fell into four main categories: branches of government, commercial organisations, self-funded organisations, and media outlets. Manual analysis of online Twitter data sets for each storm, before systematic sampling took place, totaled 127,000 tweets. Between December 2015 and February 2016 data showed that emergency responders sustained high levels of public engagement through offline channels such as news broadcasts, as well as online channels such as Twitter, blogs and other social media platforms like Facebook (table 3 below). The most active emergency responders and organisations on Twitter throughout the storm season remained similar (table 4), indicating that the level of interagency coordination for the regions affected was effective and consistent. Information was created by a select few Twitter accounts managing the hazards, whereas dissemination of information was spread by a larger range of accounts, which included; emergency services, metrological services, transport services, government, local companies, charities and voluntary groups, members of parliament (MPs), celebrities, researchers and members of the general public (table 3 below).

Table 3. The top Twitter accounts who both tweeted and were re-tweeted the most during storms Desmond, Eva and Frank.

Storm Desmond	Storm Eva	Storm Frank
HelpTheNorth	HelpTheNorth	todayCork
UKFloods	NationalRailEnquiries	EmergencyIE
AlimdaadUK	EmergencyIE	FloodsUK
QSFLancaster	TheBDMA	TheBDMA
TheBDMA	FloodsUK	AlimdaadUK
FloodAlerts	ElectricityNW	TrafficScotland
MKA UK	jeremycorbyn	BBCWeather
ITVborder	METoffice	METoffice
ClarenceHouse	BBCNews	BBCNews
Foragaid	EnergyDesk	NationalRailEnquiries

Table 4. The top Twitter accounts who were tweeted at the most during storms Desmond, Eva and Frank.

Storm Desmond	Storm Eva	Storm Frank
@AlimdaadUK	@AlimdaadUK	@BBC_Cumbria
@BBC_Cumbria	@BBCNews	@BBCScotland
@ClarenceHouse	@ElectrictyNW	@AlimdaadUK
@FloodAlerts	@CumbriaPolice	@CoastguardTeam
@HelpTheNorth	@EnergyDesk	@CumbriaPolice
@KTCouncil	@HelpTheNorth	@metoffice
@MKA_UK	@JeremyCorbyn	@RNLI
@Forageaid	@metoffice	@TrafficScotland
@ITVborder	@nationalrailenq	@scotgov
@ElectricityNW	@SkyNews	@bbcweather

Manual content analysis of the data showed that Twitter accounts were categorised as being either "official" accounts representing an organisation, group or other type of body, or "unofficial" accounts representing members of the public. Only a relatively small number of official accounts were seen to create information from December 2015 to February 2016 (table 3). Of these accounts, a majority were consistent throughout the sustained period of crisis, and throughout each of the storms. This resulted in the formation of an online network where official accounts acted as hubs (accounts who address user messages) and authorities (accounts that receive tweets from other accounts) (Adar & Adamic 2005; Manoj & Baker 2007) that individuals directed messages and tweets at (table 4 above). Some accounts, for instance @jeremycorbyn, received a high amount of public interaction for other motivations i.e. political.

Changes in Twitter Content

Manual content analysis of the storm data used python code to automatically count the most popular hashtags, terms, re-tweets and most active Twitter accounts within the data. Analysis corroborated conventional Twitter findings: firstly, a majority of retweets which featured the most popular terms were largely directly linked to the storm events (table 5 below). Secondly, unofficial accounts had the highest proportion of retweets that cited original sources of information. Thirdly, the most retweeted tweets and/or accounts were official accounts, which generally were directly involved with the management of the storms throughout the period of crisis. Finally, it is important to note that due to the quick succession of the storm's occurrence that there is crossover between popular terms across the datasets. This represents a difficult problem for the analysis of social media during sustained periods of crisis as information from multiple stages of the disaster lifecycle may still be in circulation at the same time. Crossover terms between datasets nonetheless remain important to analyse as they remain a part of the overall picture which individuals engage and react to regardless of lifecycle phase.

Table 5. The top 10 most popular tweet terms and their count for storms Desmond, Eva and Frank.

Storm Desmond Popular Terms	**Count**	**Storm Eva Popular Terms**	**Count**	**Storm Frank Popular Terms**	**Count**
FloodAware	2641	Cumbria	1479	Cork	2527
MuslimsForHumanity	1122	StormDesmond	882	Floods	2463
CumbriaFloods	1016	Flooding	620	CorkFloods	1799
Desmond	920	StormFrank	478	Weather	1536
Cumbria	642	Floods	437	Flooding	1205
ShowYouCare	640	CumbriaFloods	435	StaySafe	977
Keswick	302	UKfloods	320	FloodAware	869
StormFrank	242	ChristmasEve	276	Storm	834
Muslim	236	MuslimsForHumanity	264	StormGertrude	807
StormEva	158	Ireland	221	Flood	788

Organisations involved in the management of the storms produced a relatively small proportion of tweets. Although many organisations had a physical presence in affected areas, only a handful of these created and disseminated online information during time-critical situations. This indicates that organisations coordinating in the real-world had incorporated a structured online presence where only selected accounts created new data. The primary account for this was the Cumbria Police who created and disseminated updates, information and advice that was tailored for the public in areas that were affected by the disaster. The content produced was then re-tweeted and shared by other coordinating organisations, for example the Environment Agency. Other regional accounts, such as BBC Cumbria and Help the North were responsible for the largest amount of re-tweets. The British Damage Management Agency (BDMA) were responsible for generating the largest amount of tweets featuring the term “#stormDesmond”, “#stormEva” and “#stormFrank”. Unlike the Cumbria Police, The BDMA produced generalised content designed for the wider public by using general hashtags.

The Alimdaad Foundation UK was unexpectedly responsible for a large amount of tweets, as well as a large amount of retweets. This is explains the popularity of the terms ‘#muslim’ and ‘#MuslimsForHumanity’. This was because the foundation, in a gesture of unity and community welfare, dedicated time, resources and volunteers to areas that were badly affected by the storms. Consequently, this generated a flood of online information within the storm events as the involvement of the group was regarded as a socio-political event. Other types of update were created and disseminated by accounts such as the Met office and FloodAlertsUK who focused on communicating weather warnings and developments for meteorological hazards only. This ensured that the information they were producing did not conflict with that produced by other organisations. Popular terms associated with these also featured geographical areas that were also affected by the storm systems outside of Cumbria, i.e. ‘#Cork’, ‘#CorkFloods’.

Changes in Framework Categories

Twitter content published within the first two weeks of December 2015 featured early disaster lifecycle phase categories which fell primarily into categories 3 ‘provide and seek general disaster preparedness information’, and 4 ‘Provide and seek general disaster preparedness information’ (Figure 2 below). Local citizens published regional information from personal experience, such as remote flooding and updates about the condition of local flood defences. A majority of tweets that fell into these categories however took the form of automated updates about the weather or developing hazards that were generated by official accounts such as @METOffice, which were then re-tweeted by a large number of Twitter users. Dissemination of re-tweets occurred within quick succession of the original updates, and petered out commonly within an hour. This suggests that the information spread was timely, and that the intervals between official updates were low. Additionally, as the disaster unfolded category 14 ‘Express public and/or individual emotion or empowerment; reassure others’ increased. This may represent the desire of individuals and communities to express solidarity during crises, often using whatever medium they can (a phenomenon well-documented in similar studies, see for example St Denis et al. 2014).

Content published during the end of December 2015 featured during to post disaster lifecycle phase categories, which primarily took the form of 11 ‘Document what is happening during a disaster both online and offline’ (figure 3 below). Official accounts (many of which featured in table 4 above) addressed concerns raised by individuals who were situated in isolated rural areas who had reduced access to the Web due to network coverage, and therefore needed direct, reliable and clear updates regarding hazards nearby. In contrast to similar case studies, tweet content did not reveal public confusion or contrasting information. This indicated that the organisation of accounts involved in the management of storms were successfully mitigating the negative effects of information reliability during crisis situations, which furthermore continued for an extended duration after the initial hazard had dissipated. Figure 3 also shows that the spread of other during-post categories were more evenly spread than in figure 2. Categories 4 and 8 are most likely explained by the fact that the early stages of storm Eva had occurred. Categories 15 ‘Raise and develop awareness’, 21 ‘provide and receive information regarding disaster response, recovery and rebuilding; tell and hear stories from the disaster’ were used for updates regarding the clean-up and re-building of areas damaged by storm Desmond, but also by the public to express personal experiences to raise national and international awareness.

During the beginning of January 2016 there was a much more complex spread of categories recorded in the data (figure 4 below). Categories from all of the disaster lifecycle phases were recorded, showing that a large amount of data being created and disseminated originated from multiple disasters. Category 12 ‘Consume or create news coverage of the disaster’ was most likely linked to the early stages of storm Frank and the latter stages of storm Eva. On the other hand, category 23 ‘Discuss socio-political causes, implications and responsibility’ was linked to the post stages of storm Desmond where the public were beginning to question and debate the extent to which the UK government could have managed the situation better.

Figure 2. A pie chart showing the largest percentages of categories from the first subsample of storm Desmond tweets (15/12/2015).

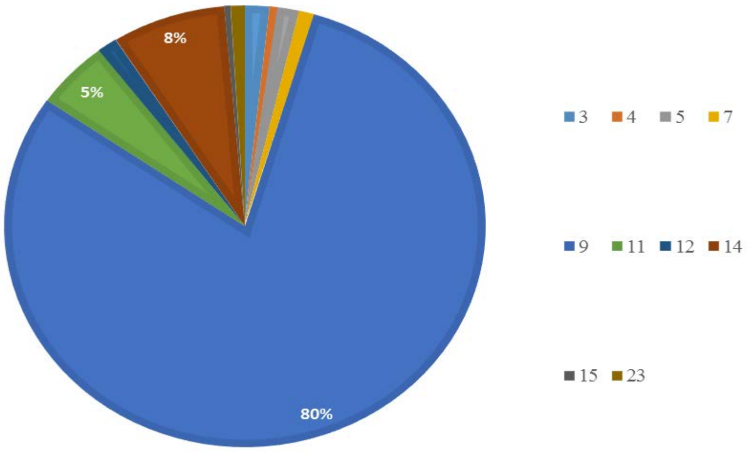


Figure 3. A pie chart showing the largest percentages of categories from the first subsample of the storm Eva tweets (29/12/2015).

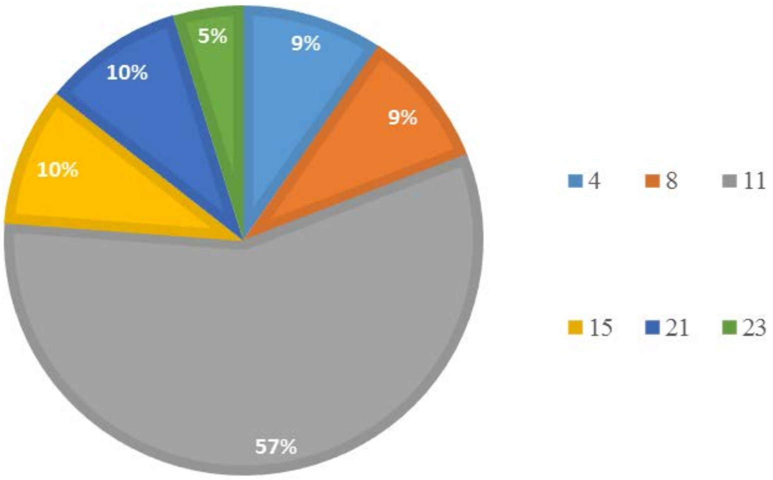
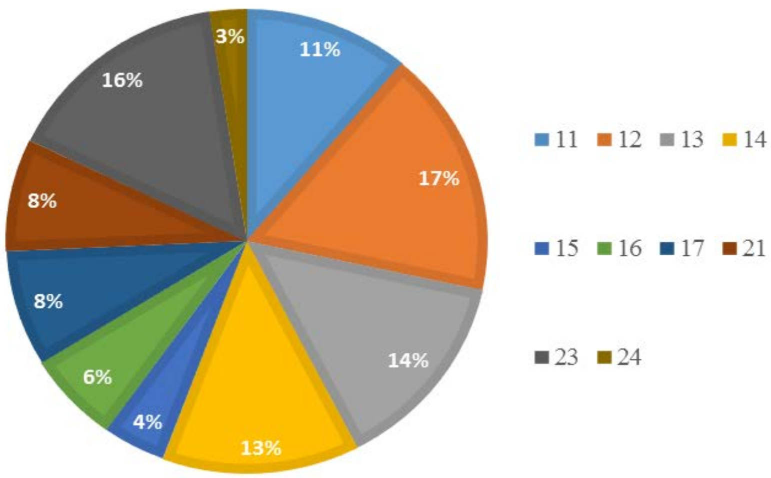


Figure 4. A pie chart showing the largest percentages of categories from the first subset of storm Frank tweets (04/01/2016).



DISCUSSION

Reducing Information Overload

Information overload remains a barrier to the effective use of social media during disasters (Hiltz & Plotnick 2013). The extent to which information overload is considered a barrier varies with the intention to use it as a disaster management tool in itself (Rao et al. 2017). Agencies and organisations seeking to effectively use online disaster management strategies therefore must consider more unified methods to tackle information overload. Higher priority should be placed on the software and applicability of tools to lessen overload across multiple platforms, as well as on the importance of developers collaborating on a standard toolkit which may easily be integrated between organisations (Rao et al. 2017). In addition to overload, the problems of information dearth, credibility, and online human behavior must be increasingly taken into account. The way in which people use, engage with, and perceive social media during disasters evolves with the development and uptake of new technologies, social media platforms, services and applications (Abdullah et al. 2017).

Reducing the Future Impacts of Multi-Hazard Disasters

Multi-hazardous disasters are predicted to increase in severity and frequency in the near future, and as such require further analysis (Fleming et al. 2014). Disaster management strategies using a multi-hazard approach rely on information for decision making processes. Although more collaborative development of tools and software is required for the ease of sharing information between agencies, social media should not be analysed in isolation (Fleming et al. 2014). Future research should consider integrating social media analysis with other qualitative methods to produce more comprehensive understanding of crisis situations in general, but also particular case studies that may facilitate future lessons (Liu et al. 2016). Mixed method and multi-hazardous approaches are vital to shed further light to disasters case studies, especially those which are sustained over a long period of time or that feature disasters in different phases of the disaster life cycle (Jin et al. 2011; Liu et al. 2016).

CONCLUSION

In conclusion, this study analysed Twitter communications during storms Desmond, Eva and Frank from December 2015 until February 2016. Communications discussed multiple hazards, which included flooding, evacuation and weather warnings using mainstream media content such as news stories, and online content such as Twitter data. Both manual and automatic content analysis using python scripts demonstrated how the general uses of social media changed, not only throughout the disaster life cycle phases for each storm, but also how the content was influenced by hazards associated with the other storms occurring in quick succession. Despite the presence of well-coordinated management efforts the study highlights that the barrier of information overload during multi-hazardous events poses future risk. This may be addressed by developing software and tools that can be applied universally across social media sites, and can be integrated between organisations with ease. Crisis communications during the course of the storms further highlighted that case studies where severe hazards occur within quick succession and frequency require further investigation as they are predicted to grow in magnitude and severity with the onset of underlying issues such as climate change (Haddow et al. 2013).

Future Work

Future output from this study will present refined data visualisations of the framework categories, demonstrating how they change throughout the entirety of the storm season as opposed to subsamples alone. Natural language processing will be used to identify trends in Twitter data relating to the occurrence of hazards in real-life. Disaster life cycle phases for each of the storms will be mapped onto the data to highlight the crossover between events. By focusing on overlapping phases and data from different hazards, contributions to online disaster management strategies may be made by the suggestion of protocols and/or best practices to lesson information overload. Additionally, employing early manual exploration of tweets before beginning data collection should be employed in future events. This will enable Twitter data collection to use varying search terms for collection rather than general terms with the aim to reduce data bias from particular accounts and individuals.

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