

Comparing Sentiment Analyses of Quote Tweets
by those affected during two extreme winter storms in Buffalo, NY in 2022

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Abstract

Twitter, a social media application, where people post up to 240-character messages called tweets, has been a helpful communication medium used during emergencies and extreme weather events. In 2015, Twitter enabled a way to repost another tweet with added commentary, called a quote tweet. Examining the volume and sentiments of quote tweets posted by those dealing with extreme weather events can provide useful insight into attitudes and concerns. This project explores the content and sentiment of quote tweets by those impacted by 2 extreme snow storms in 2022 in the Buffalo, NY area.

Keywords: Social Media, Quote Tweets, Sentiment Analysis, Buffalo NY Snow Storms 2022

1. Introduction

The social media application, Twitter, allows its users to communication with others on the internet via short posts. This has been invaluable for emergency management in obtaining situational awareness and to disseminate messages to the general public (Lachlan, K.A. *et al.*, 2014). Government officials, journalists, and individuals regularly use Twitter to learn about and/or share useful information such as weather advisories, geographical impact, and where to obtain or how to provide help (Silver & Berhlendorf, 2023). Often Twitter users will Quote Tweet (repost a tweet with commentary added) as a way to share and emphasize curated information with the intention of praising, criticizing, or debunking information contained in the original Tweet (Bastian, 2023). This project uses sentiment analysis to look at quote tweets by those directly impacted by and who quote tweeted during two extreme winter snow storms in the Buffalo, NY area in November and December of 2022.

2. Quote Tweets provide valuable commentary and context

Twitter enabled the ability for people to “quote tweet” in 2015 and its use has widely been adopted (Bean, 2021). People who use the quote tweet feature tend to be more active on Twitter and are long-time users. Quote tweets often “enable a more civilized form of communication where people discuss and agree with each other with far fewer insults being observed”, (Garimella et al., 2015). Quote tweets have been shown to have less of a sentiment polarity than that of reply tweets (Bean, 2021). Quote tweets also have a farther “reach within user networks” (Garimella et al., 2015). They are especially effective when used to debunk or make fun of misinformation when they incur a negative reaction because they spread farther and faster than the original false tweet (Babcock, 2018). People who quote tweet can resemble the behavior of information “conduits” who “provide important channels” for critical weather information to be disseminated and acted upon (Silver & Berhlendorf, 2023). Understanding sentiments expressed in quote tweets by those impacted during an extreme weather event can provide valuable insight into their attitudes and concerns about the event.

3. Two Severe Snow Storms occur in the Buffalo, NY area in 2022

Buffalo, NY experienced two extreme winter storms in November and December of 2022. It is common for Buffalo and the surrounding area to receive a large amount of snow and frequent winter storms due to proximity to Lake Erie and the resulting lake effect snow (Michael A. Rawlins Associate Director, 2023). The local government is adept in responding to and mitigating the impact of regular occurring winter storms. Notably, the November and December storms were extreme events relative to most past storms. But, the difference in impact between the November and December storms of 2022 was striking.

The November 15-22, 2022 Storm, resulted in 4 deaths, 3 were cardiac arrests after shoveling snow and 1 was due to a snow plow incident (CBS, 2022; Leffler, 2022). The December 20-29, 2022 Storm, resulted in 40 deaths. There were 39 deaths in Erie County (3 from EMS delays, 17 were found outside in the cold, 4 were found in cars, 4 were cardiac-related deaths from clearing snow, and 11 were found in their homes) and 1 in Niagara County (due to carbon monoxide poisoning) (Staff, 2022). This project defines the beginning of each storm when the “winter storm watch” was declared for each. The end of each storm is defined as when the storm warning was downgraded to an advisory (or less) and all main and minor roads were open to traffic. See Table 1 and 2 for the timelines of both storms.

Table 1. November storm - Timeline

(Donegan, 2022; Cullinane & Colbert, 2022; Elamroussi & Almasy, 2022; Hochul, n.d.; Staff, 2022)

November 15-22, 2022 Winter Storm	
Tuesday Nov. 15	Winter storm watch issued by National Weather Service for upstate New York
Wednesday Nov. 16	Snow shower starts around 7PM. Governor Hochul declares STATE OF EMERGENCY for Thursday morning. Lake effect snow becomes heavy overnight with totals between 6.5 -20inches depending on area
Thursday Nov. 17	Heavy, lake effect snow continues throughout the day (by 4pm Orchard Park received 54inches). High winds increase in the evening. Governor Hochul issues 4PM travel ban for all commercial traffic on western parts of NYS thruway. Driving ban @ 9PM announced for Erie County on Twitter, and City of Buffalo announced a state of Emergency, Bus service suspended in Erie County, area schools close. Travel advisories are in effect for areas not already under a driving/travel ban. NFL moves Buffalo Bills game originally scheduled for Sunday, to Detroit, MI.
Friday Nov. 18	Heavy, lake effect snow continues but shifts south of Buffalo., flights have been cancelled. Governor Hochul deployed the National Guard to help with snow removal. Driving ban is in effect for all of Buffalo. 400 tickets issued for people violating travel ban. There are 721 power outages in Western NY. Thruway Travel bans were lifted in the evening, and some parts of Buffalo had driving ban lifted.

Saturday Nov. 19	Heavy, lake effect snow continues Limited bus service resumed. In the evening, more travel bans lifted in some areas.
Sunday Nov. 20	lake effect snow continued. Buffalo is no longer under a lake effect snow warning but remains under a winter weather advisory due to wind. Erie County still under a state of emergency. Closed roads start to reopen.
Monday Nov. 21	President Biden declared the storm and its impact a federal emergency. Area schools remain closed. Clean-up efforts continue
Tuesday Nov. 22	Many schools remain closed. NYS Thruways and State Highways are fully open to traffic. State Emergency Operations Center is deactivated.

Table 2. December storm – Timeline

(WGRZ, 2022; Hochul, n.d.; Hochul, n.d.; Brennan & Murdock, 2022)

December 20-29, 2022 Winter Storm	
Tuesday Dec. 20	Winter Storm Watch issued for Fri 7AM – Mon 7AM, potential lake effect snow, tropical storm force wind gusts, rain and flash freeze w/ cold temperatures. Messages to travel by Friday and plan to stay put during the weekend
Wednesday Dec. 21	Winter Storm Watch - forecast outlined “extreme nature of incoming winter storm”, lake effect snow + ice + wind + blizzard conditions
Thursday Dec. 22	Winter storm upgraded to Blizzard Warning/Winter Storm Warning (depending on county). Governor Hochul declares STATEWIDE STATE OF EMERGENCY to begin Friday 6AM. Expected storm to arrive Friday and last through Sunday. Expected zero-visibility whiteouts with “impossible driving conditions”.
Friday Dec. 23	Storm hit, temperatures dropped and blizzard condition started. DRIVING & TRAVEL BANS WERE PUT IN PLACE at 10AM. The airport closed and power outages started to occur. There were wind gusts up to 79mph causing windchills below zero degrees F. By afternoon, snow evolved into lake effect band over and around Buffalo. A record 22.3 inches of snow fell at the airport on Friday. National Guard deployed (to arrive Saturday)
Saturday Dec. 24	heavy snowfall and high winds continued, emergency services unable to reach areas in and north of Buffalo. Deaths were reported. TRAVEL BANS still in effect and the airport was still closed.
Sunday Dec. 25	lake effect snow band shifted south. TRAVEL BANS still in effect and the airport was still closed.
Monday Dec. 26	There were 25 storm-related deaths at this point. Lighter lake effect snow fall allowed plow crews to start clearing snow with heavy vehicles. Governor Hochul requests a Federal Emergency Declaration. State Police assist snow removal crews

Tuesday Dec. 27	Storm warnings changed to Winter Weather Advisory for Erie County. Snow removal in and around Buffalo increased. President Biden approves state of emergency declaration.
Wednesday Dec. 28	Driving bans still in place in parts of Erie County and Buffalo. Snow removal continued. Buffalo Airport opened. Death toll increased to 40. Major Highways in the surrounding areas reopen at midnight
Thursday Dec. 29	“Main roads are open and secondary roads each have one lane open” (Krupa et al., 2022)

3. Sentiment analysis

Sentiment analysis has been used to analyze peoples’ “sentiments, attitudes, emotions and opinions” for a variety of applications including marketing, political polling, and customer satisfaction. In disaster management, it has been used to understand how local “crowds react during a disaster” by gauging attitudes and concerns (Beigi et al., 2016). This project looks at sentiment polarity (positive, negative, and neutral sentiments), 8 key emotions (anger, anticipation, disgust, fear, joy, sadness, surprise, and trust), most frequently used words & hashtags, and topic clusters with the quote tweet datasets.

4. Data and Methodology

Using the Twitter API and RStudio, all Tweets that contained at least one of the key search words or hashtags, (see Table 3), were downloaded from Twitter as JSON files for the dates November 15-22, 2022 and December 20-29, 2022. These were then formatted into 2 data frames for each storm time period with the November data frame initially containing 57,377 records and the December data frame initially containing 168,033 tweets. See Table 4.

Table 3. Keywords and Hashtags

#blizzard2022
#BlizzardOf22
#buffaloblizzard

#BuffaloBlizzard2022
#buffalolakeeffect
#buffaloNY
#buffalosnow
#Buffalosnowstorm
#BuffaloStorm2022
#BuffalowBlizzardof2022
#LakeEffectSnow
#snowmageddon
#snowvember
#storm2022
#travelban
#travelwarning
#winterstorm
#WinterStorm2022
blizzard
Buffalo
Driving Ban
lake effect
snow
snowstorm
storm
travel
travel advisory
travel ban
travel warning

A. Cleaning Data

In order to capture people affected by the storm who acted as information conduits via quote tweeting during each storm event, the following steps were taken to refine and clean the data:

1. Removed all non-English tweets.
2. Removed all tweets that were not quote tweets (but retained the source tweets of quote tweets for context)

3. Removed quote tweets that were explicitly
 - a. from a U.S. state other than New York, or
 - b. From a country other than the U.S.
4. Removed quote tweets (using keywords) that referenced
 - a. Non-storm topics (for example, Kanye, vaccine, #hunterbidenslaptop), or
 - b. Tweets that specifically mention that the quote-tweeter is NOT in the Buffalo or Western NY area experiencing the storm (for example, tweeting while on vacation, commenting about it from a clearly discernable location outside of the affected area.
5. Where there was no explicit location info provided via location data (for example, NA or “the kitchen”, “en route”) and the context of the quote-tweet was ambiguous (for example, “Amazing!”), records were removed where the source-tweet referred to:
 - a. A non-storm topic
 - b. A region that was not western NY/Buffalo
6. I removed records where there was no location data, and no reference to Buffalo or Western NY in the quote-tweet or source-tweet.

These steps resulted in 381 records in the November dataset and 803 in the December dataset. See Table 4.

Table 4. – Number of records before and after data cleaning for both storms

	# of Records captured from Twitter	Total # of Quote Tweet Records after Cleaning
November 15-22, 2022	57,377	381
December 20-29, 2022	168,033	803

B. Preprocessing

Preprocessing for each storm data set included the following steps:

1. Remove URLs in the quote tweet
2. Isolate hashtags into a separate data frame (to identify distinct hashtags and their count).
3. Copy quote tweet text into a new column excluding hashtags, ampersands, punctuation, emojis, and stop words (referred to as stripped text).
4. Copy UTC time into a new column and transform it into New York EST time
5. Make stripped text lower case
6. After polarity sentiment scores were analyzed, data frames for positive and negative quote tweets were created (to analyze separately).
7. Convert positive and negative data frames into data term matrix object (for exploratory graph analysis (EGA) to discern topic clusters).
8. Copied time and date stamp into a new column with date revised (to better accommodate temporal visualizations of emotions express in quote tweets).

C. Exploring the Data

Figures 1 and 2 are a visualization of the total number of quote tweets that occurred on each day throughout each storm. Note the marked increase in quote tweet activity on the days when driving bans were declared, November 17 (at 4PM – western NYS thruway and 9PM – Erie County) and December 23 (10AM).

Figure 1. November storm – Quote tweet count over time

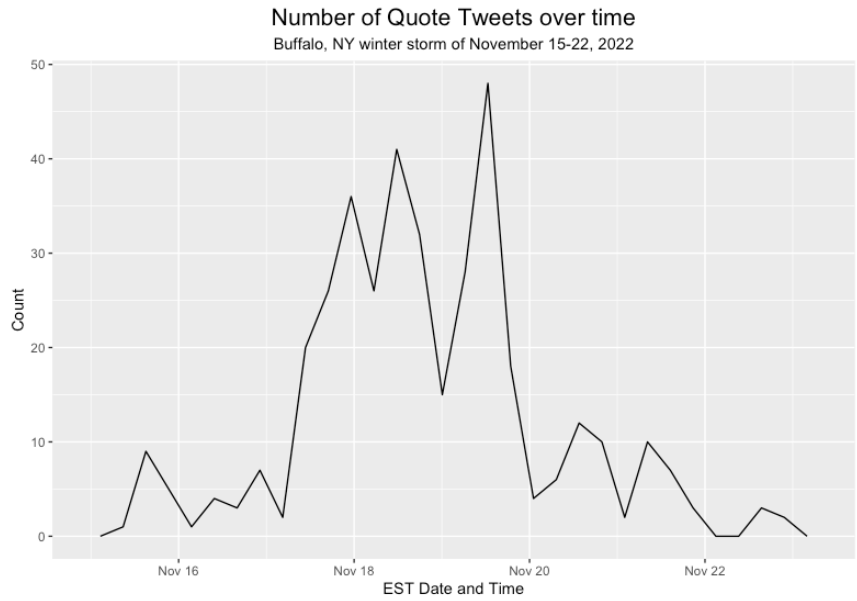
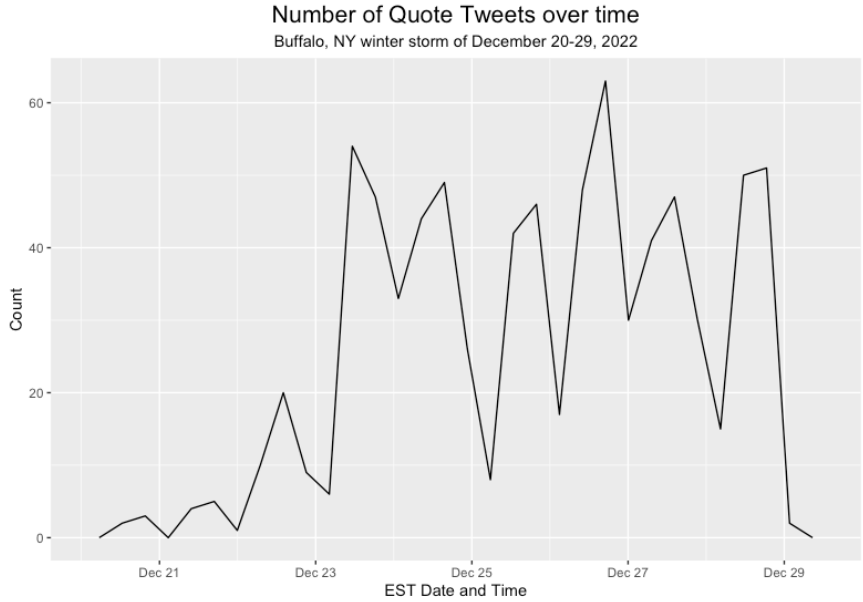


Figure 2. December storm – Quote tweet count over time



Bar charts, in Figures 3 and 4, show the count for the top 30 unique and case sensitive hashtags used throughout each storm.

Figure 3. November storm – most used hashtags

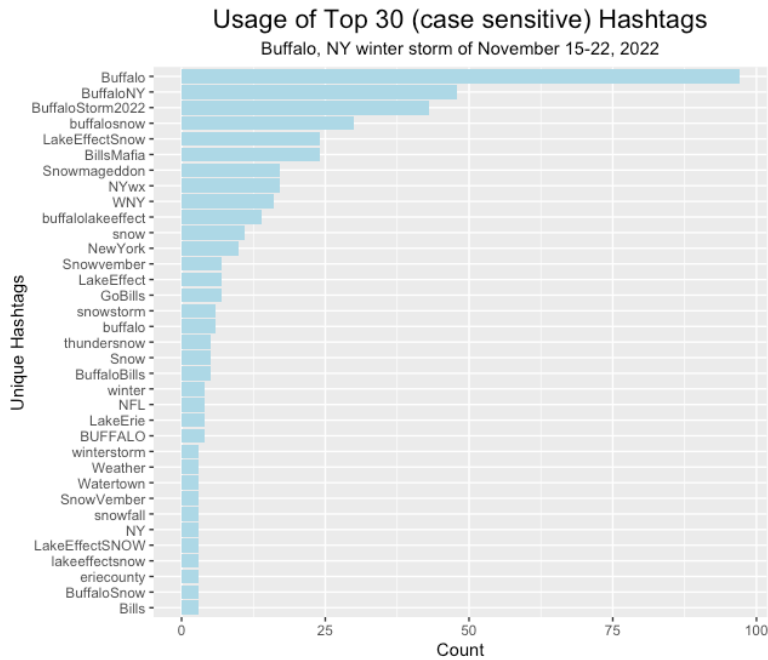
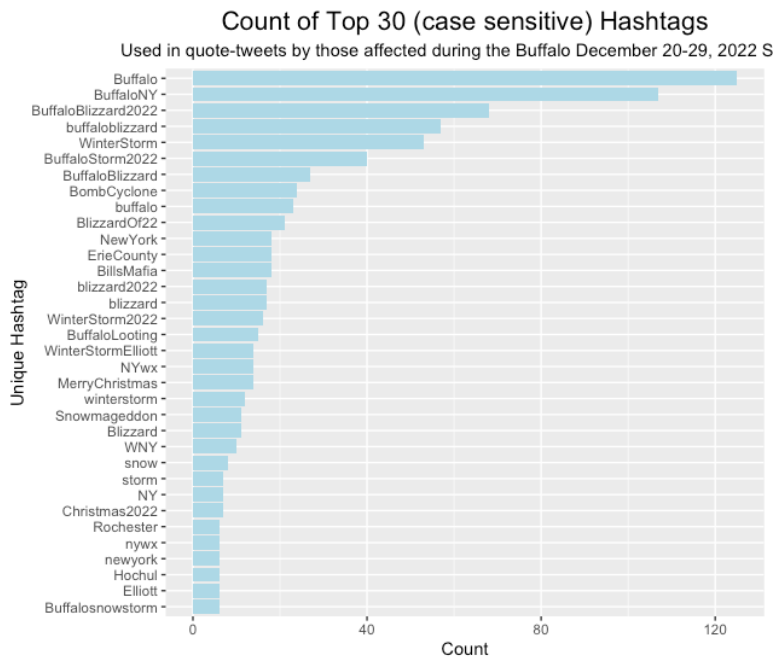


Figure 4. December storm – most used hashtags



Figures 5 and 6 show the top most frequently used words used in quote tweets for each storm. Figures 7 and 8 show a word cloud compiled from all quote tweets for each storm.

Figure 5. November storm – top 30 most frequently used words

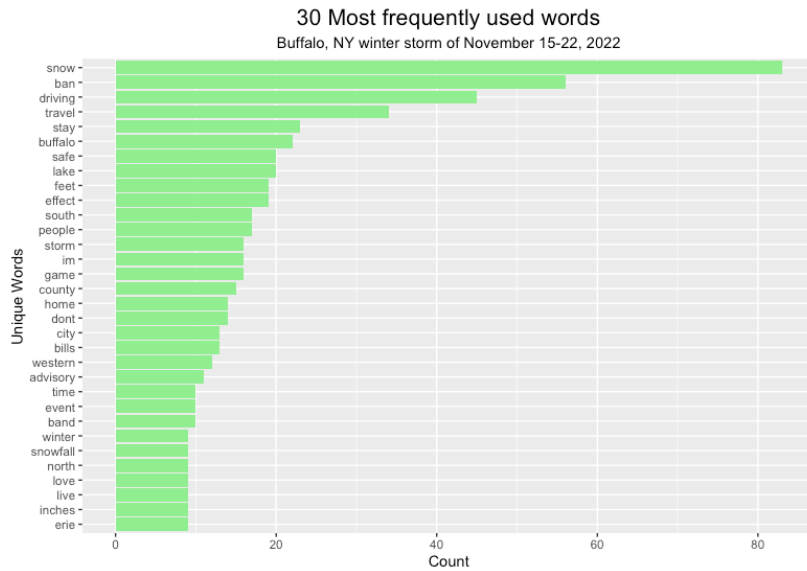
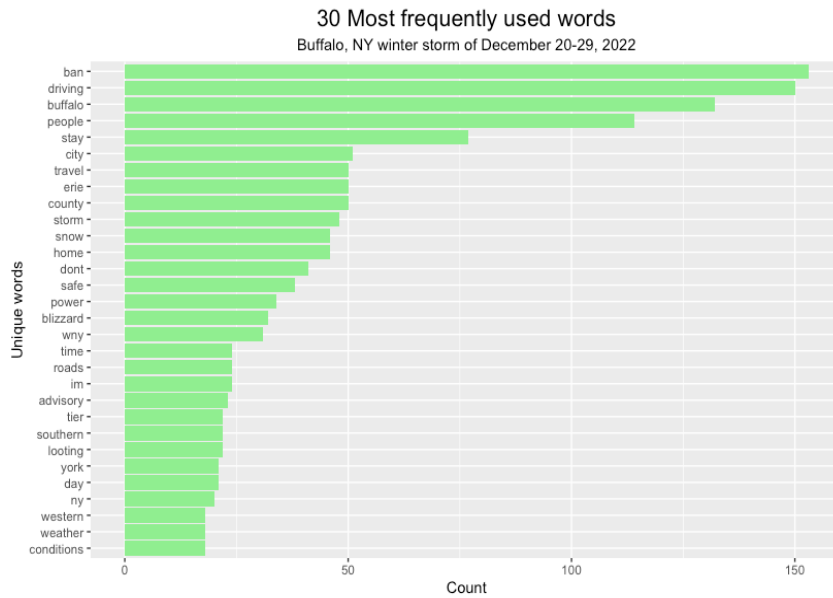


Figure 6. December storm – top 30 most frequently used words



D. Analyzing Sentiment and Emotion

1. Sentiment Polarity

The “analyzeSentiment” function from the “SentimentAnalysis” R package, (Feuerriegel & Proellocks, 2021), was used to calculate sentiment polarity scores, of each quote tweet for each storm, using 4 sentiment dictionaries. A mean was calculated from the 4 scores for each quote tweet and used to identify whether a quote tweet was negative, neutral, or positive. Scores below 0 are negative, scores of 0 are neutral, and scores above 0 are positive. See table 5 for count and percentage of negative, neutral, and positive quote tweets for each storm and Figures 9 and 10 for a visualization of the counts.

Table 5. – Total counts and percentage for positive, negative, and neutral scores for each storm

Count and percentage of Negative, Neutral, and Positive Quote Tweets			
	Negative	Neutral	Positive
November Storm (total = 381)	92 (~24%)	78 (~20%)	207 (~54%)
December Storm (total = 803)	288 (~36%)	127 (~16%)	378 (~47%)

Figure 9. November storm - Count of Negative, Neutral, and Positive Sentiments

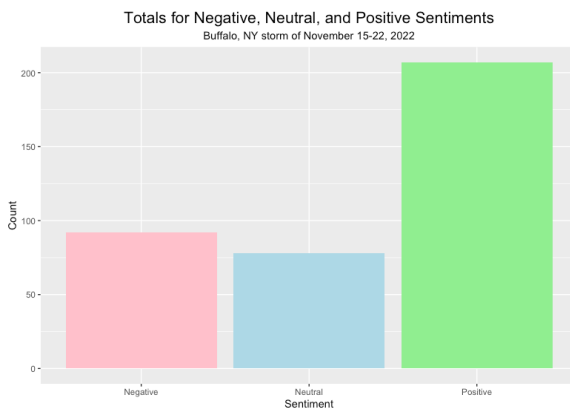
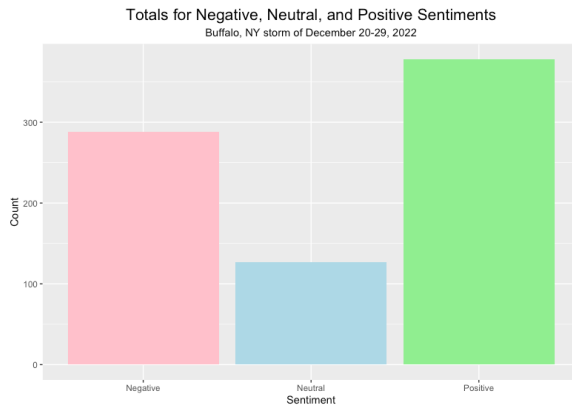


Figure 10. December storm - Count of Negative, Neutral, and Positive Sentiments



Using the mean scores, each quote tweet score was plotted over time for each storm. See figures 11 and 12. Note the continued negative quote tweets that occur thru storm end for the December storm.

Figure 11. – November Storm - Quote Tweet Polarity Sentiment Over Time

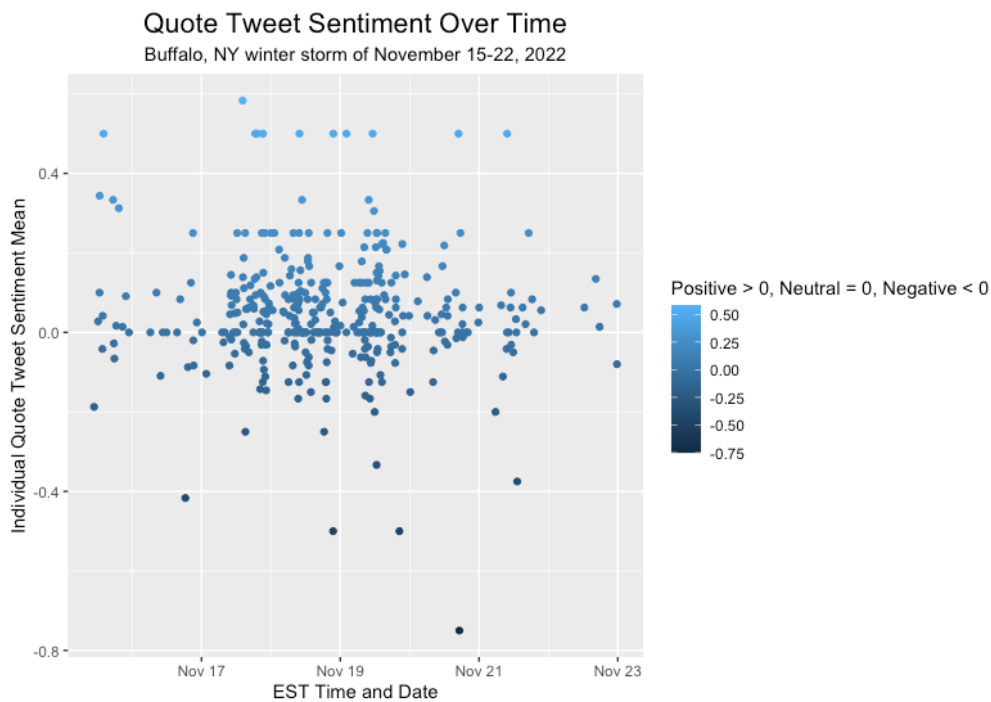
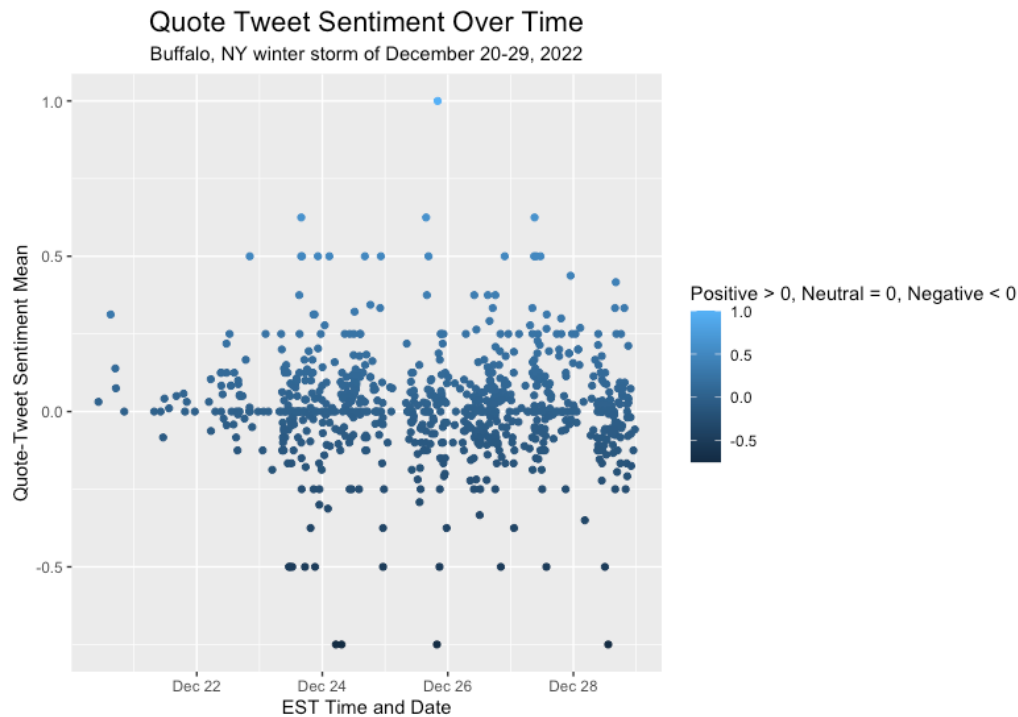


Figure 12. - December Storm - Quote Tweet Polarity Sentiment Over Time



Negative and positive quote tweet records were then analyzed separately to explore most frequent words for each sentiment polarity. Bar graphs, word clouds, and an Exploratory Graph Analysis (showing topic clusters) are used to elucidate content and topics prevalent for negative and positive sentiments. The EGA function in R uses “Spearman’s correlation coefficient using the pairwise complete observations via the cor function” (Hudson Golino [aut, 2022]).

1.A. Negative Polarity

See figures 13 and 14 for bar charts showing counts of most frequently used words in the Negative quote tweets. See figures 15 and 16 for word cloud visualizations of the Negative quote tweets. And see figures 17 and 18 for Negative topic clusters.

Figure 13. – November storm - **Negative** quote tweets, 20 most frequently used words

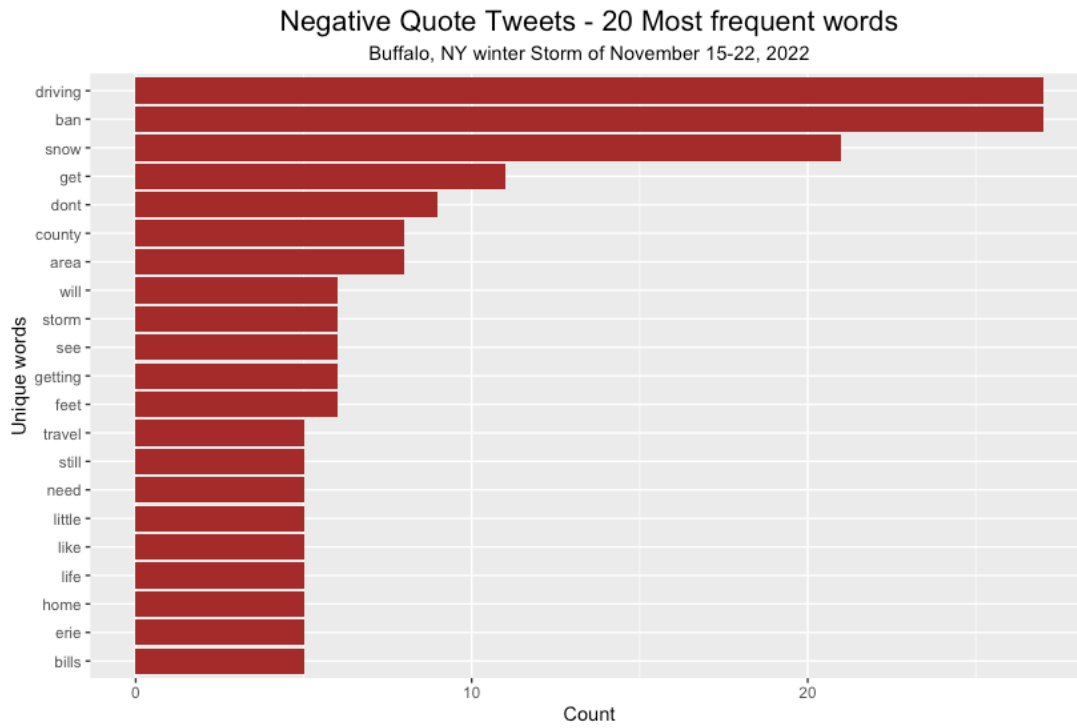


Figure 14. – December storm - **Negative** quote tweets, 20 most frequently used words

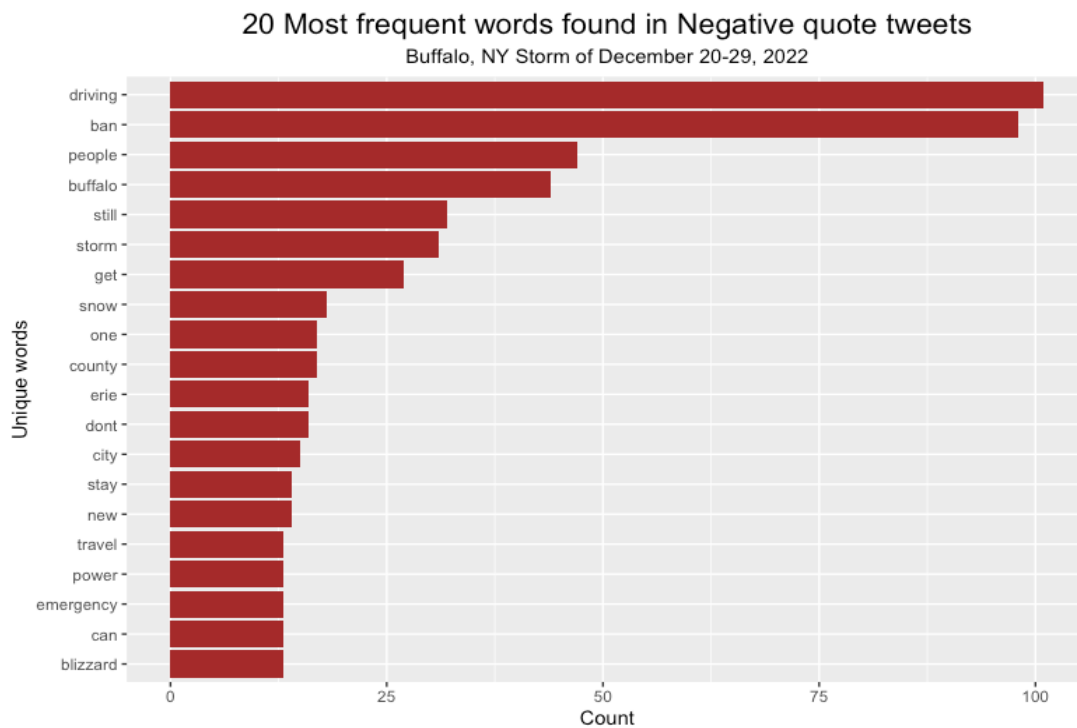


Figure 15. – November storm – **Negative** word cloud, minimum word frequency = 5

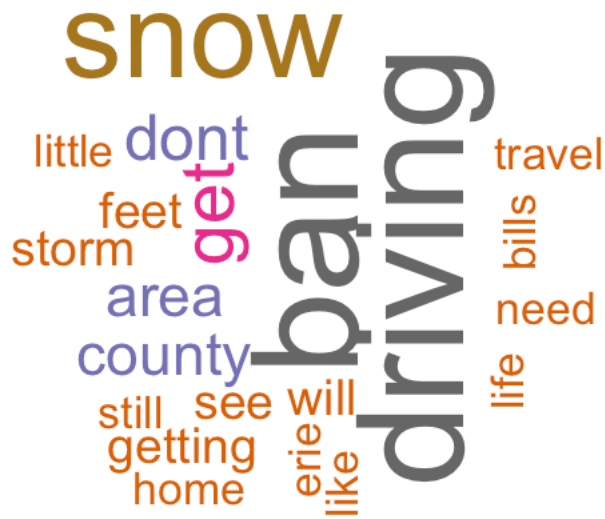


Figure 16. – December storm – **Negative** word cloud, minimum word frequency = 5



Figure 17. – November storm – **Negative** topic clusters

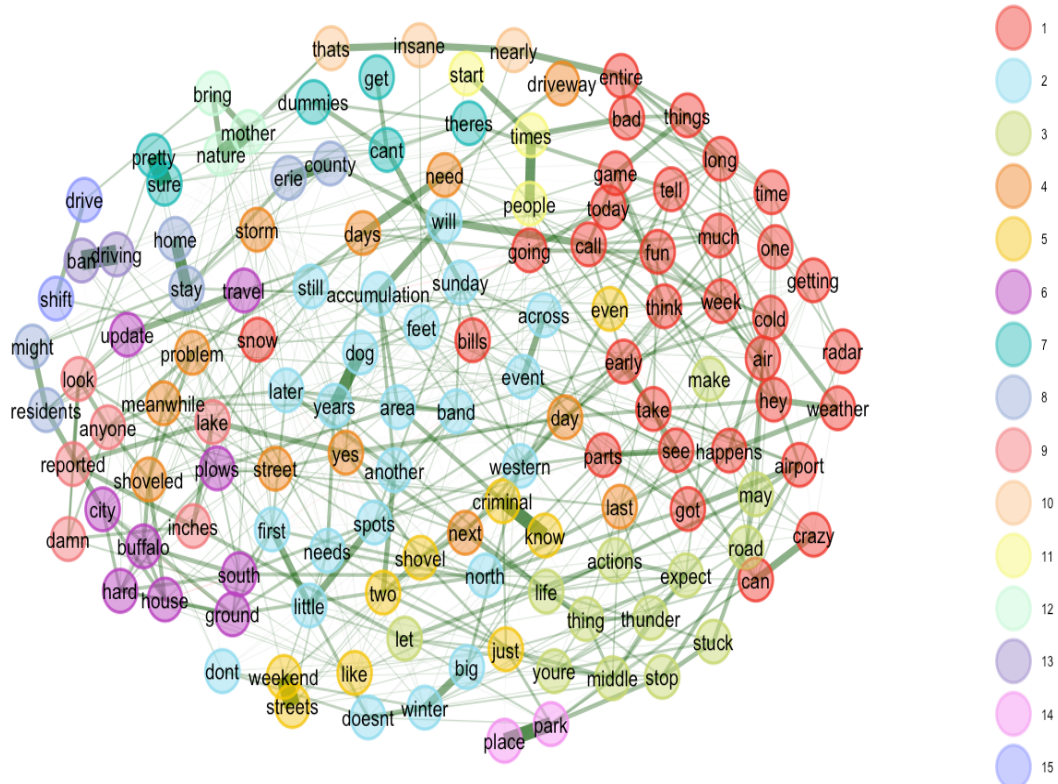
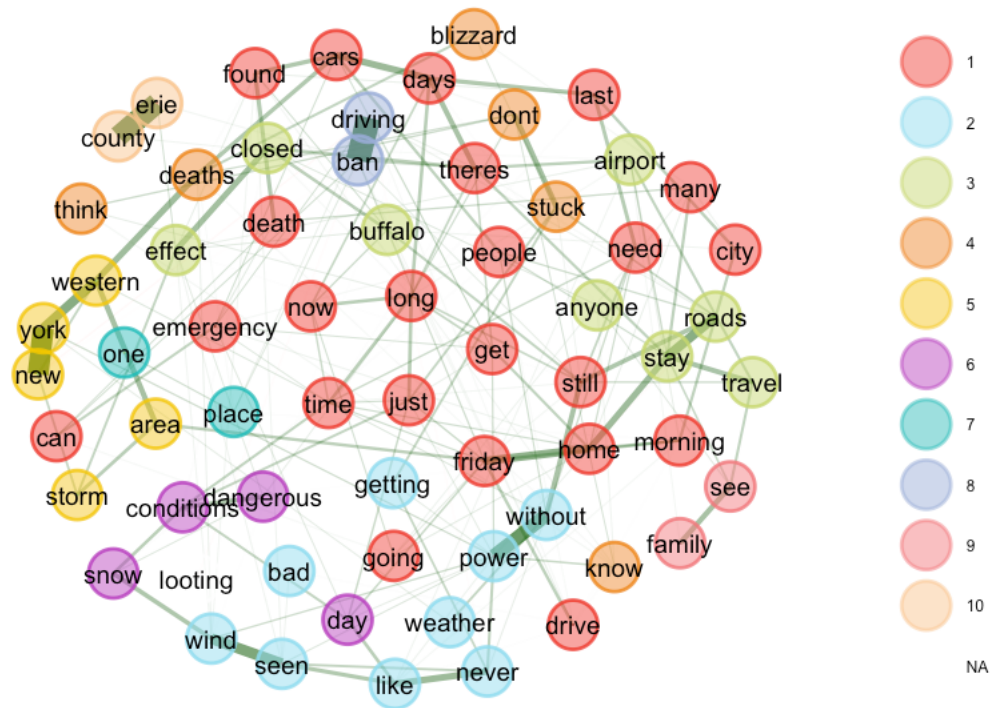


Figure 18. – December storm – **Negative** topic clusters



1.B. Positive Polarity

See figures 19 and 20 for bar charts showing counts of most frequently used words in the Positive quote tweets. See figures 21 and 22 for word cloud visualizations of the Positive quote tweets. And see figures 23 and 24 for Negative topic clusters

Figure 19. November storm – **Positive** words, 20 most frequently used

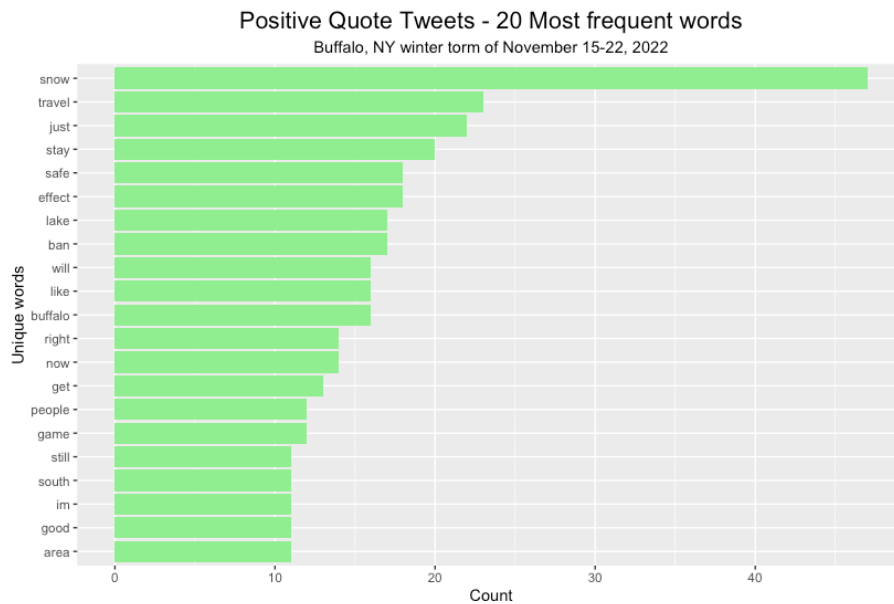


Figure 20. December storm – **Positive** words, 20 most frequently used

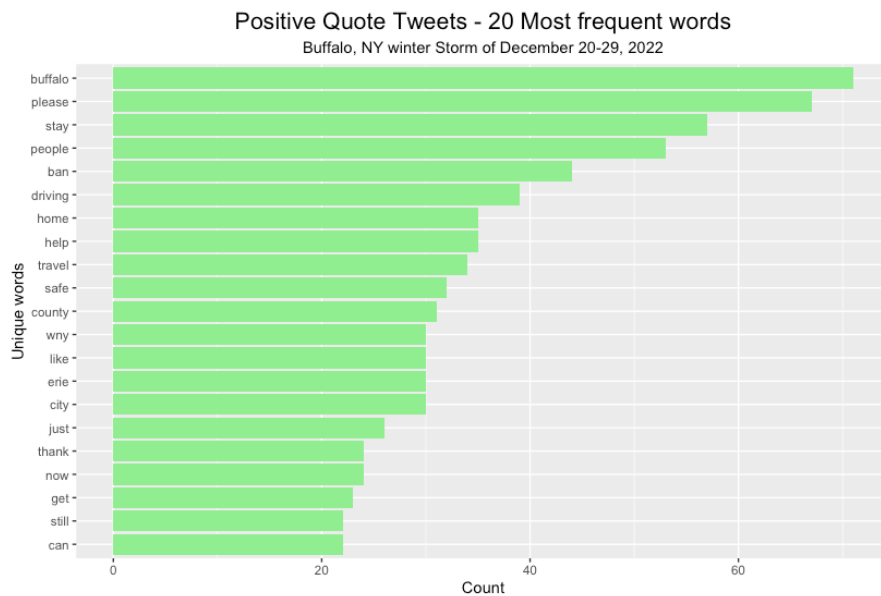


Figure 23. November storm – Positive topic clusters

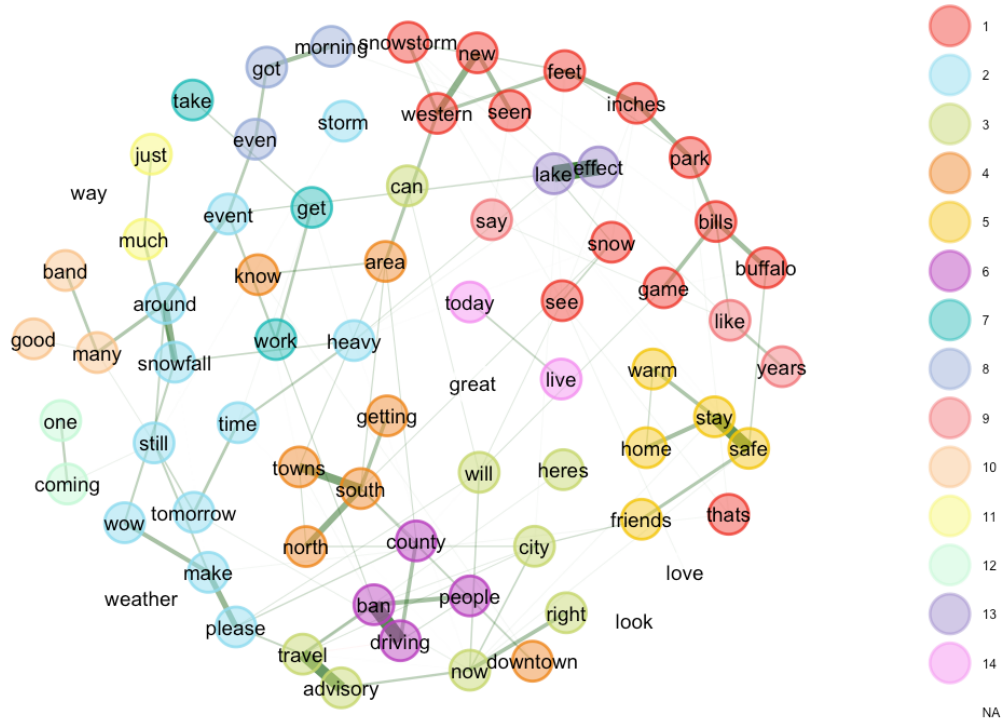
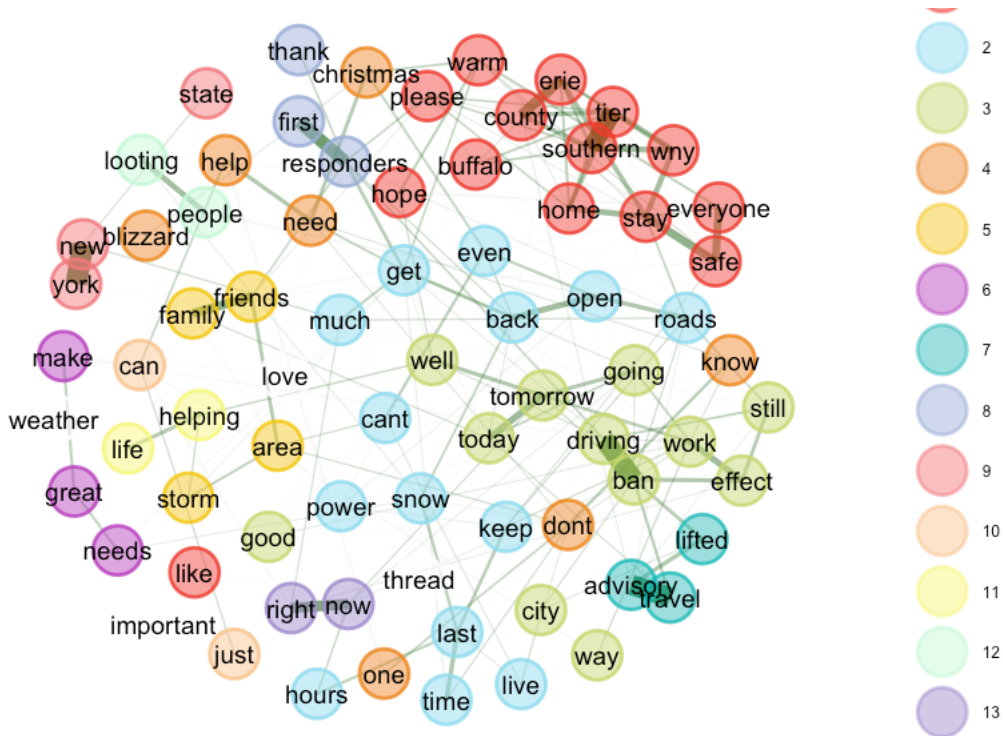


Figure 24. December storm – Positive topic clusters



2. Emotion Classification

A second type of sentiment analysis, using the NRC word association lexicon, was used to identify 8 emotions (anger, fear, anticipation, trust, surprise, sadness, joy, and disgust) conveyed by the storm quote tweets (Mhatre, 2021). Figures 25 and 26 survey total counts for each emotion for all quote tweets of each storm. Figures 27 and 28 show a stacked bar chart of emotion type and count for each for the dates of each storm. Figures 29 and 30 visualize counts of quote tweets specific to each emotion as they occurred each day of each storm.

Figure 25. November storm – Total count of each categorized emotion expressed for each quote tweet

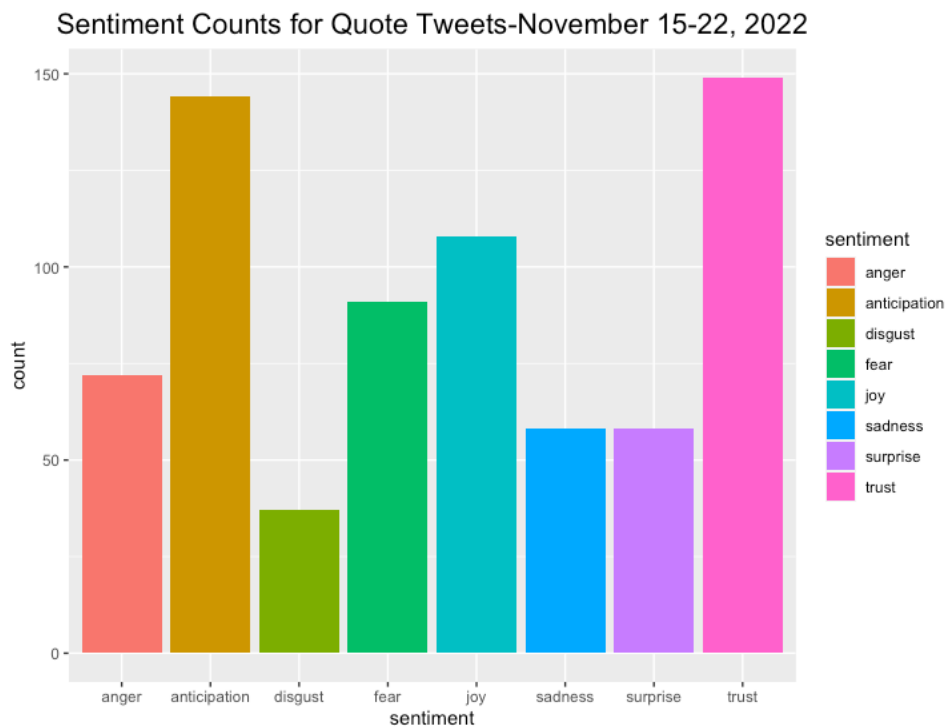


Figure 28. December storm – Daily count for each categorized emotion expressed over the course of the storm

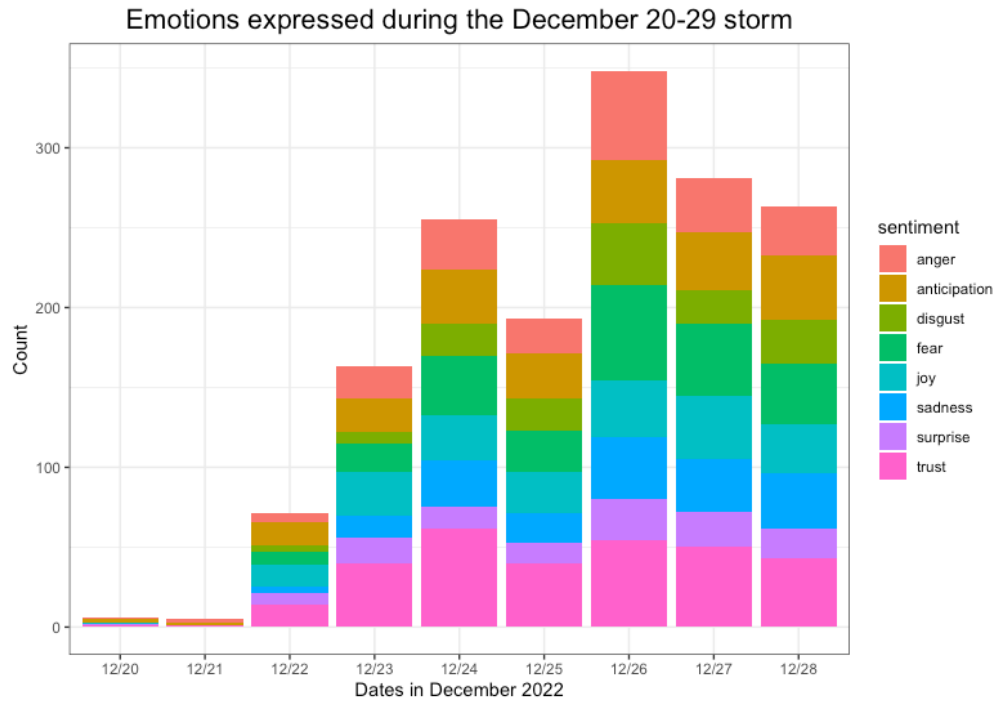


Figure 29. November storm – isolated emotion counts over the course of the storm

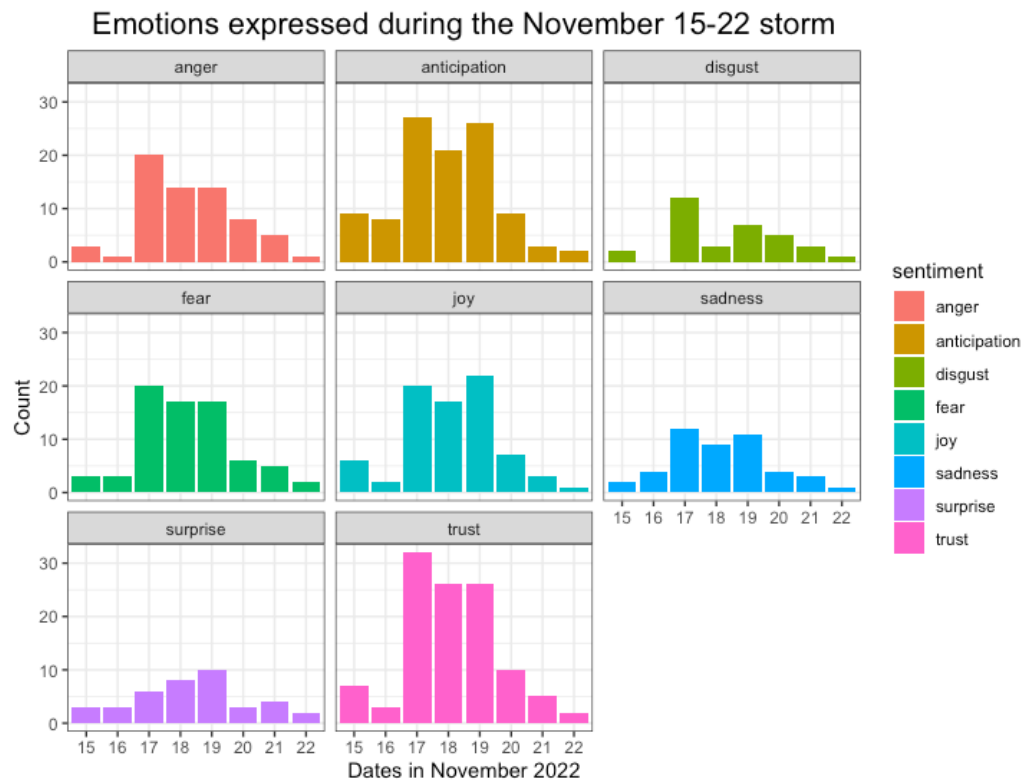
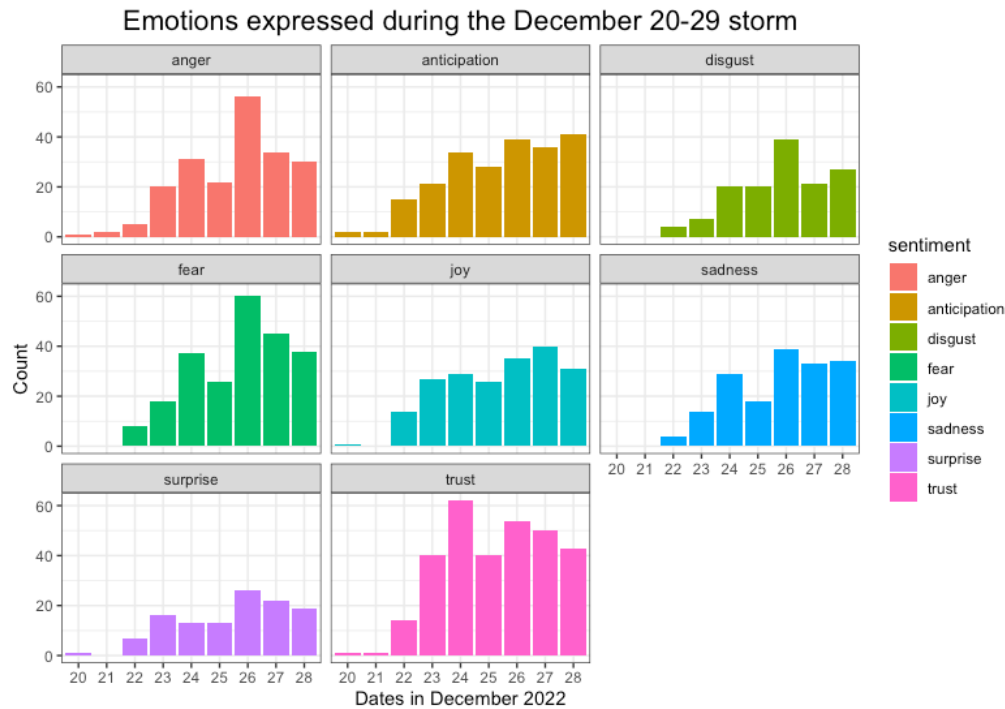


Figure 30. December storm – isolated emotion counts over the course of the storm



5. Discussion and Conclusion

The cleaned data potentially includes quote tweets that reference the storm(s) by people who were not directly affected by it/them. Initially everyone who posted a quote tweet and who identified as living in New York state was included and context was used to remove records that were not relevant. This proved useful in capturing quote tweets by people affected in the surrounding Buffalo suburbs and revealed that many Emergency Support people, who live in the state but not near Buffalo, were mobilized to help the affected region and thus became directly impacted. This also allowed a significant number of affected people who did not have any location data explicitly defined or that used non-standard descriptions to have their quote tweets be included in the data set as well.

The number of quote tweets during the November storm was most prominent during the driving ban. During the December storm quote tweets increased when the driving ban was

issued but remained high for the duration of storm and its aftermath. This is likely due to the continual devastating news released daily after severity of the storm subsided and that snow removal took longer.

Hashtag use was varied and often with a mismatch in lower or upper case. This suggests that some of their use was haphazard and ad hoc without regard to matching more prominent and likely trending hashtags during the storm.

Consistently, the key words “driving ban” rated in the top 3 most used words during both the November and December storms. But when positive and negative quote tweets were analyzed separately, the key words were prominent in the negative quote tweets but less so in the positive tweets.

Sentiment polarity for the November storm showed that there were almost 2 times the number of positive sentiment tweets as negative ones. The December storm reflected that there were only 30% more positive quote tweets than negative ones.

Topic clusters for both storms and both positive and negative quote tweets all included a small cluster with the words “driving”+”ban” . Both the November positive and negative topic clusters contained clusters that included the words, “bills”+”game”.

Emotion classification showed that the emotion “trust” was the most expressed sentiment for both storms overall and “anticipation” being the second. Separating out the quote tweets expressing the specific emotions over time made it easier to see correlations to events in each storm timeline. On Tuesday November 17, the NFL announced the Buffalo Bills game scheduled for Sunday (11/20) would be moved from Buffalo to Detroit, and a driving ban was later put in place at 4PM. On this same day (Tuesday 11/17) there is a spike in quote tweets expressing anger, disgust, and trust. On Monday, December 26, there was a surge in

quote tweets expressing anger and fear. This was also the day news organizations reported that the death toll had increased to 25. There was a spike in quote tweets expressing trust on Saturday, December 24th. One possible reason for this was because the National Guard had arrived and was helping with wellness checks and snow removal. While all the November storm quote tweets expressing all the sentiment categories decreases uniformly after the acute phase of the storm passed, it was not the case for the December storm. All the quote tweets expressing all of the sentiment categories remained at or above the median level on the last days of the December storm. This could be due to the emotional toll that learning about the loss of life had on the community and the need to process what had happened. Interestingly, the least expressed emotion throughout both storms was “surprise”. Which may not be that surprising since the affected area is Buffalo, NY and the community is used to snow storms.

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