



Università
Ca' Foscari
Venezia

Master's Degree
in Management

Final Thesis

The spread of information:
The Australian bushfire
crisis 2019-2020

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Matriculation number 856971

Academic Year

2020 / 2021

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Introduction

In the summer of 2019-2020, Australia was hit by the worst bushfire season that was ever seen by the country. Australia has always been affected by bushfires, which are an essential element for the country ecosystem, as fire is the reason why multiple plants in Australia reproduce and spread. This emergency started as early as June 2019, to then spread throughout the country leading to the biggest loss of land and animal lives by the end of March 2020. This emergency captured media attention worldwide as well as public attention, making it one of the most prominent topics of the end of 2019 and the beginning of 2020.

Seeing the importance that social media, in particular, Twitter are acquiring in these past years, the aim of this thesis was to better understand how information spread through social media, and how the public can influence the national debate by just posting a single tweet.

This thesis was divided into three chapters.

In the first chapter, the most relevant and significant literature around communication, mass media and social media will be analysed. In detail, we will see what is communication and mass communication, how the internet affected mass communication in the past years and what social media are the most popular among people to share information with others. Then we will discuss the role of social and mass media in relation to emergencies and crises. Furthermore, we will discuss the biases that influence the diffusion of information on social media and the methods of information diffusion that scholars have defined to help us understand how information spread on social networks.

In the second chapter, we will dive into the definition of bushfire and what causes them, with specifics to the Australian territory. We then will explain the connection between the increase of bushfire around the world and climate change. After this, we will discuss the Australian history of bushfire and we will examine in depth what happened during the Australian bushfire season of 2019-2020.

In the third and last chapter, we will present the case study. The method and the program (Rstudio) through which data was retrieved will be presented together with a description of the final dataset. Thereafter, we proceed to analyse the data and show the results of the focus of this analysis that was: the tweets and hashtag's frequency through the period of study and the sentiment analysis of the emotions that have been obtained from the tweets.

CHAPTER 1: Communication

1.1 Mass Communication

1.1.1 Communication

The media pervades our daily lives to such a degree that we are often ignorant of their existence, let alone their influence. We are educated, amused, delighted, and annoyed by the media. They stir our passions, test our intellects, and offend our brains. We are sometimes reduced to goods for sale to the highest bidder by them. Nevertheless, the media shapes our realities and helps characterise us.

The transmission of a message from a sender to a recipient is referred to as contact. According to Harold Lasswell (1948), addressing the following questions is a simple way to explain communication:

- Who is it?
- Who asks what?
- What channel?
- To whom is it addressed?
- What impact would it have? (Baran 2014)

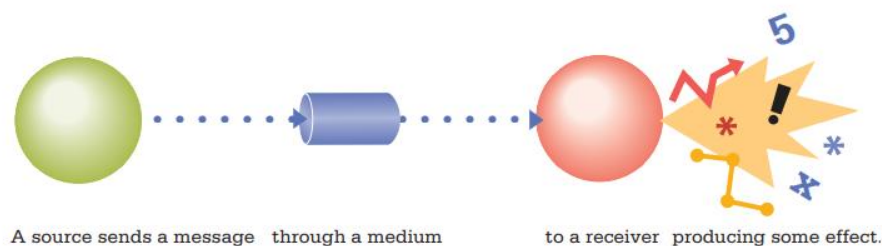


Figure 1. How communication works. Source: Baran 2014

However, even though this definition is straight forward, there are some issues with it. For example, can you imagine the event in which someone keeps talking to you in a specific technical language that you do not understand? In this case, as one of the parties does not understand the message that is conveyed to them, there is no communication taking place. As a matter of fact, communication, as opposed to just transmitting messages, necessitates the reaction of others. As a consequence, for contact to exist, there

should be a sharing (or correspondence) of sense. A second concern with this simplistic paradigm is that it means that the recipient embraces the source's message passively. Communication is a collaborative and continuous mechanism in which all people involved are involved in some way in establishing a common context. Therefore, communication is best described as the mechanism of establishing common meaning.

Wilbur Schramm, a communication scholar, created a visual representation of the mutual aspect of communication, based on concepts first formulated by psychologist Charles E. Osgood (Figure 2) (Baran 2014). This is a representation of human interaction.

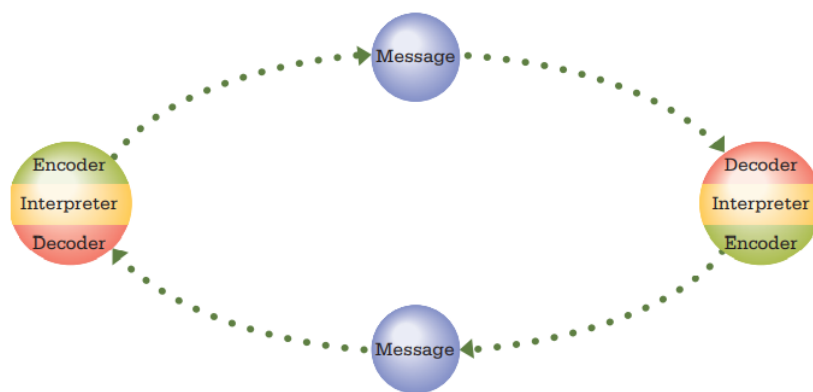


Figure 2. Osgood and Schramm's Model of Communication. Source: Baran 2014

There is no easily identified source or recipient in this representation of interpersonal contact communication between two or a few individuals. Instead, since communicating is a continuous and mutual operation, all parties, or "interpreters," collaborate to construct meaning by encrypting and decrypting messages (Baran 2014).

1.1.2 Mass communication definition

The method of establishing common meaning between the news media and their listeners is referred to as mass communication (Baran 2014).

Schramm changes his previously made model (figure 2) to assist us in imagining specific facets of the mass communication format (Baran 2014). This mass communication model and the previous model of communication have different things in common such as the

messages, the encrypting and decrypting and the interpreters. Nevertheless, the differences are the most interesting part. If the model described in figure 2 contains 'messages', the second model contains 'many identical messages'. Furthermore, the mass communication example includes the term 'feedback' that is not included in the model in figure 2. The feedback in figure 3 is referred to as 'delayed inferential feedback' and it is depicted through a dotted line, making this feedback indirect instead of direct.

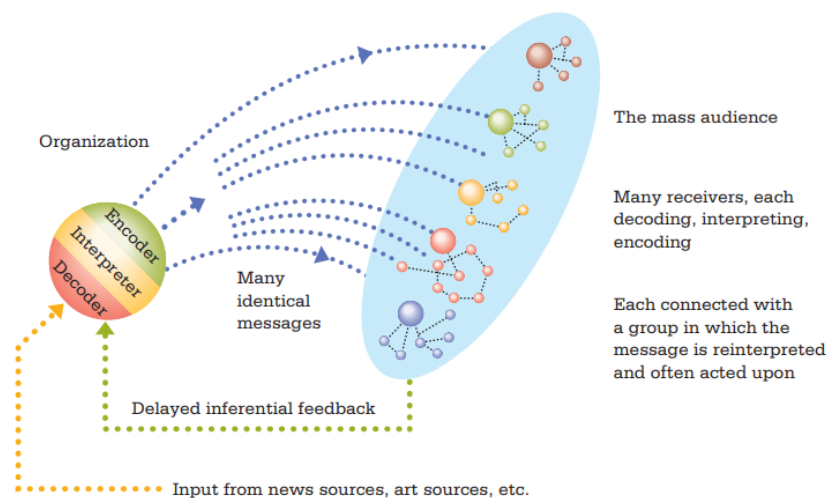


Figure 3. Schramm's Model of Mass Communication. Source: Baran 2014

The distinctions between interpersonal and mass communication alter the basic essence of the communication mechanism. Interpersonal contact is often intimate and even bold and demanding. In comparison, the technologically imposed gap between individuals in the mass communication phase produces a form of "communication conservatism". Feedback arrives too late to allow for adjustments or improvements in contact that fails. In mass communication personalisation is harder to create, making the communication more forced. Because of this, James W. Carey (1975), a media analyst, proposed a societal concept of communication that has had a significant influence on how communication is defined today (Baran 2014). He wrote that "Communication is a symbolic process whereby reality is produced, maintained, repaired and transformed" (Baran 2014, p.7). According to his (1989) interpretation, reality and communication are inextricably intertwined. Communication is a phenomenon that pervades our daily lives and

influences how we interpret, comprehend, and construct our perception of events and the universe. Our society is built on communication.

Culture is defined as the learned behaviour of individuals within a given social circle. Communication, along with mass communication, is used to create and maintain a more or less shared society.

Whatever perspective we have on the mechanism of mass media, it is difficult to argue that we spend a significant part of our lives engaging with it. Despite the prevalence of social media in our lives, plenty of us are unhappy with or dismissive of the media industries' quality and much of the coverage delivered.

1.1.3 The internet and mass media

The Internet is best conceived of as a "network of networks" that is expanding at a breakneck pace. These networks are divided into two types: LANs (local area networks) that link multiple computers in the same house, and WANs (wide area networks) that connect multiple LANs in various locations.

Connecting to the internet is already an everyday activity that happens thanks to laptops and tablets, but now with smartphones, it became way easier to connect to the internet. Obviously, a large portion of smartphone use is dedicated to social networking. These are websites that serve as online groups of people, such as social networking sites that are often characterised by shared interests like sports, occupations, or classes. The main scope of social networks is to socialize, and while there, people tend to drift into communities with a more specific type of interest (Baran 2014). Those who use a platform are traditionally thought of as members of the audience, but the Internet has users, not members of the audience. An individual could be reading Internet content and producing content at the same time, or even simultaneously. The Internet is distinct from these more conventional forms of media. Rather than altering the interaction between people and companies, the Internet alters the concept of the various elements of the mechanism and, as a result, alters the dynamic between them (Baran 2014). Usually, feedback was inferred and delayed in mass media communication, meanwhile, feedback online is instant and immediate. As a matter of fact, feedback online is closer to the feedback that we have

during social interactions (Baran 2014). The Internet, on the other hand, transforms any person into a possible mass communicator, giving to those who are usually refused speech a voice. Nevertheless, the same tool that allows people to challenge others that are stronger than them can even be used to cheat and manipulate. The Internet does not differentiate between what is real and what is fake, what is biased and what is impartial, what is insignificant and what is significant (Baran 2014). Once disinformation has been disseminated on the Internet, it is almost difficult to detect and fix it.

1.2 Social media

1.2.1 Social media around the world

The digital world is constantly changing and shifting. The total world population, as of January 2020 amounts to 7.75 billion with an increase of slightly over 1% from the year before. Almost half of the world is now active on social media. If in January 2019 3.4 billion people were active social media users in January 2020 there was an increase of 8.42% in the number of active social media users that now amounts to 3.8 billion (Kemp 2020). Meanwhile, the number of internet users grew by 7% from 2019, as now it amounts to 4.54 billion users (Kemp 2020). There was also an increase of 2.4% in the number of people that uses mobile phones, to a total of 5.19 billion (Kemp 2020).

It has been calculated that the average person with an internet connection spends around 6 hours and 43 minutes per day online, times that yearly sums up to around 100 days spent online (Kemp 2020). This means that around 40% of our time during the day is being spent online. Nevertheless, the amount of time spent connected online differs across the different countries, with the Philippines being the country with the most active internet users with 9 hours and 45 minutes per day and with Japan being the country less active users with only 4 hours and 22 minutes a day (Kemp 2020). Still, around 40% of the world does not have an internet connection, and this is happening mainly in countries like Africa, China and India (Kemp 2020).

More than 90% of internet users are connected to the web via their mobile phone, and around 50% of time spent online is spent using the mobile phone internet connection (Kemp 2020). Despite the use of mobile phones to connect to the internet has been increasing throughout the years, computers still play an important role (around 44% of

time spent online) even though their usage decreased over time (Kemp 2020). With regards to what application are being used, chat apps and social media are the most used by at least 89% of users. Then there are entertainment apps, shopping apps and map apps that around 65-66% of users utilize (Kemp 2020).

If half of the time people are connected to the internet, they do so by using their mobile phones, which means that around 3.7 hours a day is the amount of time that people spend on their phone every single day (Kemp 2020). Moreover, Social media and communication apps account for half of the time people spend on their phone. The amount of time that people spend on social media is an average of 2 hours and 24 minutes across all devices, still varying from country to country. As per internet usage, the Philippines use social media almost 4 hours a day and Japan uses them for around 45 minutes per day (Kemp 2020).

1.2.2 Social media in Australia

Australia has a population of 25.35 million that grew 1.2% from 2019 (We Are Social 2020). The country has 22.31 million active users, 57% of the total population, a number that increased by 1.2% since January 2019 (We Are Social 2020). It also has 32.9 million mobile phones connection, that is approximately a percentage of 130 compared to the total population (We Are Social 2020). Out of all the internet users, the social media users amount to 18 million, a number that grew by 4.3% compared to January 2019 (We Are Social 2020).

According to the report made by We Are Social, Australians spend around 5 hours and 41 minutes of their time using the internet and 1 hour and 44 minutes using social media. The preferred device to browse the internet seems to be the mobile phone with a share of 47.5% of the internet traffic followed by laptops, (45.3%), tablet (7.1%) and other devices (0.1%) (We Are Social 2020). Out of all the four possible devices, the only one that increased in comparison to 2019 is mobile phones, with an increase of 25% (We Are Social 2020).

The most visited website for Australians is Google followed by YouTube and Facebook, the microblogging site Twitter comes in 10th place (We Are Social 2020). Around 71% of

the Australian population is an active social media user and 98% of them access social media via their mobile phone (We Are Social 2020). Across all the different sites, the percentage of female or male users is slightly the same no matter the age, but females tend to be the gender with the highest percentage (We Are Social 2020). The average amount of account that each active Australian user has among all the social media platforms is 6.7 and the usual time spent on them is 1 hour and 44 minutes per day (We Are Social 2020). Facebook is the most used social platform, with 15 million users that mainly access the platform through their phone. Meanwhile, Twitter is the 6th most used social platform, with 6.23 million active users where the majority of them, around 58.9% is male (We Are Social 2020).

The main source of information for Australians is the television used by 66% of the population while online news and social media are respectively at the second and third place with 52% and 46% of the population using them to get news (Fisher et al. 2019). Television though it is the preferred method to obtain information for people over 55 years of age. Meanwhile, for the younger generations, social media is the favourite way to acquire news (Fisher et al. 2019). Social media is in fact used by 47% of generation Z (people born between 1997 and 2012) users and by 33% of Millennials. Online news is in between television and social media in regard to users, as both the younger generation and a portion of the over 50 uses them. As social media, Twitter is primarily used by generation Z, Millennials and generation X (people born between 1965 and 1980).

The engagement that Australians have with their online news is mainly as a source of information to then discuss the actual topic face to face with friends and family. Nevertheless, a good percentage of users' engagement online consists in sharing their news on their social media, commenting under different posts their opinion, talking online with their friends, and giving likes to the posts they deem interesting (Fisher et al. 2019).

Almost 79% of Australians check their profiles across different platforms at least once a day while 31% of Australians tend to do so at least 10 times a day (Yellow 2020). Usually, it is women that check their profile more often, around 37% of women do so compared to 25% of men (Yellow 2020). Meanwhile, based on age, the younger generations are the

most active users as 55% of people between 18-29 years old tend to check their social account at least 10 times a day (Yellow 2020). Around 29% of Australians access the internet between 10 to 20 times a day, the majority of them being females (32%) compared to the male (27%). Younger generations are also the ones that tend to access the web more often. Around 33-34% of people belonging to these three age groups: 18-29 and 30-39 and 40-50, tend to access the internet between 10 to 20 times a day (Yellow 2020). There are two times of the day during which Australians prefer to check their social media platforms and these are mornings (58%) and evenings (59%). Home is also the preferred place where 94% of people check their accounts, preferably in the living room and bedroom (Yellow 2020). The reasoning behind the use of social media is mainly to connect with friends and family. Also, most people tend to use social media while doing or watching something else. 58% of Australians in fact check their accounts while watching a movie and 50% while watching the news (Yellow 2020).

1.2.3 Twitter

Twitter is a social networking microblogging site where people exchange information through tweets that are short messages in real-time. The act of posting a tweet for the people that follow you on the platform is called tweeting. The microblogging site was created in 2006 by Jack Dorsey and it was launched a few months after its creation the same year. As of right now, there are more than 300 million monthly active users on Twitter and 152 million daily active users (Aslam 2020). The majority of the users, around 80%, use their mobile phone to access the site (Aslam 2020). Tweets have a limit of 280 characters, this allows the site to be more 'scan friendly' as it is easier to read the content of the tweets through just a brief look while scanning (Gil 2020). Estimates show that every day around 500 million tweets are sent out (Aslam 2020).

It is possible to join the platform through a free account and a Twitter name. While using it you can be either someone that tweets news and information or someone that just receives the tweets and reads through them. Tweeting is very easy, the user just needs to go to the 'What's happening' square, which can be found near the user profile, and type, add images or videos and then click tweet. Tweets can be seen by both people that follow the user account and by people who do not. Nevertheless, it is possible for Twitter users to make their account private so that only the people that follow them would be able to

see the tweets. Whenever a user encounters a Twitter account that interests him/her and would like to keep seeing its tweet on its own feed, the user just needs to click the follow button.

People tweet for various reasons, them being boredom, self-promotion, narcissism and to get recognised. The majority of the people tweet for pleasure but there are an increasing amount of Twitter users that tweet helpful information and ideas. Twitter also gives the chance to everyday people to become amateur journalists while writing about something that they deemed interesting. Also, as the platform is used worldwide it is possible to receive updates from all around the world. There is a wide variety of content on Twitter, and it is up to the user to decide which part is worth his/her attention (Gil, 2020). Posts are usually public and visible to anyone that has an account and anyone that does not. Users can also interact with other users by replying to someone else's post or liking it and they can also send private messages to other users.

Twitter is mainly used by males, around 67% of the users were male in 2019 while only 31% were females (Iqbal 2020). Age-wise, the majority of the users are between 18-24 years old, 25-34 years old, 35-49 years old and over 50 years old.

Twitter is also used as a form of advertisement by many brands and companies everywhere. As nowadays people are bored with television advertisements, they prefer something shorter that can also be personalized based on your research (Gil 2020). Brands can in fact promote their products or services through posts and they can also share trends through the use of hashtags. As said before, the brand's content will then appear to the users who are most likely to be interested in it according to its twitter information and usage (Iqbal 2020). It has been estimated that the use of Twitter helps brands to increase by 14% their positive brand sentiment and by 34% the purchase intent (Iqbal 2020).

1.2.4 Twitter in Australia

As social media, Twitter is used by 20% of the Australian population (Yellow 2020). Males are the main users of this platform, but females are just slightly less than men, as a matter of fact around 23% of the male population uses it while 17% of the female population

does (Yellow 2020). The majority of Twitter users are between the age of 30-39, between 18-29 years old and 40-49 years old (Yellow 2020). During a single week, Australians tend to use the platform around 18-19 times. People with an age between 18-29, 30-39 and 50-64 years old are the ones that tend to use it more often, respectively being 21, 20.1 and 21 times per week (Yellow 2020). During a single visit, they roughly spend around 13.4 minutes on Twitter.

1.3 Crisis Communication

The role of social media in facilitating multiple connectivities through universal interconnected computing and mobile media devices is growing in importance in emergency and crisis management (Flew et al. 2013). Governments worldwide are increasingly using the internet and social media as a forum for collaboration and interaction with their people in order to provide better access and increase public interest in political discussion. Disaster and emergency management has proved to be a networking environment where creative applications of social media have started to have a significant positive effect on the efficiency of disaster responses and the resilience of impacted local populations.

According to Mendoza et al. when using social media during an emergency, two major problems emerge. The first is concerned with issues of government and trust, such as governments' ability to provide timely and accurate information to a larger segment of the affected population, and also the legitimacy of information sourced from or transmitted by regular people on social media sites, and the degree to which better social media practises could reduce misinformation dissemination (Flew et al. 2013). The second major issue is the synchronization of activities among emergency management and media organisations, as well as the coordination of data and knowledge transfers through and through the media ecology.

There is an increasing number of studies in crisis communication that recognises social media as a key factor. According to Kaplan & Haenlein, social media are a wide category of social networks that enable users to create their own content (Coombs, Claeys & Holladay 2018). It has been argued by Utz et al. that merely using a social networking channel changes how people interpret and respond to crisis communications (Coombs,

Claeys & Holladay 2018). According to Utz et al. even though crisis communication through social media is the better option for Organizations because it conveys more credibility and decreases unfavourable secondary crisis reactions, it is important to remember that also the use of conventional media, for crisis communication, remains important as the journalist keep being reliable gatekeepers (Coombs, Claeys & Holladay 2018). According to studies, social media networks influence how people respond to emergency communication. People perceive the same disaster information in another way as it is conveyed through social media as opposed to conventional or other digital media.

Disasters and crises are often confused; however, scholars have distinguished crises as being organisational in nature, while disasters are social in nature. The National Science and Technology Council describes a disaster as “serious disruption of the functioning of a community or a society causing widespread human, material, economic environmental losses which exceed the ability of the affected community or society to cope using its own resources” (Fraustino, Liu & Jin 2018, p.284).

Disaster coordination is concerned with:

- Disaster news reported to the community by states, crisis response agencies, and emergency workers via traditional and digital channels.
- Disaster news reported and circulated by reporters and impacted citizens by word-of-mouth and social media.

In this context, social and new media are narrowly defined as engaging digital or mobile networks, apps, channels, or resources that include content that users can create, control, or affect. According to Wright and Hinson, social networking platforms encourage prompt, engaging feedback and can promote content sharing and interaction between message recipients and authors (Fraustino, Liu & Jin 2018). While many conventional media forms (such as publications, radio, and television) have become and continue to be critical for emergency communication, they are characterised by stagnant, one-way information distribution. A wide range of two-way contact technologies is available in the social media domain.

During crises, three users emerge, the social media influencers, the social media supporters, and the dormant social media users. Social media influencers recognise the disaster's significance and discuss it publicly. They either have greater expertise or familiarity with a specific disaster problem than others or they are keener to learn about a particular disaster situation than others. Social media supporters are people that collect emergency updates directly or implicitly from prominent social media influencers. As the majority of the public mainly uses social media to access or distribute emergency information rather than produce it, preliminary data suggests that the majority of those who are involved on social media during disasters are likely supporters (Fraustino, Liu & Jin 2018). Meanwhile, the dormant social media users gather their information through word-of-mouth communication.

Recent evidence indicates that people use social media differently after crises than they do on a regular basis. Reasons, why people use social media during disasters, are:

- Due to convenience. Social media provides instantaneous access to up-to-date content, group engagement, and other public resources during disasters.
- Due to common expectations. Social expectations influence social media use in general. People are more likely to use a channel if their peers and family use it regularly and if they attribute a high degree of legitimacy to social media.
- For humour. Positive feelings can be useful coping strategies both before and after a crisis. However, a significant concern is that some people think laughter is offensive during disasters, which can lead to people not using social media during disasters.
- For the purpose of gathering timely information. Disasters also create a high degree of confusion, which leads to an increase in knowledge searching. Since social media provides real-time emergency news, it may serve as a primary source of time-sensitive information.
- Uncensored Information. People often connect with each other through social media to receive crisis and catastrophe information rather than finding a conventional news source or corporate website.
- To keep in touch with family and friends. Social networking will help to ensure protection, provide assistance, and provide instant personal status updates.
- To disseminate relief information and mobilise volunteers. The general public can use social media to mobilise emergency relief efforts from near and far.

- To keep a feeling of community alive. During crises, the media will offer a rare gratification: a sense of belonging, even though people are dispersed around a large geographical area.
- Seeking Help And support. Social networking platforms are designed to provide emotional support by encouraging people to create new worlds and relationships, exchange knowledge and emotions, and even demand resolution.

Whereas, reasons, why people may not use social media during disasters, are:

- Concerns over privacy and security. During natural disasters, there is widespread concern over privacy and security breaches related to social media.
- Concerns on Accuracy. The inconsistency of emergency reports is a problem that may cause people to stop using social media.
- Inadequate knowledge of social media.
- Problems with access. The general public may not have access to the resources.

1.4 Emotional Sharing

People feel intense feelings in reaction to significant social initiatives, and these feelings often inspire people to express their emotions. According to an increasing body of research, feelings shared on social media also spread rapidly. Nevertheless, according to Christophe and Rimé in 1997 and Garcia et al. in 2016, after a brief period of time, the strength of feelings felt by users declines, as does the likelihood of emotional sharing and user participation (Goldenberg, Gross, & Garcia 2018). The total emotional sensitivity of a particular topic can be diminished further by material that is either emotionally neutral or even opposing. Emotion-inducing content abounds on social media. The reason is that attention is a precious asset on social media, and inducing emotion is a great way to get it.

Networking site feeds are tailored to users' past interests and posts. This ensures the historically evoked emotional content is recycled. When people come across emotional material, they frequently share it. As powerful as emotional sharing on social networks can be, feelings fade easily, and consumers carry on to some other hashtag. Emotional sharing may occur by original content, replies, or enjoying or sharing specific content. Emotions displayed in an initial post are often directed at a single cause or topic. The

replies to that initial post often address the very same general topic, but they often allude to the feelings conveyed in the original message.

1.5 Social Media Biases

While social media platforms grow in popularity, more and more daily conversation is shifting away from traditional contact channels like email and the internet and into the social network (Morgan, Shafiq & Lampe 2013). Social networking platforms are among the most important sources of news around the world. Nonetheless, consumers are subjected to material with dubious authenticities, such as conspiracy theories, clickbait, faux science, and even invented “fake news” stories (Ciampaglia & Menczer 2018). This implies that both humans and the technology behind social media are susceptible to exploitation.

Many with an Internet connection have incredible access to a wide range of thought, evidence, and perspective. Simon, in 1990, has defined bounded rationality as a “choice that takes into account the cognitive limitations of the decision-maker - limitations of both knowledge and computational capacity” (Morgan, Shafiq & Lampe 2013, p. 1).

There are some forms of bias in the social networks world that make it vulnerable to both deliberate and unintentional misinformation.

1.5.1 Cognitive Biases

Cognitive biases arise from the way the brain absorbs the knowledge that everybody receives on a daily basis. The brain can only process a limited volume of information, and too many incoming inputs can lead to information overload. This has serious consequences for the accuracy of content available on social media. We discovered that because of the fierce competition for users' scarce interest, certain concepts become famous despite their poor quality – even though people choose to post high-quality information (Ciampaglia & Menczer 2018).

Moreover, Simons connects his idea of bounded rationality to the subjective expected utility, economic theory. This theory states that people fully understand all possible outcomes and probabilities and they decide between them with the intention to enlarge

their utility function (Morgan, Shafiq & Lampe 2013). Nevertheless, Simon believes that people use “procedures for choosing that are computationally simpler, and that can account for observed inconsistencies in human choice patterns” (Morgan, Shafiq & Lampe 2013, p. 2). Some of these possible techniques are based on the knowledge that is easiest to find, depending on knowledge coming from previously used sources and use of straightforward heuristic methods when selecting news sources and searching for a variety of details.

The brain employs a variety of strategies to prevent being overloaded. These techniques are normally accurate, but they can often become biased when used in the wrong situations.

One cognitive bypass occurs while a person is determining whether or not to post a story from their social media feed. People are influenced by a headline of the article's emotional implications, even if this is not a strong predictor of an article's reliability. The person who wrote the article is much more significant (Ciampaglia & Menczer 2018).

In order to cope with cognitive overload, people tend to use one of many heuristics called selective exposure. This heuristic refers to the propensity to restrict information exposure to signals that are consistent with previously existing views or desires while excluding content that can trigger cognitive dissonance (Morgan, Shafiq & Lampe 2013). As a matter of fact, as in the offline world as in the online one, people tend to communicate primarily with individuals that are more similar to them.

1.5.2 Society's Bias

Society is another cause of bias. When people interact directly with their friends, the social prejudices that control their peer choice begin to affect the details they perceive. When social networks are tightly linked and isolated from other aspects of society, they are especially effective at spreading facts – reliable or not. The propensity for people to prefer input that comes from inside their own social networks produces "echo chambers" that can be manipulated, either deliberately or unconsciously (Ciampaglia & Menczer 2018).

1.5.3 Algorithm's Bias

The third type of bias stems directly from the algorithms that decide what users see on the internet. They are used by both social media sites and search engines. These personalisation solutions are intended to choose only the most entertaining and appropriate content for each unique customer. However, by doing so, it can end up strengthening users' cognitive and social prejudices, rendering them much more susceptible to exploitation (Ciampaglia & Menczer 2018).

The sophisticated targeting mechanisms incorporated into many social sites allow misinformation promoters to take advantage of confirmation bias by personalising messages to users who already support them. Furthermore, if a person frequently clicks on social media links from a specific news website, the specific social network would appear to display the user more from that site's content. This is what is called a "filter bubble". Its effect can separate people from different points of view, reinforcing the confirmation bias.

In addition, social media networks subject users to a less varied range of outlets than non-social media outlets such as Wikipedia. This is referred to as homogeneity bias because it occurs at the network level rather than at the level of a single individual (Ciampaglia & Menczer 2018).

An essential component of social media is content that is popular on the platform, based on what is receiving the most views. This creates a popularity bias (Ciampaglia & Menczer 2018).

Social bots can manipulate all of these algorithmic prejudices, as they are computer programmes that communicate with people via social networks. These bots will create filter bubbles around insecure people to send them false information. For example, they can capture the interest of human users who favour a particular party by tweeting that specific politician's hashtags or referring to and retweeting the individual (Ciampaglia & Menczer 2018).

1.6 Diffusion Speed

It is important to collect and exchange information efficiently during moments of emergency but achieving this objective has been difficult due to factors such as limited dissemination of information related to humanitarian operations during disasters (Yoo et al. 2016).

Because of the extreme complexity and variety of players participating in these emergencies, managing humanitarian operations throughout emergencies is often extremely difficult. Researchers also emphasised the importance of quick information dissemination for humanitarian organisations to collect data about situations in affected countries. Social media platforms such as Twitter or Facebook can aid in knowledge diffusion because they allow stakeholders to upload and share the news with others in real-time and at a low cost (Yoo et al. 2016).

To understand the dynamics of information cascades' diffusion in social network environments, research focused on the *Information Diffusion Theory* that has relied on various forms of adoption models. Two landmark models are the *Independent Cascade* method proposed by Goldenberg et al. and Kempe et al., and the *Linear Threshold* model created by Granovetter (Yoo et al. 2016). Each participant is presumed to contribute monotonically to knowledge diffusion in both models. In both models, knowledge dissemination occurs recursively over time, beginning with a group of participants that contribute information to be transmitted by other participants through the network. They also allow for knowledge diffusion caused by a member collecting information from sources outside the network (Yoo et al. 2016). According to Kempe et al. in the *Independent Cascade* models assume that a knowledgeable participant only has one possibility at a time to share information with one under-informed individual next to him/her in the network (Yoo et al. 2016). Meanwhile, according to Granovetter, the *Linear Threshold* models presume that a person would exchange information with her under-informed network peers if the number of knowledgeable participants next to her in the network approaches her own power limit over time (Yoo et al. 2016). Furthermore, the smaller the limit is within the network, the more the individual will exchange information with her under-informed neighbours, and the more knowledge will spread widely across the network (Yoo et al. 2016).

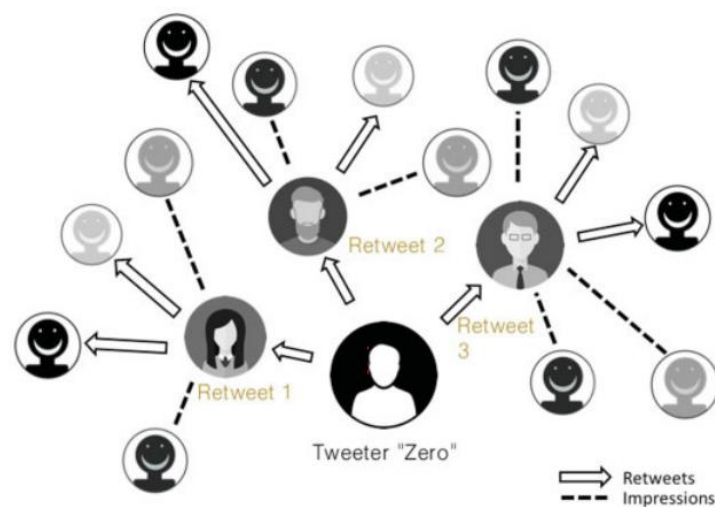
The spread of an information ripple is determined by the degree of power held by the cascade's original author in the social media platform. In case of information cascades in social networks regarding humanitarian disasters, the impact of the said original author is extremely important as consumers have been expressing serious questions about the authenticity of crisis information they accessed via social media. When an original author of a cascade has a large network audience, the information tends to spread quicker, and a larger number of people tend to be introduced to the cascade content sooner (Yoo et al. 2016).

According to Rogers-Pettite and Herrmann study, if network users believe that the contents of cascades are informative and that sharing these contents will benefit others the diffusion rates would improve (Yoo et al. 2016). As a matter of fact, social media users are most likely to engage in cascades bringing information deemed valuable to rescue operators during humanitarian emergencies.

In 2010, Boyd et al. documented a tendency for social networking site users to exchange time-sensitive information with others. This is especially important in a humanitarian setting, where participants will be inspired to exchange critical knowledge that will specifically meet their needs as well as the needs of the other users. The moment when the information is introduced on social platforms will affect the pace at which information spreads on social networks after a crisis. The knowledge that is posted early in the course of a disaster has a much faster rate of dissemination than information that is added later in the course of the catastrophe. As a matter of fact, cascades covering such issues will spread rapidly early in a crisis as more people mimic one another in exchanging information. However, as newer issues arise there will be competition between them and the earlier ones; for this reason, the rate of participation in cascade propagation will slow over time (Yoo et al. 2016). Nevertheless, to help increase the speed of diffusion and visibility of information, the original creators of cascades can post the information multiple times.

People have formed social associations since the beginning of time. According to Godin, a tribe to be formed only needs a common purpose and a means of communication. Thanks

to the diffusion of the Internet, obstacles such as geography, time and price have vanished. As of now, it is much easier to form social media tribes everywhere. As a matter of fact, belonging, spreading knowledge is an intrinsic part of human nature. To understand how information spreads on social media we take Twitter as an example. In Figure 4 Tweeter 0 is the name given to the first tweeter. Now let us assume that this person makes a comment in the form of a tweet that is originally seen by three people who agree with the comment and for this reason they 'retweet' it. Now, all the 'retweeter's' followers can see that tweet (Varghese 2017).



Anatomy of a tweet—"ripple" effect from retweets and impressions.

Figure 4. Anatomy of a tweet – "ripple" effect from retweets and impressions. Source: Varghese 2017

Networking sites have lowered the barriers of tribal membership, making it second nature. Regrettably, in the modern era, attention spans are becoming extremely short. Individuals want interaction and development, but they also want to feel like they are doing something different (Varghese 2017).

Elements that influence the distribution of information on social networks, that can lead to translate into action are:

- The influence of social norms and the urge to have the social consensus.
- Possessing a strong ethical motivation to act.
- Need for a "soft glow": the optimistic emotional boost that comes from becoming caring.

- The capacity to transition from external social pressures to intrinsic social pressures (Varghese 2017).

CHAPTER 2: The bushfires

2.1 Bushfire definition

Australia's environment has always been affected in one way or the other by bushfires that have been an essential element for the country's ecosystem. Fire played an important role in shaping Australia's environment and scenery. As a matter of fact, multitudes of plants that can be found in the Australian ecosystem rely upon fire to reproduce themselves while many others are very flammable. Native Australians have indeed been using fire as a tool to protect their possessions from the wildfires and to also manage the land by freeing more acreage for agricultural reasons (Ross & Quince 2020).

According to the Geoscience Australia website, Australia has been experiencing both bushfires and grassfires. Grassfires are considered to move very fast, with a low to a medium intensity that usually burns for a few minutes meanwhile bushfires move usually slower, they burn for days and they have a greater heat release (Australian Government Geoscience Australia n.d).

2.2 Causes of Bushfires

In the opinion of the Australian Department of Geoscience, there are seven different factors that have an influence on the creation and outbreak of a bushfire and on its intensity and speed. These factors are:

1. Fuel load is the number of branches, fallen cortex, leaves that are piling on the ground. The higher the fuel load is the greater its intensity and temperature will be.
2. Fuel moisture refers to the fuel being dry or wet. In fact, wet fuel will not burn while dry fuel will burn rapidly and for this reason, the moisture of the fuel is an important element that has to be considered when evaluating bushfire hazard.
3. Wind speed and direction. Wind influences the spread of fire by moving the fire into fresher fuel, supplying constant oxygen, and bringing it to the combustion stage. It also affects the oxygen levels by increasing it and by doing so also the speed of burning is affected. As for the direction that the wind is blowing to if it blows in the same direction that the fire is spreading it means that the wind will help the distribution of flammable elements allowing the fire to spread more

swiftly. Also, it may happen that if the wind shifts its direction a wide front could be created that would worsen the bushfire (National Museum of Australia and Ryebuck Media 2004).

4. Ambient temperature will affect if the fire will burn and for how long it will continue to do so. For example, in the case of high temperatures, there is a higher chance of a fire starting and lasting longer due to the fact that because of them the fuel would already be close to its combustion point.
5. Relative humidity. As per the ambient temperature 'dry' air that has a lower humidity percentage will increase fire's intensity as opposed to 'wet' air which has a high humidity percentage.
6. Slope angle. "Fires accelerate when travelling uphill and decelerate travelling downhill" (Australian Government Geoscience Australia n.d, para. 11). The reason why fire tends to travel quicker uphill is that 'the flame is closer to the unburnt fuel, and pre-heats it, causing it to ignite more readily' (National Museum of Australia and Ryebuck Media 2004). For every 10° of increase in the slope the fire tends to double its speed (National Museum of Australia and Ryebuck Media 2004).
7. Ignition source can be due to natural causes or human activity. One of the main agents that initiate half of the fires is lightning as part of the natural causes at the same time the other half of the time fires are caused by human activity that can be accidental or deliberate (Australian Government Geoscience Australia n.d).
8. Australia is extremely prone to bushfires due to the fact that its climate is hot, dry and inclined to aridity. For this reason, throughout the entire year, the country is vulnerable to the bushfire problem with usually New South Wales and the Northern Territories being the most affected states.

2.3 How to handle or suppress bushfires

One tactic to reduce the risk of bushfires is prescribed controlled burning. Australia has been using controlled burning to manage the country's biodiversity and fire hazards. In the past years, there has been a request to increase these prescribed controlled burnings to oppose the fire risk due to climate change effects. Nevertheless, to reduce the possible impacts that bushfires may have on cities and other properties a considerable portion of the country's forest would have to be burnt (CSIRO, 2009).

Meanwhile, in the case of a bushfire outbreak, it is the local firefighter agency that would act as the initial suppression response force by trying to extinguish the fire. If the initial suppression is found to be ineffective the other neighbouring districts will help by providing the necessary resources to put out the fire. The first and main suppression response is the ground crews of firefighters while the water-bombing aircraft are usually not deployed as a first measure to extinguish the fire (CSIRO, 2009).

There are four elements that can influence the favourable outcome of primary responses:

1. time of arrival,
2. weather,
3. degree of fuel danger,
4. fire size at the time of the first arrival.

The time of arrival of the first response team is extremely important, if the distribution of the equipment and assets is done quickly if the resources employed are suitable for an effective reach of the fire and if base locations of the equipment are covering the entire area, then the response time can be reduced (CSIRO, 2009). The degree of fuel danger, the amount of fuel, the structure of the fuel and the area that it covers can be decreased through the use of certain fuel management methods like controlled burning (Cheney, 1996). For example, fires that can be controlled promptly are those where the degree of fuel danger is low, where there is a small number of unburnt heavy fuels (CSIRO, 2009).

The initial fire size can be affected by the weather conditions, the degree of fuel danger, the response time and the landscape topography (CSIRO, 2009). So, by decreasing the degree of fuel danger in certain areas and by lowering the response time it is possible to reduce the fire size. As it was reported previously ground crews of firefighters are the initial answer to bushfire while water-bombing aircraft are usually not employed as a first measure to control and extinguish the fire. Nevertheless, these aircraft have few advantages as 'speed, access and observation' (CSIRO, 2009). As a matter of fact, if the response time necessary is too big the aircraft can approach the bushfires easily and swiftly to slow down the fire until ground crews reach the premise. In the case of entirely developed fire, water-bombing aircraft are not very useful as the fire speed would be too high and the aircraft would require a lot of time to refill and then return (Plucinski 2007). Ground crews and aircraft have to collaborate as in certain situations the aircraft on their own cannot extinguish fires on their own and the same goes for ground crews.

2.4 Where do bushfire occur in Australia?

In the northern part of Australia bushfires usually happen during the winter and spring period because the weather is sunnier, warmer and drier and all the fuel is dried up.

The bushfire season for the east coast starts in spring until halfway through summer. It is in fact during this period where general conditions are very dry as the rainy season hasn't started yet since it occurs during summertime. If also, low pressure from Tasmania carries dry and powerful winds to the east coast of Australia the hazard of fires increases.

Meanwhile, for the southeast of Australia, the bushfire season is during summer and autumn as the temperatures are very elevated and most of the grass is already dry due to the weather conditions. An example of weather conditions that could increase the dangerousness of fires, is if "a vigorous cold front approaches a slow-moving high in the Tasman Sea, causing very hot, north-westerly winds" (National Museum of Australia and Ryebuck Media 2004, p. 5). In fact, the cold front could influence the wind in changing direction causing an unexpected switch in the fire direction too.

Place	Region	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
NSW	1 Coastal strip Sydney–Brisbane	O	O						O	N	N	N	N
	3 Arc from just below the border with Qld and SA through Canberra to Victorian border	N	N	O	O							O	N
	2 Area between the above two	N	O	O						O	N	N	N
NT	1 Area between Darwin and Tennant Creek	O				O	O	N	N	N	N	O	O
	2 Area between Tennant Creek and just above Alice Springs	O	O						O	N	N	N	N
	3 Just above Alice Springs to the SA border	N	O	O						O	N	N	N
QLD	1 North Coast coast in an arc from Cairns through Mt Isa then straight to the NT border					O	O	N	N	N	N	O	O
	3 From NT border continue to near Brisbane, then drop to the NSW border	N	O	O						O	N	N	N
	2 The area between the above two	O	O						O	N	N	N	N
SA	3 Thin coastal strips from Vic border to WA border	N	N	N	O	O							O
	1 Area from WA border across to just below the NSW/Qld border	N	O	O						O	N	N	N
	2 The strip in between the above two	N	N	O	O							O	N
TAS	1 All	N	N	N	O	O							O
VIC	2 Coastal strip from Warrnambool to SA border	N	N	N	O	O							O
	3 Straight line from coast up to NSW border, in line with Canberra	N	O	O						O	N	N	N
	1 The strip between the above two.	N	N	O	O							O	N

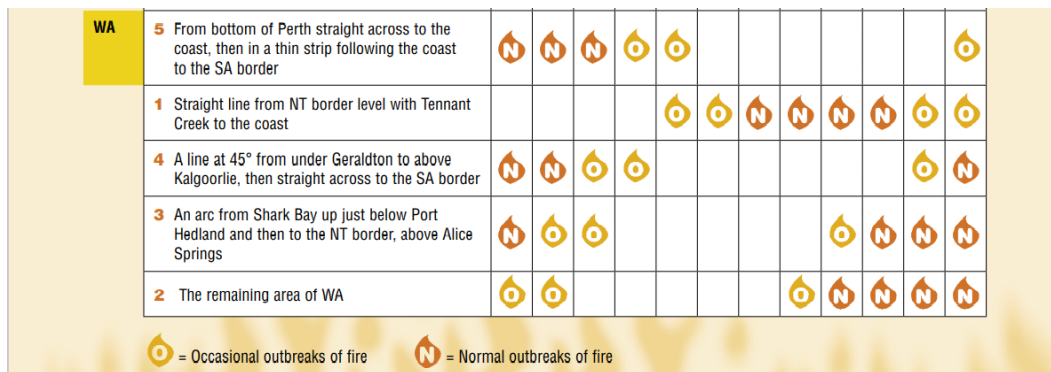


Figure 5. When and where fires happen in Australia. Source: National Museum of Australia and Ryebuck Media 2004

2.5 Impacts of bushfires in two natural environments: tropical savanna and eucalypt forest

The effects that bushfire can have depends on the environment in which they start.

Eucalypt forests are usually made up of eucalypt trees together with other shorter trees, grass and bushes. These types of trees require fire to germinate. Nevertheless, the vegetation could change if fires are too common as some species would be replaced by more fire-tolerant ones. During fires, a lot of animals die but the amount is not as high as it would be to threaten the species. Also, others are killed by predators due to a lack of coverage. For this reason, travelling animals are the ones that are more likely to survive in this situation. Meanwhile, in the case of insects, a lot of them die as they are mainly found on tree's bark. With regards to soil and water, fire can affect the soil's chemical structure making it less permeable and it can change the running water's quality as after fire usually rain comes that can move into the stream the dirt and nutrients (National Museum of Australia and Ryebuck Media 2004).

Tropical savanna is the natural environment of 25% of Australian territory (National Museum of Australia and Ryebuck Media 2004). It is the surface of this particular environment that tends to burn the most due to the climate and flora of it. Usually, fires start because of lightning and depending on the timing of the season in which they happen they can be more or less intense. If the fire happens during the beginning of the dry season, it is likely to be less intense as the soil is not completely dry yet, being still wet from the previous season. Meanwhile, if the fire happens halfway or at the end of the dry season, it

is going to be more intense as the soil is completely dry by this time. Another element that can affect the intensity of the fires is the frequency with which these fires happen because if a lot of fires happen during the season the fuel available tends to be lesser and lesser. While if between fires a lot of time goes by the intensity of the fires tend to be much higher due to the availability of a lot of fuel. The burning of the savanna usually releases “80 million tonnes of the greenhouse gas carbon dioxide (CO₂) into the atmosphere” (National Museum of Australia and Ryebuck Media 2004, p. 8) yearly. This is more than the amount of CO₂ that Australia produces through its industries and transportation methods, which amount to 70 million tonnes of CO₂. In regard to water and soil, the burning of the savanna impoverishes the soil quality and the water quality and causes erosion. The effect that fires have on animals is usually indirect. Since fire modifies the natural habitat, reduces or increases food supplies for certain species and decreases the amount of coverage. What usually happens is that some species may prevail over others. With regards to the birds, the majority takes advantage of the fire by eating insects that are driven out by the fire and by feeding on the dead animals’ bodies. Reptiles are usually the ‘cleaners’ as after the fire has been extinguished, they clean after it by eating what they find, and insects are usually slightly affected by any type of fire.

2.6 Climate change effect

Fire season is being affected by Climate Change as the duration of fire seasons around the world is increasing due to changes in the weather every single year. As a matter of fact, there has been an increase of 19% in the duration of fire seasons worldwide (Climate Council of Australia, 2015).

Since fire needs fuel, favourable weather conditions and an ignition point to start, Climate change can influence all of the three factors. For example, with regard to ignition point, one of the causes of bushfires is lightning that is directly affected by weather conditions and temperatures. Prince and Rind stated in 1994 that for each 1°C increase in the global temperatures there would be an increase in the world lighting activity by 6% (Climate Council of Australia, 2015).

Some consequences of the world’s natural resources are due to changes in the levels of carbon dioxide that influence the fertility of plants, increasing it. The intensification of the

rainy season can boost the danger of floods and diminish the danger of fires but could also increase the fire risk for the year after, as it would have affected the growth of fuel loads. Furthermore, any impact that climate change has on temperatures, wind and humidity will directly affect the chances of bushfires. So, even though climate change doesn't actually start the fire itself it gives the possibility of it starting by increasing the temperature and the fuel available and by reducing the amount of water that is available (Climate Signals, 2020).



Figure 6. How greenhouse gas emissions affects bushfires. Source: Climate Signals 2020

As a matter of fact, Australia's climate has been getting hotter and drier leading to additional bushfires that are also more severe. Since 1910, the average temperature rose more than 1°C (Singh, 2020) over the years and the amount of recorded hot days has doubled since 1950 (Climate Signals 2020). Australia has broken its temperature records twice, once in 2013 where the average temperature was 40.3°C and then in December 2019 when the temperature reached 40.9°C and then 41.9°C and by the end of December across all Australia, temperatures were over 40°C (BBC News, 2020). The temperatures in 2019 were in fact 1.52°C over the average temperature of the season (Climate Signals 2020). In a balanced climate the number and severity of heatwaves should not change throughout the decades.

Mean maximum temperature, 29 Dec

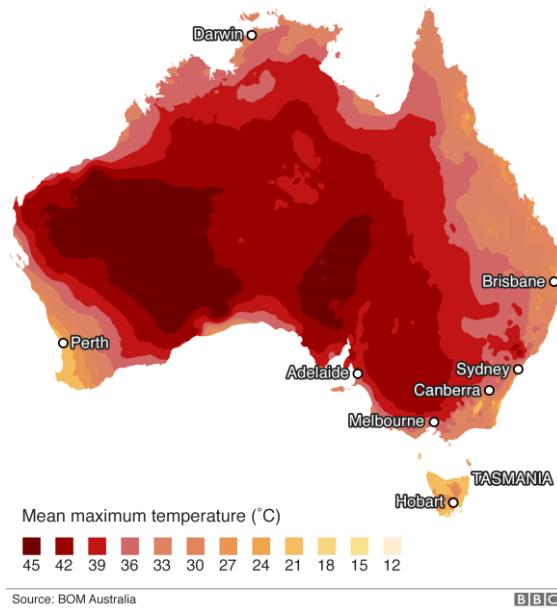


Figure 7. Temperature on the 29th of December 2019. Source: BBC News 2020

Extreme weather that can lead to bushfires is usually characterized by a Forest Fire Danger Index (FFDI) of over 100 (Lucas et al. 2007) and this happened already in 1983 during Ash Wednesday, in 2003 during Canberra Fire and in 2009 during Black Saturday (CSIRO, 2009). During the 2019-2020 bushfire season, the Australian Forest Fire Danger Index during the month of December ‘was the highest on record for most of the country’ (Climate Central, 2020).

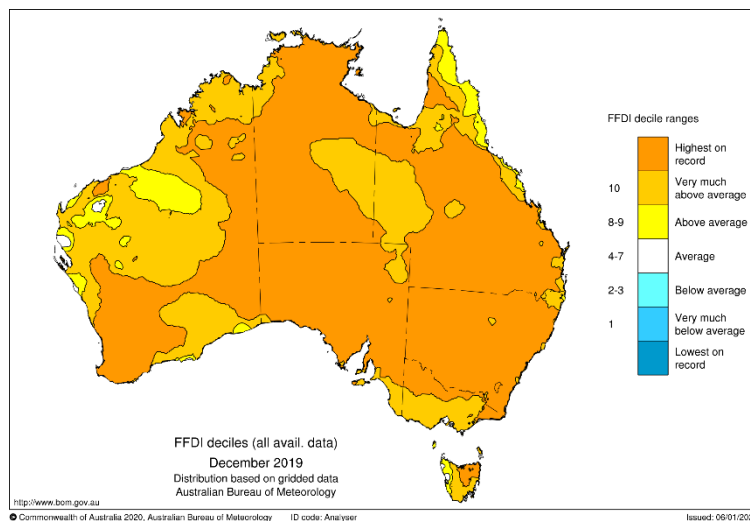


Figure 8. Monthly accumulated FFDI for December. Source: Australian Bureau of Meteorology 2020

One of the reasons that experts claim to be influencing the Australian climate making it drier and hotter is a “positive Indian Ocean Dipole (IOD) - an event where sea surface temperatures are warmer in the western half of the ocean, cooler in the east” (BBC News, 2020, para. 36). This phenomenon is contributing to the increase of floods and rainfall in eastern Africa and to drought in Australia and south-east Asia (BBC News, 2020)

2.7 History of bushfires

Australia has been dealing with the bushfire problem for at least 65 million years (Cary et al. 2012), as usually each year between 3 and 10% of land burns (Climate Council of Australia 2015).

One of the oldest recalling of devastating bushfire is from the 6th of February 1851 and it is called the ‘Black Thursday Bushfire’ that incinerated 5 million hectares of Victoria, almost a quarter of the state and caused 15 fatalities while burning down 1300 buildings. At the time it was the worst case of bushfires near an inhabited area. Then March the 3rd, 1926, there was the ‘Gippsland fires and Black Sunday’ that killed 60 people and destroyed 1000 buildings burning down an area of 400.000 hectares. Thirteen years after, from the 13th to the 20th of January, 1939, there was one in Victoria another ‘Black Friday bushfire’ that burned down 1.750.000 hectares, killing 71 people and leaving 3000 people homeless. During the time span from the 2nd of December to the 14th of January, 1958 a fire occurred in the Blue Mountains, a mountainous region in New South Wales, where 2.000.000 hectares of forest were destroyed along with 158 properties. In Western Australia, from the 20th of January until the 15th of February 1961, 1.800.000 hectares were burned down by fires. Also, in Tasmania from the 7th until the 14th of February 1967 a bushfire erupted leaving 7000 people homeless, destroying 4000 buildings and 270.000 hectares of land. Other fires that happened were in Daylesford Victoria from the 8th until the 9th of January 1969 and ‘Ash Wednesday’ that happened the 16th of February 1983 in Victoria and South Australia. In 1974 and 1975, the bushfires were spread across all Australia but with the majority being in Central Australia, at the time 15% of the Australian territory was burnt to the ground approximately 117.000.000 hectares and 50.000 livestock died (McFadden 2020). Then from the 25th of December 1984 until February 1985, there was the ‘Western division fire’ that destroyed 3.500.000 hectares of western NSW due to a lightning strike that initiated around 100 different fires.

In 2001, on the 25th of December NSW found itself to have a so-called 'Black Christmas' due to a bushfire that quickly spread on Christmas day burning an area of 774.000 hectares (theguardian.com 2013). One of the deadliest bushfires, called the 'Black Saturday,' happened in Victoria between the 7th and the 8th of February 2009. That day due to strong winds and extremely high temperature (over 40 degrees) 173 people were killed (Williams 2011) and around 1 million animals died (McFadden 2020). Then between late 2014 and early 2015, there were 18 active bushfires spread over 65 government areas that were acknowledged as a national emergency (Climate Council of Australia 2015).

2.8 2019-2020 Australian bushfire season: the Black Summer

The 2019-2020 bushfire season started earlier than usual. Bushfires started burning as early as June 2019 way before the beginning of Spring while the wild and difficult to control fires started in early September 2019 with the conditions aggravating in November 2019. All fires were extinguished by the end of March 2020.

The beginning of this bushfires season started in Northern Australia in June 2019, due to dry soil and temperatures higher than average and then it spread to some areas in Queensland. The state of Queensland has, in fact, been getting drier seasons and hardly any rain since 2009 (Withey 2019). However, out of the six Australian states, two have been the worst affected by this bushfire season: New South Wales and Victoria.

It was in October that the bushfire season officially began. A lightning bolt struck in Gospers Mountain, NSW causing the biggest forest fire that generated from a unique point, destroying 444.000 hectares. Other fires keep arising throughout the different states and on November 11 2019, in the states of New South Wales and Queensland, the state of emergency was declared. From November to December fires keep spreading across the country with new ones breaking in South Australia and the situation worsening for Queensland, New South Wales and Victoria.

At the beginning of December for the first time ever the United States stationed firefighters in Australia to help the local firefighters fight the bushfires that kept blazing throughout the country thanks to an agreement that exists between the two countries to

share equipment in case of fire hazards. It is also during this month that Australia records its hottest day with temperatures with an average of 40°C (Hadden 2020). Fires continue to spread. In the East Gippsland region in Victoria, a bushfire starts to generate its own weather due to the smoke that it releases. This bushfire ends up creating clouds that lead to thunderstorms and in the end more bushfires. A week later thousands of people from this region were asked to evacuate their properties because the region was deemed unsafe and those who were unable to evacuate in time found themselves being trapped inside the danger zone, due to the fact that major roads were closed. By the end of the year, at least 16 people were killed in the country due to bushfires and air pollution levels in Sydney reached '11 times worse than harmful levels' (Create Digital, 2020 para. 10). Due to the bushfire smoke lingering over major cities as Sydney, Canberra and Melbourne and parts of regional Australia, big sports events like the World Rally Championship, Christmas events, music festival and also transportation methods like the ferries had been cancelled (Henriques-Gomes 2020).

In January 2020, while fires keep spreading, a fire in Kangaroo Island burns down an area that is equal to a third of the island. Meanwhile, the city of Penrith in New South Wales becomes the hottest place on earth on the 4th of January with a temperature of 48.9°C. A fire propagates from the southeast part of the state of Victoria to the Bega Valley Shire in New South Wales burning more than 60,000 hectares.

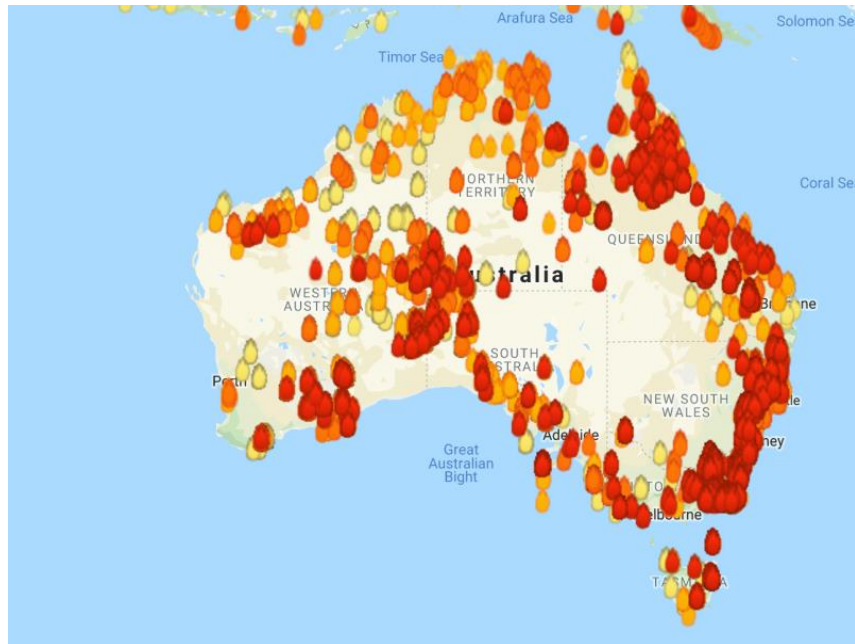
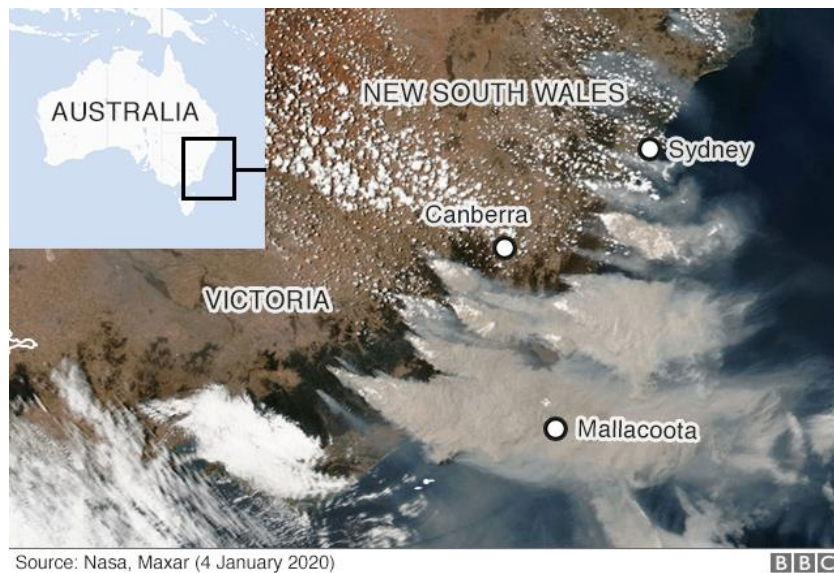


Figure 9. A map showing hundreds of wildfires across the nation on January 1 2020. Source: BBC News

As hazardous as the smoke already is, it starts to become a major problem for other countries too. Smokes coming from the bushfire in NSW and Victoria started to affect the air quality in the neighbouring country, New Zealand (BBC News 2020).



Source: Nasa, Maxar (4 January 2020)

Figure 10. Satellite Image of NSW and Victoria the 4th of January. Source: BBC News 2020

Furthermore, black carbon, an element of particulate matter that causes Climate Change and is toxic for humans, coming from Australia travels 7.000 miles (BBC News 2020).

Plumes of 'black carbon' have travelled more than 7,000 miles from the fires

Black carbon is harmful to human health and contributes to climate change

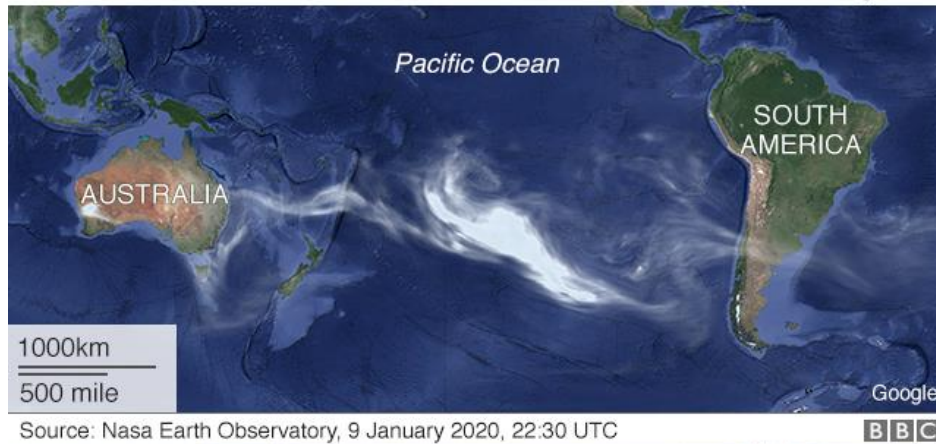


Figure 11. Satellite image of black carbon travelling from Australia. Source: BBC News 2020

The New South Wales premier declares a state of emergency while the Victoria premier declares a state of disaster. On the 6th of January the federal government decided to allocate 2 billion Australian dollars to a recovery fund for bushfires. Australia is at the same time experiencing some short-term water risks. Forest fires are damaging the water supply infrastructure and the risks associated with the flames may persist even after they are extinguished. Power outages, for example, are preventing some important treatments such as disinfection of water with chlorine, necessary to kill microorganisms and make it safe to drink. As some of the water that enters the water system comes directly from the rivers, where wastewater and industrial wastewater ends up: without treatment, the risk of exposing themselves to dangerous pathogens, including pests, becomes much higher. This is what is happening for example in the cities of Eden and Boydtown on the south coast of New South Wales where residents have been advised to boil their water before drinking it and use it for cooking, brushing their teeth and so on (Bongioanni 2020). Meanwhile, there is also a possibility of some long-term water risks. The fires are also "stressing" river basins, which can lead to long-term dangers for drinking water: these basins are generally wooded areas. And therefore, vulnerable to the damage that a fire can cause. For example, forest fire ash contains substances such as nitrogen and phosphorus: the increase in their concentrations can stimulate the growth of cyanobacteria, commonly known as 'blue-green algae'. They, in turn, produce chemicals that can cause a number of water quality problems, including bad taste and odour.

By the end of January, 30 have died along with 500 animals due to the bushfires and the damage estimates sum up to \$1 billion (Create Digital 2020). During the first week of February, a third of the active fires in the southeast of Australia were extinguished thanks to a wave of torrential rain. Only a few uncontrolled fires were left after the rain passed, the others were all under the control of firefighters. Nevertheless, even if rain came and helped to extinguish most of the active outbreaks, experts were worried that the arrival of rainfall could lead to new risk situations. For example, flooding, due to heavy rain or that the water falling to the ground could drag debris, ash and particulate matter, with the risk of contaminating the groundwater. Now water treatment plant operators and reservoir operators are also being called upon to adapt to changing weather conditions and prepare for increasingly extreme future weather events.

Despite everything, by the end of March, all fires across the country were extinguished. This bushfire season that is known as the Black Summer burned around 18.000.000 hectares of land (Burton 2020), more than 9.000 buildings were destroyed (O'Mallon & Tiernan 2020), nearly 3 billion animals were affected (Slezak 2020) and 34 people died due to bushfires directly (Arriagada et al. 2020) and 417 people died because of smoke inhalation (Tolhurst 2020). Because of all the damages that were caused by this bushfire season, the Australian economy took a hit and the financial impact caused by bushfires was accounted to be more than \$100 billion (Gifford 2020).

The 2019-2020 bushfire season has been defined as unique in Australia and everywhere else in the world. The elements that make this event unprecedented are:

- The early start of the bushfire season and the force with which they burned.
- The weather conditions, as it was drier, warmer and windier.
- The fire was behaving differently than in past seasons.
- The enormous impact it had on Australia's environment (Australian Academy of Science 2020).

Since this was the summer of the most devastating fires ever it caused a collective emotional crisis in Australians and triggered a dramatic debate between a part of public opinion and the government that continues to deny any direct link with climate change in the world. Prime Minister Scott Morrison and his Minister for Reducing Emissions, Angus

Taylor, reiterated that Australia does not need to cut coal emissions to limit global warming despite the drought that has been plaguing some areas for three years and the terrible fires (Il Sole 24 Ore 2020).

2.9 The companies and celebrity's response to the bushfire emergency

2.9.1 Companies' response to bushfire emergency

In addition to all the celebrities who have decided to donate money to help Australia, many brands have also taken this action in recent months. In response to this emergency, several companies and brands have launched different initiatives in support of this cause. In addition to making donations directly to non-profit organizations such as the Australian Red Cross, NSW Rural Fire Service and WIRES Wildlife Rescue, consumers can contribute in other ways to helping to fight the fires and helping people and animals.

The Kering Group, which includes companies such as Gucci and Saint Lauren, has made a donation of 1 million Australian dollars to be divided between several local relief organizations. In a Gucci Facebook post, the group also admitted its intention to participate in reforestation and biodiversity conservation programs (Baptista 2020).

Unilever Australia, through a partnership with the Food Bank, will donate thousands of products (primary goods such as food, personal hygiene products and also household cleaning products) to families who are homeless, firefighters and volunteers fighting fires in Australia. A Unilever spokesman told The Drum that they believe companies can be extremely helpful in the relief and recovery process and that they want to help the communities that have been damaged during these times. The company also thanked its employees for volunteering for first aid services by offering them extended paid leave during their volunteer time. In addition, the multinational also pledged to support its retail partners and also its suppliers, especially small businesses that have been affected by the fires and have suffered major damages (Baptista 2020).

Several members of the various KFC Australia teams have suffered the consequences of the dramatic situation experienced in recent months. KFC has declared to offer them support and, together with Yum! Brands Foundation, the chain will donate \$700,000 to Red Cross Disaster Relief & Recovery (Baptista 2020).

The WWF launched an appeal and a fundraiser. WWF needs to support an emergency plan for the care of injured wildlife and, when the fires finally die out, to help restore the forest habitat for koalas and other surviving animals (Serafini 2020).

Funko, the U.S. house famous for its vinyl figures, in collaboration with PopCultcha, the Australian online shopping site, announces a limited edition of the Australian Bushfire Heroes Firefighter with Koala". All proceeds of the Bushfire Heroes were donated to The Royal Society for the Prevention of Cruelty to Animals (RSPCA) National Bushfire Appeal through monthly payments while stocks last. The RSPCA was working with government and emergency agencies of veterinarians and local authorities to provide equipment, supplies, emergency care and assessment of injured animals in need of assistance (Carillo 2020).

Many Australian brands have offered their help. Among them, the Australian ethical fashion brand Little Tienda decided to sell some garments, the proceeds of which will be donated to the Australian Red Cross, in favour of firefighters and local communities. Also the skincare company Frank Body, during the month of January, donated 100% of its A-Beauty Scrub revenues, corresponding to global sales, to organizations such as Wireswildliferescue, County Fire Authority and Rural Fire Services. A similar initiative was also carried out by clothing company Alex Perry, who decided to donate revenues from all online and in-store sales achieved in seven days to the NSW Rural Fire Service (Baptista 2020).

NOAH, a brand that has always distinguished itself for its strong ecological footprint, has also joined the cause with the creation of a special t-shirt. 100% of the sales went to WIRES, Australia's largest wildlife rescue organization (Pacciardi 2020). Likewise, the American brand Rowing Blazers created four rugby jerseys inspired by the Ivy League and authentic Australian motifs and 100% of the sales went to WIRES too (Pacciardi 2020).

To draw even more attention to the theme and raise funds, some brands have also created limited-edition themed products. Among them, there is the soap "All The Wild Things",

shaped like a Koala, produced by Lush. It is a product based on eucalyptus, peppermint and lemongrass, reminiscent of the thousand koalas that died in the fires in Australia. The proceeds will be donated to the Bush Animal Fund created by the company to help animal rescue and habitat restoration groups. The jewellery brand Francesca has created a bracelet through which to raise funds for the Australian Red Cross. In six hours, from the moment it went on sale, the company raised a total of \$100,000. Balenciaga (part of the Kerin group) has created sweatshirts and t-shirts with the design of a small koala, still a reference to the dramatic situation experienced by this species and many others in Australia. The garments proceeds were used to fight fires. The Australian self-tanning brand Bondi Sands has produced a limited Australia-themed edition of reusable ceramic bottles whose proceeds were donated to the Australian Red Cross. A major donation of 100,000 Australian dollars has also been made by this company to The Salvation Army and the Wires Wildlife Rescue Organization (Baptista 2020).

2.9.2 Celebrities response to bushfire emergency

Celebrities are mobilizing to help Australia devastated by the fires through Prayers, appeals, but above all donations.

Earth Alliance, an environmentalist association founded by the actor Leonardo Di Caprio in 2019 together with Laurene Powell Jobs and Brian Sheth, launched the Australia Wildfire Fund. The actor donated \$3 million to support critical firefighting efforts in New South Wales, to help the most affected local communities, to enable the rescue and recovery of wildlife and to support the long-term restoration of Australia's rare ecosystems (Desando 2020).

The Australian actor Chris Hemsworth made a donation of one million dollars to help firefighters fight the flames in his home country. And he launched an appeal on socials to involve followers to donate through the links that he added to its social media bio in support of firefighters, association and charities that are already working on helping Australia (Desando 2020).

Celebrities like Nicole Kidman and her husband Keith Urban, Kylie Minogue, and the singer Pink donated \$500,000 each to local fire services (Desando 2020). Also, the singer

Elton John that at the time was touring Australia, announced while on stage that he would donate \$1 million to firefighters (Monnis 2020). In addition, the Australian tennis player Ashleigh Barty donated all her winnings at the Brisbane tournament to the Red Cross to help the victims of the fire (Monnis 2020). Metallica, the legendary metal band, made a donation of 750 thousand dollars to the NSW Rural Fire Service and the CFA, Country Fire Authority (Maselli 2020).

Furthermore, Fire Fight Australia, a concert to raise funds for the victims of fires in Australia was held on February 16 and brought many artists from the international and Australian scene to the stage of the Anz Stadium in Sydney. Fire Fight Australia included nine hours of concerts to raise funds to help associations that had been working for months to fight fires in different parts of the country (Billboard Italia 2020).

In addition to all the donations, celebrities around the globe kept publishing several posts to raise awareness of the Australian situation and they mentioned it during speeches at the most popular award shows like the Golden Globes.

CHAPTER 3: Research analysis of the 2019-2020 Australian bushfire emergency on Twitter

3.1 Dataset description

3.1.1 Twitterscraper

As previously mentioned, we utilised Twitter as my source of data for the analysis. Twitter provides REST's API and Streaming API, which give the chance to access and read Twitter data and to have access to real-time data from Twitter (Taspinar 2020). To retrieve the data, we specifically used the package Twitterscraper, which can be found on Github, a code-sharing site that enables different people to collaborate on specific projects from anywhere in the world. The reason why Twitterscraper was used instead of Twitter's API is that the API's have multiple limitations. The limitations that Twitter's API have are:

- Only 180 requests can be submitted, with a maximum of 100 tweets per request, every 15 minutes with the search API provided by Twitter. Meanwhile, with Twitterscraper there are no limitations except for those related to your internet connection.
- A downside of the Search API is that only tweets posted in the last 7 days can be accessed. Instead, Twitterscraper, allows you to retrieve older data that is what was needed for this analysis (Taspinar 2020).

3.1.2 Process to retrieve data

The Twitterscraper package uses the Python programming language. Before start using the package, we need to install it by running this line of code in Python:

```
pip install twitterscraper
```

Now that Twitterscraper is installed, we can start retrieving data by running our line of code through Command Prompt on our laptop, which "is a program that emulates the input field in a text-based user interface screen with the Windows graphical user interface (GUI)" (Dell n.d., para 1). This program, in fact, allows you to execute specific management tasks. We first create a python file called *Twitter.py* that contains a code that will allow us to scrape the necessary tweets for our analysis. In the 'query' part we just need to insert

the keyword that we want the tweets we are retrieving to contain and in the *start_date* and *final_date*, the time frame of our study. We also ask the code to print an error when there are no tweets available for a specific date and to stop running the code. In the end, all the data that was retrieved was saved into JSON files.

```
from twitterscraper import query_tweets
import datetime as dt
from twitterscraper.main import JSONEncoder
import json

if __name__ == '__main__':
    query = "Australia AND firefighter"
    start_date = dt.datetime.strptime('02112019', "%d%m%Y").date()
    final_date = dt.datetime.strptime('03112019', "%d%m%Y").date()

    while(1):

        end_date = start_date + dt.timedelta(days=1)

        try:
            list_of_tweets = query_tweets(query, limit=None,
begindate=start_date, enddate=end_date, lang='english')
        except:
            print("Error at"+start_date.strftime("%d_%m_%y"))
            exit(1)

        file_name = query+start_date.strftime("%d_%m_%y")+ ".json"
        print(len(list_of_tweets))
        if(len(list_of_tweets)==0):
            exit(0)
        file = open(file_name,"w")
        for tweet in list_of_tweets:
            # print(tweet)
```

```

        if(tweet.timestamp.date()==start_date):
            json.dump(tweet, file, cls=JSONEncoder)
            file.write('\n')
    file.close()
    print("Finished: "+file_name)

    start_date = end_date

    if(start_date == final_date):
        break

```

To specifically run this code through command prompt we need to run this line of code:

```
twitterscraper Twitter.py
```

As said before, the result of this code of line is a JSON file that contains the following information about the tweets: “Tweet-id, Tweet-Url, Tweet text, Tweet Html, Links inside Tweet, Hashtags inside Tweet, Image URLs inside Tweet, Video URL inside Tweet, Tweet timestamp, Tweet Epoch timestamp, Tweet No. of likes, Tweet No. of replies, Tweet No. of retweets, Username, User Full Name / Screen Name, User ID, Tweet is a reply to, Tweet is replied to, List of users Tweet is a reply to, Tweet ID of parent tweet” (Taspinar 2020, para. 8).

After scraping all the tweets for our analysis, we need to transform the JSON file that we have into a CSV file, that can be read and uploaded to Rstudio to then start our analysis.

We start by installing the necessary packages

```
install.packages("ndjson")
library(ndjson)
```

We then set up the working directory

```
setwd("F:\\TESI MAG\\CODES and STUFF\\DIVISO PER MESI\\BUSHFIRE AUS\\Ottobre")
```

Then we proceed to create a vector with the list of files in the working directory.

```
filenames=list.files(path = ".", pattern = ".json", all.files = FALSE,  
  full.names = TRUE)
```

Now we create an iteration on the files to transform them into a tabular format and aggregate them into one.

```
"dataframe" (usando rbind)  
for(i in 1:length(filenames)){  
  if(i==1){  
    imported_tweets = ndjson::stream_in(filenames[i])} else{  
    imported_tweets = rbind(imported_tweets, ndjson::stream_in(filenames[i]),fill=TRUE)  
  }  
}
```

We then delete duplicates using the ID.

```
imported_tweets=imported_tweets[!duplicated(imported_tweets$tweet_id),]
```

As a final step, we save the resulting data frame into a CSV and RDS file.

```
write.csv(imported_tweets,"OctoberBushfireAus.CSV")  
saveRDS(imported_tweets, "OctoberBushfireAus.RDS")
```

Following we have an example of how the database looks when loaded into Rstudio.

screen_name	text	text_html	timestamp	timestamp_epochs	tweet_id	tweet_url	user_id	username
howard_gewirtz	I'm sure they'll be delighted to see him. Will so...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:59:59	1577923199	1.212524e+18	/howard_gewirtz/status/1212523897964285953	2.163845e+07	Howard G.
jocksjig	Australia, your country is burning – dangerous ...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:59:36	1577923176	1.212524e+18	/jocksjig/status/1212523800446693378	9.248486e+07	PIPELINEPETE
iamsammaher	Australia's Angry Summer: This Is What Climat...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:59:29	1577923169	1.212524e+18	/iamsammaher/status/12125233771707289601	4.983087e+08	Sam Maher
Laup561	Australia's Angry Summer: This Is What Climat...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:59:34	1577923114	1.212524e+18	/Laup561/status/1212523543260360704	9.947583e+17	Laup561
WrittenOnWater	"Australians need only wake up in the morning...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:57:39	1577923059	1.212523e+18	/WrittenOnWater/status/1212523310224797696	3.526928e+08	The Isolated Bury
winimwil	If you haven't read this do so. You decide who ...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:57:28	1577923048	1.212523e+18	/winimwil/status/1212523263508660225	5.005551e+08	Nicky Riley
CarbonReduction	Australia, your country is burning – dangerous ...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:57:27	1577923047	1.212523e+18	/CarbonReduction/status/1212523259616346113	3.709551e+07	NOCO2
DebErupts	Australia, your country is burning – dangerous ...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:55:52	1577922952	1.212523e+18	/DebErupts/status/1212522862306742274	1.316431e+08	Deborah
taikvera	Welcome to 2020, but first an area average rev...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:55:44	1577922944	1.212523e+18	/taikvera/status/1212522828391542784	3.064441e+07	John Englart EAM
howard_gewirtz	Don't upset the president of the United States ...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:55:31	1577922931	1.212523e+18	/howard_gewirtz/status/121252277203768576	2.163845e+07	Howard G.
debraanddave	.@GretaThunberg. Despite Devastating Wild Fi...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:54:51	1577922891	1.212523e+18	/debraanddave/status/1212522606731186177	2.235215e+09	Debra DeKoff
DrCEriksen	"Australians need only wake up in the morning...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:53:09	1577922789	1.212522e+18	/DrCEriksen/status/1212522176986923008	5.824965e+08	Dr Christine Eriksen
LymanAWhitney	As wildfires hit Australia, ocean warming from ...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:53:08	1577922788	1.212522e+18	/LymanAWhitney/status/1212522172234784770	1.072535e+18	Anne Whitney Lyr
RoyThom40406656	Australia bushfires: PM's climate stance critic's...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:51:54	1577922714	1.212522e+18	/RoyThom40406656/status/1212521862753685506	7.328764e+17	Roy Thompson
petersonmatthe4	We're lucky to have Professor Mann on seabattl...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:51:54	1577922714	1.212522e+18	/petersonmatthe4/status/1212521862481104896	7.548379e+17	Matthew
davidblock	Australia, your country is burning – dangerous ...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:51:41	1577922701	1.212522e+18	/davidblock/status/1212521810448493994	4.333183e+07	David Block
rosiedream	Australia, your country is burning – dangerous ...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:50:38	1577922638	1.212522e+18	/rosiedream/status/1212521544812859392	5.259580e+07	Jacqueline Lee Le
PradoxGamerAu	Year for climate change to go the other way I ...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:50:36	1577922636	1.212522e+18	/PradoxGamerAu/status/1212521537669976064	9.644233e+17	Pradox
hollyjasmine_	Ngeri ya dengan segala climate change ini. De...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:49:28	1577922568	1.212521e+18	/hollyjasmine_/status/121252151664584705	2.502196e+07	Jasmine amalia
Prugemeister	TRENDS. Australia's sensitivity to forest fires st...	<p class="TweetTextSize js-tweet-text tw...	2020-01-01 23:49:04	1577922544	1.212521e+18	/Prugemeister/status/1212521152213594112	1.178408e+07	Peter Stoyko

Figure 12. Example of a loaded database on Rstudio

3.1.3 Dataset description

The datasets used for this analysis were made of tweets collected during the time period going from the 20th of October 2019 to the 09th of February 2020 and it is made of tweets in the English language. Based on an initial analysis of what people, during the bushfire season, were tweeting and which were the most common hashtags and words used; the following are the keywords that were decided to study:

- Bushfires
- #AustraliaBurns
- #NswFires
- #BushfireAustralia
- #AustraliaFires
- Australia + Climate Change
- Australia + Fire
- Australia + Firefighters
- Australia + Global Warming
- Australia + Animals

The name of the datasets used during our Rstudio analysis are respectively as follows:

- Bushfires: *bushfiretweets* dataset containing 243.251 observations.
- #AustraliaBurns: *ausburntweets* dataset containing 53.460 observations.
- #NswFires: *nswfiretweets* dataset containing 6.992 observations.

- #BushfireAustralia: *bushhaustweets* dataset containing 13.315 observations.
- #AustraliaFires: *australiafiretweets* dataset containing 72.228 observations.
- Australia + Climate Change: *AUSCLIMATEtweets* dataset containing 82.133 observations.
- Australia + Fire: *AUSFIREtweets* dataset containing 256.311 observations.
- Australia + Firefighters: *AUSFIREFIGHTtweets* dataset containing 35.648 observations.
- Australia + Global Warming: *AUSGLOBALWARMtweets* dataset containing 9.245 observations.
- Australia + Animals: *ausanimaltweets* dataset containing 96.662 observations.

The datasets are going to be analysed separately since if put all together the resulting database would be too big for a normal laptop to handle. Nevertheless, the total of unique observations that were analysed is 778.136.

3.2 Frequency

3.2.1 Hashtags on Twitter

One of the characteristics of the microblogging site Twitter is the use of specific words, that are preceded by the '#' (hashtag) symbol. These words are called *Hashtags* in the Twitter-verse. Any word that is preceded by the hashtag symbol is, in fact, easily searchable inside the Twitter platform. The first hashtag to be ever used was #barcamp by Chris Messina (an American blogger) back in 2007 while he was promoting an open-source community and after this fact, the use of hashtags has developed into a different strategy to label tweets allowing users to easily find information on any given subject (Pervin et al. 2015). Hashtags are used constantly by Twitter users. They are used while watching television, while listening to the radio and to promote different products. These hashtags are extremely important within the Twitter platform, as they help users in their inquiry for specific subjects, as whenever separate users discuss the same topic, to reach a greater amount of people they tend to use these hashtags to tag their tweets. A study showed that, for people or for brands, a tweet engagement can skyrocket if hashtags are used in it by respectively 100% and 50% (Pervin et al. 2015). Hashtags allow tweets to broaden their scope beyond the simple followers of a user, allowing anyone interested in that hashtag to find any tweet containing it. The success of a hashtag is defined by the

number of people using it and users tend to use those hashtags that are more relevant and appealing to them according to their metacognitive experience (Pervin et al. 2015). “Metacognitive experiences are those experiences that are related to the current, ongoing cognitive endeavour” (Pervin et al. 2015, p. 170). Through the hashtags is also how ‘trends’ are established. As a matter of fact, trends are those hashtags that have attracted the highest amount of tweets and also including other factors, according to Twitter’s algorithm. As trends can be applied to various contexts and fields, to help better understand the various facets of our society, the data that can be extrapolated from Twitter has piqued interest from scholars from all over the globe. Generally, hashtags do not come alone in a tweet, but they commonly occur in clusters and this peculiarity makes it so that tweets containing more than one hashtag spread more easily than those containing only one hashtag.

3.2.2 Research procedures

The tools and packages used for this analysis are:

1. `quanteda` library. This is an R programme created by Kenneth Benoit that allows the user to manage and examine text while generating and modifying tokens, managing corpus etc.
2. `quanteda.corpora` library. This is a programme that provides additional text functionalities to the `quanteda` package.
3. `ggplot2` library. This is an R programme that allows the user to generate graphs. The user just needs to give the numbers, tell it how to aesthetically map the variables and which graphical elements to use and the program handles the rest.
4. `readtext` library. This is an R programme that allows the user to format and import different types of text files, such as ‘.csv’, ‘.json’, ‘.xls’, etc.
5. `RColorBrewer` library. This is an R programme that allows the user to create visually appealing colour palettes.

For this study, we are going to use the same dataset that was previously downloaded through Twitterscraper. We are going to use ten different datasets, that are based on these keywords: Bushfire, Nswfire, BushfireAustralia, AustraliaBurns, AustraliaFires, Australia & Climate Change, Australia & Fire, Australia & Firefighters, Australia & Global Warming and Australia & Animals. The analysis that will be carried out is related to the hashtags

used throughout the months from the end of October 2019 to the beginning of February 2020.

The following Rstudio code that is going to be used as an example to show how this analysis was carried out is based on the keyword 'nswfires'.

After loading the necessary databases on the Rstudio global environment we continue by installing and loading the essential R libraries.

```
install.packages("quanteda")  
install.packages("readtext")  
install.packages("devtools") # get devtools to install quanteda.corpora  
devtools::install_github("quanteda/quanteda.corpora")  
install.packages("ggplot2")  
require(quanteda)  
require(quanteda.corpora)  
require(ggplot2)  
require(readtext)  
library(RColorBrewer)
```

Then we start our analysis by creating a corpus using the function 'corpus' from the quanteda package. To specify, a corpus is an object that we construct through the use of the 'corpus' function to allow the package 'quanteda' to analyse the text we desire (Malkovich 2018).

```
NswFireCorpus <- corpus(nswfiretweets$text)
```

Then we proceed to create a token containing only the hashtags that can be found in the *NswFireCorpus*. To specify tokens are by default sole words but it is possible to change them to characters or sentences if required (Malkovich 2018). For this analysis, we will use the default version of tokens.

```
toks_NswFire <- tokens(NswFireCorpus, remove_punct = TRUE)
```

```
dfmat_NswFire <- dfm(toks_NswFire, select = "#*")
tstat_freqNswFire <- textstat_frequency(dfmat_NswFire)
```

For example, these are the first 20 hashtags in the *tstat_freqNswFire* database.

```
head(tstat_freqNswFire, 20)
```

	feature	frequency	rank	docfreq	group
1	#nswfire	1625	1	1619	all
2	#nswfires	1516	2	1496	all
3	#nswbushfires	614	3	613	all
4	#auspol	613	4	613	all
5	#nswrfs	417	5	417	all
6	#nswbushfire	311	6	307	all
7	#bushfires	246	7	239	all
8	#australiafires	232	8	231	all
9	#vicfires	221	9	219	all
10	#australiaburns	212	10	212	all
11	#australianfires	202	11	201	all
12	#australia	201	12	198	all
13	#safires	168	13	166	all
14	#qldfires	166	14	166	all
15	#nswpol	157	15	155	all
16	#climateemergency	157	15	157	all
17	#australiabushfires	153	17	150	all
18	#australiaburning	134	18	134	all
19	#actfires	124	19	122	all
20	#climatechange	109	20	108	all

Figure 13. First 20 hashtags in the *tstat_freqNswFire* database

We continue our analysis by plotting the first 20 hashtags, through the use of the ‘ggplot2’ R package. To display the results for this analysis we decide to use a ‘barplot’ through the ‘geom_bar’ function. A barplot is the best way to display this type of data as it allows to depict the distribution of the data while at the same time it gives the opportunity to compare the values between the various groups of data. It is also the graph that most easily shows which are the most frequent categories in comparison to others (Yi 2019).

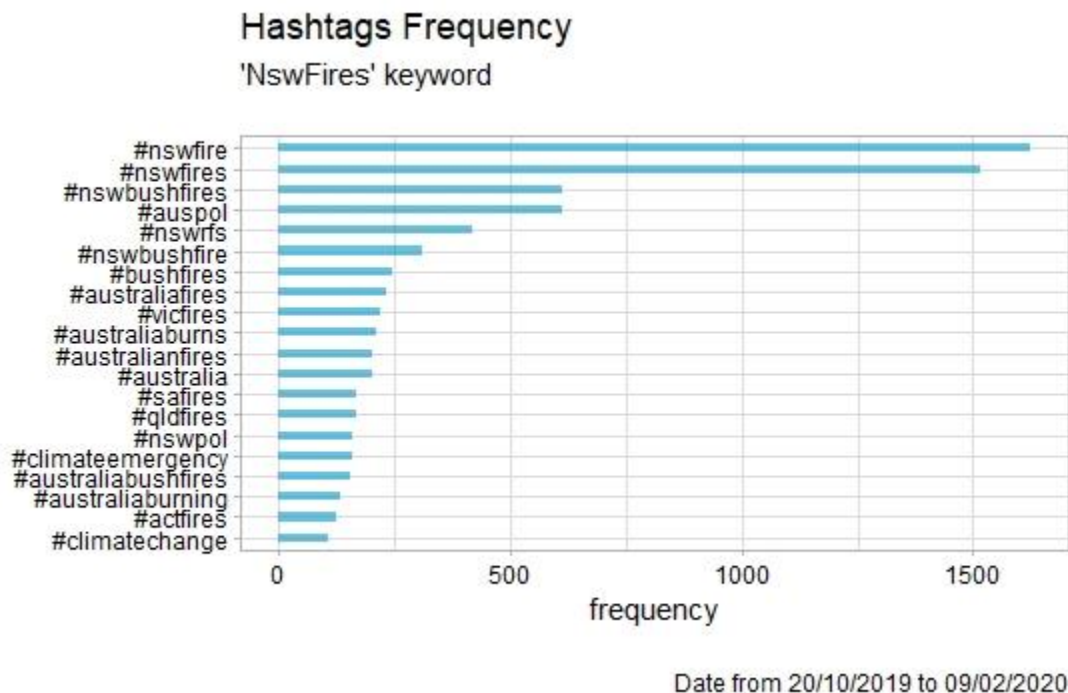
```
dfmat_NswFire %>%
  textstat_frequency(n = 20) %>%
  ggplot(aes(x= reorder(feature, frequency), y=frequency)) +
  geom_bar( stat = "identity", fill = "deepskyblue3", alpha=.6, width=.4) +
  coord_flip() +
  labs( title = "Hashtags Frequency",
        subtitle = "'NswFires' keyword",
        caption = "Date from 20/10/2019 to 09/02/2020",
        x = NULL,
```

```

y = "frequency") +
theme_light() +
theme(axis.text = element_text(color = "black"))

```

The result of this last line of code is the following:



Graph 1. Hashtag's frequency, keyword NswFires.

With the same dataset that we have created previously, we then continue by plotting a 'word cloud' displaying the first 100 hashtags that are contained within the database. Word clouds are a fun way to display and highlight specific keywords that allow the writer to redirect the reader's attention to specific words. In fact, the more important are the words, the bigger and bolder they will be inside the word cloud (Lepki 2020). To create a word cloud we utilise the 'textplot_wordcloud' function, where the size of the different words is equal to their numerical value (R Documentation n.d.).

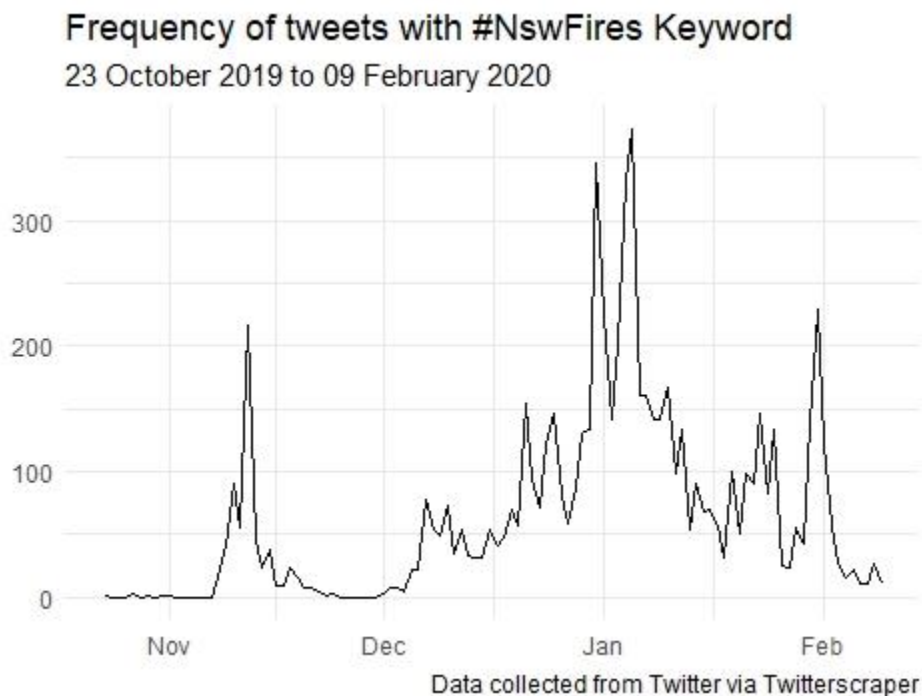
```

set.seed(132)
textplot_wordcloud(dfmat_NswFire, max_words = 100, color = brewer.pal(8, "Dark2"))

```

This is the outcome of the previous line of code. As we can see some words are bolder and in a different colour based on the frequency to which they were used during the period of study in question.

The outcome of the previous line of code is this:



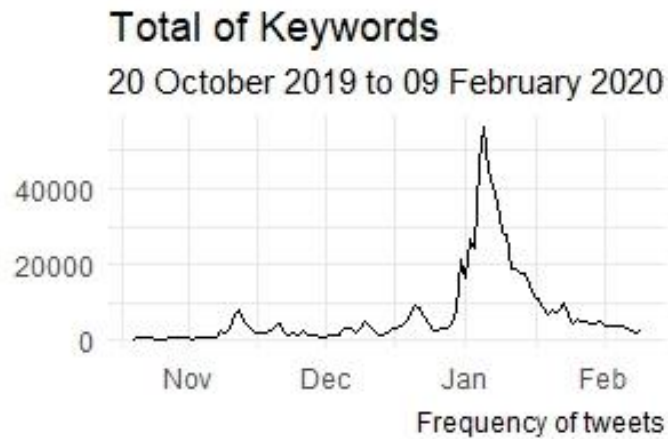
Graph 2. Frequency of tweets, Nswfires keyword

3.3 Frequency findings

3.3.1 Frequency of tweets

The first variable that we are going to study for this analysis is the frequency to which tweets were tweeted and the changes they have undergone over time. The tweets were sorted by date in Rstudio as shown in the previous paragraph. On the x-axis of the plot, we have the months concerning our analysis, on the y-axis, we have the number of tweets about specific keywords that were tweeted. The keyword analysed can be found on the top part of the graph in bold black letters, while below that we have the period of study of that specific graph.

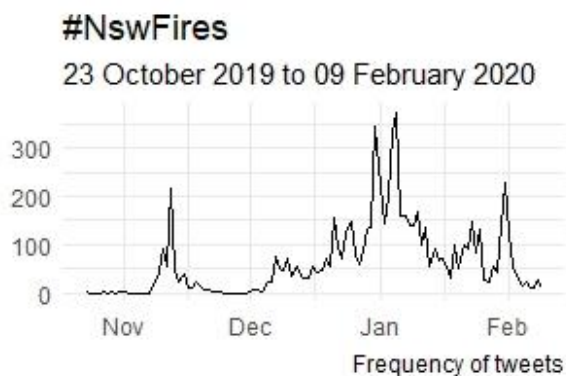
The following graphs are showing the number of tweets, divided by keywords, that were tweeted for each day between the 20th of October 2019 and 09th February 2020.



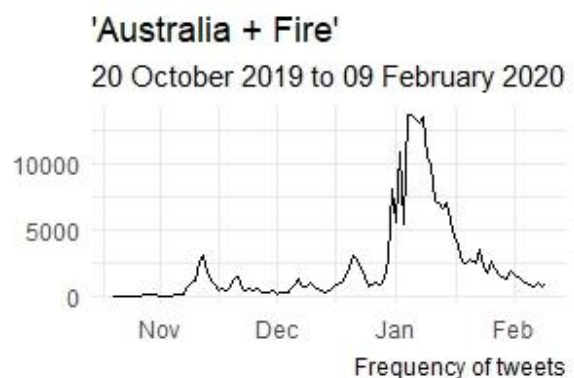
Graph 3. Frequency of tweets all keywords.

The frequency of tweets is an important factor to take into account while carrying out this analysis, as it can show the interest and concern people have towards the 2019-2020 Bushfire season.

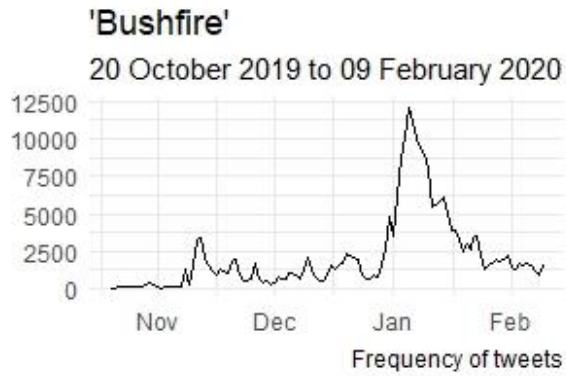
In graph 3 (based on the totality of tweets) we can see that the tweet’s frequency starts growing suddenly, as of the last days of December 2019, where tweets regarding the bushfire problem increase from less than 5.000 to reach a peak of over 50.000 daily tweets during the first weeks of January 2020. At the time, the bushfire emergency was getting worse day by day, as the level of pollution was 11 times higher than the dangerous levels (Create Digital, 2020) and a state of emergency was declared in different states. After reaching that peak, tweets start to dramatically decrease to an initial minimum of 9.000 to then lightly rise again to 10.000 to steadily decrease afterwards to new minimums.



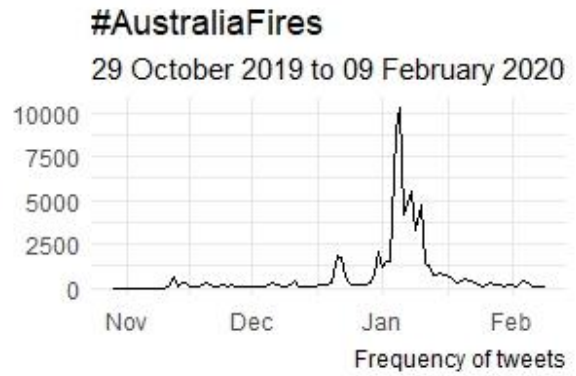
Graph 4. Frequency of tweets, NswFires.



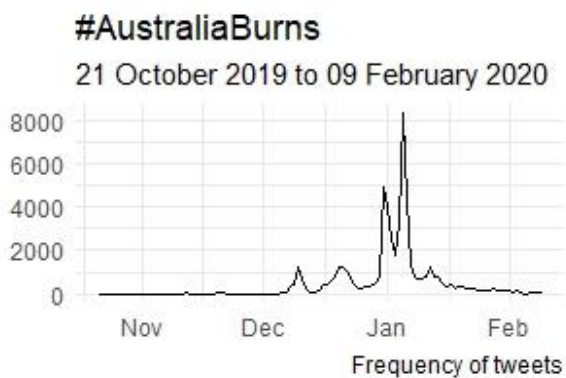
Graph 5. Frequency of tweets, Australia + Fires



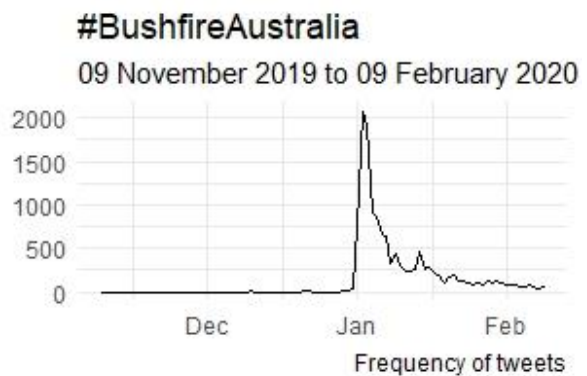
Graph 6. Frequency of tweets, Bushfire



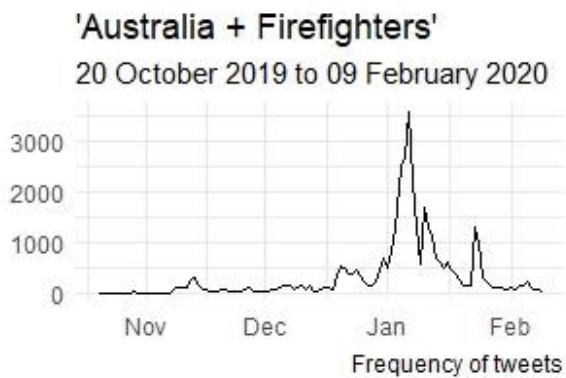
Graph 7. Frequency of Tweets, AustraliaFires



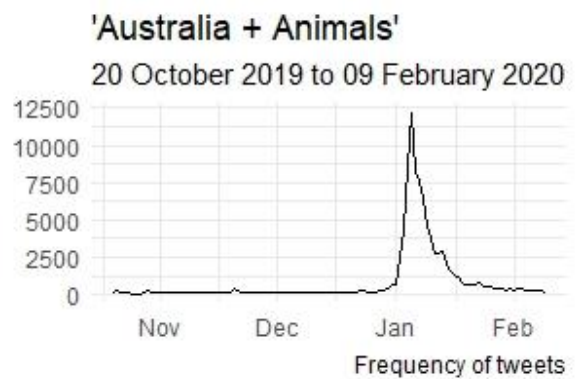
Graph 8. Frequency of tweets, AustraliaBurns



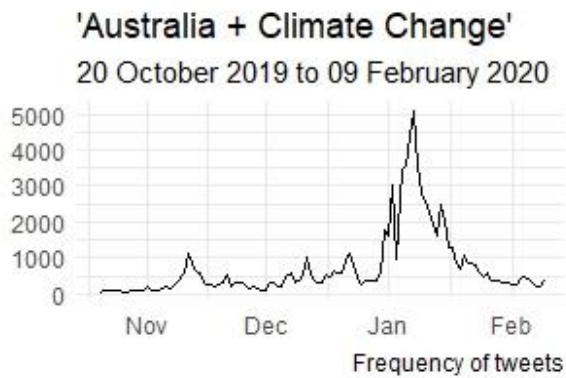
Graph 9. Frequency of tweets, BushfireAustralia



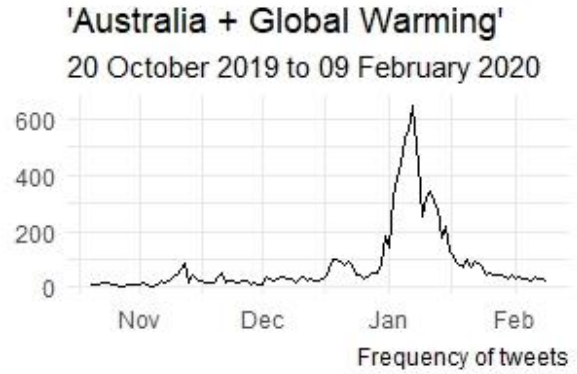
Graph 10. Frequency of tweets,
Australia + Firefighters



Graph 11. Frequency of tweets,
Australia + Animals



Graph 12. Frequency of tweets, Australia + Climate Change



Graph 13. Frequency of tweets, Australia +Global Warming.

Most of the keywords tweet’s frequency followed the same trend of graph X during the months of December and January. As for the previous months, most of the keywords had very small daily fluctuations, with the tweet’s numbers never going over the 2.500 daily mentions.

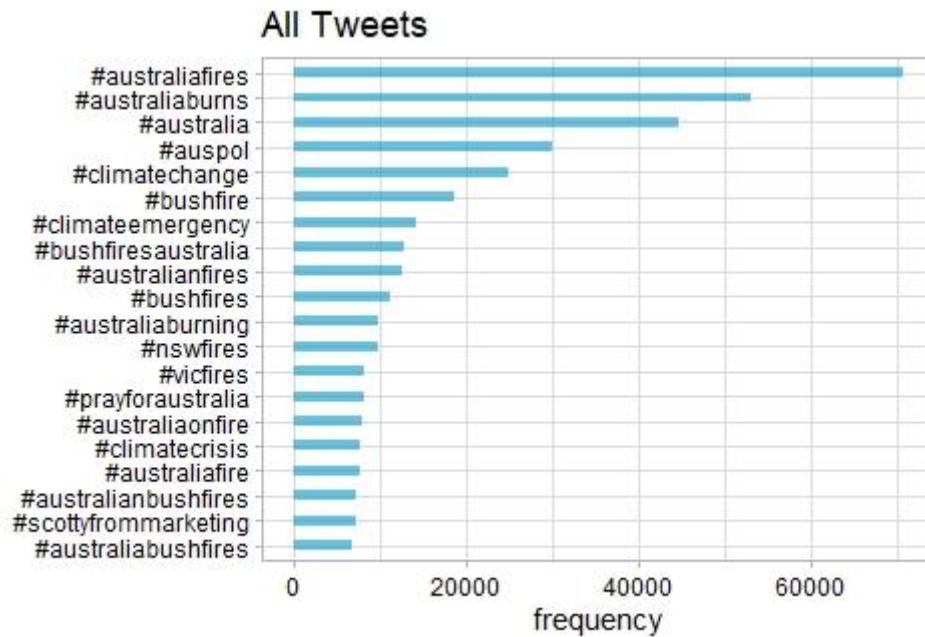
Nevertheless, from these graphs, we can tell that the most active and used keywords were: #NswFires, Bushfire, Australia + fire, Australia + Climate change and Australia + Global Warming.

The general trend shown by these graphs demonstrate that in the months preceding December, in particular, the last days of this month, the general concern and the public debate was extremely low for an event of this size and duration. In fact, it is only at the end of 2019 and during January 2020 that the general debate started to become more spread as it is during these times that tweet’s concerning this catastrophe were soaring.

3.3.2 Hashtags Frequency

We are now going to take a closer look at which specific hashtags were most popular from October 2019 to February 2020.

Undoubtedly, there are a vast number of hashtags and keywords surrounding the 2019-2020 Bushfire Season’s open debate on Twitter. Some in fact have been used more commonly by Twitter users across our different datasets, compared to other hashtags.



Graph 14. Hashtag's frequency whole dataset.

Our analysis shows that the hashtags that were used the most among the various keywords we decided to analyse were:

- #australiafires, used more than 70.000 times;
- #australiaburns, used more than 50.000 times;
- #climatechange, used more than 20.000 times;
- #bushfiresaustralia, used more than 10.000 times;
- #nswfires, used almost 10.000 times.

The plots for every single keyword can be found in the appendix section.

The *#ClimateChange* is one of the hashtags that we find within each individual dataset of study. This shows that the public continues to express concern about the effect that Climate Change is having on the environment.

One interesting hashtag that keeps coming up is *#ScottyFromMarketing*. This hashtag is directed to Australian Prime Minister Scott Morrison. This hashtag was first used back in February 2019, but it became extremely popular during the bushfire crisis as the Australians grew day by day frustrated with the lack of consideration and action that the

3.4 NRC Emotion Lexicon

The NRC Word-Emotion Association Lexicon, that is also known as EmoLex, “is a list of English words and their associations with eight basic emotions (anger, fear, anticipation, trust, surprise, sadness, joy, and disgust) and two sentiments (negative and positive)” (Mohammad 2020). This lexicon was created, for the English language, by Peter Turney and Saif Mohammad in 2010 and all the notes were done by hand through crowdsourcing. Nevertheless, despite certain regional variations a plurality of affective norms have been shown to be consistent across languages. For this reason, they are able to provide different lexicon variants for over a hundred different languages through the use of Google Translate to translate the English words. This glossary was the first of its kind, as it was the first glossary that had a word to emotions pairing with not only entries for general positive or negative sentiments but also word to emotions associations with eight essential feelings.

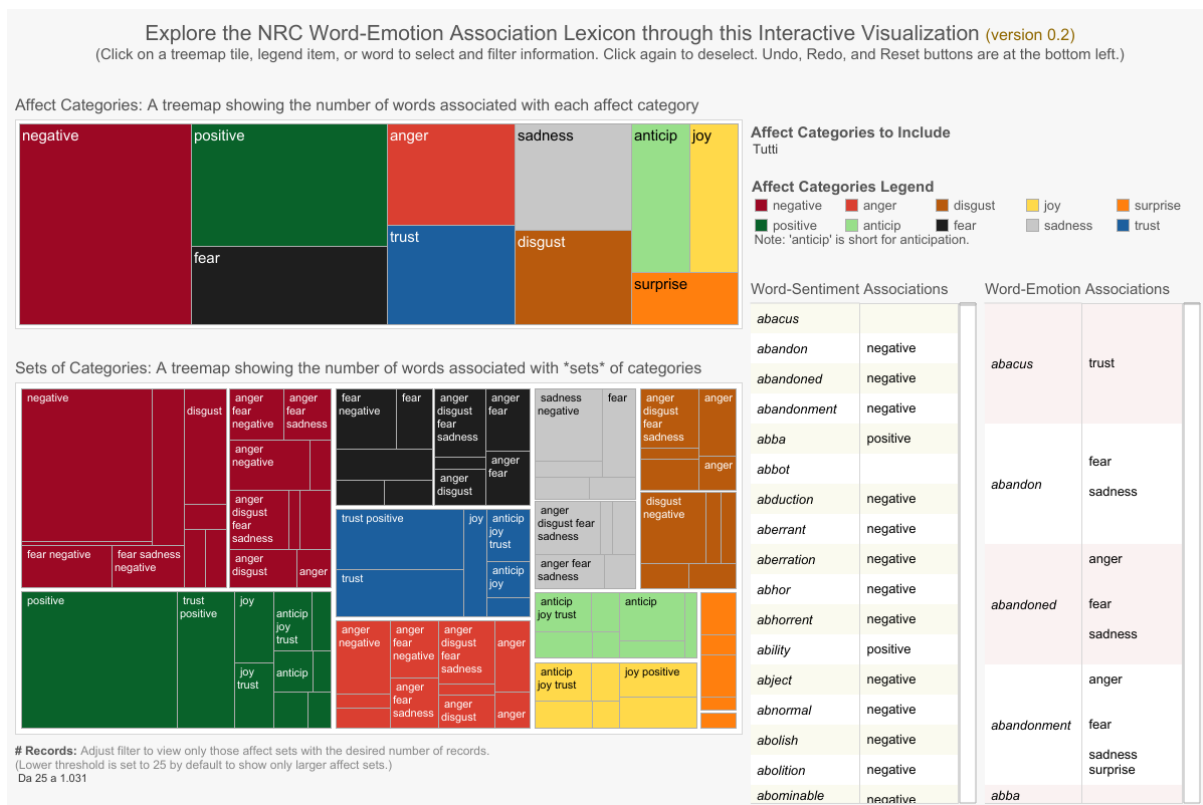


Figure 16. NRC word-emotion association. Source: Saif Mohammad 2020

To this day, it remains the biggest glossary of this kind. Even though it was created through the use of crowdsourcing, it was heavily monitored through a process of quality control that every time a new annotation was created it would pop up a separate word choice query, to ensure that the annotators understood the word, by showing them the meaning of the word they were requesting to work on. This lexicon also had an impact on Neuro-linguistic programming, and it helped different research on reactions to a pandemic, vaccines, hate speech, bullying etc. Furthermore, it helped in tracking emotional patterns and it was used in various research on how people communicate their feelings and their related emotions towards specific events such as fake news and viral videos.

3.4.1 Sentiment Analysis

The progress in technology we have lived these past years has altered how people share their thoughts, views and sentiments, as well as the place in which they do so. For example, micro-blogging is a very popular platform so much so that there are more than 111 around. In detail, micro-blogging platforms are social networking sites where frequently people publish brief messages.

Sentiment Analysis is a type of textual mining that recognises and extracts subjective and personal information from the source content. Through the use of Sentiment Analysis, a company can learn about the clients' perception of their products, it can assess customer loyalty and it can make decisions regarding possible changes to their product or service. In this paper, to perform the Sentiment Analysis the R programming language will be used. Sentiment Analysis is in fact used to examine people's opinions, points of view, tastes and interests by looking at various perspectives. Thanks to its different uses and the growth of web-based life, this type of analysis is becoming very important. Since it can be extended to a wide variety of activities and plans of actions; business, politics and public actions all use this analysis. Business uses it mainly for marketing reasons to better understand the emotions that customers have towards them. Politics uses it to track media events and political views and to try and forecast the outcomes of the possible elections. Meanwhile, public actions use it to track and interpret social phenomena, identifying potentially risky scenarios and determining the best course of action.

The tools and packages used for this Sentiment Analysis are:

1. dplyr library. This is an R data manipulation program that offers a regular collection of verbs that help overcome the most popular data manipulation problems.
2. purrr library. This is an R program that includes a comprehensive and reliable range of methods for dealing with functions and vectors.
3. syuzhet library. This is an R program that includes four different sentiment dictionaries that allow accessing a sentiment extraction tool.
4. reshape2 library. This is an R program that makes the conversion of broad and lengthy formats easier.
5. ggplot2 library. This is an R programme that allows the user to generate graphs. The user just needs to give the numbers, tell it how to aesthetically map the variables and which graphical elements to use and the program handles the rest.

For this analysis, we are going to use the same datasets that were previously downloaded through Twitterscraper that allowed us to scrape Twitter for specific keywords through python. Moreover specifically, for this analysis, the dataset was divided monthly as they were too big to be processed all together. This sentiment analysis will be carried out on a monthly basis for every searched keyword. To reiterate the keyword used are: Bushfire, NswFire, BushfireAustralia, AustraliaBurns, AustraliaFires, Australia & Climate Change, Australia & Fire, Australia & Firefighters, Australia & Global Warming and Australia & Animals.

As an example, I am going to display the Rstudio code for the analysis of the keyword 'nswfire' for the month of February 2020.

After loading on Rstudio the necessary datasets we start by loading all the essential R library that have been mentioned above (dplyr, purrr, syuzhet, reshape2, ggplot2).

```
library(dplyr)
```

```
library(purrr)
```

```
library(syuzhet)
```

```
library(reshape2)
```

```
library(ggplot2)
```

Then we start by creating a database extrapolating only the dates from the previously loaded database.

```
DateFebNswFire = data.frame(FebruaryNswFire$timestamp)
DateFebNswFire  <-  format(as.Date(DateFebNswFire$FebruaryNswFire.timestamp),
"%Y/%m/%d")
DateFebNswFire <- data.frame(DateFebNswFire)
colnames(DateFebNswFire) <- "Date"
```

Then we proceed by creating a database with only the text part of the previously loaded dataset.

```
FebTextNswFire = data.frame(FebruaryNswFire$text)
FebTextNswFire <- data.frame(FebTextNswFire)
colnames(FebTextNswFire) <- "Text"
```

Subsequently, we continue by uniting the two data frame just created: *DateFebNswFire* and *FebTextNswFire*.

```
FebNswFire <- data.frame(DateFebNswFire$Date, FebTextNswFire$Text)
colnames(FebNswFire) <- c("Date", "Text")
class(FebNswFire$Date)
FebNswFire$Date <- as.Date(FebNswFire$Date, format = "%Y/%m/%d")
```

After creating a unique dataset we go ahead by performing the Sentiment Analysis by analyzing the text part of the previously created dataset while grouping the results by date.

```
FebNswFire %>%
  split(.$Date) %>%
  imap_dfr(~get_nrc_sentiment(.x$Text) %>%
    summarise(across(fns = sum))) %>%
```



```
mutate(date = .y, .before = 1)) -> resultFebNswFire
resultFebNswFire
```

We continue our analysis by dividing the result into two different data frame; one only containing the emotions extrapolated and one only containing the polarity.

```
#dividing emotions and polarity
```

```
resultFebNswFire_em = data.frame(resultFebNswFire$date, resultFebNswFire$anger,
resultFebNswFire$anticipation, resultFebNswFire$disgust, resultFebNswFire$fear,
resultFebNswFire$joy, resultFebNswFire$sadness, resultFebNswFire$surprise,
resultFebNswFire$trust)
resultFebNswFire_em
colnames(resultFebNswFire_em) <- c("Date", "Anger", "Anticipation", "Disgust", "Fear",
"Joy", "Sadness", "Surprise", "Trust")
class(resultFebNswFire_em$Date)
```

```
#polarity
```

```
resultFebNswFire_pol = data.frame(resultFebNswFire$date, resultFebNswFire$negative,
resultFebNswFire$positive)
resultFebNswFire_pol
colnames(resultFebNswFire_pol) <- c("Date", "Negative", "Positive")
```

At this moment, we are ready to plot our results. We start to organise our data based on the date through the “melt” function and then we proceed to plot both sentiments and polarity.

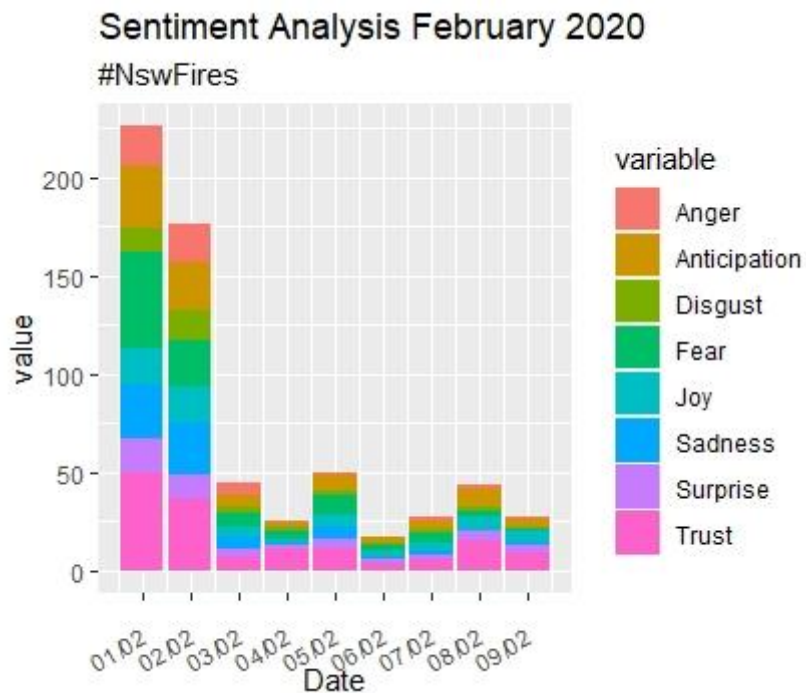
```
#plotting emotions
```

```
FebEmNswFire <- melt(resultFebNswFire_em, id.vars='Date')
lct <- Sys.getlocale("LC_TIME"); Sys.setlocale("LC_TIME", "C")
FebEmNswFire$Date <- as.Date(FebEmNswFire$Date, format="%Y-%m-%d")
Sys.setlocale("LC_TIME", lct)
```

```

ggplot(FebEmNswFire, aes(x=Date, y=value, fill=variable)) +
  geom_bar(stat='identity') +
  scale_x_date(date_labels="%d/%m",date_breaks = "1 day") +
  theme(axis.text.x = element_text(angle = 30, vjust = 0.5, hjust=1)) +
  ggtitle("Sentiment Analysis February 2020") +
  labs(subtitle = "#NswFires")

```

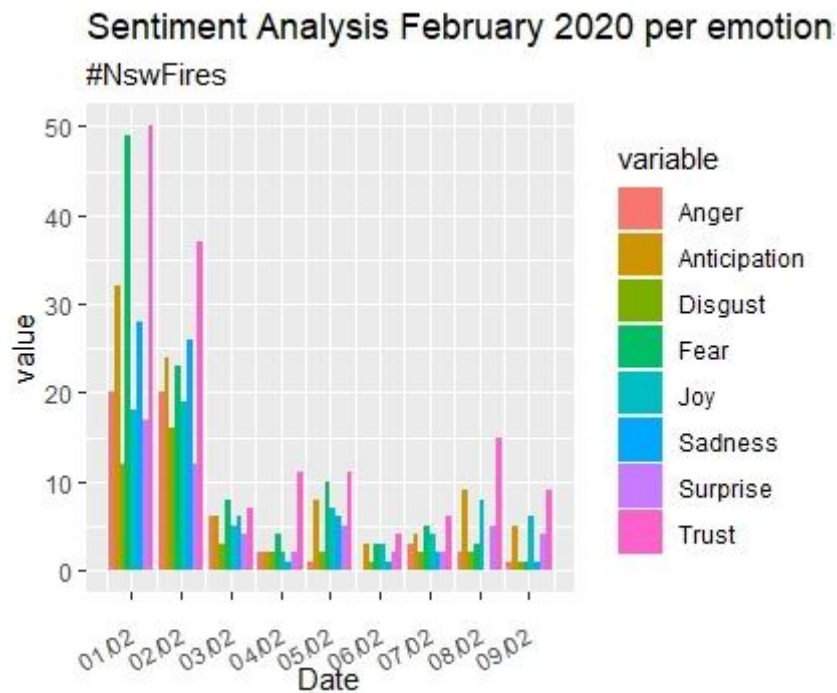


Graph 15. Sentiment analysis, February 2020, NswFires

```

ggplot(FebEmNswFire, aes(x=Date, y=value, fill=variable)) +
  geom_bar(stat='identity', position='dodge') +
  scale_x_date(date_labels="%d/%m",date_breaks = "1 day") +
  theme(axis.text.x = element_text(angle = 30, vjust = 0.5, hjust=1)) +
  ggtitle("Sentiment Analysis \nFebruary 2020 per emotions") +
  labs(subtitle = "#NswFires")

```

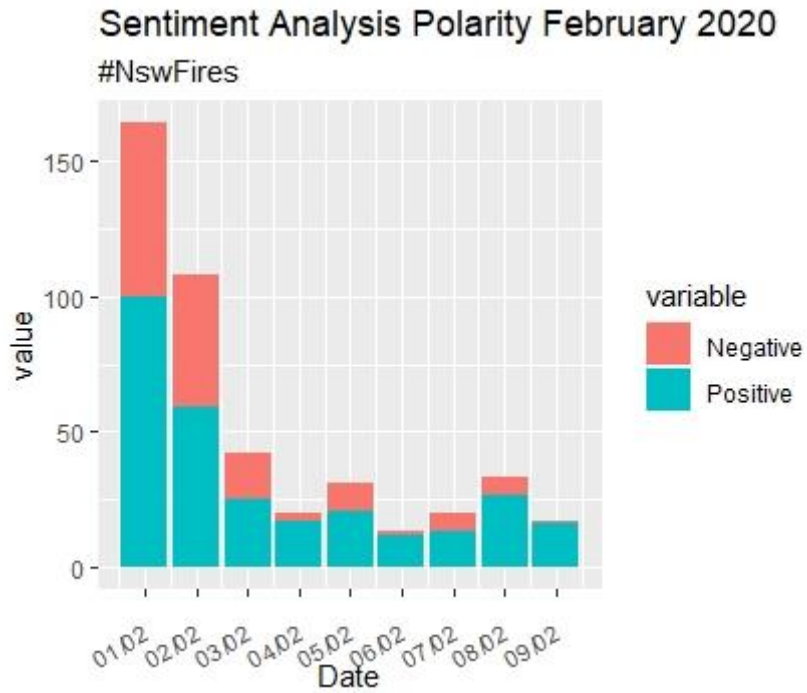


Graph 16. Sentiment Analysis per emotion, February 2020, NswFires

#plotting polarity

```
FebpolNswFire <- melt(resultFebNswFire_pol, id.vars='Date')
lct <- Sys.getlocale("LC_TIME"); Sys.setlocale("LC_TIME", "C")
FebpolNswFire$Date <- as.Date(FebpolNswFire$Date, format="%Y-%m-%d")
Sys.setlocale("LC_TIME", lct)

ggplot(FebpolNswFire, aes(x=Date, y=value, fill=variable)) +
  geom_bar(stat='identity') +
  scale_x_date(date_labels="%d/%m", date_breaks = "1 day") +
  theme(axis.text.x = element_text(angle = 30, vjust = 0.5, hjust=1)) +
  ggtitle("Sentiment Analysis Polarity February 2020") +
  labs(subtitle = "#NswFires")
```

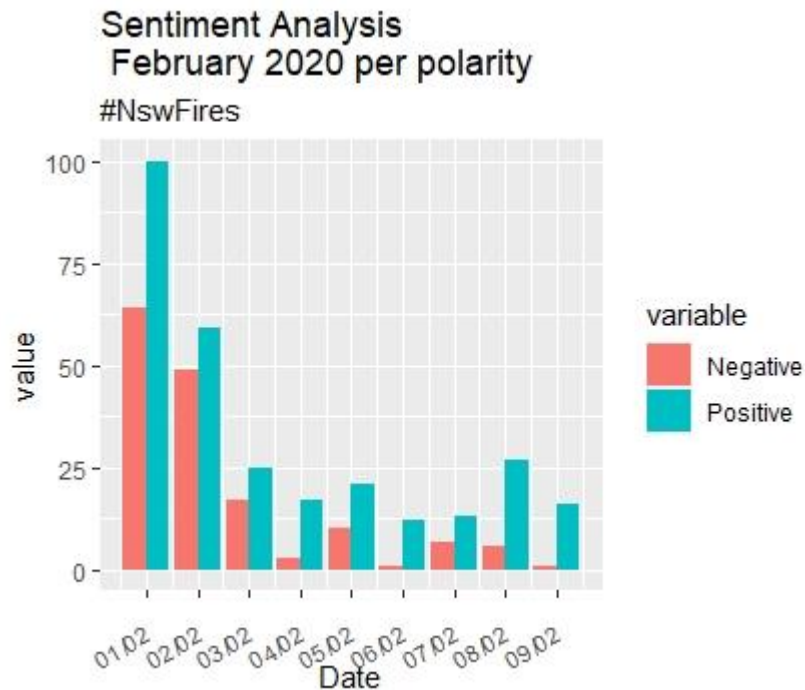


Graph 17. Polarity. February 2020, NswFires

```

ggplot(FebpolNswFire, aes(x=Date, y=value, fill=variable)) +
  geom_bar(stat='identity', position='dodge') +
  scale_x_date(date_labels="%d/%m", date_breaks = "1 day") +
  theme(axis.text.x = element_text(angle = 30, vjust = 0.5, hjust=1)) +
  ggtitle("Sentiment Analysis \n February 2020 per polarity") +
  labs(subtitle = "#NswFires")

```



Graph 18. Polarity per variable, February 2020, Nswfires

3.5 Findings

In the following paragraphs, we are going to analyse the monthly result we obtained for the Sentiment Analysis that we carried out on our ten different keywords. For each month that we obtained data for we are going to analyse the results, we gathered through Rstudio.

3.5.1 October

Even though the 2019-2020 bushfire season began sooner than usual, the first started as early as June 2019; the official beginning of the bushfire season is October 2019. As a matter of fact, towards the end of the month, there were multiple active bushfires and around 444.000 hectares of land in NSW was destroyed from a single ignition point.

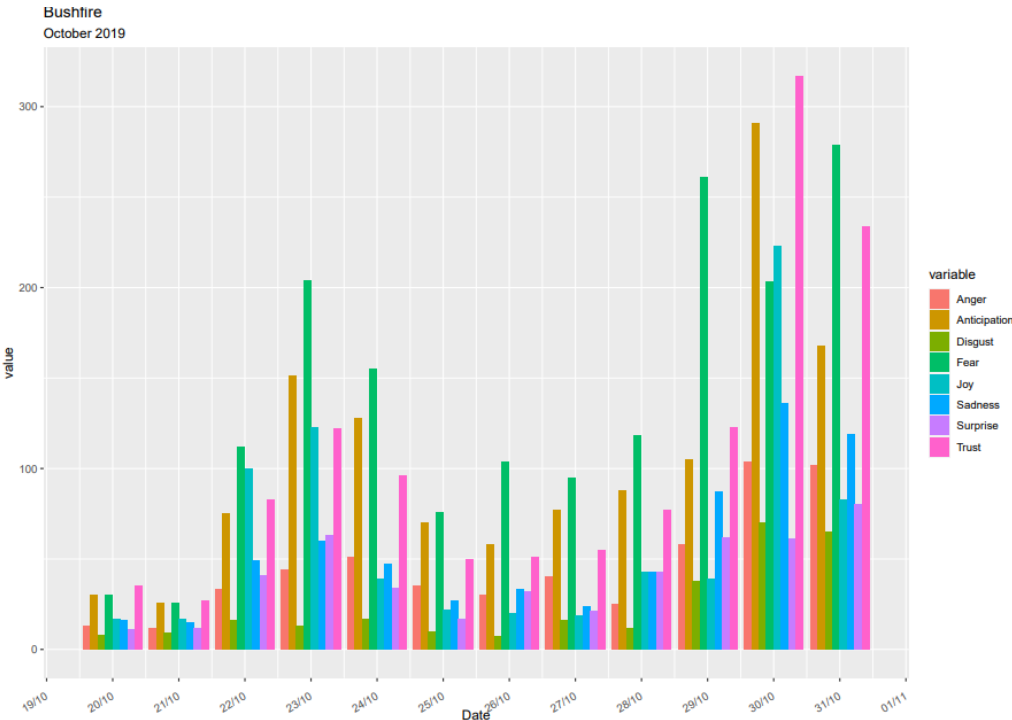
The different bar charts per keywords show that the majority of words used by the Twitter user were mainly associated with the negative emotion 'Fear'. In fact, throughout the various graphs, this association happened on a regular basis more or less than 100 times and on some specific days, it could happen around 300 times. The keyword that shows the highest word association with the 'fear' sentiment are 'Australia + Climate

Change', 'Australia + Fire' and '#NSWFire'; where each day this sentiment dominates the chart being most of the time shown double the amount of any other emotions.

The second most shown emotion is trust, which appears to be exhibited around 100 times a day with peaks of over 300 times. For this specific emotion, there are various keywords that have this emotion in second places, such as: 'Australia + Global Warming', '#NSWFires', 'Bushfire' and so on.

The other more prominent emotions that words were associated with are anticipation, anger and sadness, which generally appear the same amount of time daily.

Here we have an example of the sentiments that were expressed by Twitter users during the month of October for the keyword 'Bushfire'. To have a more in-depth look at every single keyword go to Annex Graphs.



Graph 19. Sentiment Analysis, October 2019, Bushfire

Specifically, in this graph, we can see how the number of sentiments varies day by day based on the number of tweets published (see paragraph 'Frequency of Tweets') and how the fear and trust sentiments prevail in the chart.

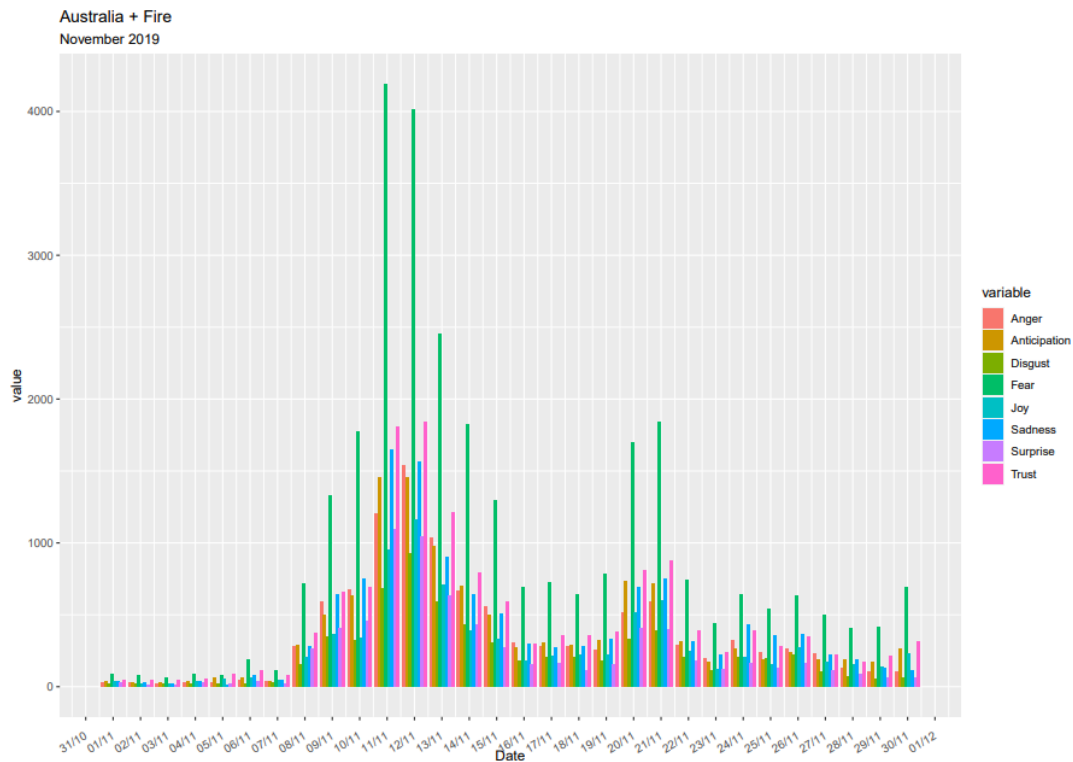
3.5.2 November

During the month of November 2019, bush and grass fires keep spreading across the country, worsening the situation especially for New South Wales, Victoria and Queensland.

As of October 2019, also the month of November sees similar sentiments displayed by Twitter users. Fear remains the top-charting emotion across the different keywords as in fact it dominates every single day of the month. If for some keywords the word to emotion association peak does reach more than 100 times daily, for others the association reaches over 4000 times. The keywords with the highest word-to-‘fear’ association are ‘Australia + Climate Change’, ‘Australia + Fire’ and ‘Bushfire’.

For this month we have an increase in the ‘sadness’ and ‘anticipation’ emotion shown daily, across the different terms analysed with peaks of 2.000 and 2.500 times, respectively. Trust remains one of the most displayed emotions even if it is shown slightly less compared to the previous month. Meanwhile, ‘anger’ is a constant negative emotion that Twitter users show daily in their tweets with slight variations day by day.

It is interesting to notice that across the various term analysed, there are some specific days during which there was a spike in the emotions and therefore in the number of tweets posted for all different keywords. These days were between the 11th and 16th of November. During these days, three people died, and weather conditions kept worsening for New South Wales and Queensland as the two states declare a state of emergency as Australia was bracing itself for the most unprecedented bushfire danger it has ever seen (BBC 2019).

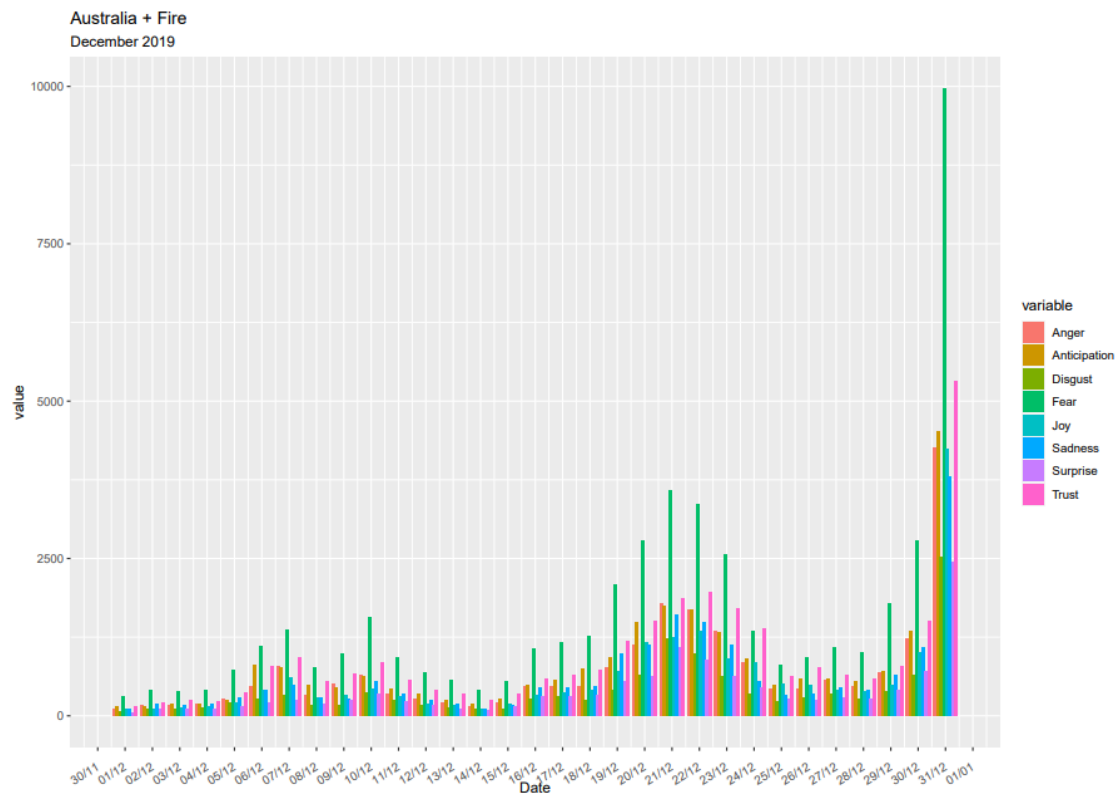


Graph 20. Sentiment analysis, November 2019, Australia + Fire

3.5.3 December

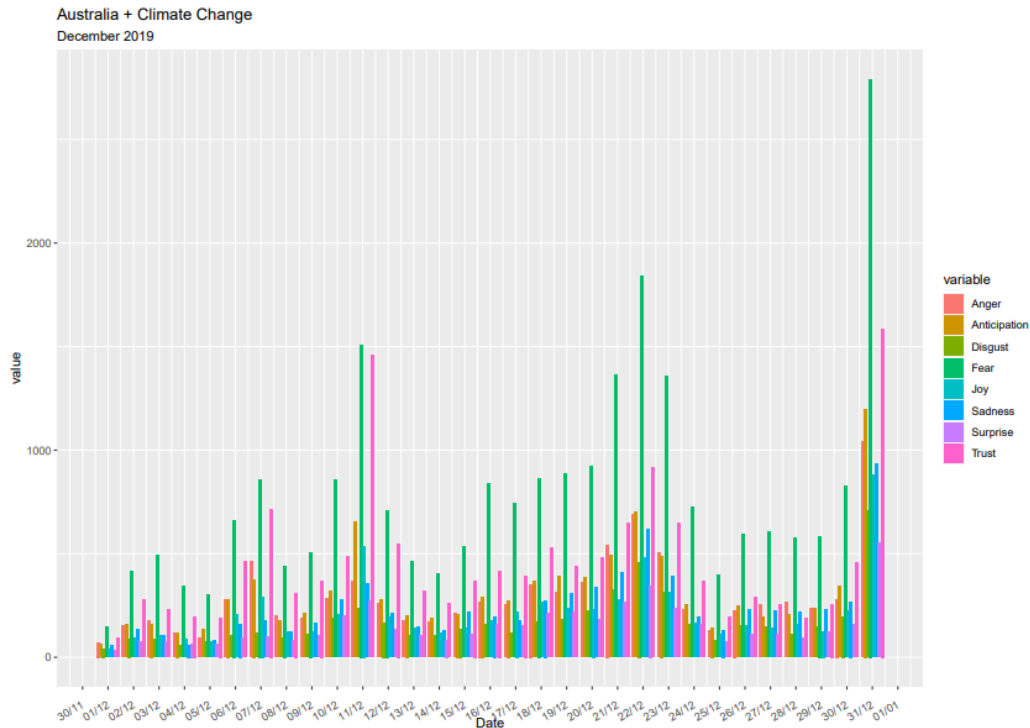
In December 2019, the fire continues to spread, and thousands of people are being asked to evacuate their homes daily. It is during this month that the United States stations firefighters in Australia for the first time to help with this emergency.

For December 2019, we can see the same trend in emotions shown by the previous months. Fear remains the emotion mostly displayed, even though its number generally decreases compared to November 2019. It is with the keyword 'Australia + Fire' that we see for the first time, this emotion to be shown more than 10.000 times. Meanwhile, trust, sadness and anger keep being the second, third and fourth most shown sentiment with their order changing daily and depending on the word-term considered. Nevertheless, for the first time, we have the positive emotion of 'joy' being shown with the 'Australia + Firefighters' keyword, with a peak of 575 times.



Graph 21. Sentiment analysis, December 2019, Australia + Fire

As for December, one specific day, the 31st, shows the most activity in terms of tweets tweeted and emotion displayed. The reason why the public felt like expressing their feelings through Twitter on that specific day is that pictures of apocalyptic scene kept being shared as the sky became black and then red and thousands of people were trapped on the Mallacoota beach while the fire blazed in their direction. In particular, with connection to Climate Change, we have fear, anger, anticipation and sadness emotions that rockets in comparison to the day before as the Prime Minister, Scott Morrison refuses to discuss possible climate policy as the economy of the country has to come first.



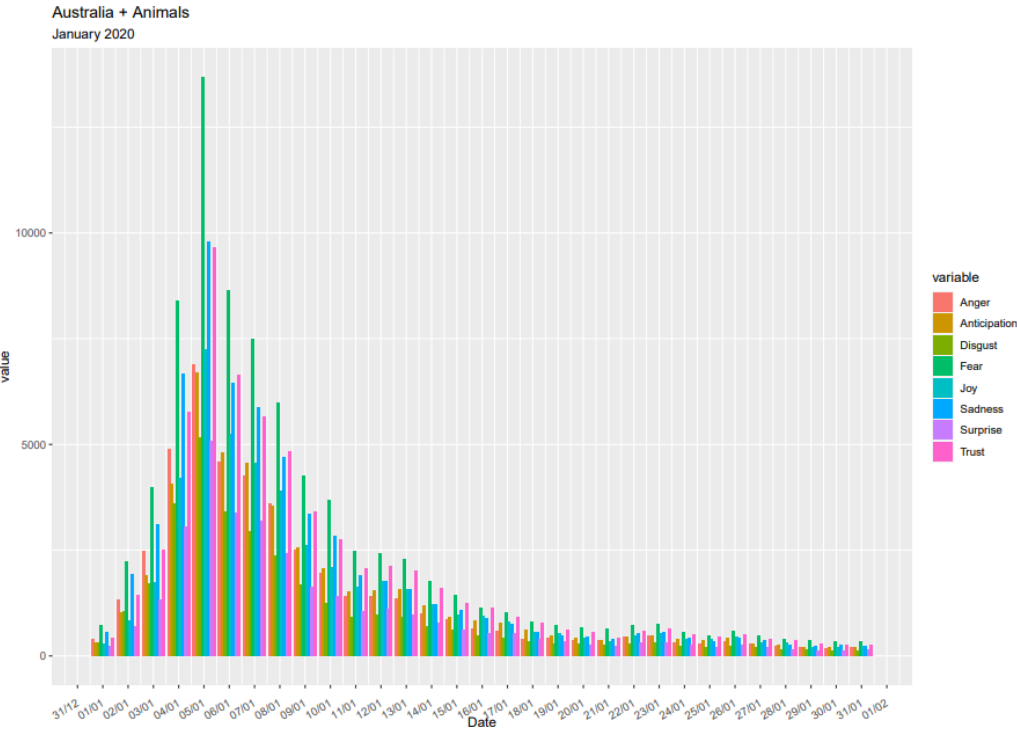
Graph 22. Sentiment analysis, December 2019, Australia + Climate Change

3.5.4 January

In January 2020, conditions continue to worsen. the city of Penrith becomes the hottest place on earth with a temperature of 48.9°C, the smoke from the bushfire starts to become a major problem not only for Australia but for neighbouring countries too like New Zealand where it starts to affect the air quality. More states of emergencies are being declared while the State of Victoria declares a state of disaster.

Fear continues to remain the most displayed emotions. For this month we have new peaks for this emotion with different keywords that previously did not have many users commenting on. For example, for the first time, we have this emotion reaching the peak of 12.000 times with the 'Australia + Animal' keyword, while previously any sentiment shown for this term was below 1.000 times. We also have a peak of 15.000 words to sentiment association with the 'Australia + Fire' keyword, around 10.000 times, fear is found in tweets with the keyword 'bushfire'; also, for the 'Australia + Firefighters' keyword we have that fear is present more than 6.000 times.

The other main emotions that were shown are, as usual, trust, anger, anticipation and sadness. Nevertheless, we can also see that the sentiment ‘joy’ is present mainly in correlation with two keywords: ‘#NswFires’ and ‘Australia + Firefighters’.



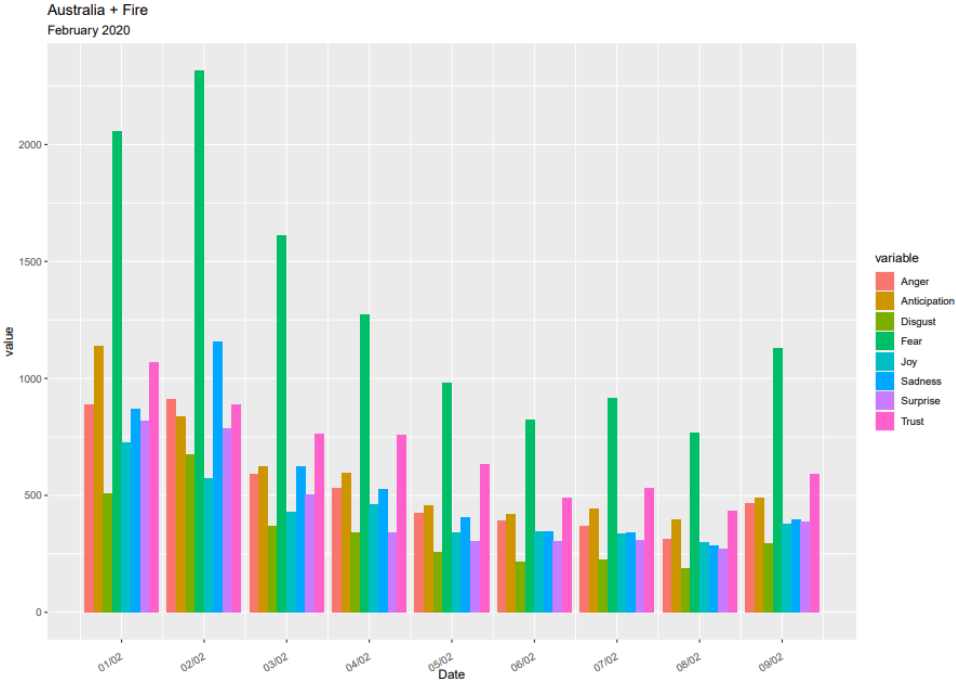
Graph 23. Sentiment analysis, January 2020, Australia + Animals

The trend for the month of January shows a steady increase of emotions, until the days between the 3rd and 6th of January that is when most of the peaks in emotions occurred and then a subsequent gradual decrease in the tweets tweeted. During these days, more than 150 different fires are burning in NSW, more than 50 in Victoria in addition to the ones burning in the rest of the nation. Experts also estimate that by the 7th of January around 1 billion animals were killed by the bushfires (Samuel 2020).

3.5.5 February

Meanwhile, in February 2020, there was torrential rainfall across the country that helped extinguish a good amount of the active fires even though the amount of rain that fell caused some floodings. Nevertheless, the situation started to get better little by little and by the end of March 2020 all fires would have been extinguished.

Compared to the previous months that saw a sharp increase in the number of tweets tweeted and in the number of emotions displayed, during the first nine days of February there mainly was a fluctuation in sentiments with not too big of increase or decrease. Fear remains the major emotion shown across the majority of keywords, even though for some of the keywords all the emotions were displayed for almost the same amount of time with very small differences. Trust, anticipation, sadness, and anger remains the more shared emotions across the platform. Moreover, 'joy' and 'surprise' start to increase across the various terms studied making themselves more prominent especially in 'Australia + Firefighters', 'Australia + Fire', '#AustraliaFire' and 'Australia + Global Warming'.



Graph 24. Sentiment analysis, February 2020, Australia + Fire

Conclusions

The bushfire emergency that hit Australia during the summer of 2019-2020, which is commonly referred to as the 'Black Summer' was the worst bushfire emergency that the country had ever had in years. A difficult situation that started as early as June 2019 making it one of the earliest starts of a bushfire season. Even though the start of this bushfire season was this early, the fires that were too wild and difficult to be controlled started around September 2019. As a matter of fact, these fires are the reason why 18.000.000 hectares of land burnt, more than 9.000 buildings were destroyed, nearly 3 billion animals were affected, 34 people died due to bushfires directly and 417 people died because of smoke inhalation. All these damages caused a financial impact to the country higher than \$100 billion. Nevertheless, this emergency situation showed the good in people, with celebrities and important brands getting involved in the matter, raising money for the people in need and the animals suffering. While at the same time, multiple people brought climate change into the discussion, bringing attention to the various negative effects that it is causing to the country. We also saw the first execution of the agreement between Australia and the United States regarding the sharing equipment in case of fire hazards, as in December 2019 the United States stationed firefighters in Australia to help with the bushfire emergency.

In the first chapter, it was helpful to establish the foundations for the whole study, by identifying and debating the key points regarding communication and social media. Communication is an extremely important part of our everyday life, as it is also what influences our behaviours and decisions, sometimes even without us realizing it. We saw the different definitions and explanations that scholars had throughout the years. All these definitions tell us that communication is a collaborative and continuous mechanism that require a common context and meaning, the encryption and decryptions of messages, a common understanding and feedback. We saw how communication is different between mass communication and social media, making one more similar to the face-to-face communication than the other. We described biases that are involved in social media and how they can affect people's decisions, reactions, and thoughts. We talked about cognitive biases, society biases, confirmation biases, technological biases, popularity biases and so on. We also saw how easy it is for news to spread online and become cascades. As a matter

of fact, only one person is needed to express their opinion online, for then other people to see it and agree with it and then spread the opinion for a bigger cluster of people to see. Two methods can be used to explain the diffusion of information on social media: the *Independent Cascade* method and the *Linear Threshold* method. Important elements for information diffusion are the original author network and its credibility and also the timings to which the information was introduced in the online world. The bigger the network of the author is, the faster information spreads, and the earlier the information is spread the faster it will circulate; as the moment it becomes 'old news' its propagation will decrease over time.

Meanwhile, in the third chapter, we introduced the case study to analyse. The case study was analysing the Australian bushfire emergency of summer 2019-2020 through the use of Twitter data. To retrieve data from Twitter, the Twitterscraper package was used. This package allowed us to download multiple tweets over 5 months (from 20.10.2019 to 09.02.2020) from the social media platform Twitter. The tweets downloaded were based on ten different keywords: Bushfires, #AustraliaBurns, #NswFires, #BushfireAustralia, #AustraliaFires, Australia + Climate Change, Australia + Fire, Australia + Firefighters, Australia + Global Warming, Australia + Animals. The total of unique observations that were part of the analysed dataset is 778.136.

We started to analyse the frequency of the tweets to which they were posted during that time. The frequency shows us the level of interest and concern that people have towards this specific disaster based on how many tweets were posted and specifically based on when these tweets were posted. As we could see the majority of tweets happened during December 2019 and January 2020 as those were the most tragic months for Australia and the public concern was higher in comparison to the previous months.

We then proceeded to study the hashtag frequency, which showed us that the #ClimateChange was one of the popular ones, that was mentioned together with all the other hashtags studied. We also noticed an interesting hashtag, #ScottyFromMarketing that was directed to the Australian Prime Minister as the Australians were becoming more frustrated with him and his lack of consideration and action towards this disaster.

To finish we carried out a monthly sentiment analysis on our dataset. In October 2019, fear and trust were dominating the sentiment that arised from the tweets with peeks of 300 and 100 times respectively. In November 2019, fear remains the highest-charting emotions, with the word-to-sentiment association going over 4000 times. Compared to the previous month two more emotions became more predominant: sadness and anticipation. In December 2019, the emotions shown keep remaining the same as the previous months with fear surpassing the 10.000 mentions for the first time at the end of the month. In January 2020, the word-to-emotions association become generally higher, as more people tend to comment on the disastrous situation. Fear again is the most shown emotion followed by trust, anger, anticipation, and sadness. In February 2020, the primarily emotions displayed keep being the same as the previous months, the only thing that changed is the number of tweets posted and subsequently the number of emotions exhibited by the users.

As we saw, fear was the dominant emotion that characterised the disaster that was the 'Black Summer' in Australia. The other emotions that were mainly displayed were sadness, anger, trust and anticipation. All these emotions can sum up pretty well what the Australian population felt through this particular bushfire season and how they perceived this emergency in correlation with climate change, politics, animal wellbeing etc.

In conclusion, this study helps explain how information spread during an emergency through social media, in particular Twitter. It also shows how easy it is for the public to influence the national debate on a certain topic and bring more attention to others. Social media is the perfect way to access information about what people are thinking and feeling not only for companies and brands but also for national emergencies and for this reason its use in these situations should be studied more in-depth.

References

Alboukadel n.d., *TOP R COLOR PALETTES TO KNOW FOR GREAT DATA VISUALIZATION*, Data Nova, viewed 10 January 2021, <<https://www.datanovia.com/en/blog/top-r-color-palettes-to-know-for-great-data-visualization/>>.

Arriagada, N.B., Palmer, A.J., Bowman, D.MJS, Morgan, G.G., Jalaludin, B.B & Johnst, F.H. 2020, 'Unprecedented smoke-related health burden associated with the 2019–20 bushfires in eastern Australia', *The Medical Journal of Australia*, 23 March, viewed 15 August, <<https://www.mja.com.au/journal/2020/213/6/unprecedented-smoke-related-health-burden-associated-2019-20-bushfires-eastern>>.

Aslam, S. 2020, 'Twitter by the Numbers: Stats, Demographics & Fun Facts', Omnicore, 10 February, viewed 15 August 2020, <<https://www.omnicoreagency.com/twitter-statistics/>>.

Australian Academy of Science 2020, 'The Australian bushfires—why they are unprecedented', 3 February, viewed 15 August 2020, <<https://www.science.org.au/news-and-events/news-and-media-releases/australian-bushfires-why-they-are-unprecedented>>.

Australian Bureau of Meteorology 2020, *Australia in December 2019*, Australian Bureau of Meteorology, 9 January, viewed 15 August 2020, <<http://www.bom.gov.au/climate/current/month/aus/archive/201912.summary.shtml>>.

Australian Government Geoscience Australia n.d, *Bushfire*, viewed 15 August 2020, <<https://www.ga.gov.au/scientific-topics/community-safety/bushfire>>.

Baptista, R. 2020, 'Incendi in Australia: ecco la risposta dei brand a questa emergenza, dai prodotti in edizione limitata alle donazioni', *Inside Marketing*, 1 February, viewed 15 August 2020, <<https://www.insidemarketing.it/incendi-in-australia-risposta-dei-brand-allemergenza/>>.

Baran, S., J. 2014, *Introduction to Mass Communication : Media Literacy and Culture*, 8th edn, McGraw-Hill, New York.

Basford, S. 2020, *Where The Legend Of 'Scotty From Marketing' Began*, *lifehacker*, viewed 20 January 2021, <<https://www.lifehacker.com.au/2020/01/where-the-legend-of-scotty-from-marketing-began/>>.

BBC 2019, *Australia bushfires: State of emergency declared over 'catastrophic' threat*, viewed 20 December 2019, <<https://www.bbc.com/news/world-australia-50365131>>. BBC News 2020, *'Australia fires: A visual guide to the bushfire crisis'*, *BBC News*, 31 January, viewed 15 August 2020, <<https://www.bbc.co.uk/news/amp/world-australia-50951043>>.

Billboard Italia 2020, *'I Queen e Alice Cooper suoneranno al "Fire Fight Australia"'*, *Billboard*, 13 January, viewed 15 August 2020, <<https://www.billboard.it/eventi/fire-fight-australia-queen-alice-cooper-concerto/2020/01/1327977/>>.

Bongioanni, M. 2020, *'Australia, anche l'acqua potabile è a rischio per colpa degli incendi'*, *Life Gate*, 23 January, viewed 15 August, <<https://www.lifegate.it/incendi-australia-rischio-acqua>>.

Burton, J. 2020, *"It was a line of fire coming at us': South West firefighters return home'*, *Busselton Mail*, 7 February, viewed 15 August, <<https://www.busseltonmail.com.au/story/6620313/it-was-a-line-of-fire-coming-at-us-firefighters-return-home/>>.

Carillo, G. 2020, *'I pompieri australiani si trasformano in Funko Pop per aiutare gli animali colpiti dagli incendi boschivi'*, *Green Me*, 7 February, viewed 15 August 2020, <<https://www.greenme.it/vivere/speciale-bambini/funko-pop-pompieri-australiano/>>.

Cary, C.G. , Bradstock, R.A., Gill, A.M. & Williams, R.J. 2012, *Flammable Australia: Fire regimes, biodiversity and ecosystems in a changing world*, CSIRO Publishing, Collingwood, VIC.

Cheney, N.P. 1996, *The effectiveness of fuel reduction burning for fire management*. In: *Fire and Biodiversity: the effects and effectiveness of fire management*, Paper No. 8, 7-16 Department Environment Sport and Territories Biodiversity Series, Canberra.

Ciampaglia, G. L. & Menczer, F. 2018, 'Misinformation and biases infect social media, both intentionally and accidentally', *The Conversation*, 20 June, viewed 15 January 2021, <<https://theconversation.com/misinformation-and-biases-infect-social-media-both-intentionally-and-accidentally-97148>>.

Climate Central 2020, 'Australia Fire Danger Index', Climate Central, 9 January, viewed 15 August 2020, <<https://www.climatecentral.org/gallery/maps/australia-fire-danger-index>>.

Climate Council of Australia 2015, *The Burning Issue: Climate Change and the Australian Bushfire Threat*, Climate Council of Australia Limited, <https://www.climatecouncil.org.au/resources/burningissuereport2015/?atb=DSA01a&gclid=CjwKCAjw4rf6BRAvEiwAn2Q76oHuTtnBk_hfkPv2qOr-70M9R-8FguC1sunvK1-MK1VhaLaymJNfhoCaj0QAvD_BwE>.

Climate Signals 2020, 'Australia Bushfire Season 2019-2020', *Climate signals*, 28 April, viewed 15 august 2020, <<https://www.climatesignals.org/events/australia-bushfire-season-2019-2020>>.

Coombs, W. T., Claeys, A. & Holladay, S. 2018, 'Social Media's Value in a Crisis: Channel Effect or Stealing Thunder?', in L. Austin & Y. Jin (eds), *Social Media and Crisis Communication*, Routledge, New York, pp. 159-167.

Create Digital 2020, 'Australian bushfires: A timeline of what's happened so far', *Create Digital*, 20 January, viewed 15 August, <<https://www.createdigital.org.au/australian-bushfires-a-timeline-of-whats-happened-so-far/>>.

CSIRO 2009, *Bushfires in Australia*, CSIRO, Canberra.

Dell n.d., *The Command Prompt: What It Is and How to Use It on a Dell System*, viewed 20 January 2021, <<https://www.dell.com/support/kbdoc/en-au/000130703/the-command-prompt-what-it-is-and-how-to-use-it-on-a-dell-system>>.

Desando, C. 2020, 'Incendi in Australia, la mobilitazione delle star tra donazioni e appelli social', *Io Donna*, 7 January, viewed 15 August 2020, <<https://www.iodonna.it/personaggi/star-internazionali/2020/01/07/incendi-in-australia-la-mobilitazione-delle-star-tra-donazioni-e-appelli-social/>>.

Fisher, C., Park, S., Lee, J.Y., Fuller, G. & Sang, Y 2019, *Digital news report: Australia 2019*, News and Media Research Centre (UC), 12 June 2019, Canberra, Australia, <<https://apo.org.au/node/240786>>.

Flew, T., Bruns, A., Burgess, J., Crawford, K. & Shaw, F. 2013, 'Social Media and its Impact on Crisis Communication: Case Studies of Twitter Use in Emergency Management in Australia and New Zealand', *Communication and Social Transformation*, ICA, Regional Conference, Shanghai, China.

Fraustino, J. D., Liu, B. F. & Jin, Y. 2018, 'Social Media Use During Disasters: A Research Synthesis and Road Map', in L. Austin & Y. Jin (eds), *Social Media and Crisis Communication*, Routledge, New York, pp. 283-295.

Gifford, C. 2020, 'How technology is helping us fight fires before they start', *The New Economy*, 28 August, viewed 29 August, <<https://www.theneweconomy.com/technology/how-technology-is-helping-us-fight-fires-before-they-start>>.

Gil, P. 2020, 'What Is Twitter & How Does It Work?', *Lifewire*, 29 April, viewed 15 August 2020, <<https://www.lifewire.com/what-exactly-is-twitter-2483331>>.

Goldenberg, A., Gross, J., Garcia, D., 2018, 'Emotional Sharing on Social Media: How Twitter Replies Contribute to Increased Emotional Intensity', Web.

Hadden, J. 2020, 'Australia's bushfires are ravaging the country. Here's how it all happened', *Insider*, 9 January, viewed 15 August 2020, <<https://www.insider.com/when-how-australia-bushfires-started-in-2019-2020-1>>.

Henriques-Gomes, L. 2020, 'Sports matches and festivals cancelled: the impact of Australia's bushfire smoke on its major events', *The Guardian*, 7 January, viewed 15 August 2020, <<https://www.theguardian.com/australia-news/2020/jan/07/sports-matches-and-festivals-cancelled-the-impact-of-australias-bushfire-smoke-on-its-biggest-cities>>.

Il Sole 24 Ore 2020, 'L'Australia brucia ma il governo nega legami con il climate change', *Il Sole 24 Ore*, 7 January, viewed 15 August 2020, <<https://www.ilsole24ore.com/art/l-australia-brucia-ma-governo-nega-legami-il-climate-change-ACvDFCAB>>.

Iqbal, M. 2020, 'Twitter Revenue and Usage Statistics (2020)', *Business of Apps*, 30 July, viewed 15 August 2020, <<https://www.businessofapps.com/data/twitter-statistics/>>.

Kemp, S 2020, 'DIGITAL 2020: GLOBAL DIGITAL OVERVIEW', *DataReportal*, 30 January, viewed 15 August 2020, <<https://datareportal.com/reports/digital-2020-global-digital-overview>>.

Kwak, H., Lee, C., Park, H. & Moon, S. 2010, 'What is Twitter, a Social Network or a News Media?', Association for Computing Machinery, New York, NY, USA.

Lepki, L. 2020, *How Do You Create a Word Cloud?*, ProWritingAid, viewed 15 January 2021, <<https://prowritingaid.com/art/425/What-the-Heck-is-a-Word-Cloud-and-Why-Would-I-Use->

[One.aspx#:~:text=Word%20clouds%20are%20fun%20to,right%20words%20in%20yo
ur%20prose>.](#)

Lucas, C., Hennessy, K., Mills, G. & Bathols, J. 2007, *Bushfire weather in southeast Australia: Recent trends and projected climate change impacts*, Bushfire CRC, Australian Bureau of Meteorology and CSIRO Marine and Atmospheric Research, Consultancy report prepared for the Climate Institute of Australia, 84 pp,
<http://www.cmar.csiro.au/e-print/open/2007/hennesseykj_c.pdf>.

Malkovich, L. 2018, *A Beginner's Guide to Text Analysis with quanteda*, University of Virginia Library, viewed 15 January 2021, <<https://data.library.virginia.edu/a-beginners-guide-to-text-analysis-with-quanteda/>>.

Maselli, T. 2020, 'I Metallica donano 750mila dollari per aiutare l'Australia che brucia', Green Me, 8 January, viewed 15 August 2020,
<<https://www.greenme.it/vivere/costume-e-societa/metallica-donazione-incendi-australia/>>.

McFadden, C. 2020, '7 of the Most Destructive Wildfires in Australian History', *Interesting Engineering*, 24 January, viewed 15 August 2020,
<<https://interestingengineering.com/7-of-the-most-destructive-wildfires-in-australian-history>>.

Mohammad, S. 2020, NRC Word-Emotion Association Lexicon (aka EmoLex), viewed 11 January 2021, <<http://saifmohammad.com/WebPages/NRC-Emotion-Lexicon.htm>>.
Monnis, M. 2020, "'Una mia foto nuda in cambio di una donazione per gli incendi in Australia". Totale: 1 milione di \$', *Elle*, 8 January, viewed 15 August 2020,
<<https://www.elle.com/it/magazine/women-in-society/a30440545/australia-incendi-donazioni/>>.

Morgan, J. S., Shafiq, M. Z., & Lampe, C. 2013, 'Is News Sharing on Twitter Ideologically Biased?', CSCW '13: Computer Supported Cooperative Work, San Antonio, Texas, USA.

National Museum of Australia & Ryebuck Media 2004, Fire in Australia investigating a natural hazard, brochure, National Museum of Australia, Canberra.

O'Mallon, F. & Tiernan, F. 2020, 'Australia's 2019-20 bushfire season', *The Canberra Times*, 10 January, viewed 15 August, <<https://www.canberratimes.com.au/story/6574563/australias-2019-20-bushfire-season/>>.

Pacciardi, G. 2020, 'I brand che stanno aiutando l'Australia', *Collateral*, 7 January, viewed 15 August 2020, <<https://www.collater.al/brand-australia-foundraising/>>.

Pervin, N. , Phan, T. Q., Datta, A., Takeda, H. & Toriumi, F. 2015, 'Hashtag Popularity on Twitter: Analyzing Co-occurrence of Multiple Hashtags', G. Meiselwitz (ed.), *Social Computing and Social MediaSCSM 2015. Lecture Notes in Computer Science* , Springer International Publishing Switzerland, pp. 169-182.

Plucinski, M., Gould. J., McCarthy, G. & Hollis, J. 2007, *The Effectiveness and Efficiency of Aerial Fire Fighting in Australia, Part 1*, Bushfire Co-operative Research Centre, Australia.

R Documentation n.d., *textplot_wordcloud: Plot features as a word cloud*, viewed 15 January 2021, <https://www.rdocumentation.org/packages/quanteda/versions/2.1.2/topics/textplot_wordcloud>.

Ross, M. & Quince, A. 2020, 'The history of fire in Australia — and how it can help us face the bushfires of the future', BBC News, 10 February, viewed 15 August 2020, <<https://www.abc.net.au/news/2020-02-10/fires-bushfires-in-australia-history-lessons-for-future/11937652>>.

Samuel, S. 2020, A staggering 1 billion animals are now estimated dead in Australia's fires, Vox, viewed 20 February 2020, <<https://www.vox.com/future-perfect/2020/1/6/21051897/australia-fires-billion-animals-dead-estimate>>.

Serafini, L. 2020, 'Il WWF in prima linea per l'Australia: aiutiamola!', *Rivista Natura*, 13 January, viewed 15 August 2020, <<https://rivistanatura.com/wwf-per-laustralia-aiutiamolo/>>.

Singh, I. 2020, 'Top maps and charts that explain the terrifying 2019-20 Australian bushfires', *Geo Awesomeness*, 6 January, viewed 15 August, <<https://www.geoawesomeness.com/map-charts-graphics-explain-australian-bush-fires/>>.

Slezak, M. 2020, '3 billion animals killed or displaced in Black Summer bushfires, study estimates', *ABC News*, 28 July, viewed 15 August, <<https://www.abc.net.au/news/2020-07-28/3-billion-animals-killed-displaced-in-fires-wwf-study/12497976>>.

Taspinar 2020, *Twitterscraper*, Github, viewed 15 January 2021, <<https://github.com/taspinar/twitterscraper>>.

theguardian.com 2013, 'History of Australian bushfires: interactive', *The Guardian*, 1 December, viewed 15 August 2020, <<https://www.theguardian.com/news/datablog/interactive/2013/dec/01/history-bushfires-australia-interactive>>.

Time 2020, 'A map from researchers in Western Australia shows hundreds of wildfire hotspots across the nation as of Wednesday, Jan. 1, 2020', viewed 15 August 2020, <<https://time.com/5753584/bushfires-australia-catastrophic-fire-alert/>>.

Tolhurst, K. 2020, 'It's 12 months since the last bushfire season began, but don't expect the same this year', *The Conversation*, 10 June, viewed 15 August, <<https://theconversation.com/its-12-months-since-the-last-bushfire-season-began-but-dont-expect-the-same-this-year-139757>>.

Trafford Data Lab 2020, *Exploring tweets in R*, Medium, viewed 15 January 2021, <<https://medium.com/@traffordDataLab/exploring-tweets-in-r-54f6011a193d>>.

Varghese, T. K. 2017, 'How Does Information Spread on Social Media Lead to Effective Change?', *Clin Colon Rectal Surg*, vol. 30, no. 4, pp. 240-243.

We Are Social 2020, *Digital 2020 Australia*, We Are Social, viewed 15 August 2020, <<https://wearesocial.com/au/digital-2020-australia>>.

Williams, L.T. 2011, 'The worst bushfires in Australia's history', *Australian Geographic*, 11 November, viewed 15 August 2020,

<<https://www.australiangeographic.com.au/topics/science-environment/2011/11/the-worst-bushfires-in-australias-history/>>.

Withey, A. 2019, 'Bushfire season starts early across northern Australia due to ongoing hot, dry conditions', *ABC News*, 27 June, viewed 15 August 2020,

<<https://www.abc.net.au/news/2019-06-27/bushfire-outlook-queensland-2019/11251150>>.

Yellow 2020, *Yellow Social Media Report 2020*, July 2020, Melbourne, Victoria,

<https://2k5zke3drtv7fuwec1mzuxgv-wpengine.netdna-ssl.com/wp-content/uploads/2020/07/Yellow_Social_Media_Report_2020_Consumer.pdf>.

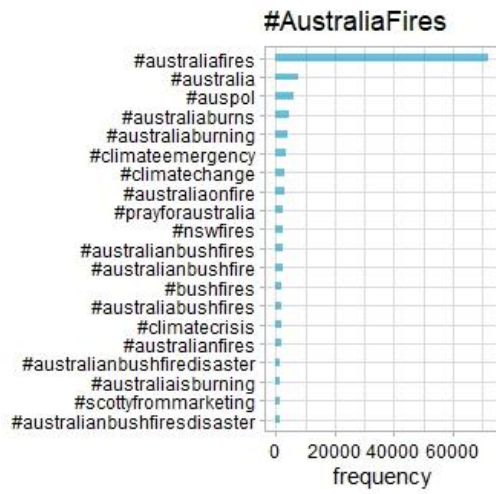
Yi, M. 2019, *A Complete Guide to Bar Charts*, Chartio, viewed 15 January 2021,

<<https://chartio.com/learn/charts/bar-chart-complete-guide/#:~:text=When%20you%20should%20use%20a,groups%20compare%20against%20the%20others.>>>.

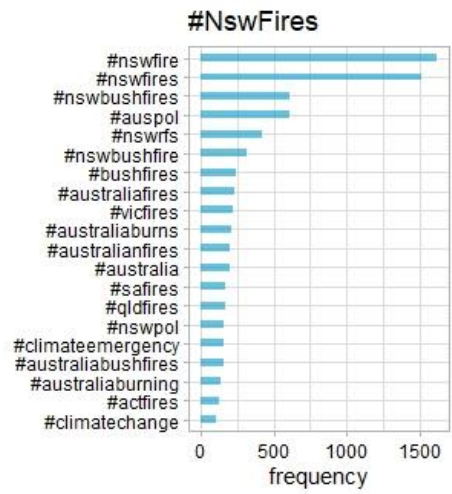
Yoo, E., Rand, W., Eftekhari, M. & Rabinovich, E. 2016, 'Evaluating information diffusion speed and its determinants in social media networks during humanitarian crises', *Journal of Operations Management*, vol.45, pp. 123-133.

Appendix Graphs

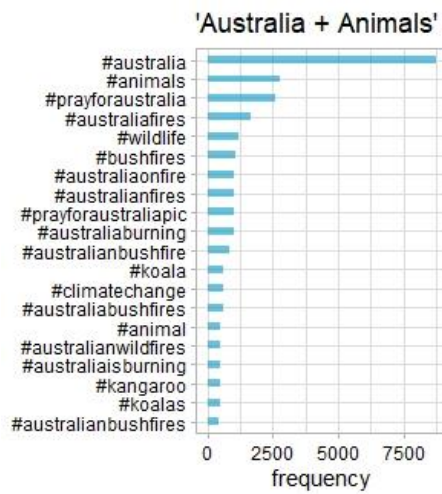
A - Hashtags Frequency



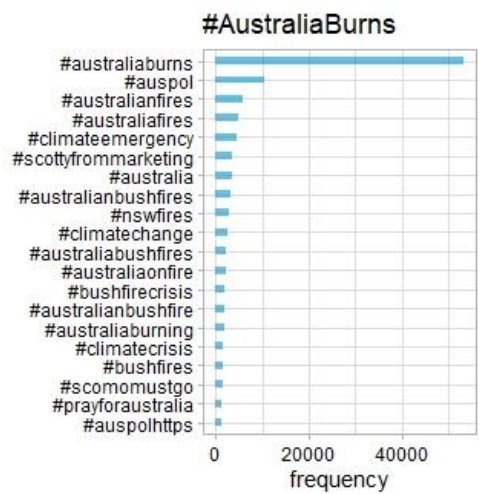
Graph 1a



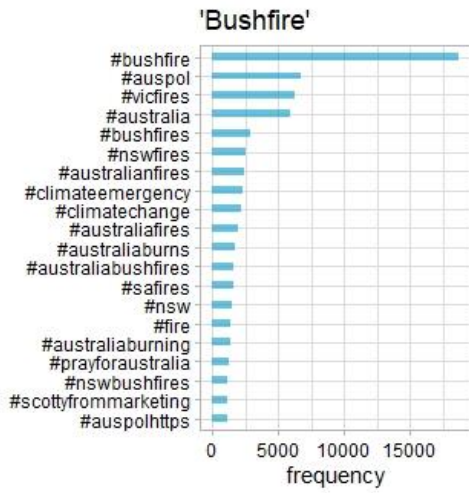
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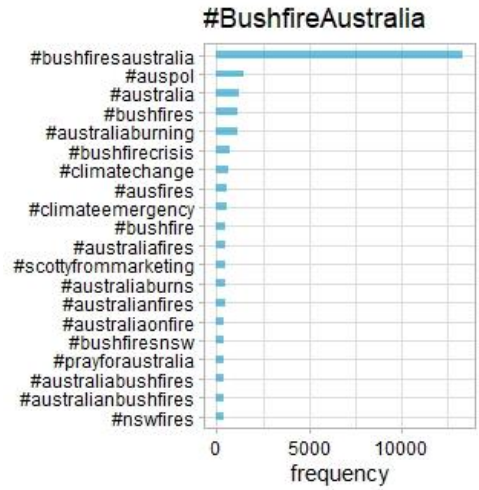
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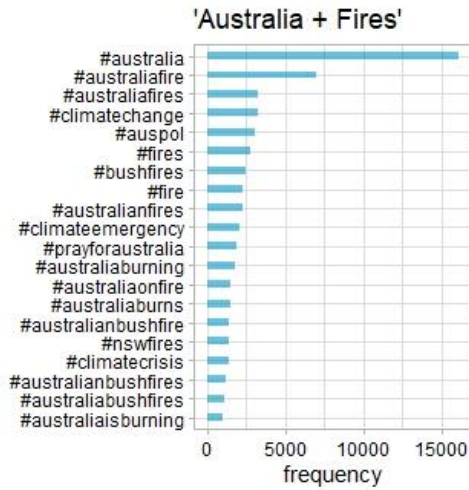
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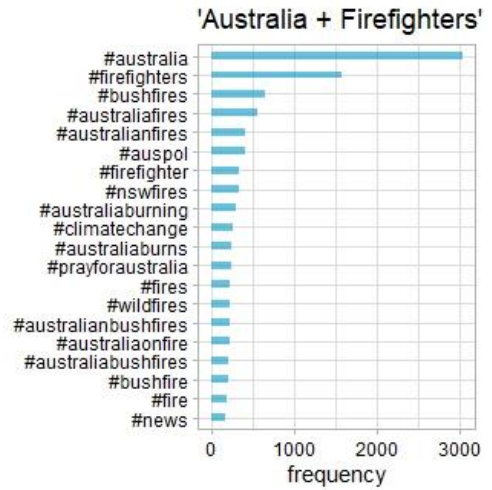
Graph 5a



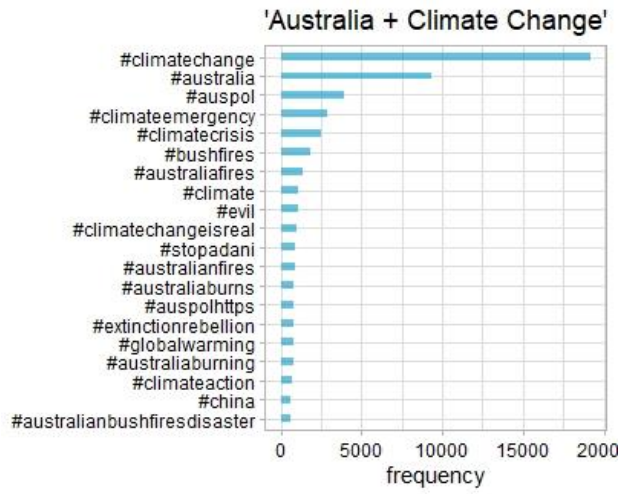
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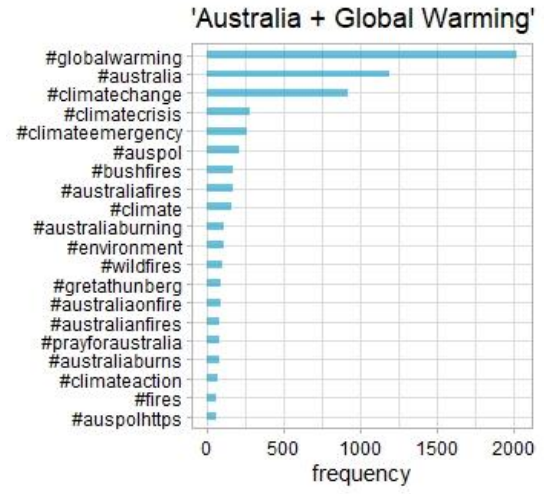
Graph 7a



Graph 8a



Graph 9a

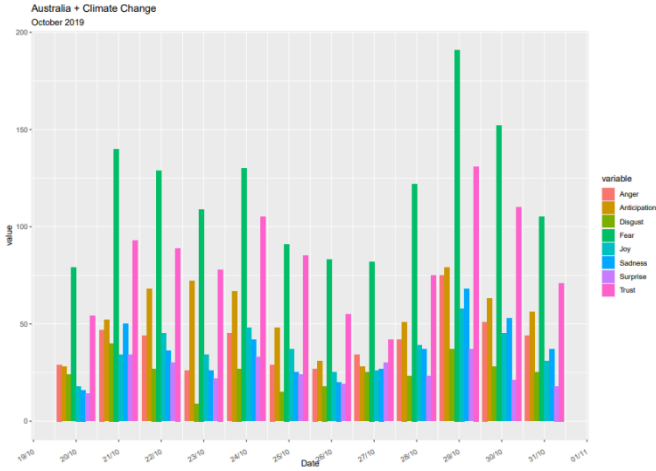


Graph 10a

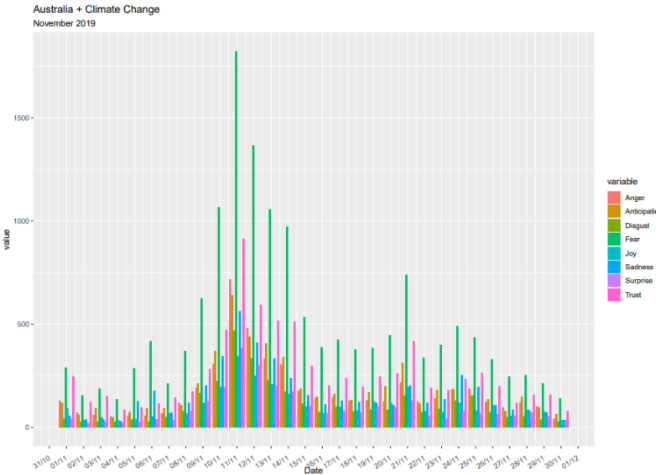
C - Sentiment Analysis

C.1 Sentiments

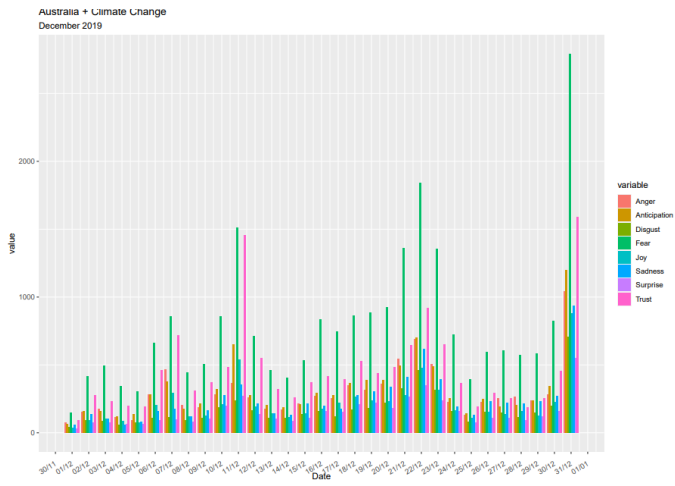
Australia + Climate Change



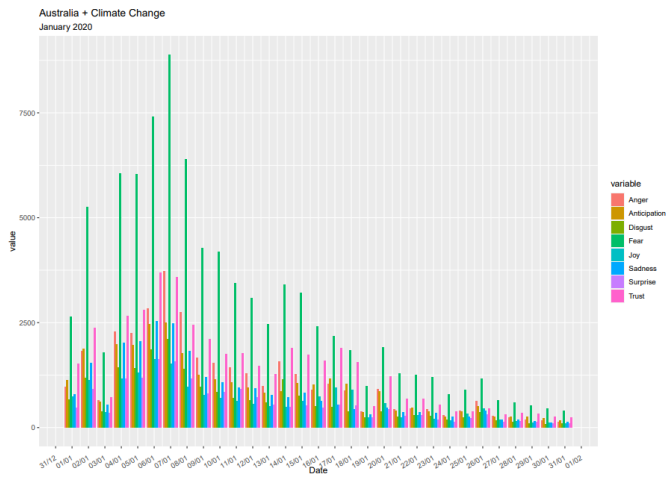
Graph 1c



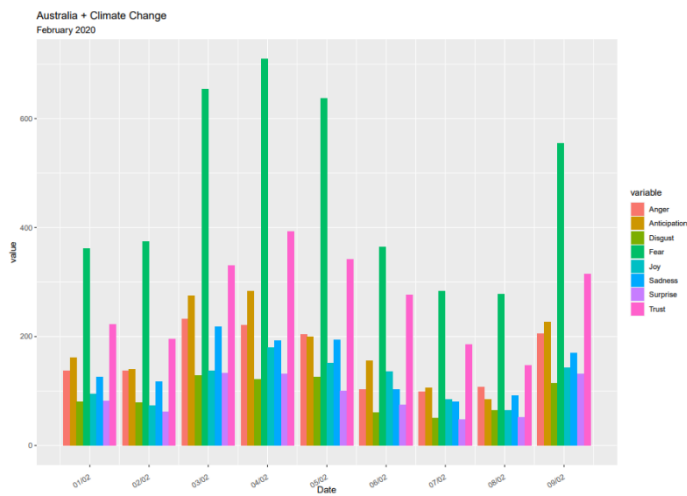
Graph 2c



Graph 3c

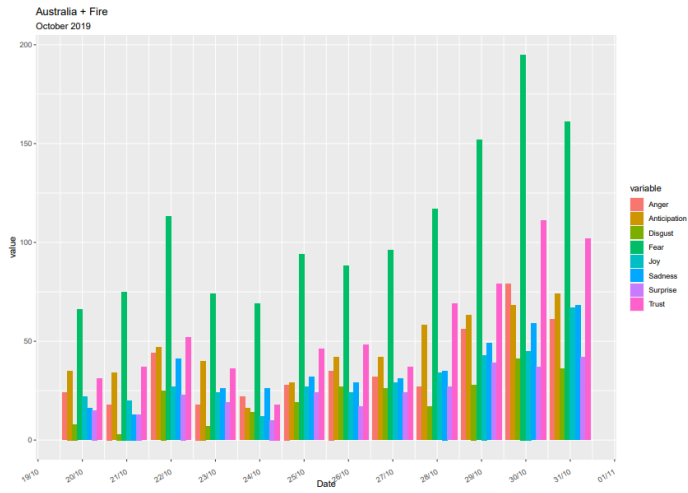


Graph 4c

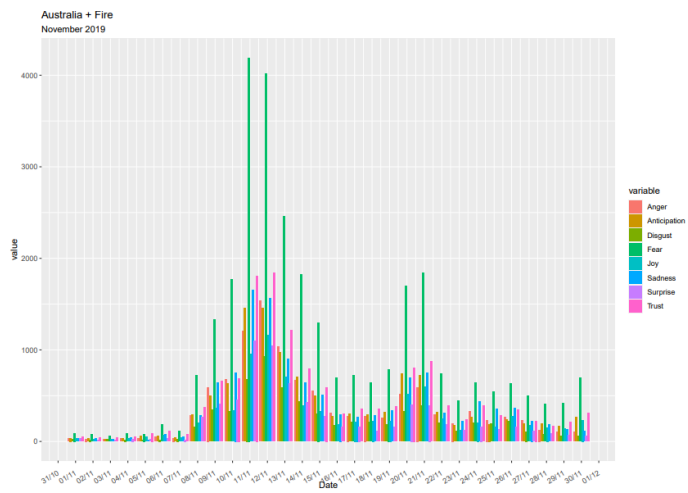


Graph 5c

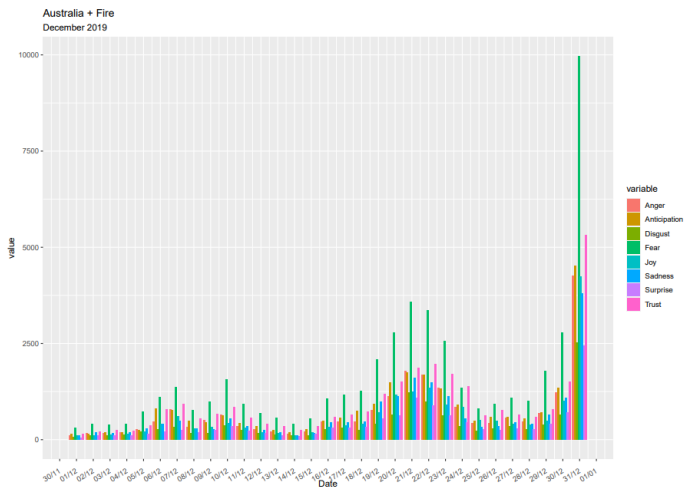
Australia + Fire



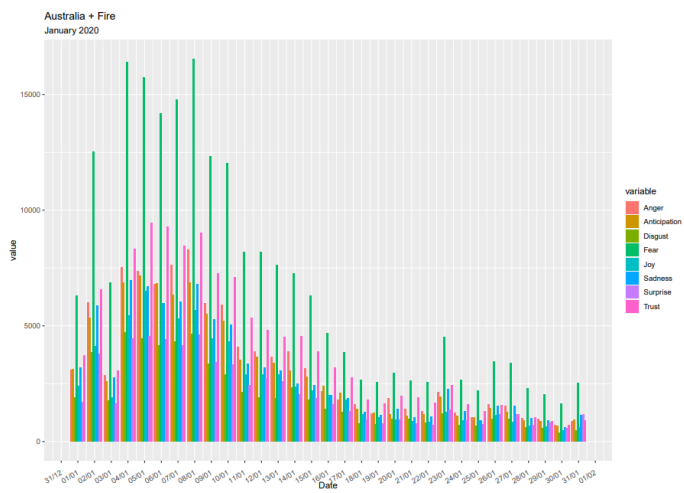
Graph 6c



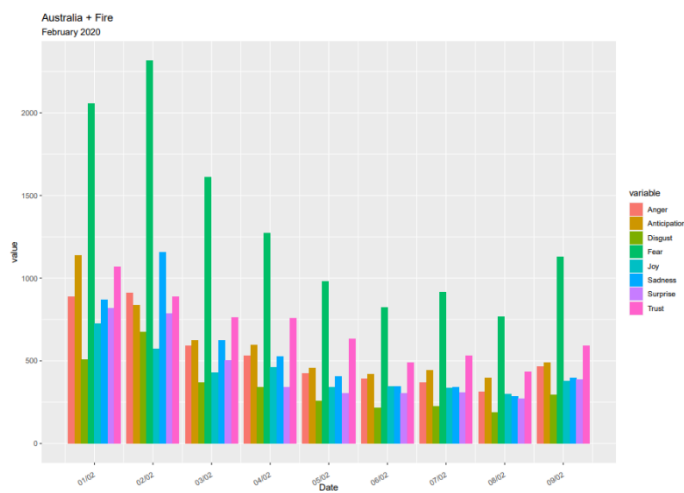
Graph 7c



Graph 8c

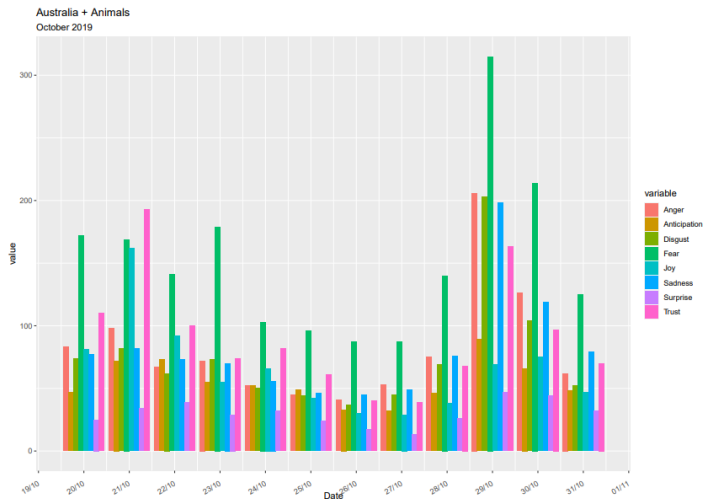


Graph 9c

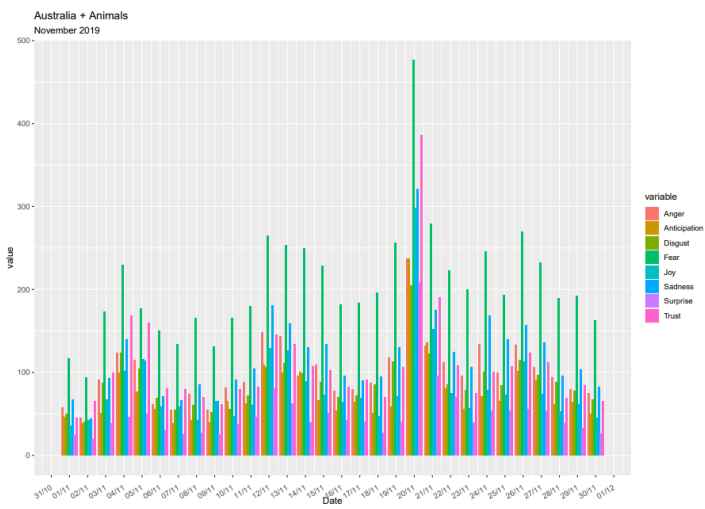


Graph 10c

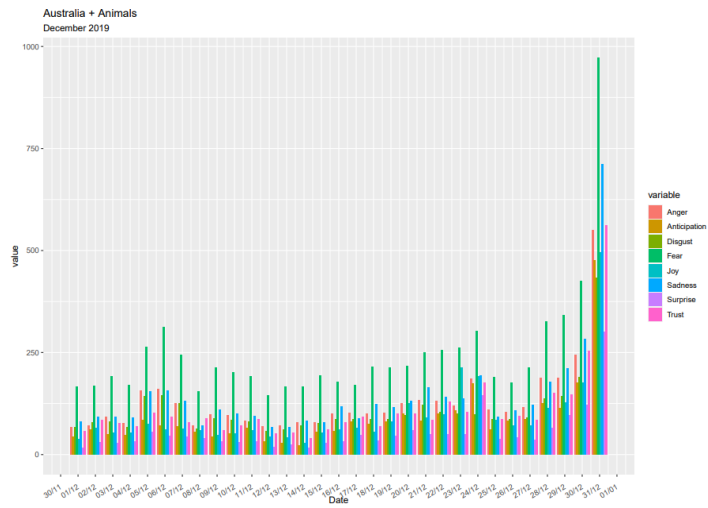
Australia + Animals



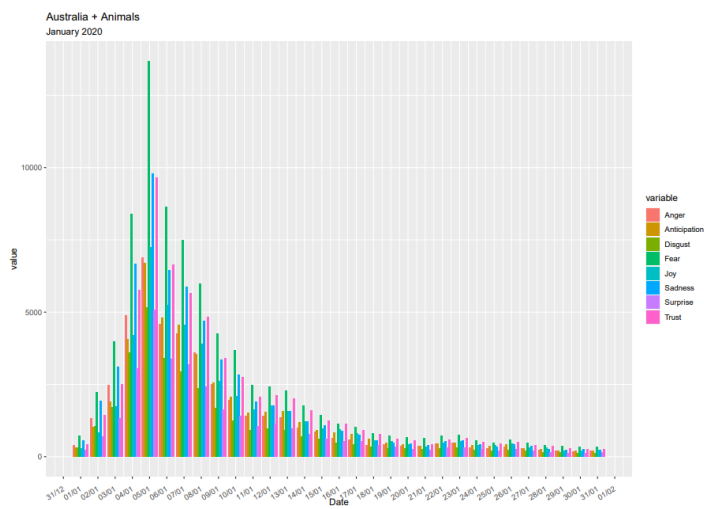
Graph 11c



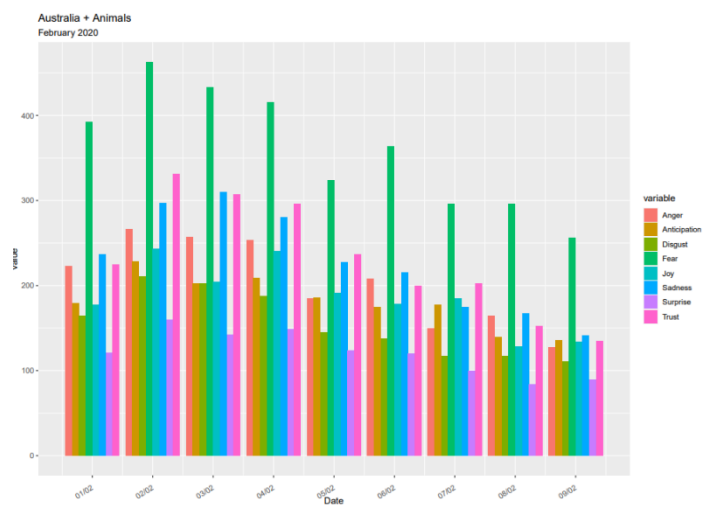
Graph 12c



Graph 13c

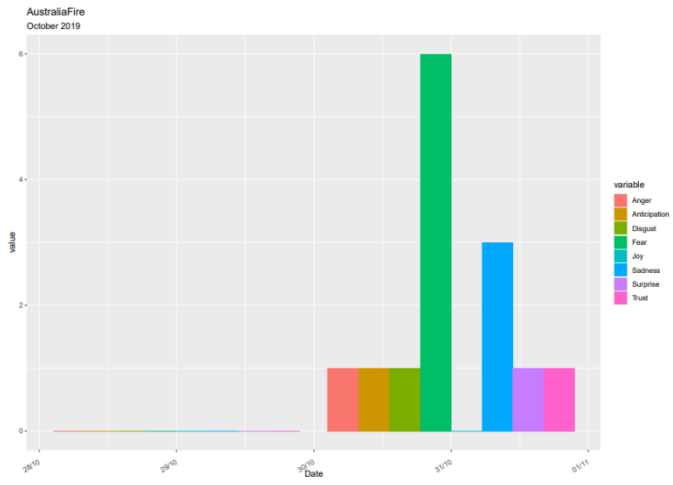


Graph 14c

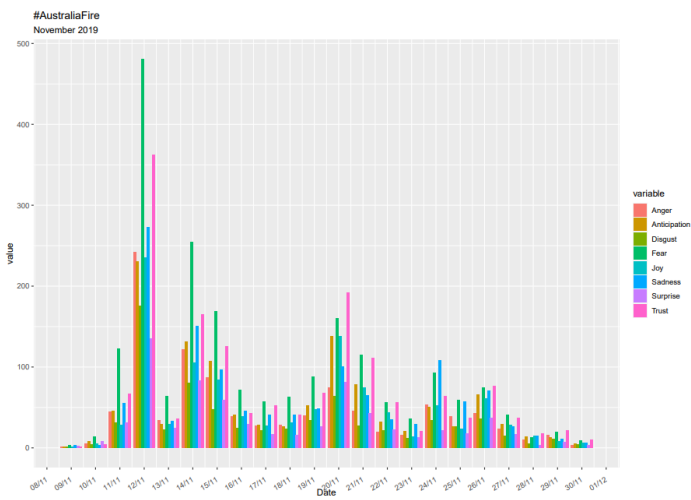


Graph 15c

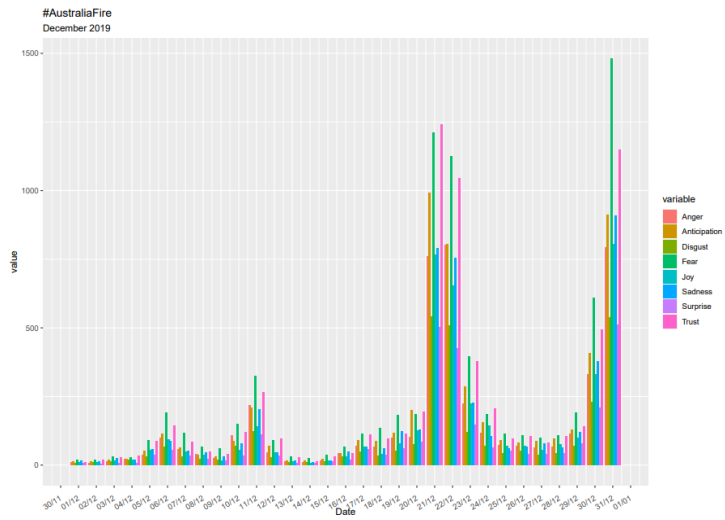
#AustraliaFire



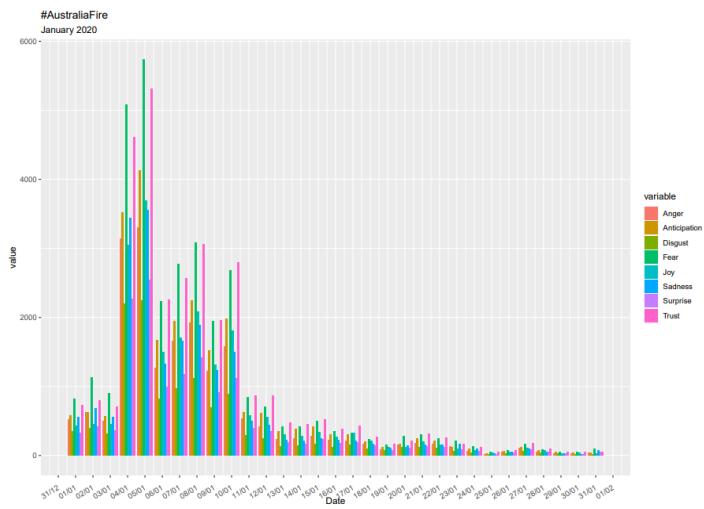
Graph 16c



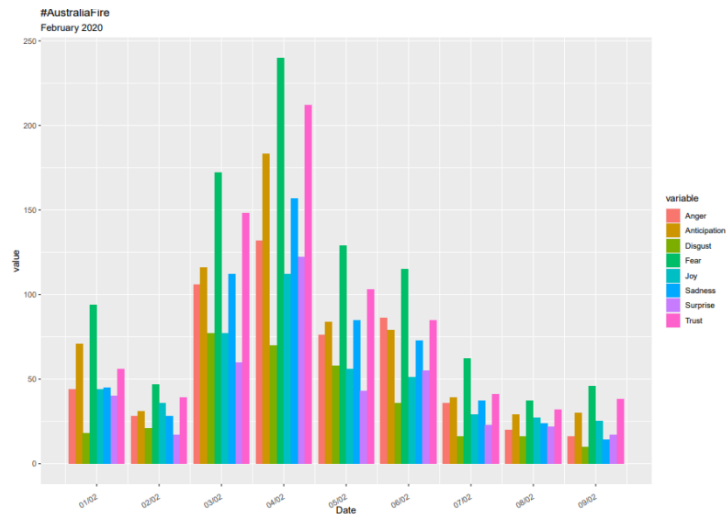
Graph 17c



Graph 18c

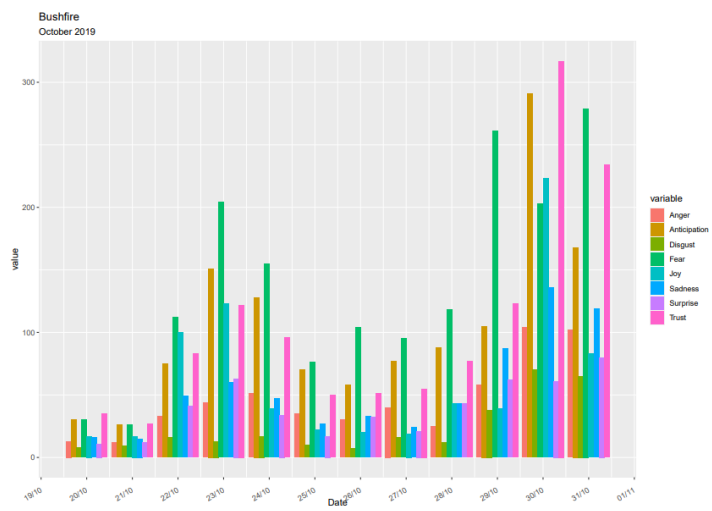


Graph 19c

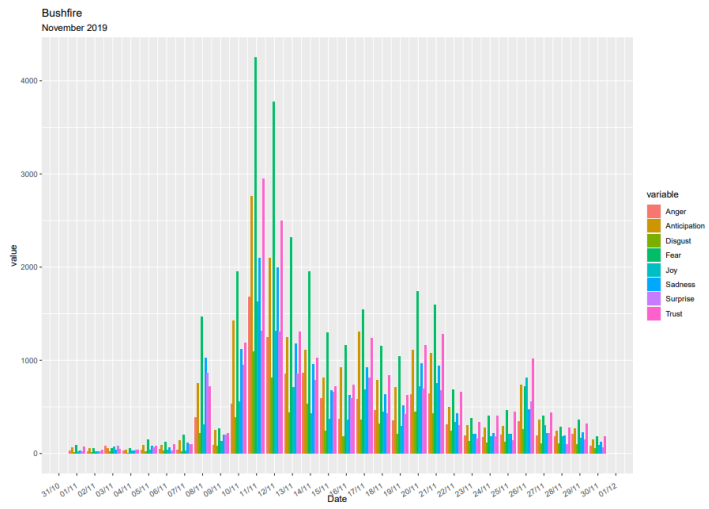


Graph 20c

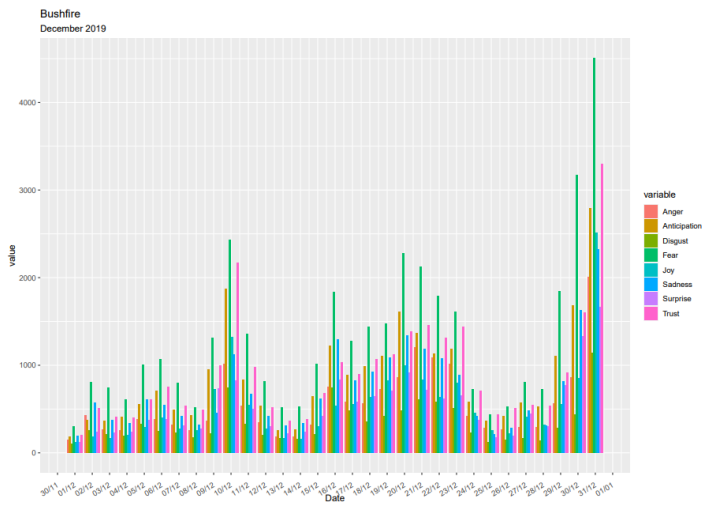
Bushfire



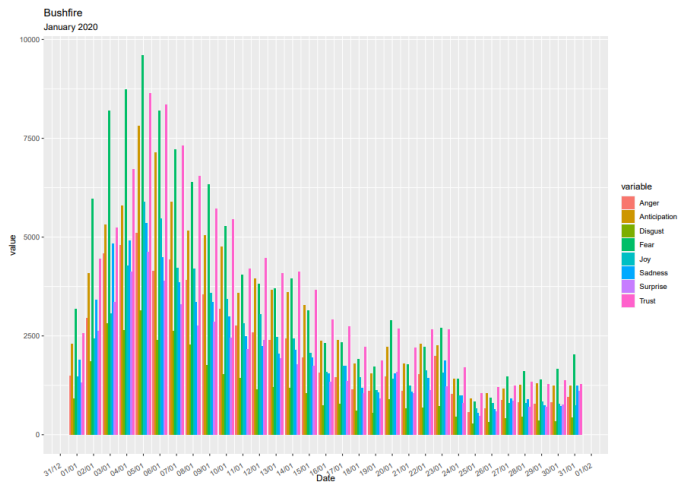
Graph 21c



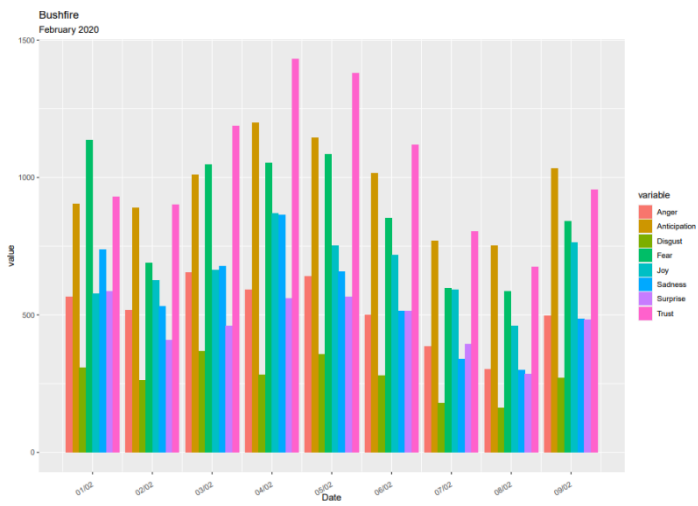
Graph 22c



Graph 23c

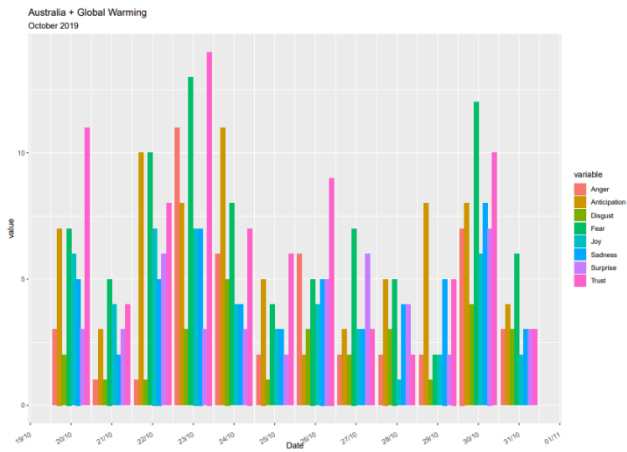


Graph 24c

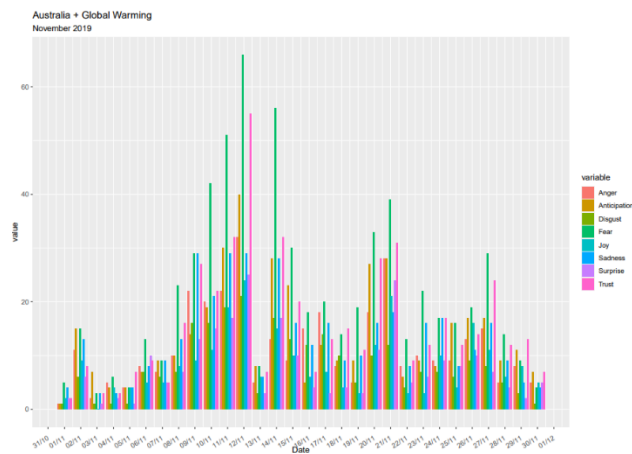


Graph 25c

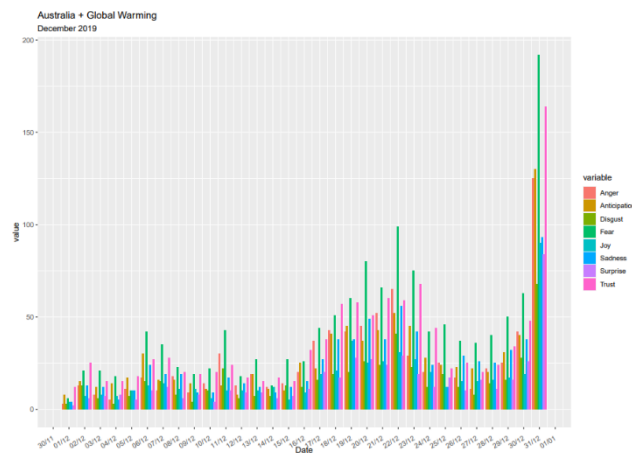
Australia + Global Warming



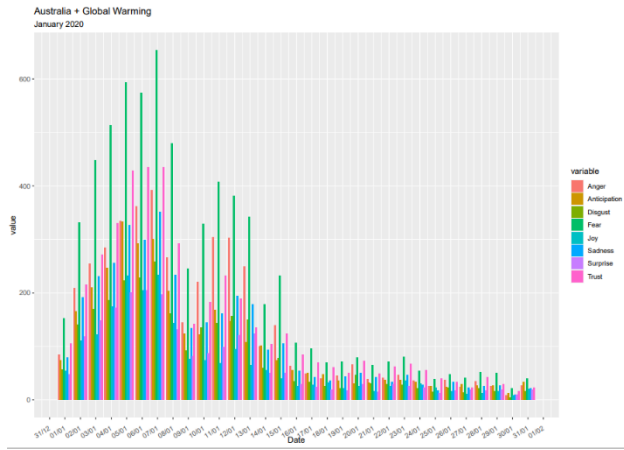
Graph 26c



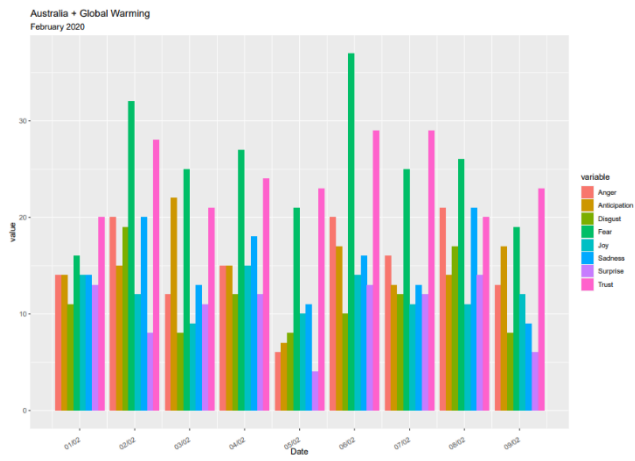
Graph 27c



Graph 28c

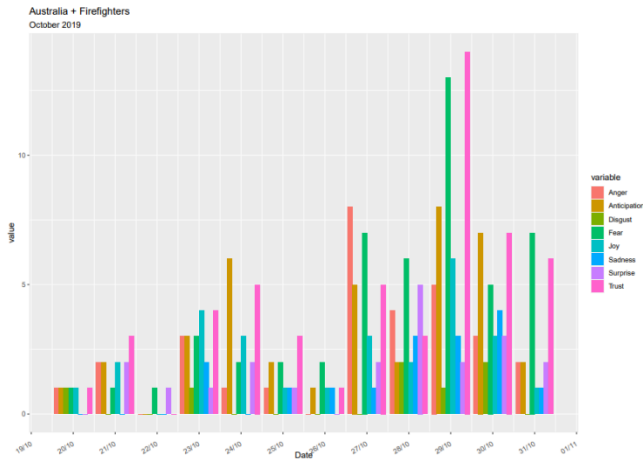


Graph 29c

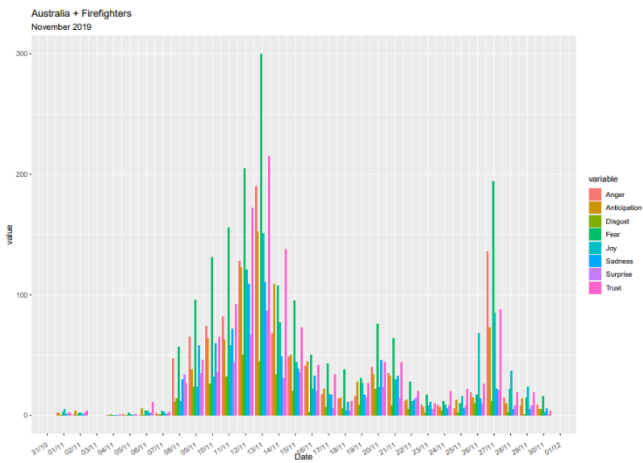


Graph 30c

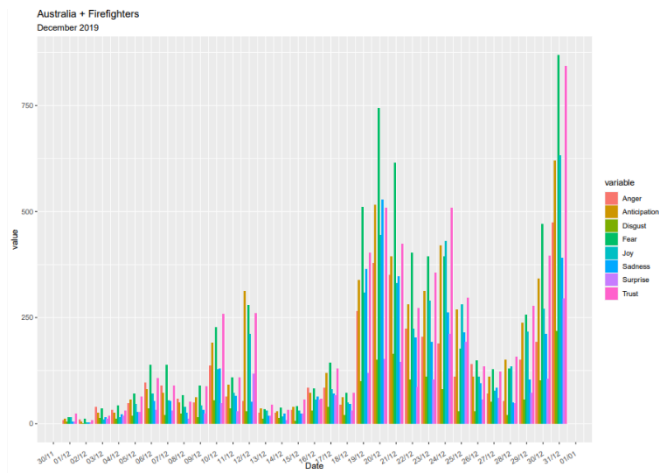
Australia + Firefighters



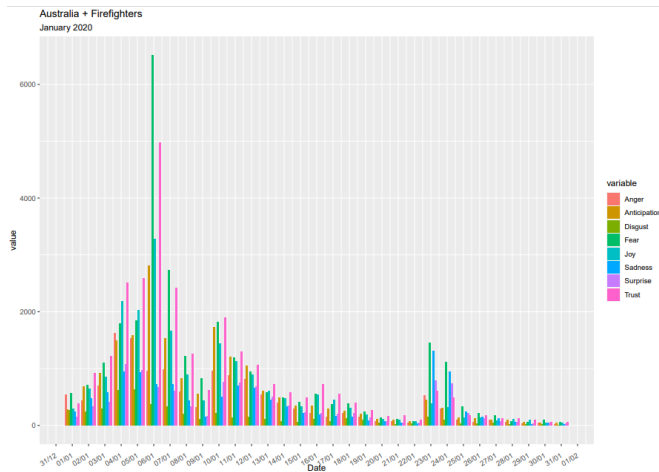
Graph 31c



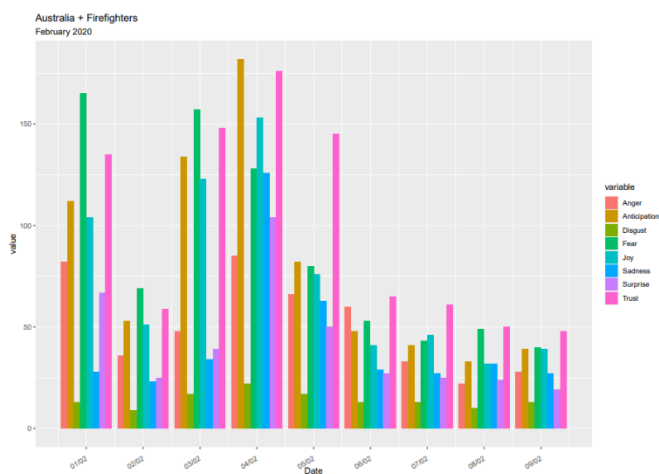
Graph 32c



Graph 33c

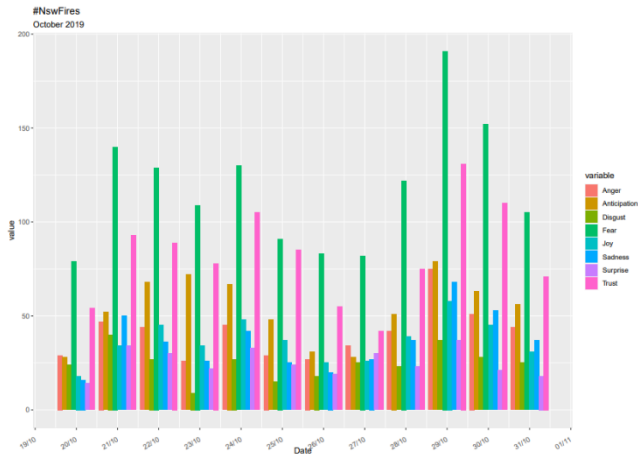


Graph 34c

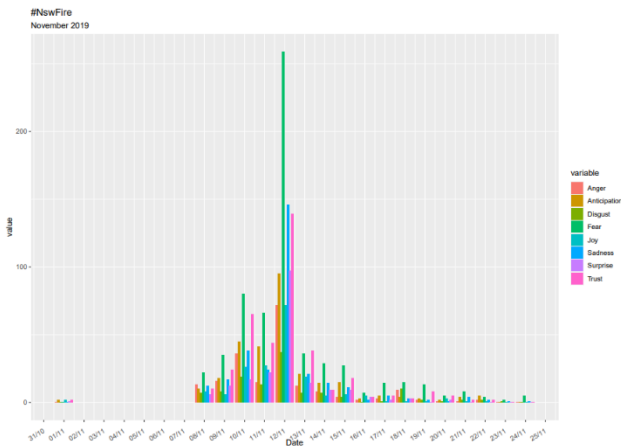


Graph 35c

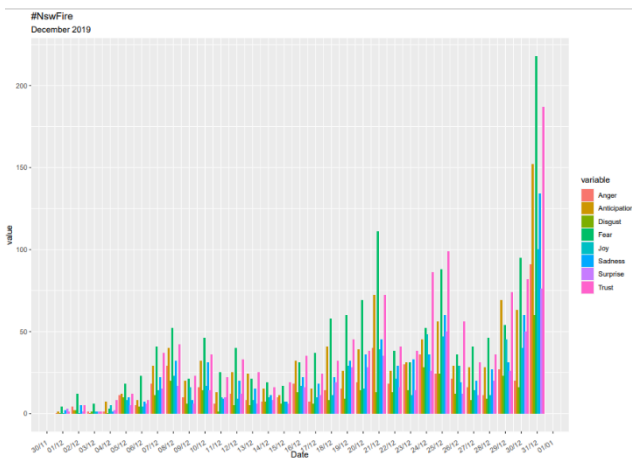
#NswFires



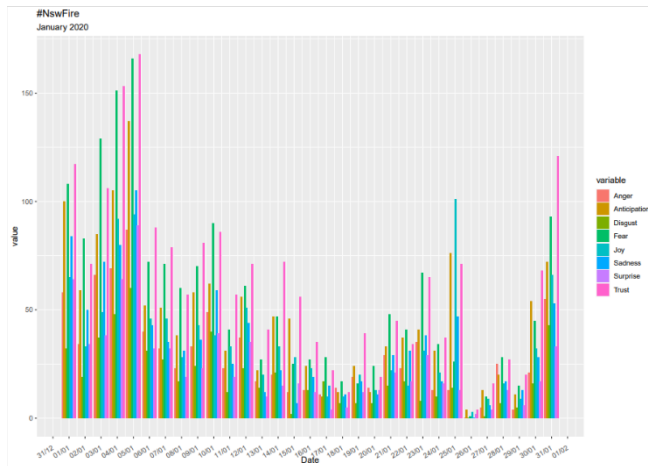
Graph 36c



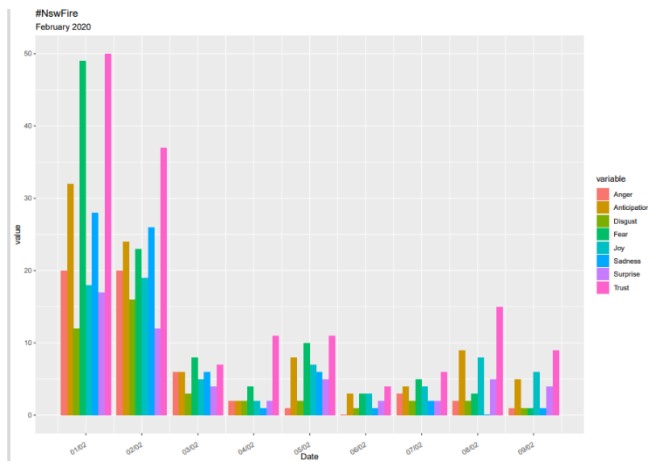
Graph 37c



Graph 38c

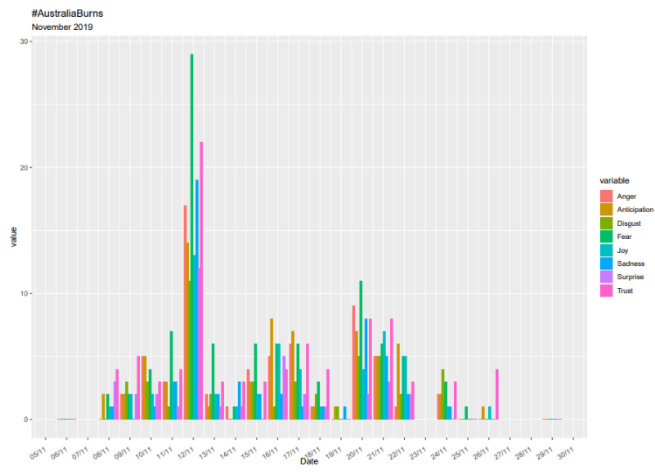


Graph 39c

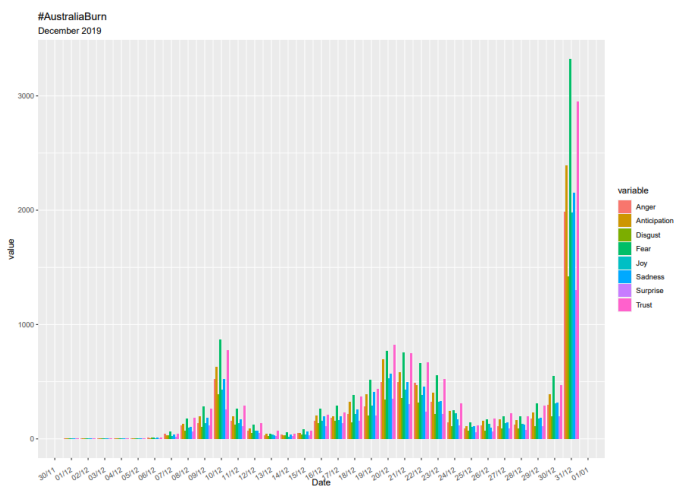


Graph 40c

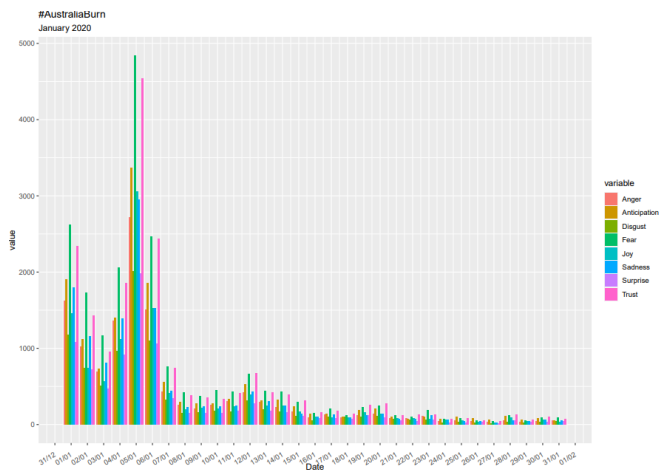
#AustraliaBurns



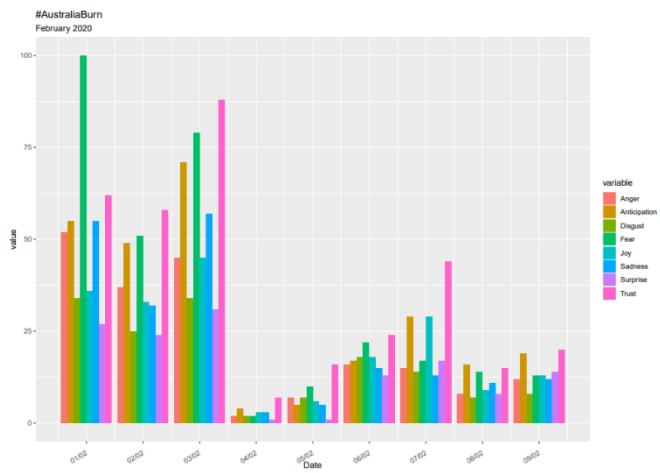
Graph 41c



Graph 42c

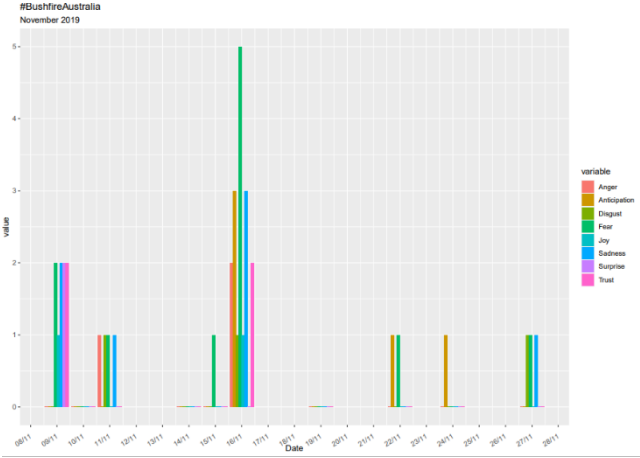


Graph 43c

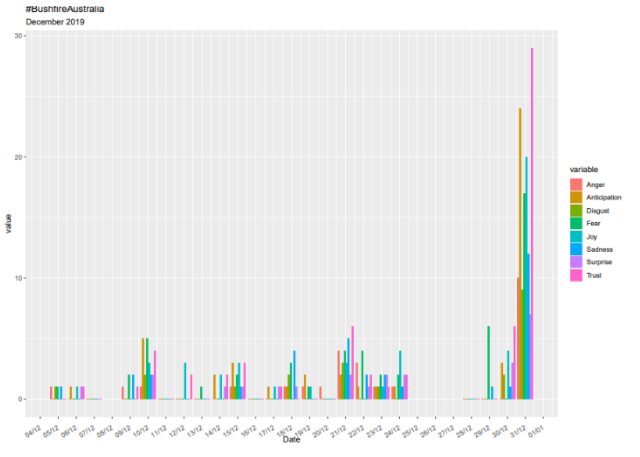


Graph 44c

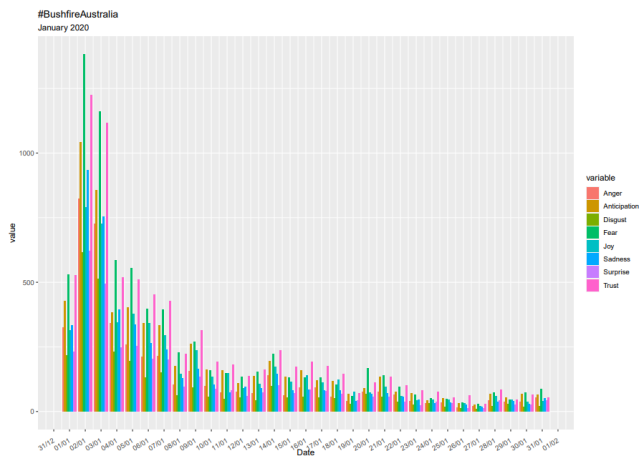
#BushfireAustralia



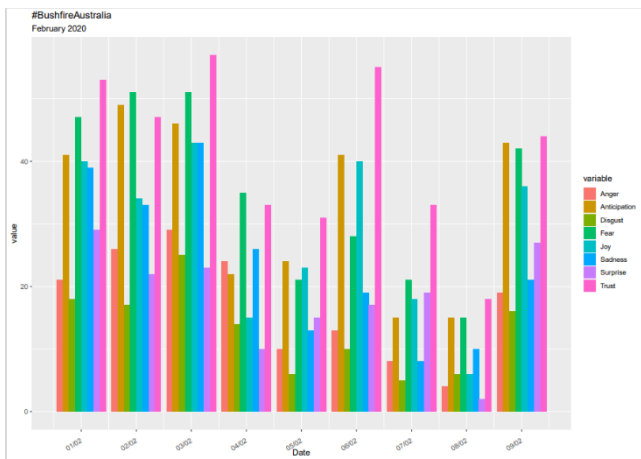
Graph 44c



Graph 45c



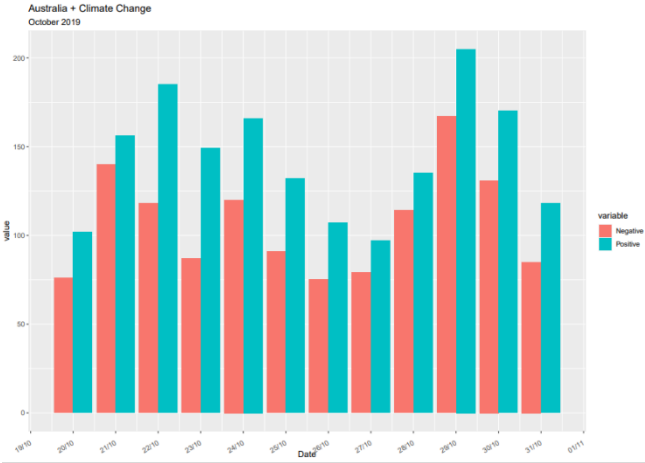
Graph 46c



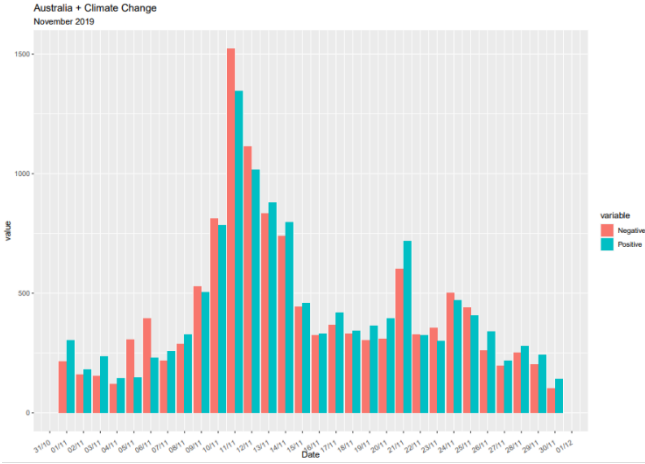
Graph 47c

C.2 Polarity

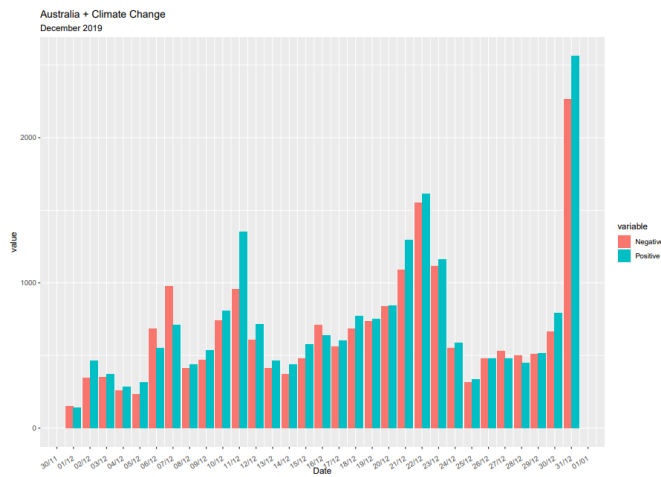
Australia + Climate Change



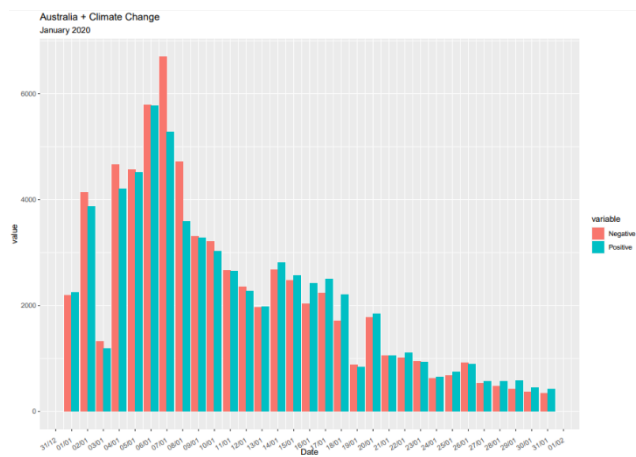
Graph 48c



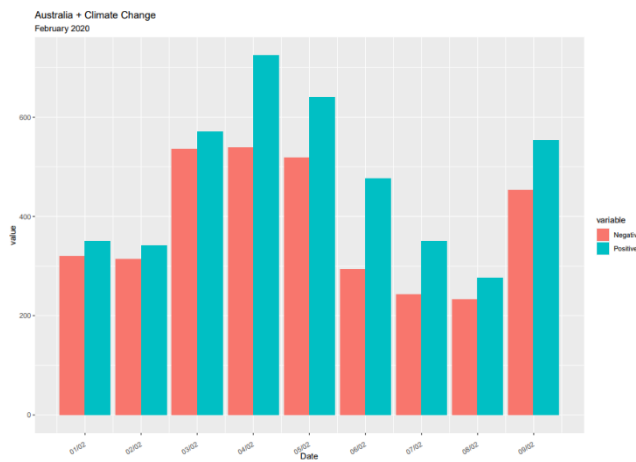
Graph 49c



Graph 50c

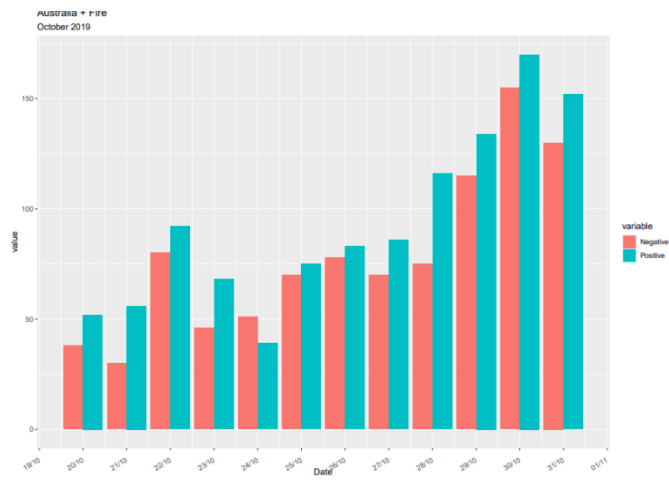


Graph 51c

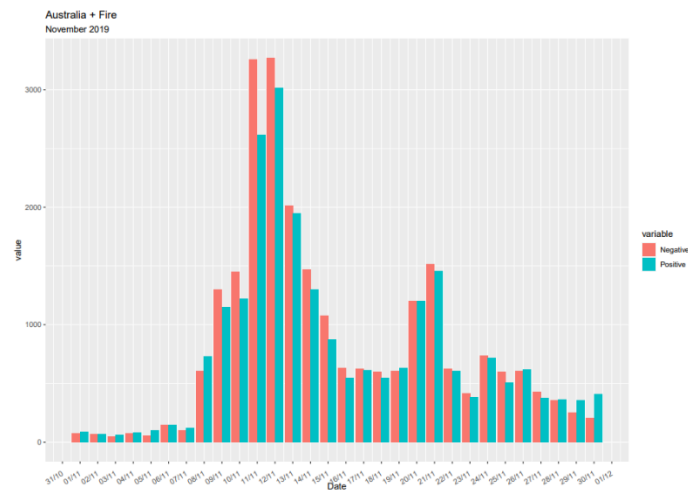


Graph 52c

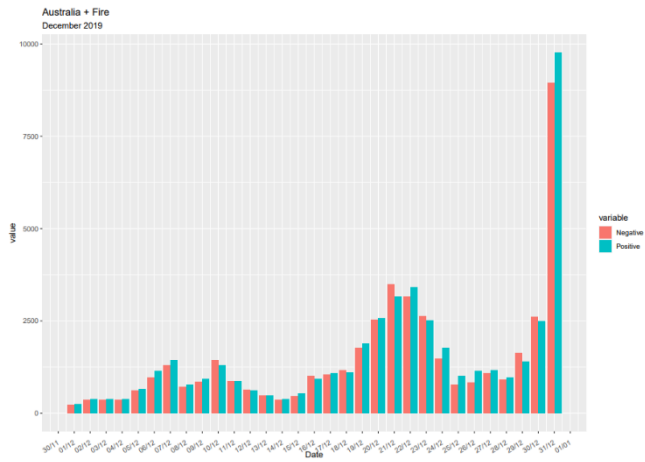
Australia + Fire



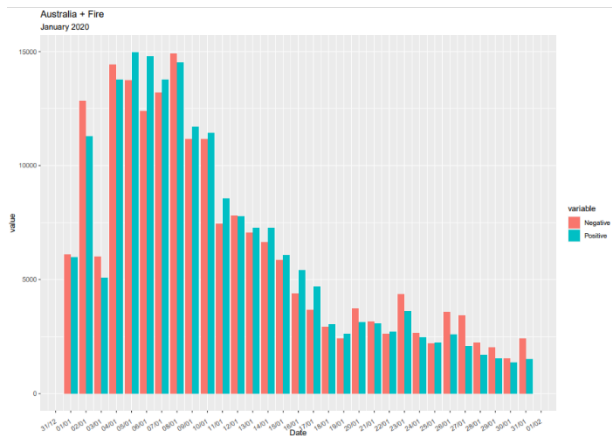
Graph 53c



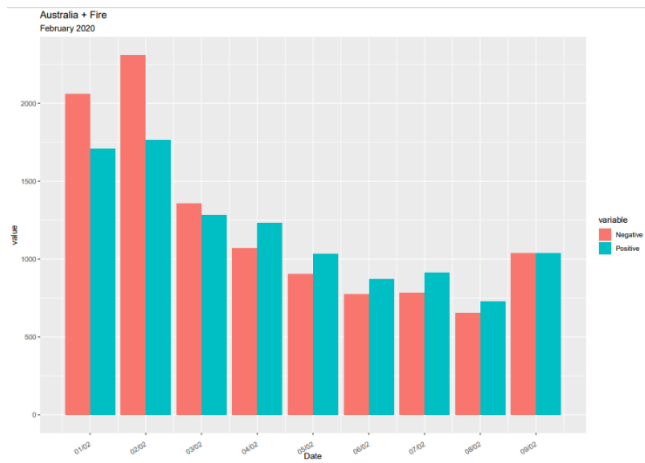
Graph 54c



Graph 55c

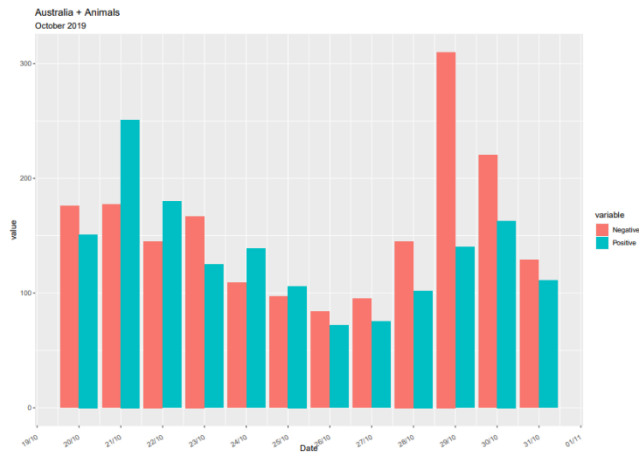


Graph 56c

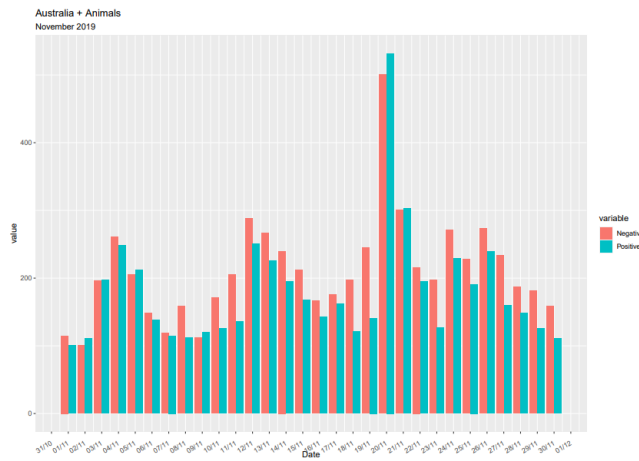


Graph 57c

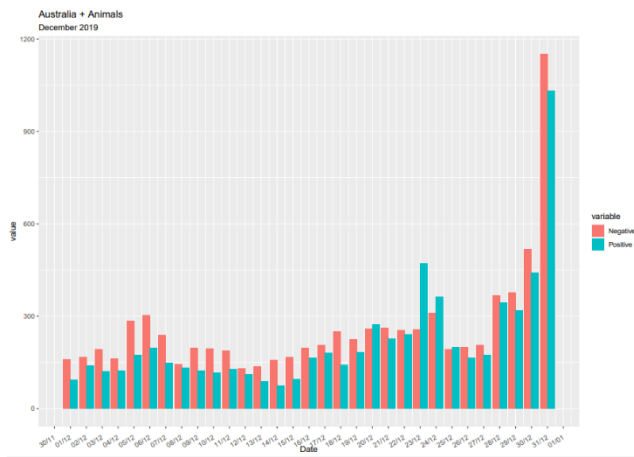
Australia + Animals



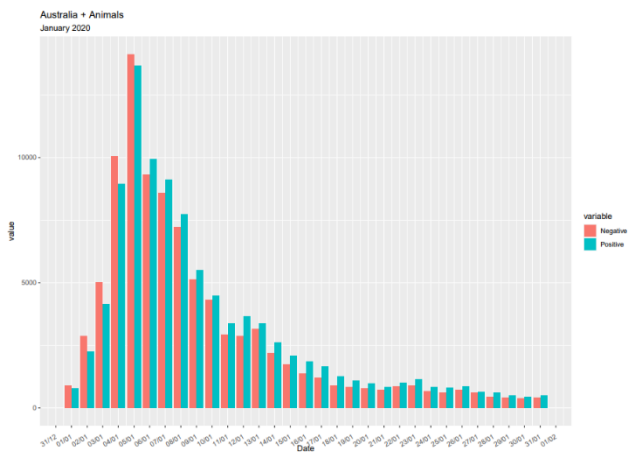
Graph 58c



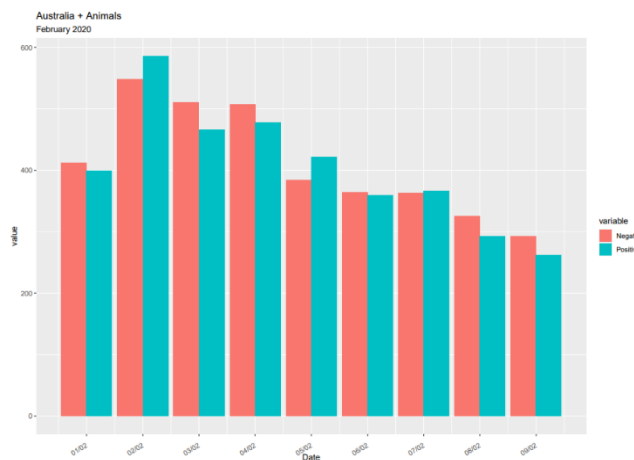
Graph 59c



Graph 60c

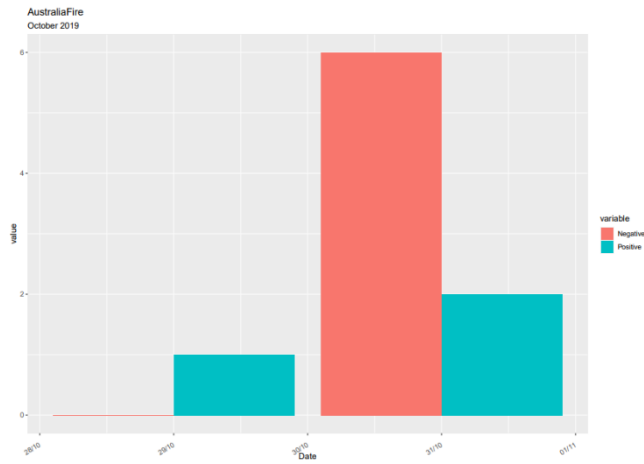


Graph 61c

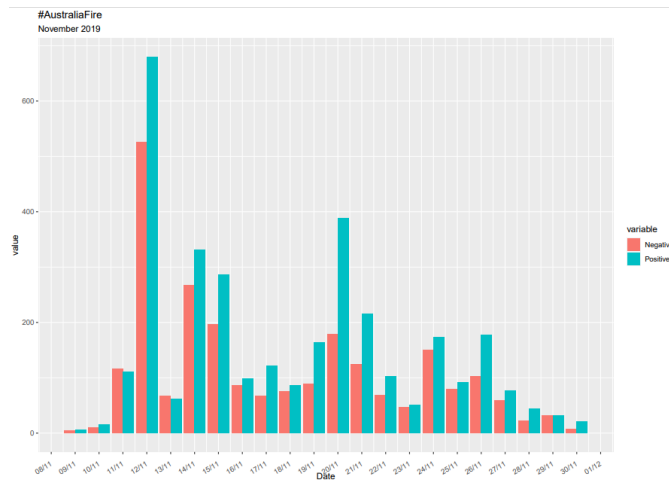


Graph 62c

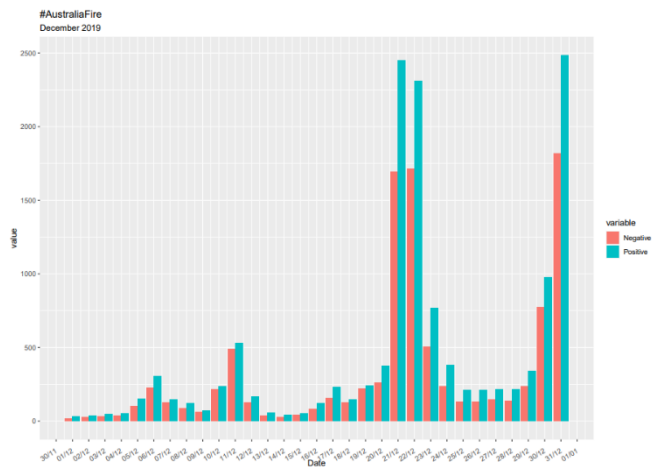
#AustraliaFire



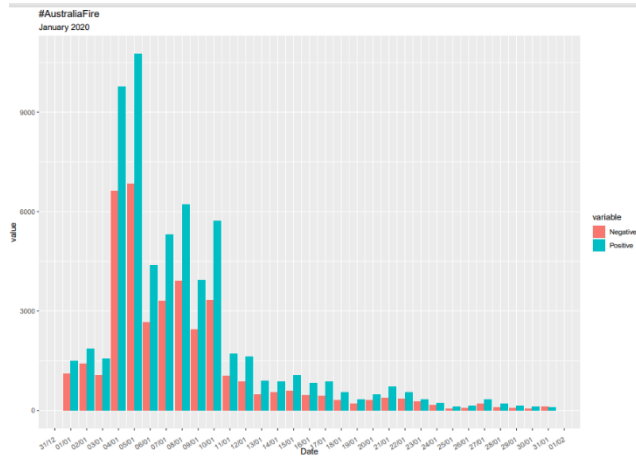
Graph 63c



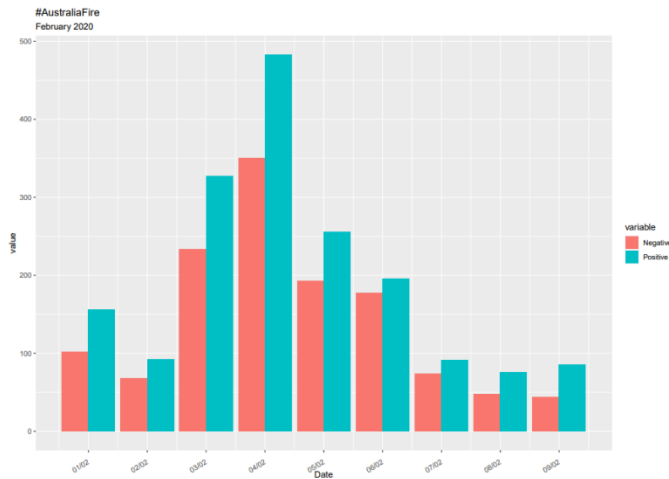
Graph 64c



Graph 65c

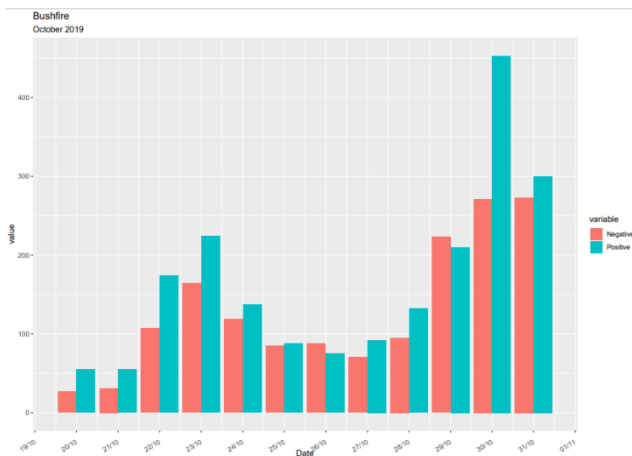


Graph 66c

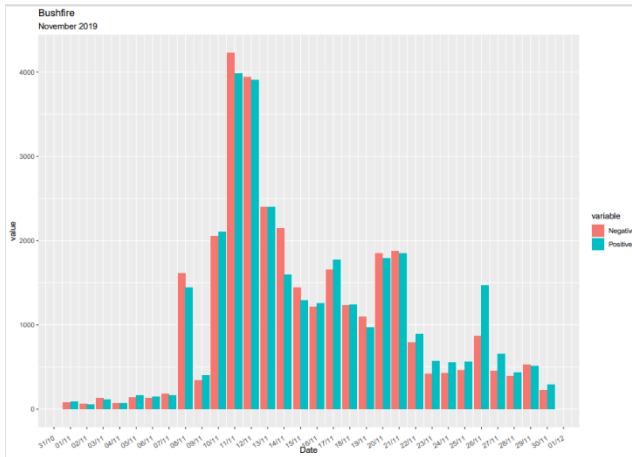


Graph 67c

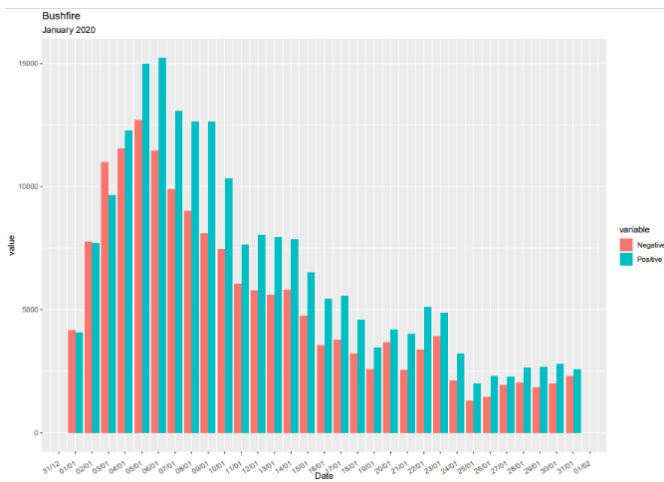
Bushfire



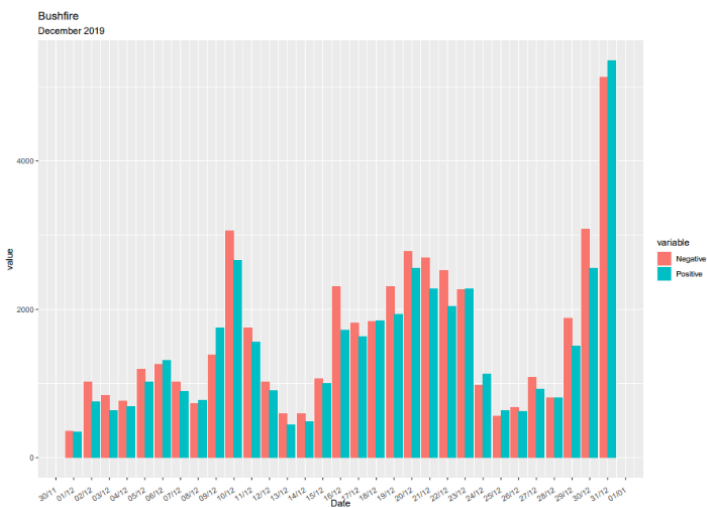
Graph 68c



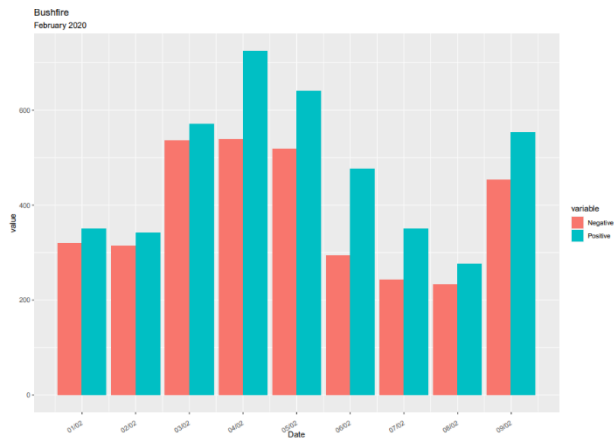
Graph 69c



Graph 70c

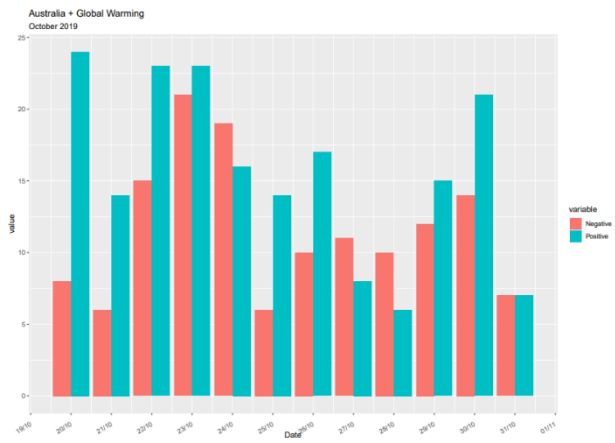


Graph 71c

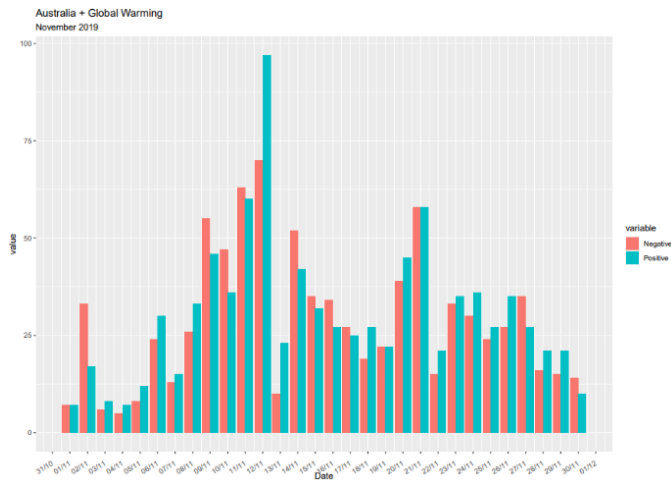


Graph 72c

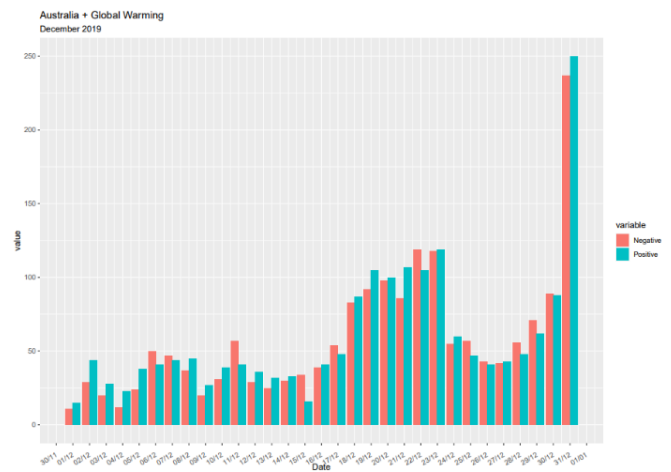
Australia + Global Warming



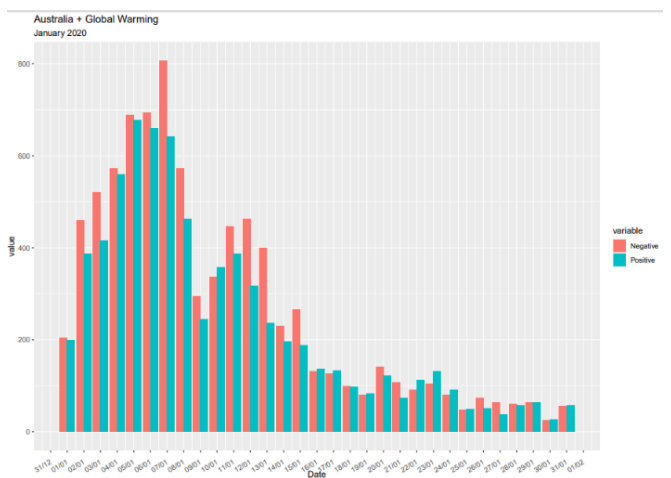
Graph 73c



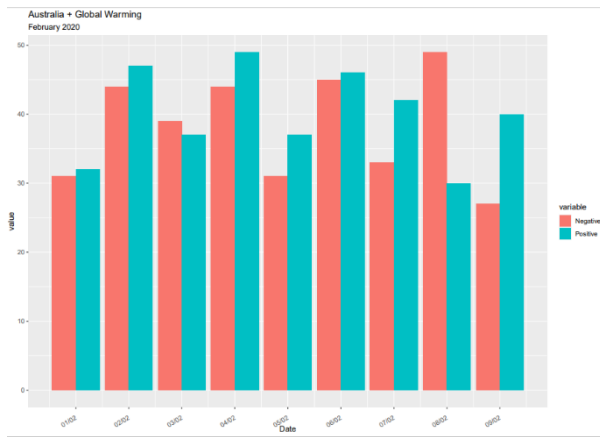
Graph 74c



Graph 75c

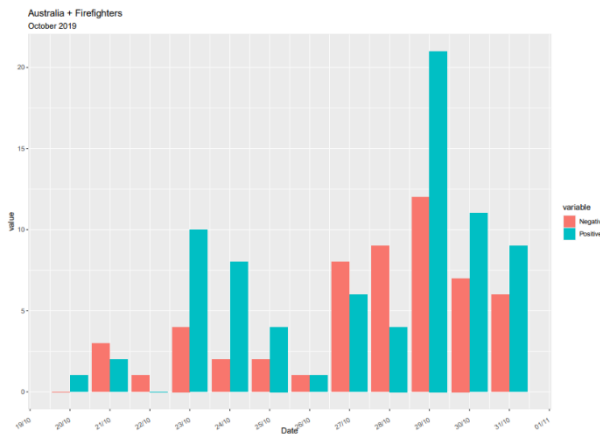


Graph 76c

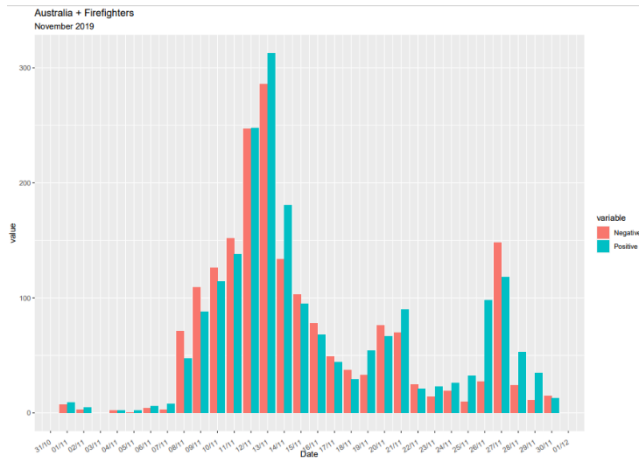


Graph 77c

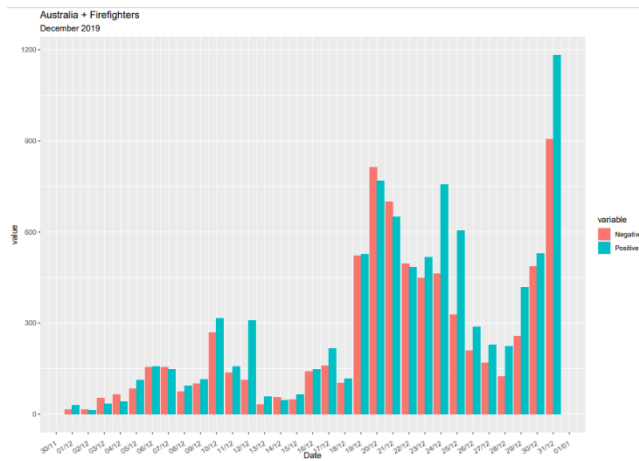
Australia + Firefighters



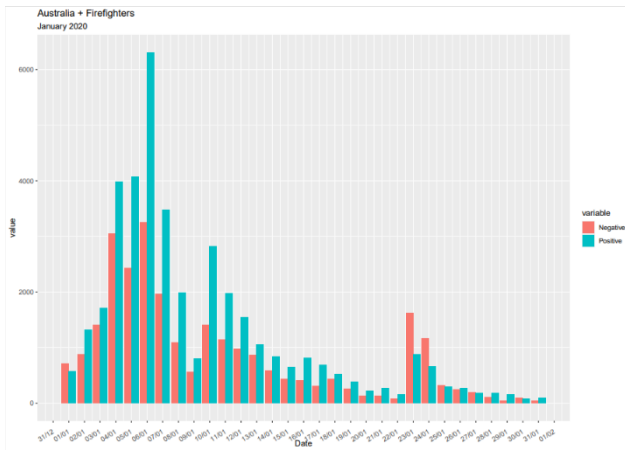
Graph 78c



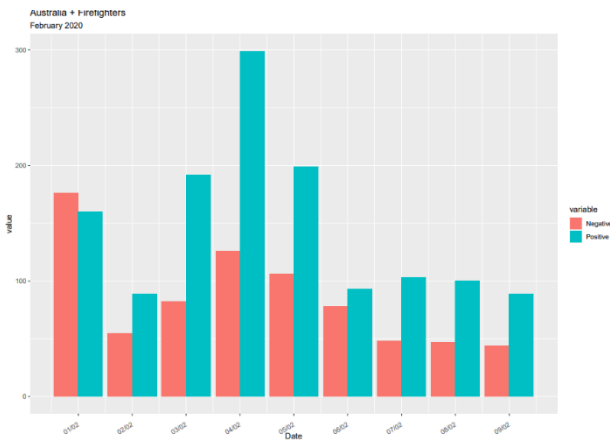
Graph 79C



Graph 80c

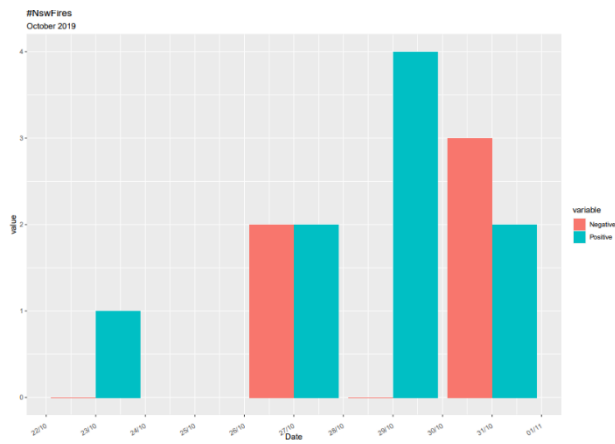


Graph 81c

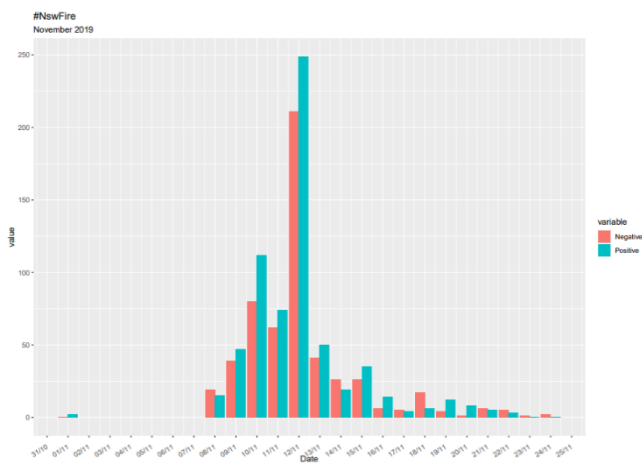


Graph 82c

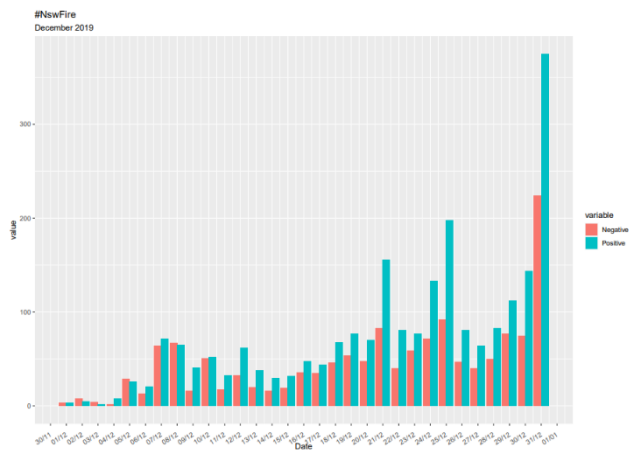
#NswFires



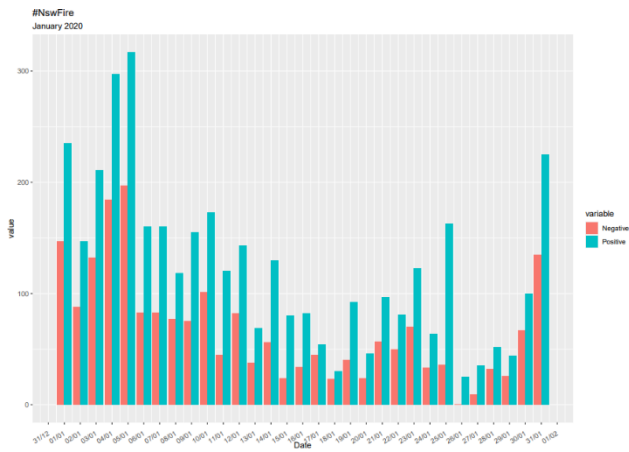
Graph 83c



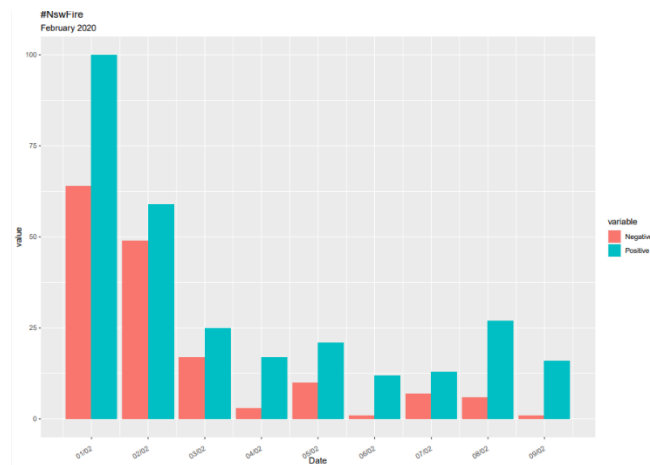
Graph 84c



Graph 85c

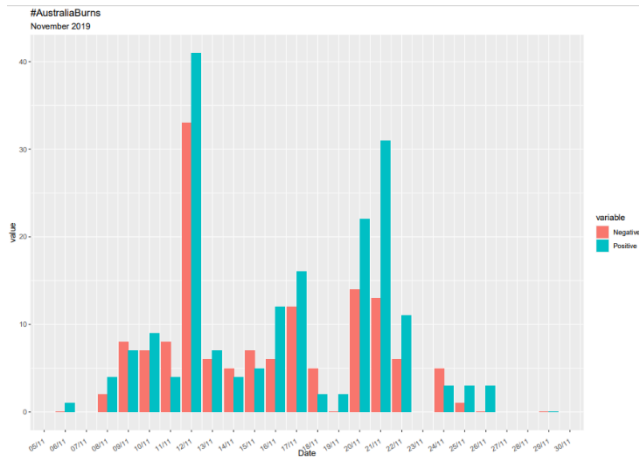


Graph 86c

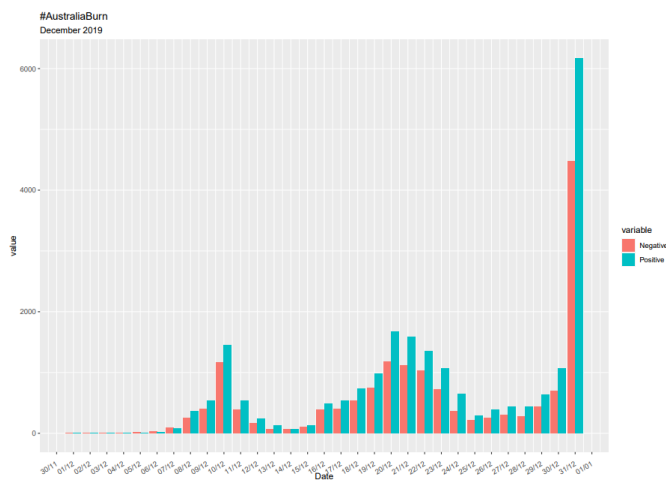


Graph 87c

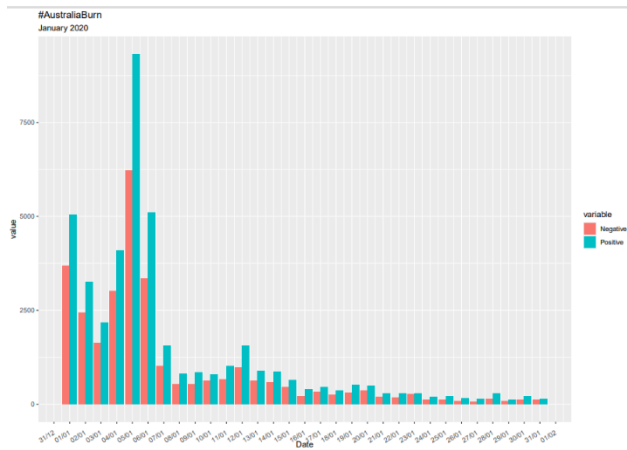
#AustraliaBurns



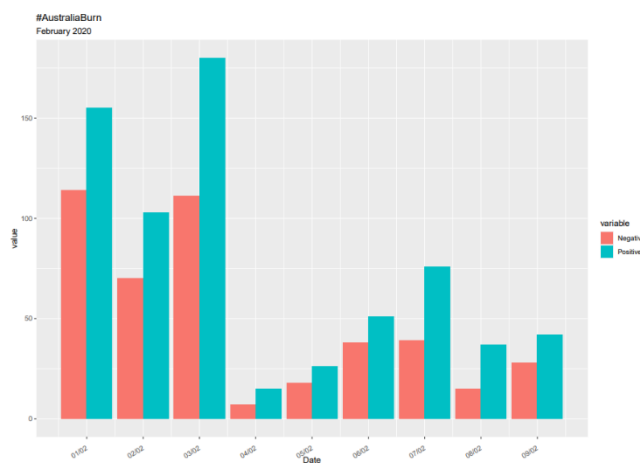
Graph 88c



Graph 89c

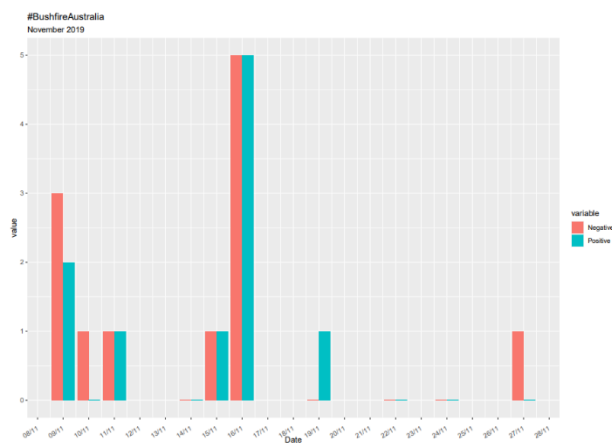


Graph 90c

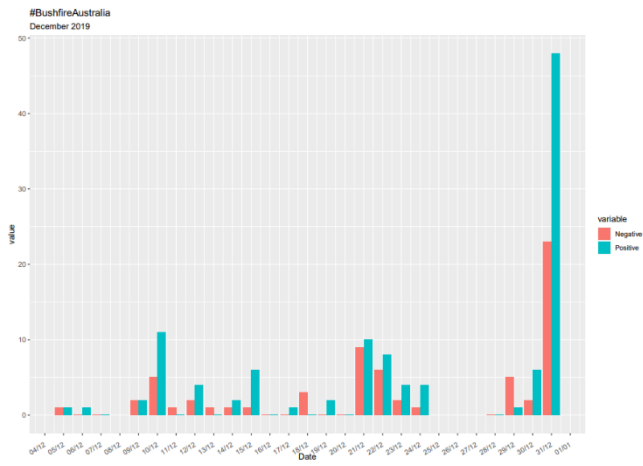


Graph 91c

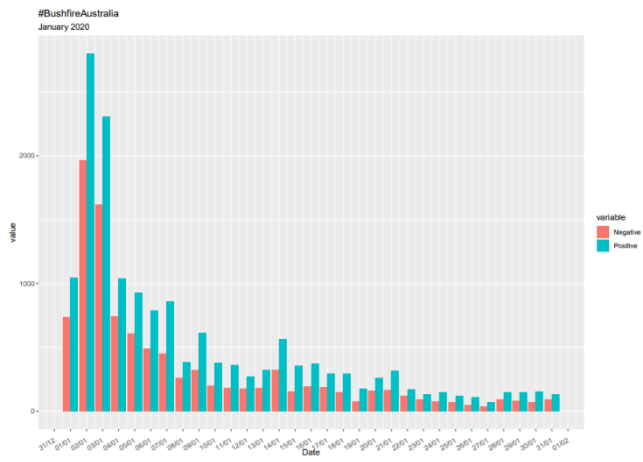
#BushfireAustralia



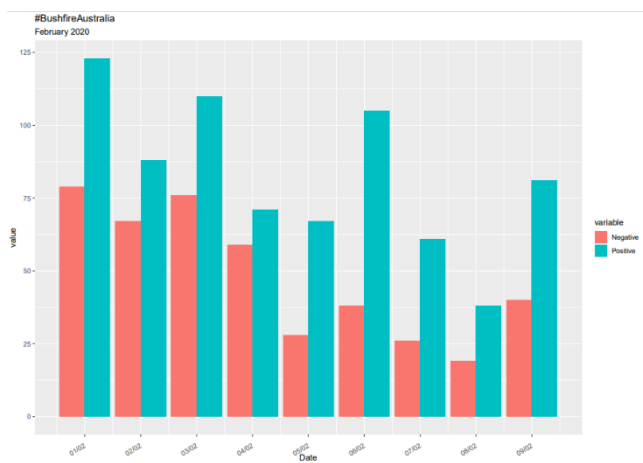
Graph 92c



Graph 93c



Graph 94c



Graph 95c