**Title**: Of Bubbles and Sentiments: Virtual Communities in the Aftermath of Dorian

**Author**: Oluwole M. Badmus (FIMS, Western University, London Canada)

## Abstract

"The study investigated the structural qualities of the dominant virtual Twitter communities enduring in the aftermath of a natural disaster and how they influence the flow of information among social actors in the network. By employing a combination of textual and social network analyses on tweets associated with Hurricane Dorian, the study reinforces the findings of previous studies that information propagation is determined by nature of interactional communities built in the different stages of an emergency event and that sentiments and choice of user message keywords follow along the lines of geographical proximity to the affected zines. Engagements among social actors led to formation of virtual communities that were found to be dominated by hierarchical, polarized and insulated structural. Implications of these findings for both research and practice as well as the limitations of research findings were discussed".

## Introduction and Objectives

Hurricanes by nature are destructive events that disrupt the everyday lifestyle of people and places. To prepare for and cope with the impacts of such a significant eventuality, information is important for all those involved. Some research (Kim, Bae, & Hastak, (2018); Qu, Huang, Zhang, & Zhang, (2011); Ukkusuri, Zhan, Sadri, & Ye, (2014), etc.) have looked into the patterns of how the flow of information in virtual communities evolve before, during and aftermath of natural disasters, but such transitional perspectives lead to overstretched breadth but shallow depth kind of analyses.

By shedding more light on the critical actors, community structures, social engagements, and the sentiments of conversations occurring in the aftermath, this study demonstrated how interactions on social networks shape the flow of critical information for all actors. Finally, the understanding of post-event information searching practices of disaster-affected communities provides insights for designing and providing adequate measures to ensure that the appropriate information is surgically targeted at deserving populations in the most accessible manner. The objectives of the study are captured in the following research questions:

1. What are the characteristics of the dominant post-event online communities and their peculiar information flow pattern?
2. What discernible pattern(s) of information propagation arising from social engagements can be detected among actors?
3. Do locational differences among Twitter users have any impact on their sentiments about post-event activities?

## Methods

Some initial 95,000 tweets were collected between Sept 25th (1700hrs UTC) and Mon. Oct. 10th, 2019 (1700hrs UTC) but thereafter cleansed to produce a residual 33,639 tweets. Out of these, unique 28,368 Twitter users, about 26,231 were retweets while the rest (7,408) were original tweets.

To find answers to the objectives of this research, two distinct analytical processes were employed: 1) sentiment analysis, necessary to gauge the public attitude towards the topical issues in the conversations, and; 2) social network analysis (SNA), capable of showing network structures, relationship properties of networks, communication's patterns between users, the role of various actors in the network, and community detection (Williams et al., 2015). Analysis of such node-link structures provide important individual- & network-level metrics (such as number of nodes/links, density, degrees, diameter, strongly/weakly connected components, etc.) which enable us to draw further qualitative and quantitative interpretations (Chatfield & Brajwawidagda, 2012).

SNA employed the *Gephi* software while the *Louvain* method was to detect modularity (clusters) of Twitter users who showed more interaction and shared similar topical interests. Zubcsek et al. (2014) referred to these modules as information communities. The identification of these communities is useful for uncovering inherent informational networks (Good et al., 2009).

## Results and Discussions

The analysis of Twitter users who interacted with each other by way of replies, retweet or mentions reveals several community clusters showing some largely differentiated traits and distributions. The details of the graph are represented in *Tab 1*.

*Tab 1. Hurricane Dorian community clusters analysis.*

| **Network Metric** | **Values** |
|---|---|
| Average Degree | 1.567 |
| Average Weighted Degree | 1.660 |
| Density | 0.00 |
| Average Clustering Coefficient | 0.389 |
| Network Interpretation | Directed |
| Diameter | 7 |
| Average Path length | 1.5304174516917615 |
| Modularity (with resolution) | 0.812 (0.812) |
| Number of Communities | 1,541 |
| Weakly Connected Components | 1,452 |
| Strongly Connected Components | 27,735 |

The high modularity value indicates that the boundaries of the various clusters within the network are highly defined and that overlaps among them are not common. Also, the density value means that the network is a not a very tightly connected one (Croitoru et al., 2015).

The *Louvain* method produced 1541 community clusters with modularity value (0.812). Typical of many social networks, the distribution of node points followed the power law distribution as the top ten communities cumulatively represent more than half (56%) of the node mass of the entire network.

*Top Virtual Communities (clusters)*

The analysis of the overall network reveals that the cluster networks are characterized by high modularity and low density exhibit significant polarization. This meant that these twitter users largely expressed some almost exclusive interests in certain issues and actors. A similarly low clustering indicates that other nodes connected to a primary node hardly have links to each other. In this type of scenario, information tends to circulate within few famous users and those who share common clustering with them to the exclusion of those without. An obvious implication of this is that if a storm survivor does not belong to the circle of privilege information, they stand a risk of not benefiting from such. Likewise, recovery and relief managers could be excluded from the "small world" of those who really need help badly or those whose messages could reveal vital information about recovery expectations.

Highly delineated structural feature of the clusters implies that information practices within the network would be mostly derivative, resulting in continuous recycling of the same information with attendant risk of redundant or contradictory information (Sutton et al., 2012). Fragmented and polarized structures ensure that community members are averse to welcoming opinions from opposing sides. However, the overlap of interests among followers of media actors shows that mass media is still a viable channel of reaching diverse interests during and after a storm.

*Patterns of social engagements: Reply and Retweet networks*

The patterns of user interaction on social media is a valid reflection of the information exchange among them (Kim & Park, 2019). Derivative behaviors (replies and retweets) as measures of social engagement among the Twitter public are represented in *fig. 1* and *fig. 2***.** The fact that tweets from the major actors in this community received large retweets from among likeminded political leaning persons and media organizations could also be responsible for low cohesiveness among the larger section of the community members whose rallying points seems to be only around these famous political and media nodes. Similarly, the pattern of information diffusion through reply/retweet reinforcement of noticeable delineation along political leanings. The interest shown in famous actors in the community reflects how post-disaster opinions can instigate a community building around people who personify the survival or even advancement of such opinions.

*fig. 1 Tweets reply network*

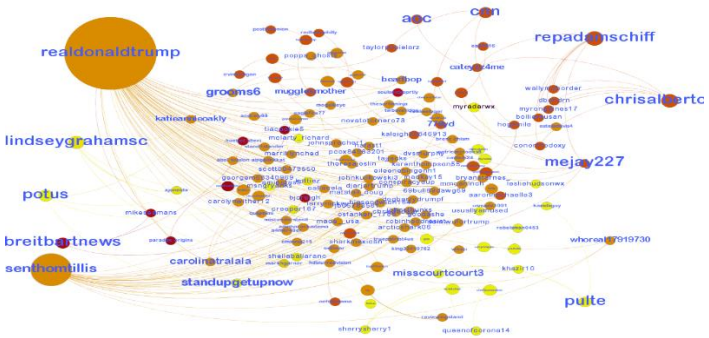
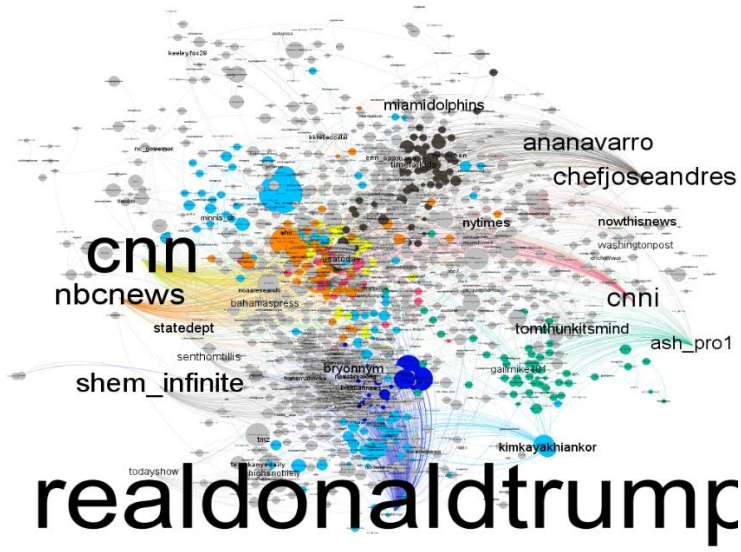



*fig. 2 Top Retweeted Actors*




*Sentiments and Keywords*

Sentiments expressed by users living in the directly impacted areas **(***fig. 3***)** contrasted slightly with those from areas not directly impacted (*fig. 4*). Within each group, we could see that it appears that the tweets carry more positive sentiments than negative. Although, slight polarity on both sides of the neutrality appears to be strongest in both case, users still exhibited more positivity. On the surface, this could be misleading as data capture was done when recovery efforts were at advanced stages, hence raw emotions could have been assuaged as at this time. Similarly, since the tweet location indicated that the unequal representation of all impacted countries positive sentiments recorded for the post-disaster periods might not reflect absolute realities on ground.

*fig. 3 sentiments among directly affected users*

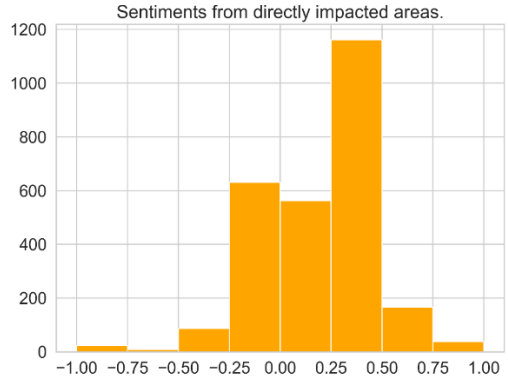
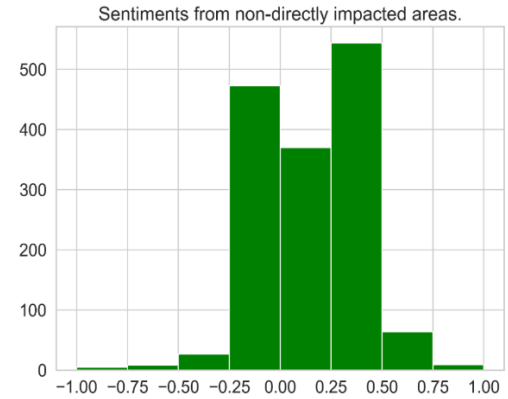



*fig. 4 sentiments among non- directly users*




## Conclusion

The major contribution of this paper is in outlining the features of the prominent post-disaster virtual communities that can be formed as well as how such features can be used as an advantage

in addressing recovery and response efforts. In addition to the burgeoning list of practical factors that contributes to post disaster recovery and resilience that research continues to point out, the pattern of post-disaster information propagation according to virtual community structures that this study just examined is another important item. The nature of the top communities that were discussed demonstrate the diversity of interests that could develop in the aftermath of a natural disaster as well as how secondary issues can quickly become dominant, thereby drowning out genuine conversations crucial to response and recovery. They also show us how such communities are built around persons, organizations and/or sentiments that represents the interests of the online public.

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