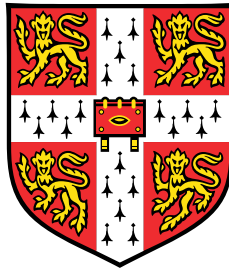# Radical Activism in the Misinformation Age

How can Social Movements Counter the Circulation of Online False Information about Climate Change?

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Doctor of Philosophy

To Ettore and Nora

Declaration

I hereby declare that except where specific reference is made to the work of others, the contents of this dissertation are original and have not been submitted in whole or in part for consideration for any other degree or qualification in this, or any other university. This dissertation is my own work and contains nothing which is the outcome of work done in collaboration with others, except as specified in the text and Acknowledgements. This dissertation contains fewer than 80,000 words including appendices, bibliography, footnotes, tables and equations and has fewer than 150 figures.

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Giulio Corsi
August 2022

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Radical Activism in the Misinformation Age

Giulio Corsi

Over the past several years, online disinformation and misinformation concerning climate change have gained substantive attention within the scientific community. However, while the dynamics that drive the circulation of false online information have been analysed extensively, it remains unclear whether (and how) this phenomenon can be counteracted. This research project analyses the emerging role of bottom-up mobilisations as a form of noise-reduction, thereby examining how social movements may deploy peer-produced communication narratives to counteract the circulation of online disinformation and misinformation relating to climate change. To investigate this communication dynamic, this research applies techniques from computational social sciences to an original dataset of ≈ 250k Facebook posts produced by two movements that best embody this novel and innovative generation of radical environmental activism: Extinction Rebellion and Fridays for Future. The central thesis of this project forwards two original contributions to the fields of climate change communication and social movement studies. First, it analyses the emergence of a new generation of radical climate change movements and the significance of this new development in climate activism (Chapter II). Second, it offers interdisciplinary empirical evidence on how radical climate movements can act as a bottom-up force for what I term 'epistemic activism'. It presents a theoretical framework where activist-led, peer-produced communication can provide a countering force to both vertical disinformation and horizontal misinformation. It quantitatively analyses two channels through which these forms of false information can be opposed. For reducing vertical disinformation, this work assesses the use of naming and shaming against information polluters (Chapter III), while for horizontal misinformation, it evaluates the dissemination of scientific counter-narratives (Chapter IV). Ultimately, this thesis shows that the two movements under analysis engage extensively in epistemic activism, with great potential to influence the online climate change debate positively.

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Chapter 1

Introduction

1.1 Aims of the Research

1.1.1 Primary Objective

In recent years, online disinformation and misinformation about climate change have gained increased attention within the scientific community, and numerous studies have shown how the so-called denial machine has long been actively spreading false information to undermine the perceived validity of climate science (Brulle and Aronczyk, 2019; Dunlap and McCright, 2011). However, while the dynamics that fuel false online information on climate change have been analysed extensively, it remains unclear whether and how this phenomenon can be effectively tackled.

From a regulatory perspective, the circulation of misleading content on online platforms, particularly social media, presents a wicked problem. On the one hand, top-down regulatory interventions are often met with high levels of scepticism, raising ethical and moral implications as to how command and control regulations can be harmonised with the principles of freedom of expression and media pluralism (Marsden et al., 2020). On the other hand, it is evident that the approaches that rely on self-regulation and voluntary measures from tech giants, such as the European Union Code of Practice on Disinformation (CPD), have only provided limited results (Kobernjuk and Kasper, 2021; Shattock, 2021).

In this complex regulatory scenario, this thesis analyses a 'third way' in which societies can tackle online epistemic threats, where organised publics can, through sustained mobilisation and online activism, produce new channels of knowledge circulation, improve

information quality, and accelerate social change. Therefore, the main objective of this thesis is to research the emerging role of climate activism in creating peer-produced channels of communication that may counteract the circulation of online disinformation and misinformation relating to climate change. Ultimately, this work aims to produce empirical evidence of how what I term epistemic activism, which refers to the use of communication in order to contrast epistemic threats, can be leveraged to tackle online information disorders, producing findings that may potentially apply to mobilisations occurring in other social and political disputes. Notably, this work does not attempt to measure an impact but rather to identify and measure the existence of such peer-produced communication dynamics.

1.1.2 Scope

The past four years have witnessed the emergence of a string of global civil society mobilisations calling for bolder efforts in tackling climate change, culminating in the foundation of several radical climate movements of a transnational nature. In order to achieve the research goal outlined above, this project analyses the two largest active movements that emerged as part of this new wave of climate change activism, Extinction Rebellion and Fridays for Future (Richardson, 2020). The two movements perfectly exemplify the innovative approach to climate activism that began to take shape in 2018 and, by virtue of their evident political influence, large activist base and extensive online presence, represent an optimal object to analyse how epistemic activism and peer-produced communication can be leveraged to contrast the circulation of false information relating to climate change.

As the main objective of this project is to analyse recent climate change mobilisations and their potential to help mitigate online false information, the two movements' communication is evaluated by analysing data on their social media activities, in this case, utilising data collected from the social media platform Facebook. The data set used in this work is an original collection of $\approx$ 250k English-language posts produced by the two movements' public Groups and Pages between September 2018 and June 2021. While there are now numerous social media platforms, Facebook remains the most widely used and representative social media platform globally. Indeed, doubts still exist about the representativity of social media platforms, yet studies show that Facebook performs better in this metric than other commonly analysed social media platforms such as Twitter (Mellon and Prosser, 2017).

1.1.3 Contribution

This thesis makes two main contributions to the fields of climate change communication and social movement studies. First, it analyses the emergence of a new wave of radical climate change movements and the significance of this new development in climate activism. It examines the two movements' key characteristics and distinctive elements, such as their founding principles, protest tactics, and the main topics emerging from their online communication. This approach allows for the production of a large-scale measurement and characterisation study of Extinction Rebellion and Fridays for Future.

Second, this work presents interdisciplinary empirical evidence on how radical climate movements may act as a bottom-up force for epistemic activism, working at the intersection between social media analysis and social movements studies. It offers a novel theoretical framework where through their epistemic activism, social movements may contribute to providing a countering force to both vertical disinformation and horizontal misinformation and quantitatively analyses two channels through which these forms of false information could be opposed. For reducing vertical disinformation, this work assesses the use of naming and shaming against information polluters, while for horizontal misinformation, it evaluates the use of scientific counter-narratives.

1.2 An Epistemological Review of False Information and its Terminology

This Section of the thesis begins to set the conceptual foundations for the theoretical framework that informs this research. In particular, this Section provides an in-depth epistemological review of false information and its terminology, detailing a working definition of the term information and exploring the social dynamics that may lead to the emergence of false information. Finally, this Section presents a definitional model of two key operational terms that will be used to describe false information within this work: disinformation and misinformation.

1.2.1 A Definition of Information

Information scientists have long debated the nature of the concept of information (Karlova and Fisher, 2013), and several scholars have attempted to draw a definition of this elusive concept,

leading to a vast and often contradictory body of literature (Braman, 1989; Hoffmann, 1980; Perry, 1990; Weaver, 1949). While advancing the definitional boundaries of the concept of information is beyond the scope of this research, this Section will draw from the relevant academic literature, proposing a working definition of information, which should facilitate the analysis carried out in the rest of the thesis. A definition of information should grasp the essential nature of this concept in a detailed description while clarifying what sets information apart from similar concepts such as knowledge and meaning. Establishing a better understanding of the term information is essential to this work, as this term underlies every step of the empirical research process carried out in the following sections.

Drawing partly from McCreadie and Rice (1999) and Fallis (2015), within this work, information is defined as a message, truthful or false, representing a part of the world as being in a certain way. Aware that the concept of information can acquire different meanings according to the context in which it is used (Floridi, 2011; Hoffmann, 1980), the development of this working definition is guided by the research questions of this thesis and two conceptual elements of this definition are particularly worthy of further discussion.

First, this work endorses the conceptualisation of information as a resource and a commodity that can be replicated, distributed, sold, or manipulated (McCreadie and Rice, 1999). This conceptualisation is consistent with a model of sending information as a message from sender to receiver. However, this does not assume that the receiver will interpret and understand the message as intended by the sender. This view of information captures the increasing commodification of information in our information society, where emerging technologies have made information into a fully commodified object of trade (Adair, 2010), which has intrinsic value and can be used to obtain economic, social, and political gains.

Second, this definition of information includes both truthful and false messages. This definitional nuance rejects Dretske (1983) and Floridi (2011)'s views, according to which its content must be factual for information to be considered as such. Accepting the necessary-truth condition would ultimately undermine the breadth of the definition developed above and sit in tension with the view of information as a commodity. In addition, reducing information only to accurate messages would cast a shadow on what ultimately counts as information, as the concept of truth is one in continuous evolution, particularly within scientific disciplines. Instead, this work will refer neutrally to information to include truthful and false messages. This view is in line with those of information philosophers such as Fox (1983), Fetzer (2004), and Scarantino and Piccinini (2010), who argued that for information to be such, it need not be accurate.

1.2.2   False Information: An Old Problem in a New Context

In 1646, the English polymath Sir Thomas Brown published an avant-garde book titled *Pseudodoxia Epidemica*: the epidemic of erroneous beliefs. Convinced that humans are by nature easily deceived in the process of acquiring knowledge, the author presented a vast collection of incorrect beliefs and myths that were common at the time of writing. These included stories such as that of the Vegetable Lamb of Tartary, a Central Asian plant allegedly capable of yielding lambs as its fruit, the existence of which was at the time supported by leading naturalists and botanical scholars. Interestingly, many of those even claimed to have seen and touched its 'wonderful wool and flesh' (O'Connor and Weatherall, 2019). Nearly four centuries after the publication of *Pseudodoxia Epidemica*, a man stormed Comet Ping Pong, a pizza restaurant in Washington DC, firing several rounds of rifle on the ceiling. The gunman intended to investigate an alleged underground child sex ring run by US Presidential Candidate Hillary Clinton. As it later emerged, the claim was unfounded: members of the American alt-right had spread the 'Pizzagate' conspiracy theory on social media platforms such as 4chan and Twitter to discredit Clinton's 2016 Presidential campaign (Hindman and Barash, 2018; Silverman and Alexander, 2016; Tandoc Jr et al., 2018).

While these are merely two examples of how rational human beings have, in different historical times, come to accept and act upon fabricated information, it is evident that the circulation of false information is not unique to our times but rather has been a feature of human communication since its origin. However, the 21st century has seen the diffusion of false information and its weaponisation within social and political processes reach unprecedented levels. The rapid diffusion of accessible technologies for disseminating peer-to-peer information- such as social media and the blogosphere - have propelled society into what has been defined as the information age, an era characterised by the free, unregulated, and spatially unlimited circulation of information (Seraj, 2012; Soma et al., 2016; Stark, 1997). Increased flows of information within environments with low barriers to publications and little oversight on published content have resulted in what Wardle (2018) defined as a polluted online informational environment, characterised by the circulation of high volumes of false information leading to an overall decrease in average information quality, posing an entirely new set of challenges for governments and civil society alike.

In principle, citizens want to be informed about the status of the world. However, gathering and processing information on the myriad of complex social and political issues to which we are exposed is virtually impossible (Fallis, 2015; Lupia, 2016; O'Connor and Weatherall, 2019). Therefore, individuals must rely on publicly available information to guide their opinions. However, in a polluted informational environment, people are faced

with the complex task of identifying what sources of information can be trusted, and the prevalence of false information can provide a barrier to informed decision-making, rendering it less likely that individuals will form beliefs based on truthful information (Persily, 2017). The impacts of this process can be significant, as beliefs are not idle, but rather, they influence our preferences and the decisions we make as a society (Bennett and Livingston, 2018), and whenever individuals form beliefs based on false information, this can drive society as a whole towards suboptimal outcomes.

Several examples of this epistemological dynamic exist. According to Alcott and Gentzkow (2017), false information played a crucial role in the 2016 United States Presidential Elections. As the study shows, a significant share of the electorate, estimated at 28.6%, used the internet and social media as their primary source of information and, through these channels, was exposed to large amounts of false stories. News such as that Hillary Clinton sold weapons to ISIS or that the Pope endorsed Donald Trump was shared millions of times (Gunther et al., 2018), and according to Silverman and Alexander (2016), in the three months leading to the election, false stories had more engagements than mainstream news stories. Consistent findings emerge from Howard et al. (2017), who found that US voters were exposed to large amounts of false and polarising content on the eve of the 2016 Presidential Elections, particularly in swing states that were crucial in adjudicating the election, suggesting a possible impact of false information on the outcome of the vote.

Similarly, numerous studies analysed how the circulation of false information was of great importance during the 2016 Brexit Referendum held in the United Kingdom (Del Vicario et al., 2016; Howard and Kollanyi, 2016; McGeehan, 2018; Spohr, 2017). Among the findings, we see that thousands of social media automated accounts - often traceable to Russia - were active in spreading pro-leave false information during this period, to then disappear after the ballot (Bastos and Mercea, 2019). Furthermore, social media campaigns of false information were compounded by several newspapers and tabloids who shared false or misleading stories. For example, on the eve of the Referendum, The Sun, the most widely read news brand in the UK, published an article titled 'The Queen Backs Brexit' - the article was never supported by any evidence (Katsirea, 2018). As numerous authors concluded, the circulation of false information of this intensity may have significantly impacted the outcome of the Brexit Referendum.

1.2.3 *Fake News*: An Inadequate Term

The growing circulation of false information recently rose to prominence among the broader public through the term fake news, which came to define any wholly or partly false informational news message that circulates within media and social network sources (Hindman and Barash, 2018; Tandoc Jr et al., 2018). A rich literature developed on the topic, mainly focusing on fake news' potential for disrupting democratic processes (Oates, 2018). Performing a Google Trends analysis, it can be seen that global interest in the expression fake news grew quite suddenly during the 2016 US Presidential election cycle and rapidly became the most searched term in relation to false information globally (see Figure 1.1), outshining more meaningful terms such as disinformation and misinformation. Despite its popularity as a buzzword, the expression fake news is critically flawed, making it inadequate for the study of a multifaceted phenomenon such as the circulation of false information.
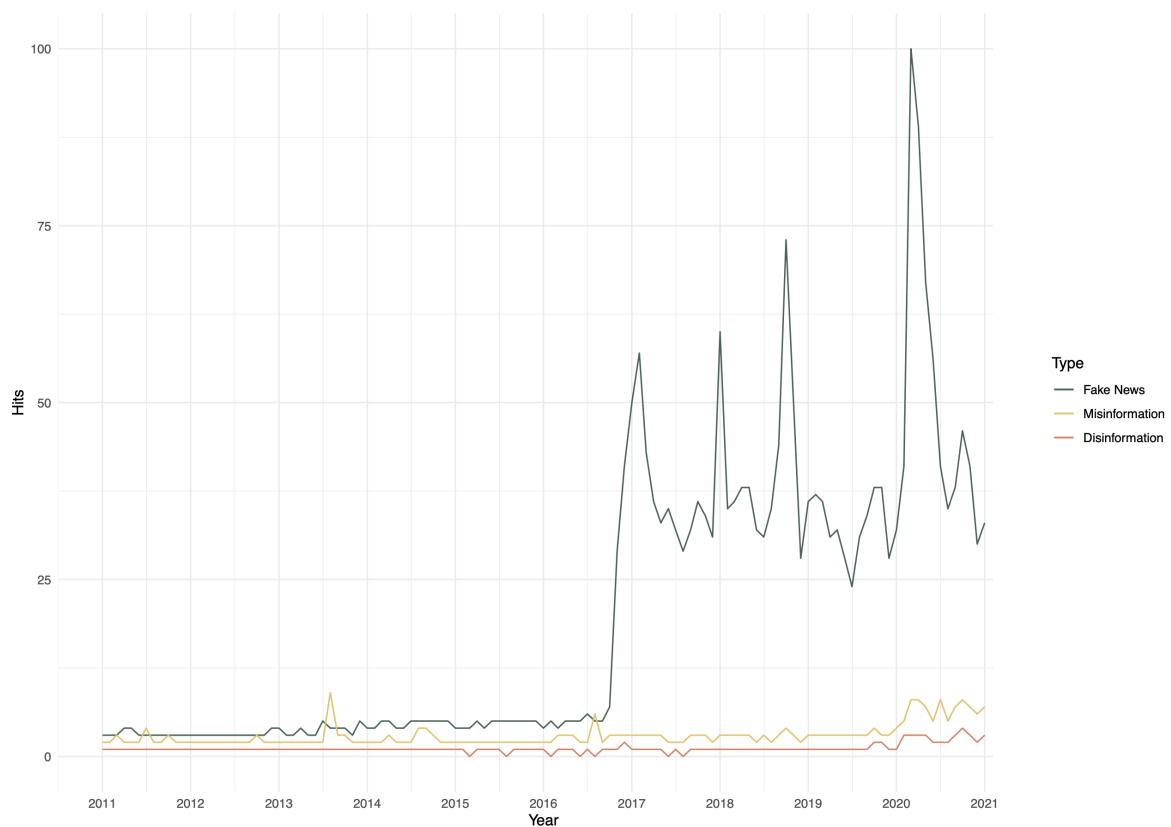
Fig. 1.1 Google Search Queries for False Information-Related Terms

Three main reasons make the expression fake news unsuitable for use in this project. First, the term is (1) too narrow, as its scope is inherently limited to news appearing within the media system. The problem of false information appears much more profound, extending

to the whole information ecosystem and its components, with more complex and far-reaching consequences. By focusing on written news articles, the term ignores that a large share of false information circulates outside this area (de Cock Buning, 2018), particularly through manipulated videos, memes, automated accounts, public statements, targeted advertisements, and even academic and pseudo-academic literature. In short, not all false information is news; rather, only a small part is.

Second, the term is (2) void of definitional meaning, as it fails to provide us with any information on the characteristics of the false informational message. For example, fake news does not include details on whether the spreading of the message was intentional, whether it had a purpose or an agenda, or whether it was expected to mislead the audience. An honest reporting mistake in a reputable newspaper would classify as fake news as much as an editorial produced and paid for by an oil company to sow doubt on climate change. In this sense, the term fake news is of little use in analysing the circulation of false information.

Last, the term fake news is (3) misleading, as it has increasingly developed into a buzzword used by politicians to muddy the waters around information quality and to carry out attacks on the mainstream media. The very fact that fake news has been used to discredit any news organisation whose coverage is found disagreeable is *per se* a solid reason why the term should be avoided. For example, Donald Trump - arguably one of the leading global disseminators of fake news - is also a recurrent user of the term. This is not unexpected, as, after the circulation of large volumes of pro-Trump false stories during the presidential elections (Alcott and Gentzkow, 2017), Trump started using the term to discredit mainstream media sources, going so far as to establish Fake News Awards that he assigned yearly to journalists from outlets such as CNN, The Washington Post, ABC News, and the New York Times. Notably, no fake news awards have ever been assigned to Pro-Trump media outlets such as Breitbart and Fox News, showing how fake news has become a radically politicised term used to discredit political opponents (Nielsen and Graves, 2017).

1.2.4 A Definitional Model of False Information: Disinformation and Misinformation at Play

After outlining why the term fake news is unsuitable for this type of research, we can now turn to more meaningful alternatives. The research literature concerned with the terminology surrounding the concept of false information is vast and in constant development and has evolved significantly in the past five years. This thesis will limit the terminology used when analysing false information to two content-heavy concepts: disinformation and

misinformation. These concepts will be used extensively throughout this project, and their characteristics will inform the empirical research presented in the following sections.

Disinformation is defined as a false or misleading message that the sender knows to be false and that is spread with the intention of misleading the information receiver. This definition draws mainly from the work of Fallis (2015), Skyrms (2010), and Nimmo (2016), all of whom recognise the intention to deceive as the critical trait of disinformation. With disinformation, the message sender willingly develops a false, partly false, decontextualized or manipulated message to deceive an audience, often for private gain. This damages the audience, which may form false beliefs as a consequence. A typical example of disinformation is the 'Great Moon Hoax', a series of six articles published by The Sun, a New York newspaper, in 1835 (Foster, 2016). The articles described how an astronomer had discovered a civilisation on the moon composed of fantastic animals such as unicorns and bat-like humans. The Sun published the article to mislead the public and earn a private gain through increased revenues. The Sun's circulation increased dramatically thanks to the Moon Hoax and never returned to its previous levels, establishing the latter as a successful newspaper. This happened at the expense of the audience, who was, for several months, led to believe in the existence of civilisation on the moon.

More recently, Oreskes and Conway (2010) demonstrated how the tobacco industry attempted to undermine science on the effects of smoking for nearly half a century, spreading doubt on the validity of mainstream science and producing several studies demonstrating a lack of health impacts from smoking, all knowingly false. Again, the tobacco industry had a clear intention to deceive the public, the message was wholly or partly false, and this was aimed at deceiving the audience, who, as an effect of these campaigns, may have continued to smoke, suffering physical damage. While in the cases mentioned above, the intention to mislead is clear, identifying this condition is, in practice, very difficult, as it requires a complete understanding of an actor's knowledge and intention. Nonetheless, orchestrated attempts to propagate false information are typically considered disinformation (Persily and Tucker, 2020). A successful example of proven intention emerges from Supran and Oreskes (2017), who set out to demonstrate that ExxonMobil's communication on climate change over 37 years aimed to mislead the public. To do this, the researchers analysed the company's historical internal and external communications. They demonstrated that while internal documents consistently recognised the risks posed by climate change, the external documents blatantly denied them, demonstrating an intention to mislead the public.

Following the work of Chadwick and Vaccari (2019) and Karlova and Fisher (2013), misinformation is instead defined as false information that the message sender does not

know to be false and that is spread without an intention to mislead the information receiver, although this may still happen in practice. Thus, misinformation can be seen as a form of 'innocent' false information. For example, satire and parody, characterised by exaggeration and absurdity to amuse an audience, are forms of misinformation, as they rely on false or manipulated content to amuse rather than deceive the public. However, misinformation need not be harmless. Conspiracy theories such as those on chemtrails, which hold that planes are used to spray toxic chemicals through contrails, with goals ranging from weather manipulation to mind control (Tingley and Wagner, 2017), can be considered misinformation, as the message sender often holds genuine beliefs in the truthfulness of the information and has no intention to deceive others.

A Three-Stage Definitional Model of False Information

In the relevant academic literature, disinformation and misinformation are often placed at the same level as two distinct forms of false information or, in the cases in which misinformation is interpreted as an umbrella term for false information, disinformation is considered as a subset of misinformation. This section of the thesis presents a model which describes the interaction between these two concepts, where disinformation and misinformation are not seen as two independent forms of false information but rather as two complementary mechanisms. This model is a crucial cornerstone of this research, as it guides the empirical questions answered in the following sections.

Within this model, disinformation is seen as the source of a false message, while misinformation is considered the horizontal, often unwilling mechanism through which disinformation spreads at a larger scale. This dynamic is fundamental to understanding climate change denial, as the arguments used by deniers are typically not spontaneous scientific objections but rather the result of strong top-down messaging that is then circulated broadly by unaware individuals who come to believe in the trustworthiness of this information. This dynamic will be illustrated through a three-stage definitional model.

Notably, this model fits the majority of false information in the political sphere, although cases exist where false information emerges spontaneously rather than as a result of disinformation. This is the case for some complex conspiracy theories, such as those on the existence of chemtrails or those claiming that the earth is flat. Unlike political forms of denial, such as climate change denial, no one stands to gain from these theories circulating, and they often arise spontaneously from individuals prone to conspiratorial thinking and anti-mainstream views (van Prooijen and Douglas, 2018).

Stage One - Creation of the Misleading Message

In the first stage of this model, a message sender intending to mislead the public - be it a newspaper wanting to sell more copies or a company trying to delay regulation in its sector - formulates a message based on false or manipulated information. This message can vary in terms of both argument type and the communication channel used. As to the type of false message, three non-exhaustive strands can be identified: (1) Entirely false arguments, as in the case of the aforementioned Moon Hoax, where the story was wholly invented and was not supported by any evidence, (2) Partly false arguments, as in cases in which genuine scientific doubt is portrayed as an irremediable gap in scientific understanding of a phenomenon (Oreskes and Conway, 2010), and (3) Accurate information that is manipulated and placed out of context in a way that makes it equivalent to disinformation. An example of this is the anti-climate change regulation rhetoric claiming that CO_2 is plant food, and for this reason, emissions are beneficial to the planet. While CO_2 can be considered 'plant food', the induction is fallacious, as this does not detract from the fact that a high concentration of CO_2 in the atmosphere may produce adverse effects on the climate (Sneed, 2018). As to the type of communication channels used to convey the message, two principal types can be identified. The first, historically more common type, is that of verbal communication, which includes written and spoken communication. A second, more innovative type is visual communication, which is increasingly used to convey disinformation messages on social media (Vaccari and Chadwick, 2020). Visual disinformation includes elements such as memes, pictures containing false messages and deep fakes, and doctored videos that use artificial intelligence to closely resemble actual footage of people (Beridze and Butcher, 2019). Visual disinformation arguably represents the new frontier of disinformation, and at the moment, it remains quite challenging to detect, track and analyse (Tandoc Jr et al., 2018).

Stage Two - Vertical Diffusion of the False Message

In the second stage of the model, the message is circulated vertically to reach a target audience that is likely to accept and disseminate the message. This process occurs through several channels, such as social media, news outlets, think tanks, and academic publications. Many examples of this vertical diffusion of information exist. For example, McHenry (2018) analysed how the biotech giant Monsanto sponsored the ghostwriting of articles falsely supporting the safety of the controversial glyphosate, published in peer-reviewed toxicology journals and discussed widely in the media.

Similarly, a previously mentioned study by Supran and Oreskes (2017) demonstrated how ExxonMobil regularly used paid advertorials in the New York Times to convey false messages to the readers, attempting to convince them that the science around climate change was uncertain. Wardle (2018) also described how during the 2016 French election campaign, a sophisticated duplicate of the Belgian newspaper Le Soir appeared online and spread large amounts of disinformation on the French president Emmanuel Macron. Finally, studies have shown that disinformation is often spread through automated accounts on social media (Bradshaw and Howard, 2018; Scheufele and Krause, 2019). For example, during the 2016 US Presidential election, intense disinformation flows originating from Russia circulated on social media through thousands of bots posing as genuine profiles (Oates, 2018). Indeed, the platforms in which a false message can be vertically circulated are virtually infinite, and what all these examples have in common is that the creator of the message intended to confuse the public and used available means of communication to disseminate this false message.

Stage Three - Horizontal Circulation of the False Message

In this model's third and final stage, the message reaches the broader public. When disinformation starts circulating, some message receivers reject it, doubting its veracity, while others accept the message as valid. Unaware of the poor informational value, they may share it with their networks and communities, where again, many will reject it, and others will accept it (O'Connor and Weatherall, 2019). Through this process of acceptance and rejection, disinformation begins circulating and spreading in the form of misinformation. Individuals who share this message are no longer aware of its falsity and circulate it under the conviction that they are not harming the audience. In this sense, misinformation can be considered a propagation mechanism of disinformation.

Once misinformation reaches the public, its circulation is often amplified by psychological mechanisms that may come into play while acquiring information. For example, according to McCright and Dunlap (2010), individuals may manifest anti-reflexivity when receiving climate change information, meaning that they may be more prone to acquire information that questions mainstream climate science, intending to protect the status quo and defend an economic system they deeply trust. Similarly, the theory of motivated reasoning formulates that individuals may be more likely to believe in false information whenever this aligns with their deeper values and worldviews (Druckman and McGrath, 2019). According to Bennett and Livingston (2018), through these mechanisms, misinformation may become so embedded within individual worldviews that it cannot be countered through direct fact-checking. This points to a further problem with misinformation: individuals are not idle, and some will

actively look for information that confirms their beliefs, indicating that there may be both a problem of supply of disinformation and a problem of demand for it. A sketch of the model is shown in Figure 1.2.
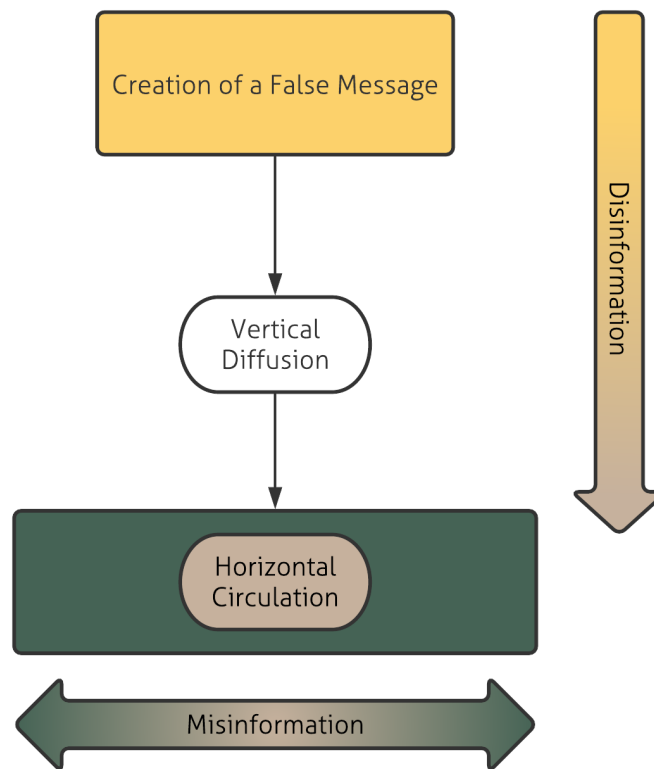
Fig. 1.2 Flowchart of the Three-Stage Definitional Model of Disinformation and Misinformation

Finally, as this model suggests, disinformation and misinformation cannot be analysed in a vacuum. Instead, it is essential to fully understand the deeper dynamics that lead to the creation of a false message and its vertical and horizontal diffusion. While most false information circulates horizontally among unaware individuals, this should not take attention away from how the false message was produced and disseminated in the first place. This means that the battle against false information must be fought on two fronts: it is crucial, at the same time, to attempt to reduce misinformation circulating horizontally while also finding effective strategies to prevent disinformation sources from effectively contaminating the public debate. This understanding is essential to the research questions that motivate this research, as this definitional nuance suggests that radically different approaches are necessary to tackle different types of false information.

1.3 Climate Change Denial: an Overview

After defining at a higher level of abstraction concepts such as information, disinformation and misinformation, it is now possible to move on to the form of false information that forms the central research interest of this thesis, false information relating to climate change. This Section begins diving into the history of climate change denial, exploring the emergence of a so-called consensus gap, the main strategies used by climate change contrarians, to then turn to the current scholarly understanding of the most promising approaches to reduce the circulation of false information on climate change.

1.3.1 The Consensus Gap

The understanding that manmade emissions are leading to a changes to the global climate system has been publicly recognized in scientific and political spaces for a very long time. Already in 1965, a group of scientists led by Roger Revelle sent a report to President Lyndon B Johnson establishing a clear correlation between the planet's warming and greenhouse gas emissions and calling for the US government to take action against these 'invisible pollutants' (Nuccitelli, 2015). In 1988, James Hansen, director of NASA's Institute for Space Studies, testified before the US Senate Energy and Natural Resources Committee, claiming that his research on the earth's climate showed with 99% certainty that emissions of carbon dioxide and other gases in the atmosphere were causing an unnatural warming trend (Shabecoff, 1988).

The early warnings of both Revelle and Hansen were later confirmed and further elaborated by a rapidly growing body of scientific proof as to climate change. Since 1990, this evidence has been regularly grouped and summarised in reports by the United Nations Intergovernmental Panel on Climate Change (IPCC), which has repeatedly confirmed the critical tenets of climate change science, stating that the literature agrees that climate change is real and indisputable, it is mainly attributable to human activity, and that current emissions are the highest in history (Intergovernmental Panel On Climate Change, 2007).

Today, despite a sense of agreement permeating from the scientific community, parts of the public remain unconvinced of the human influence on climate, and climate change is often perceived as a controversial object of debate (Boykoff and Mansfield, 2008; Engels et al., 2013; Oreskes and Conway, 2010; Tranter and Booth, 2015). This rift between public opinion and scientific agreement - often labelled as 'consensus gap' - has been the object of a notable amount of research, which from its inception, focused on analysing the level of

expert consensus on the causes and impacts of climate change and how this perception of consensus can be undermined - both in the social and political sphere - through contrasting accounts of climate science.

The first study analysing this 'consensus gap' is Oreskes (2004), who found that scientific consensus regarding the causes and impacts of climate change had been overwhelming since the 1990s and suggested that widespread popular scepticism may be the result of a coordinated disinformation effort. Since 2004, numerous studies have attempted to quantify scientific consensus on climate change by resorting to methodologies such as survey-based questionnaires and scientometric analysis (Anderegg and Goldsmith, 2014). The results clearly show high levels of expert consensus, generally above 95%, with small variability according to the time frame and methodology used (Anderegg and Harold, 2010; Cook et al., 2013; Doran and Zimmerman, 2009; Oreskes, 2004). These studies also show that consensus typically increases with the level of climate expertise, peaking among highly published climate scientists (Cook et al., 2016; Verheggen et al., 2014). Conversely, perceived consensus on the causes and impacts of climate change is usually found to revolve between 50% and 70% (Cook et al., 2016; Jamelske et al., 2015; Lewandowsky et al., 2012). This type of study also shows significant political polarisation, with climate scepticism peaking among subjects with a declared conservative ideology and media outlets associated with these ideologies (Boykoff and Mansfield, 2008; Whitmarsh and Corner, 2017).

While the use of the concept of 'consensus gap' has been criticised by a small number of scholars, arguing that focusing on minimalistic claims such as 'humans cause global warming' are distractions from the complexity of the problem (Pearce et al., 2017), several studies have highlighted the importance of analysing scientific consensus. For example, Van der Linden et al. (2015) empirically demonstrated that the idea of consensus might act as a 'gateway belief', suggesting that a better understanding of scientific consensus is predictive of increased support for regulation. Similar findings emerged from McCright et al. (2013) and Ding et al. (2011), who showed that perceived agreement is closely linked to support for government action. This is critical as it proves that undermining the perception of consensus and portraying climate change as a controversial topic may ultimately reduce public engagement with the issue. Ultimately, the concept of 'consensus gap' is a critical one in the study of climate change denial, as, in practice, the underlying assumption that supports every consequent form of climate change denial is that there is no agreement among scientists and that the tenets of climate science are still being discussed and determined.

1.3.2 Disinformation and Organised Climate Change Denial

By the early 2000s, climate change was growing in importance on the international agenda and enjoyed a generalised consensus. For example, in 2000, both candidates running for the US Republican presidential nomination George W. Bush and John McCain, recognised the urgent need to reduce greenhouse gas emissions (Michaels, 2019). At the same time, on the other side of the Atlantic Ocean, the United Kingdom was launching its Climate Change Programme, with a target of reducing emissions to 20% below 1990 baseline levels by 2010. However, as the climate crisis became increasingly evident, this grace period of bipartisanship began to fall through, and extreme polarisation started turning climate change into fertile ground for a political and cultural war. Several scholars have suggested that this transition of climate change becoming a controversial object of discussion was not a naturally occurring phenomenon but rather the result of years of carefully planned disinformation strategies (Cook et al., 2016; Freudenburg et al., 2008; Lewandowsky et al., 2015).

In April 1998, a secret plan drafted by the American Petroleum Institute - a trade association representing the oil and gas industry - was leaked (Dunlap and McCright, 2011). The plan, titled 'The Global Climate Science Communications Plan', was drafted shortly after the signing of the Kyoto Protocol in 1997 by the representatives of the world's largest oil companies. The plan boldly states that victory for the fossil fuels industry will only be achieved, among other things, when both the media and average citizens recognise the uncertainties of climate change, and these uncertainties become part of conventional wisdom. The plan included a multimillion-dollar budget to achieve its goals, which should have been used to disseminate climate change denial in various ways, ranging from recruiting scientists for media outreach to distributing climate change information through media channels. The Global Climate Science Communications Plan perfectly summarises the strategy that has characterised counter-climate change communication in the past two decades, which involved using any accessible communication channel for manufacturing uncertainty around the reality and urgency of climate change through disseminating disinformation.

Over time, various studies have analysed and mapped networks of climate change disinformation spreaders, proving the existence of a complex web of think tanks, pressure groups, public relations firms, front groups, media outlets and contrarian scientists engaging in the diffusion of climate change disinformation, particularly in the United States and United Kingdom (Brown, 2017; Farrell, 2016). According to Mayer (2017), these networks are inevitably linked to fossil fuel interests and politically right-wing groups. As that study shows, the Koch Brothers, owners of one of the largest US oil companies, have donated a staggering $25 million to organisations fighting climate change policies between 2005 and

2008. Similar findings emerged from Brulle (2014), who conducted a financial resources mobilisation analysis of the organisations that make up the climate change countermovement and found that the overwhelming majority of philanthropic support to organisations engaged in undermining climate change regulation in the United States, amounting to a total of \$558 million, comes from conservative foundations. These conclusions are also supported by Farrell (2016), who, analysing the verbal and text communications of 164 organisations opposing climate change regulation in a 20-year period, found that the organisations funded by conservative foundations or fossil fuels were more likely to have written and disseminated contrarian text, and were also more likely to use polarising language in their communication. Finally, multiple studies point to the involvement of several high-profile politicians in slowing down action on climate change. For example, Craig (2016) discusses how US President Reagan filled high level EPA positions with fossil fuel lobbyists in order to halt any progress on climate change. Similarly, Dunlap and McCright (2011), describe how the Bush administration attempted to undermine climate science by emphasizing the uncertainties and calling for the need for a 'sound science'.

The literature is also quite informative regarding the strategies and channels used to spread disinformation vertically. Supran and Oreskes (2017) analysed how the oil giant ExxonMobil waged a public campaign to sow doubt on the existence of climate change through the creation of 'advertorials' in the New York Times. In a survey of ExxonMobil's advertorials published between 1977 and 2014, the authors found that these pieces were consistently used to attack climate science while posing as genuine op-eds and, in 81% of cases, express doubts about climate change. Further, Michaels and Monforton (2005) and Hansson (2018) analysed the creation of junk science and pseudoscience to discredit climate action. This approach often relied on funding contrarian scientists and their credentials to publish academic or pseudo-academic literature. An example of this strategy is the oil industry's funding of Harvard-Smithsonian Centre for Astrophysics researcher Willie Soon. Between 2001 and 2015, Soon received \$1.2 million in funding from prominent oil and gas industry members to contrast the widely accepted science on climate change (Gillis and Schwartz, 2015). Soon does not accept that climate change is of anthropogenic nature and claims that the heating we are experiencing is driven by the sun. Thanks to its relationship with Harvard, Soon's research was used widely to reject the very existence of climate change.

A further strategy used to spread disinformation vertically is the creation of a complex ecosystem of Astroturf groups. Astroturf groups represent a category of fake front groups posing as genuine grassroots groups Dunlap and McCright (2011). An exemplary instance of astroturfing was described by Farrell et al. (2019), who analysed how in 2018, the energy company Entergy hired a public relations firm that paid 50 actors to appear at a New Orleans

City Council hearing on a controversial new gas power plant. These people appeared wearing T-shirts printed with the words 'Clean Energy. Good Jobs. Reliable Power'. These actors were to act as grassroots activists to provide the false impressions that people supported the new power plant.

The strategies highlighted above are a limited sample of the dozens of direct and indirect strategies adopted by climate change deniers to vertically spread disinformation on climate change. Over time, deniers have successfully created a complex ecology of think tanks, front groups, allied politicians, media organisations and social media pages that form a robust echo chamber where climate change disinformation circulates freely, taking a wide variety of forms.

1.3.3 A Taxonomy of Climate Change Denial

A growing body of academic research has documented and categorised different forms of climate change denial. In its earlier stages, climate change denial focused primarily on contradicting climate science, denying the very existence of anthropogenic climate change. However, as scientific certainty increased, denialist strategies adapted and innovated and today, climate change denial goes much further than simply denying that this phenomenon is happening. This Section of the thesis will present a broad taxonomy of climate change denial, identifying the main types of arguments used to weaken the public understanding of climate change and to deter policy action. This taxonomy builds upon previous work in the field, but also incorporates the author's own analysis and observations on the evolution and current state of climate change denial.

The first high-level distinction that has to be drawn when defining a taxonomy of climate change denial is between scientific denial and political denial. As its name suggests, scientific denial entails arguing against the scientific bases of climate change, and work in this area was pioneered by Rahmstorf (2004), who created the first taxonomy of sceptical scientific arguments. Drawing from Rahmstorf (2004) as well as more modern taxonomies such as Coan et al. (2021), four key categories are relevant today:

- *Trend Denial* - Trend denial represents the oldest form of climate change denial and argues that the climate is not changing. Trend denialists have traditionally used a variety of arguments, ranging from claims that temperature records are unreliable to creative claims on the fact that the world is heading towards an ice age. While trend denial was commonplace in the past, it has become quite rare and is primarily confined

to highly polarised environments, and interestingly, to the United States, where trend denial is more prevalent than in other countries where data is available. For example, the latest Yale Climate Opinion Map (Ballew et al., 2019) found that in the United States, 12% of the sample contested the very existence of climate change. In the European Union, this number was significantly lower at 6.8%.

- *Attribution Denial* - Attribution denial argues that while climate change may be happening, humans are not responsible for it. Hence, it does not refuse the concept of climate change but rather that of anthropogenic climate change. Those who endorse attribution denial often claim that climate change is natural and that the climate has changed before and, as such, will always change, ignoring the impact of greenhouse gas emissions on atmospheric balance. Some of the most common arguments to support this narrative are that climate change is caused by the sun or that the heating we are experiencing now is merely the heating phase of a natural cycle. As of today, attribution denial remains quite commonplace. For example, the latest European Social Survey found that in the European Union, 45% of the interviewed sample claimed that climate change was caused equally by natural and non-natural processes, while in the United States, 32% of the Yale Climate Opinion Map sample claimed that climate change is an entirely natural phenomenon (Ballew et al., 2019).

- *Impact Denial* - Impact denial argues that while climate change is happening and may be anthropogenic, it will have no negative impacts, and in some cases, it may even positively affect life on Earth. Impact denial often highlights the positive consequences of climate change, such as extending agriculture into higher latitudes, while ignoring the downsides that would come with it. For example, a common argument reflecting impact denial is the claim that CO_2 is 'plant food', and the higher the concentration in the atmosphere, the better. Indeed, this claim has been debunked, and studies showed that a high concentration of CO_2 in the atmosphere hurts key crops more than it helps. While there is no available survey data on impact denial, anecdotal evidence suggests it remains common nowadays. For example, a 2020 CFACT article titled 'Watching CO_2 feed the world' claimed that CO_2 is the essence of the global food supply and that our meat, fruit and vegetables are built almost entirely from carbon dioxide and water (Wojick, 2020). The article goes on to argue that while water is plentiful, carbon dioxide is scarce, and increased CO_2 emissions are increasing plant productivity and helping to feed a growing population, ultimately suggesting that a higher concentration of CO_2 would be a desirable outcome.

- *Consensus Denial* - The term consensus denial links directly to the previously discussed idea of a consensus gap and describes the claim that there is no scientific consensus on the causes, consequences and overall impact of climate change. Consensus denial is perhaps the most studied narrative of climate change denial in recent years (Cook, 2016; Farmer and Cook, 2013; Treen et al., 2020), and its importance largely stems from the finding that consensus is a gateway belief for support for climate action (Van der Linden, 2021; Van der Linden et al., 2015). Broadly, consensus denial is rooted in the tradition of the so-called scientific certainty argumentation methods (Freudenburg et al., 2008), a communication tactic where those who want to oppose regulation play up the role of scientific uncertainty to delay any policy action. Indeed, science is never unambiguous, and by delaying regulation until it cannot be unambiguously justified, most policies can be defeated by simply claiming that the science is uncertain. This phenomenon has been analysed extensively in areas such as harm from smoking tobacco (Brownell and Warner, 2009; Samet, 2016), football-related brain injuries (Goldberg, 2013; Trimbur, 2021), and climate change (Carlton et al., 2015; Roper et al., 2016; Supran and Oreskes, 2017)

A second essential category of climate change denial arguments is political denial. Political denial consists in fighting climate change in the political arena, finding creative ways of suggesting that, while climate change may exist, there is no need to take any regulatory action, and often discussing the disruptiveness of climate policy and its alleged impacts on the economic system. While scientific denial is easy to identify, political denial tends to be less clear-cut and hard to detect, albeit just as dangerous. While political denial is constantly changing, four types are identified in this taxonomy:

- *Climate Defeatism* - The concept of climate defeatism describes the idea that it is too late to stop climate change, and for this reason, we should avoid any corrective measures altogether. Climate change defeatism represents the essence of disengagement and apathy towards climate change and is increasingly weaponised by those who want to maintain business-as-usual to strike down any form of climate action. Climate defeatism may be considered a softer, less aggressive form of climate change denial, and for this very reason, it often runs across party lines. For example, in 2019, US Democratic Presidential candidate Andrew Yang claimed that even if the US were to curb their emissions, the Earth would still warm and that we are ten years too late to fight climate change (Meyer, 2019). Indeed, this reasoning is critically flawed. First, climate change policy is not an all-or-nothing proposition, and there is clear evidence that progress - although limited - is being achieved in curbing climate change.

Furthermore, while significant changes to the climate system are already in motion, research shows that we are still in time to avoid some of the direst consequences of climate change. Additionally, even if the planet went beyond various mitigation tipping points, there would still be reasons to justify a proactive approach to climate change adaptation.

- *Climate Realism* - The expression climate realism describes a novel form of climate change denial, which consists in claiming that while climate change is real, we should be 'realists' and accept that the impacts of climate policy do not justify its benefits, and for this reason, we should remain calm and accept that solutions to climate change will eventually emerge (Levantesi, 2020). Climate realists typically oppose themselves to whom they define as 'alarmists', creating a compelling us-versus-them narrative between realists, who are calm and rational, and alarmists, who are out of touch with reality and want to sacrifice a prosperous economy in the name of climate policy. As a form of denial, climate realism perfectly represents how denialist strategies have evolved, softened and mutated their language over time to become less clear-cut but very impactful. Climate realism offers a compelling value proposition: they argue we should not panic, but instead we should think, ultimately implying that adopting any bold climate action would be an irrational choice guided only by emotion. The arguments used by so-called climate realists are evident in a recent interview given by well-known denialist Bjorn Lomborg, who claimed that while climate change is real and man-made, it should not have high priority in policymaking and that alarmists want people to think climate change is the end of the world merely to obtain funding for their activities (Lomborg, 2020).

- *Conspiratorial Denial* - Conspiratorial denial is a quite blurred yet very relevant area of climate change denial that has been growing in relevance in the past year. This area groups various conspiracy theories that are ultimately used to argue that climate change policy is merely a facade to implement controversial political agendas. Several strands of conspiratorial climate change denial are currently observed worldwide, and these narratives often attempt to disengage the public from climate activism by creating a sense of fear around the implications of climate change policy. Multiple instances of this strategy can be identified. For example, in the United States, a popular strand of conspiratorial denial that recently rose in uptake claims that climate change policy is a trojan horse to implement socialism, dismantling the current capitalist system (see Varney, 2019). This type of denial exploits decades-old red threat narratives to muddy the waters and create a sense of fear around climate policy. Similarly, many

conspiratorial denialists have recently endorsed claims that climate policies' ultimate goal is a society-wide great reset, leading to totalitarian new world order. While these theories are at best quite imaginative and hardly believable, they appear to circulate widely on social media, particularly within far-right environments. An additional form of conspiratorial denial is the idea that scientists are motivated by personal gain, rather than a desire to uncover the truth. This perspective suggests that scientists, particularly those studying climate change, are more concerned with obtaining grant money and advancing their own careers than they are with accurately representing the state of the environment. One notable example of this type of denial can be found in Michael Crichton's novel "Fear of State" (2005) which portrays scientists as "climate terrorists" who fabricate catastrophes in order to secure funding.

- *Climate Nationalism* - Climate nationalism presents a novel and relatively unstudied branch of climate change denial. This narrative describes a strand of indirect climate change denial where the scientific bases of climate change are accepted and turned into motivation for racial divides and nationalism, using Malthusian arguments to blame developing countries and their growing population and immigration for the consequences of climate change and environmental degradation. Climate nationalism is not strictly a form of climate change disinformation, but rather, a more generic form of racist misinformation that weaponizes science to promote racist ideals. Through this narrative, climate change is politically weaponised to shift responsibility away from Western countries and direct it towards developing countries, with the ultimate goal of claiming that no policy action is required. An example of this narrative can be found in a 2019 speech from the far-right French Front National leader Marine LePen, where the politician suggested that borders are the environment's greatest allies, claiming that nomadic populations and immigrants do not care about the environment (Mazoue, 2019), an argument that has been contradicted by empirical evidence (Ma and Hofmann, 2019). Further, a recent study on the imageboard platform 4Chan highlighted how this type of narrative is on the rise on underground communication platforms, particularly far-right leaning ones such as 4chan, and could, in the future, permeate more mainstream environments (Corsi, 2021). The growing acceptance of climate change and its harmonisation with a political agenda based on racism and nationalism is a worrying trend in climate change communication, and it symbolises that climate change acceptance is, *per se*, not a solution but rather a complete acceptance of the need for policy action on climate is required.

1.3.4 Contrasting Climate Change Denial Through Non-Regulatory Approaches: What We Know So Far

While the literature on how climate change denial operates is quite rich, less is known about how the circulation of disinformation and misinformation can be effectively reduced. Currently, the majority of proposed approaches in this area draw from psychological sciences and cognitive psychology, mainly focusing on the role of behavioural biases in acquiring incorrect information. This is largely because of the many unique difficulties in regulating information-related problems with policy-based approaches (Pielemeier, 2020).

For example, a problem with any regulatory approach against disinformation normally lies in definition what is false content, as there is often a lack of consensus within information spaces on what constitutes disinformation or misinformation, as different groups may have a varying definitions and interpretations on the concept, which may be influenced by their political beliefs (Pielemeier, 2020). In practice, truth is difficult to define and delineate through law, as it is often context-dependent and may be influenced by a rapidly changing scientific environment.

Furthermore, as noted by van Hoboken and Fathaigh (2021), there are also critical free speech considerations in regulating false content, as any attempts to regulate disinformation may be perceived as infringing upon the right to free expression. This criticality was evident in Singapore's 2018 Protection from Online Falsehoods and Manipulation Act (POFMA), which attempted to address the widespread circulation of false content. As suggested by Han (2019), this law de-facto stifled free speech in the country, as it was often used to silence critics of the government. As a consequence, it is widely recognised that delegating the power to regulate truth to the government is a risky proposition. For this reason, a large share of ongoing research on noise-reduction focuses on the role of behavioural biases in acquiring incorrect information rather than on how to prevent individuals from acquiring false information.

For example, Cook (2016) suggests using debunking, defined as countering climate change scepticism with facts aimed at weakening their previously acquired beliefs (Cook and Lewandowsky, 2012). However, several flaws in this approach have been identified. Studies have shown that while people may accept a correction to their beliefs, they often continue resorting to this information in other settings, such as drawing inferences (Lewandowsky, 2021). In addition, Porter et al. (2019) showed in an experimental setting on climate change disinformation from former US President Donald Trump that while subjects accepted the correction, their policy attitudes towards climate did not change, suggesting the effectiveness

of debunking may, in practice, be quite limited. However, the debate on the effectiveness of these approaches remains open.

A second psychological approach that has been proposed as a channel to reduce the circulation of false information is public inoculation. Drawing from lessons learned from immunology on vaccinations, this theory suggests that informing the public on climate change before they are exposed to false messages may prevent them from assimilating false information (Cook et al., 2017; Van der Linden et al., 2017). A limited number of studies have demonstrated the effectiveness of inoculation, and Roozenbeek et al. (2021) argued that the protective effect of inoculation persists for at least three months. However, inoculation has mainly been tried in experimental settings, and although these are reliable in estimating the size of the effect under analysis, doubts remain as to whether this approach is scalable - this question will be discussed in greater detail in Chapter IV of this work.

A further promising approach lies in using tailored communicative frames to convince different audiences across the political spectrum. As comprehensive attitudes towards a phenomenon may be hard to change, this approach focuses on specific policies and framing these policies in ways that may be acceptable to broader audiences. For example, Petrovic et al. (2014) showed that framing climate change mitigation in terms of its health benefits, such as reduced air pollution, may be particularly effective in convincing self-identified conservatives of the need for climate action.

Remarkably, little research exists on the bottom-up social mechanics that could effectively reduce the circulation of climate change disinformation and misinformation and how such bottom-up approaches may be synergetic with other forms of disinformation and misinformation mitigation. For example, as it will be argued in Chapter IV of this thesis, ideas such as inoculation and prebunking can be leveraged by climate movements through the mass use of science-based counternarratives.

1.4 Theoretical Framework and Methodology

1.4.1 Theoretical Approach

The academic literature on social movements has abundantly analysed the role of groups of activists as a force of knowledge production and epistemic innovation, and it is now recognised that social movements are often crucial in generating and mobilising knowledge in the public sphere (Choudry and Kapoor, 2010; Conway, 2013; Esteves, 2008; Jamison,

2006, 2010; Leung, 1992). At its foundations, this thesis is informed by the theoretical and empirical underpinning - emerging under various names in the literature - that social movement may act as a critical source of knowledge creation and transmission, with the implied capability of prompting new debates, shifting public opinion, raising awareness, and lending issues a new urgency. Building from this concept, this Section of the thesis presents the theoretical framework that informs this work, outlining how, through their role as 'cognitive praxis' and their epistemic activism, radical climate movements may leverage their online communication to deliver peer-produced forms of noise-reduction A visualisation of this theoretical framework is shown in figure 1.3
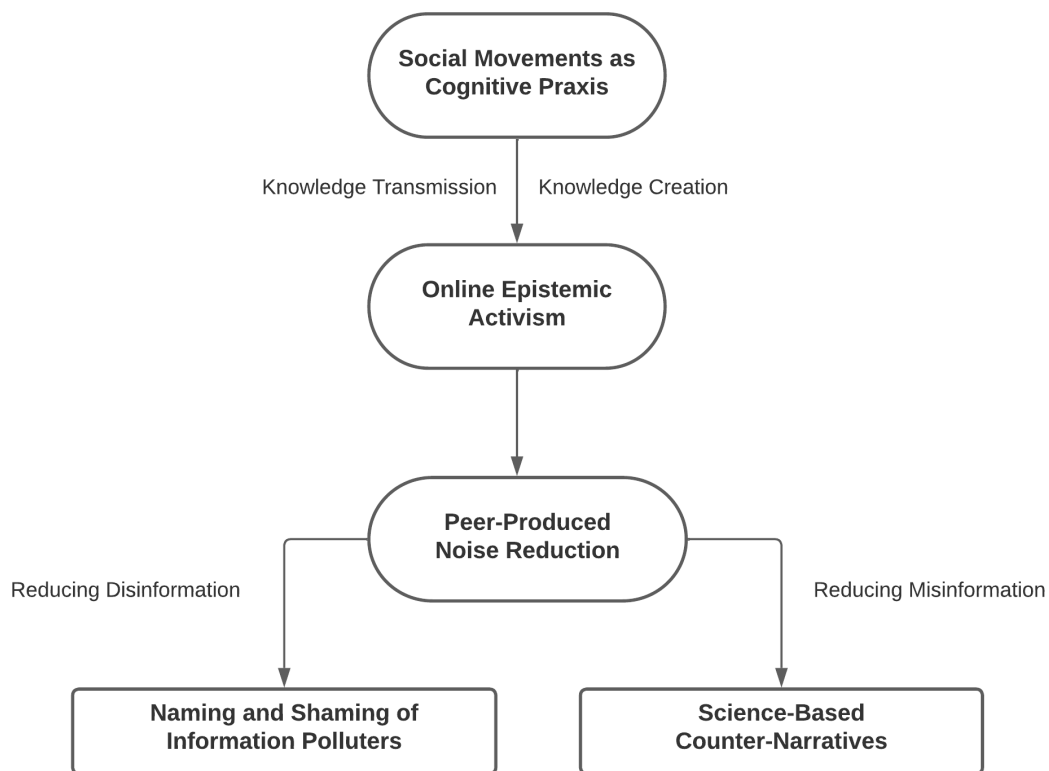
Fig. 1.3 Theoretical Framework

Social Movements as Cognitive Praxis

The first building block of this theoretical framework is the concept of cognitive praxis, which summarises social movements' role as epistemic innovators. The idea of social movements as a force of epistemic change was first theorised by Eyerman and Jamison (1991), who argued that social movements should be seen 'not merely as a challenge to established power,

but also and more so a socially constructive force, as a fundamental determinant of human knowledge'. Eyerman and Jamison proposed a wholly new conceptualisation of social movements as 'cognitive praxis', from which 'science and ideology and general knowledge develop new perspectives' (Holford, 1995).

According to the authors, 'it is precisely in the creation and articulation, formulation of new thoughts and ideas - new knowledge - that a social movement defines itself in society', hence identifying social movements' role in shaping information amongst the essential functions they perform. However, it is important to specify that the expression 'new knowledge' should not be interpreted too strictly, as this can also include mediations and interpretations (e.g., variations) of existing knowledge. The view of social movements as knowledge producers and transmitters is supported by Conway (2013), according to whom knowledge production and diffusion are central to both the making and meaning of social movements, in which the generation of movement-based interpretation of the world becomes a tenet of social movements' capacity to enter into political struggles in which contestation over knowledge is central. Thus, social movements typically recognise the need and value of engaging with, disseminating and advancing formal knowledge as a critical dimension of their social change work.

From an operational perspective, following a characterisation proposed by Della Porta and Pavan (2017), it can be argued that social movements act as cognitive praxis by engaging in two critical knowledge practices. The first practice is knowledge creation, where movements engage with the production of new knowledge. This characteristic of social movements was already present in the seminal work of Eyerman and Jamison (1991), who argued that movements produced knowledge within three dimensions: a cosmological one, developing information as to how the world works, an organisational one regarding the functioning of social movements, and a technological one, concerned with the creation of novel institutions. A second knowledge practice is knowledge transmission, where movements provide spaces and occasions for radical education and learning (Pavan and Felicetti, 2019). Knowledge transmission naturally entails the public display, circulation and diffusion of information, often with an explicit pedagogical aim to increase the reach of movement knowledge to broader society. Both forms of cognitive praxis are relevant to this research, although particular attention is paid to social movements' role in disseminating existing knowledge on climate change.

Online Epistemic Activism

While a large share of research on the role of social movements as cognitive praxis was conducted before the so-called digital revolution, this concept can be comfortably applied to the current communicative ecology dominated by online communication and social media. This logical step leads to the second block of this theoretical framework, which is the understanding that social movements' cognitive praxis can extend and adapt to online spaces, translating into what I term 'online epistemic activism', where their activism-related communication serves to influence and shape public debates and information flows. In a way, movements' role as epistemic activism can be interpreted as an operationalisation of their cognitive praxis.

In this work, the term online epistemic activism is used to describe the use of activism practices and online communication as a means of combating epistemic threats, which are threats to the production, dissemination and acceptance of knowledge. This tactic describes a key function of many modern social movements, where online activism through the strategic production and dissemination of information is increasingly used to improve the information circulating within online spaces. In principle, online epistemic activism can include efforts to promote the use of reliable sources, expose misinformation and disinformation and to generally raise awareness of epistemic threats. However, perhaps the main innovation of online epistemic activism is the use of tactics that are unique to online environments, such as hashtag activism, a practice that describes the use of hashtags to bring attention to a particular issue or cause (Jackson et al., 2020). Notably, this definition differs from some of the conceptualisations of epistemic activism found in the literature, which mainly focus on the use of activism to fight epistemic insensitivities (Medina, 2019).

Despite its unclear framing and definition, this phenomenon has been analysed, under different names, in the existing literature, with scholars examining various forms and strategies of online epistemic activism, as well as the ways in which this concept may intersect with other forms of activism and social justice work. For example, Pavan and Felicetti (2019) provide an exhaustive analysis of the nexus between social movements, digital media and knowledge, investigating how activists resort to digital media to produce and diffuse alternative forms of knowledge on the issues on which they mobilise. Analysing the Italian TI Movement, the authors find that social media were used extensively to circulate original content produced by the movement, fostering public knowledge and acting to showcase good collaboration practices. The literature has also demonstrated that movements' production and dissemination of knowledge have significantly affected protest repertoires (Tilly, 1986) as movements now tend to communicate online by setting up websites and spaces on social

networking sites, using protest hashtags, and organising digital protests (Pavan and Felicetti, 2019), all elements that will prove of interest to this work.

In addition, research on a select number of recent mobilisations has investigated social movements' role in disseminating online information and influencing knowledge production mechanisms. For example, Juris (2012) analysed the Occupy Movement and its practices of knowledge sharing and public outreach, finding that platforms such as Facebook, Youtube and Twitter were primary means of disseminating information, particularly during the early phases of the movement. In addition, Della Porta (2020) suggested that during the first stages of the Covid-19 pandemic, activists and social movements were crucial in disseminating simplified information on the pandemic. Using digital resources, social movements synthesised and connected information from different fields, helping the public construct alternative forms of knowledge. The evidence emerging from the literature amply highlights how social movements can use online communication platforms in their epistemic activism, sharing and producing new forms of knowledge, influencing - and improving - online debates.

Peer-Produced Noise-Reduction

The next block of this theoretical framework describes the mechanism that forms the research object of this thesis: the use of peer-produced approaches to contrasting the circulation of disinformation and misinformation. In light of the empirical evidence described above highlighting how activists can use social media to engage in knowledge production and sharing, it can be theorised that social movements may use - knowingly or not - their role as an epistemic influence to counteract the circulation of false information while engaging in online debates (Farkas and Neumayer, 2017). The idea that information disorders could be tackled via bottom-up, peer-produced approaches has previously been explored by Pennycook and Rand (2019), who proposed that false information could be successfully countered on social media by adding embedded structures for the public to detect false information. However, the relevant literature has until now mainly focused on structural forms of peer-produced noise reduction, largely neglecting communication-based forms. This thesis analyses this phenomenon, framing online epistemic activists with a view that online activism may act as a force to tackle online epistemic threats.

Drawing from the definitional model presented in Section 1.2, this research project focuses on analysing two potential channels to contrast false information on climate change through peer-produced communication and activism, one for disinformation and another for misinformation. These channels were selected in the early stages of this PhD project, and

the choice was driven by preliminary findings from the quantitative content analysis of the two movement, as well as the literature review. This selection is indeed not exhaustive, as other channels may be discovered and analysed in the future. As a peer-produced form of disinformation reduction, this work analyses the use of naming and shaming against information polluters, such as creators and spreaders of disinformation, while for misinformation, it analyses how radical climate movements are using scientific counternarratives to improve the public understanding of climate change science. The theoretical and empirical underpinnings of these two channels are described in greater detail in the following analytical chapters.

Finally, the view of social movements as cognitive praxis and online epistemic activists offers a coherent framework to analyse radical climate movements' use of peer-produced noise reduction mechanisms on climate change. In particular, this theoretical framework suggests that the activity of information creation and dissemination is inherent to the very functioning of social movements and that in virtue of this, radical climate movements may represent an effective, bottom-up force of noise-reduction in the public debate on climate change. This approach is notably absent from contemporary research on climate change communication.

1.4.2   Research Methods

This thesis aims to understand how radical climate movements may influence the circulation of online disinformation and misinformation on climate change. For this purpose, this research will mainly focus on the quantitative, computer-assisted analysis of information circulating on the social network Facebook.

Social networks provide a powerful window into the structures and dynamics of online communities, and the growing use of social networking platforms by a wider audience of citizens presents opportunities to use the web as a tool to track and explore public views. While the circulation of online disinformation and misinformation is not limited to social networking sites - news websites and the blogosphere remain fertile ground for false information to circulate - social networks are often an accessible and reliable source of data on the lived experience and social representation of complex social phenomena. The study of social networks has proven particularly suitable for the analysis of social movements, as it has been shown that the latter have often used social networks to increase their engagement, facilitate events organisation, foster conversation and generate awareness of their goals (Brady et al., 2015; Hwang and Kim, 2015; Kidd and McIntosh, 2016; Lopes, 2014; Tufekci, 2017).

In the so-called 'analog age', collecting data on individual and collective behaviour was expensive, complex and hardly accessible (Salganik, 2019). However, with the coming of the digital age, information availability and data flows changed radically. Today, the behaviours, preferences and attitudes of billions of internet users are constantly recorded and stored, producing nearly limitless amounts of data. In fact, every time we interact with an online platform, for example, by tweeting or writing a Facebook post, we now leave a digital trace. The aggregation of these digital traces provides unique research opportunities, allowing researchers to observe and analyse public behaviour on an unprecedented scale. According to Jungherr (2015), two main types of digital trace data can be identified, both of which will be used to answer the research questions of this PhD thesis. The first type is primary trace data produced by direct interactions between users and online services. For example, a Facebook post represents a form of primary data. A second type is meta-data, digital traces that the service platforms use to contextualise the interactions by its users. This may refer to time-stamps or geo-localisation of the digital trace. The analysis of meta-data is fundamental, as it allows researchers to analyse the context of the evidence found in the primary data.

The sheer volume of trace data produced by social networks and other online communication platforms is frequently referred to as big data. While there is no universally accepted definition of what constitutes big data, the most common characterisation of this expression focuses on its three main characteristics: volume, variety and velocity. In other words, big data is not simply denoted by volume (King, 2016). Instead, it is data that is large in volume, comes in various formats, and is being created constantly and at high speed within online spaces. Social media data perfectly fits this description, as data circulates on social media in huge volumes, in various forms - e.g. pictures, videos, text - and at a very high speed, as millions of digital traces are produced every minute.

The burst in the production of big data has led many scholars to argue that a data revolution is underway, with far-reaching consequences on how knowledge is created in academic environments and on how traditional methods and paradigms may continue to remain relevant in a changing world (Kitchin, 2014; Shah et al., 2015). Interestingly, some went insofar as suggesting that big data would have led the world in an era of unbridled empiricism, where the volume of data, accompanied by machine-based analysis methods, would have marked 'the end of theory, where the data may speak for itself free of theory, ultimately making traditional research methods based on theoretical frameworks and hypothesis testing obsolete (Anderson, 2008). In reality, the opposite has proven true, as the increased availability of data has allowed researchers to test and update existing theories, as well as formulate new ones. For example, the influential two-step flow communication theory developed by Katz (1957) has recently been revisited using Twitter data (Choi, 2015), finally materialising some

of the original goals of the author, who stated that: 'Ideally, we should have liked to trace out all of the interpersonal networks in the community to see how they link up with each other' (Katz, 1957). This goal was finally achieved 58 years later, thanks to data gathered on social media.

While the big data revolution did not indeed mark the end of theory, it is now undeniable that the increased availability of vast amounts of data in machine-readable formats has radically changed research paradigms, particularly by leading to the rise of computational social sciences, a research paradigm that underlies this work. The concept of computational social sciences is derived from the intersection between computer science, statistics and social sciences (Mason et al., 2014), and its primary focus is unlocking new research potential in big data analytics, using advanced computation methods to create procedures to collect, organise, visualise and model large quantities of data (Conte et al., 2012; Gilbert, 2010; Lazer et al., 2009). A key feature of computational social sciences is its interdisciplinarity, as this field ultimately focuses on analysing issues studied by social scientists with the computational methods developed by computational scientists (Zhang et al., 2020). According to Shah et al. (2015), computational social sciences are defined by four elements: (1) the use of large and complex data sets, (2) the involvement of 'naturally occurring' social and digital media sources, in the sense that researchers do not influence the data in any tangible way, (3) the use of computational or algorithmic solutions to gather insights on the data, and (4) the application of social theory for the examination of social and political events.

As suggested by Theocharis and Jungherr (2021), the field of computational social sciences is particularly suitable for disentangling complex political communication processes and their effects. In fact, the decreasing costs of computational power and broad access to text data from social networks have provided access to a wide range of applications of studies on social and political communication. These developments are often discussed under the term computational communication sciences (Hilbert et al., 2019; van Atteveldt and Peng, 2018), which can be considered a sub-discipline of computational social sciences. Computational communication sciences draw on techniques developed in natural language processing (NLP) such as automated text analysis, information retrieval, text mining and machine learning to answer pressing questions on online communication, in particular regarding disinformation, polarisation and political disagreement, such as those that this work aims to assess (Rodriguez and Storer, 2020; Theocharis and Jungherr, 2021).

Finally, while each of the following analytical chapters will provide an overview of the unique methodologies used, the remainder of this Section will discuss in greater detail the data set used and the individual methodological approaches used in this thesis.

1.4.3 The Data Set

The data used in this PhD thesis was collected from the social media platform Facebook, and three advantages that the latter presents over similar platforms informed this decision. First, Facebook is the most popular social media platform globally, and over the past 13 years, the number of monthly active Facebook users has grown from 145 million in 2008 to over 2.85 billion in 2021, representing roughly 36% of the global population (Statista, 2021). Today, Facebook is far more popular than any other social media platform - for reference, Twitter, a commonly studied social media platform, has an average of 396 million monthly active users. Thanks to its widespread popularity, Facebook is expected to grant the highest degree of representativity of the global population among all social media platforms.

Second, Facebook data is highly granular, as every query returns a detailed data frame containing over 30 different primary and secondary traces, including a post's date of creation, the interactions and engagement received, any media attached, and even an 'overperforming score', which quantitatively computes a post's performance in comparison to similar posts. The granularity of Facebook data and the abundance of meta-data makes the latter very suitable for analysing complex social phenomena, providing an opportunity to understand and contextualise the research object extensively.

Third, Facebook data has already been used broadly to analyse social movements and their online presence and communication, particularly in light of the role that social media platforms play in helping information flows within movements (Bruns et al., 2013; Caren et al., 2012; Costanza-Chock, 2012; Gaby and Caren, 2012). For example, Harlow (2012) examined the Guatemalan justice movement's use of Facebook and how the social media website provided a platform for the organisation of offline protests, finding that the emergence of several Facebook groups supporting the cause was instrumental in mobilising the public. won Kim et al. (2014) took a similar approach to analyse the South Korean Gangjeong movement and its behaviour on Facebook, focusing on how activists and the public used Facebook to engage with the movements and its causes. Conover et al. (2013) instead analysed the Occupy movement and how the latter used social media to mobilise resources and strengthen its communication, proving how social media data is an increasingly common data source in the study of social movements and their online activities.

Facebook data was collected directly from Crowdtangle, Facebook's own platform monitoring tool. While Crowdtangle is currently not open to the public, access was granted by Facebook as part of their data opening process for university-based researchers and academics. Currently, Crowdtangle's data includes Facebook's full historical archive for

Pages, Public Groups and Verified Profiles, excluding all data that is not publicly available on the platform. However, in this work, I only use data from Pages and Groups, excluding verified profiles of individuals, with the final dataset being composed of 200,185 posts from Extinction Rebellion's Groups and Pages, and 50,246 posts from Fridays for Future's Groups and Pages. While this limitation could be considered as an obstacle within a specific research design, in this case, this is not detrimental to the analysis, as the object of this thesis is to study the online communication of Extinction Rebellion, and Fridays for Future and the data for these movements falls under the categories currently supported by Crowdtangle, namely Pages and Public Groups.

Through Crowdtangle, data was collected for the period going from September 1st 2018, the month in which both movements were established, and June 1st 2021, which was selected as an arbitrary cut-off date to limit the temporal scope of the data under analysis. To effectively extract the online communication originating from the two movements, Crowdtangle was queried for all English-language posts from public Pages and Groups containing the strings 'Extinction' AND 'Rebellion OR 'Fridays' AND 'Future'. This list of 1151 Facebook Pages and Groups was then validated manually, removing all entities that are not connected to the two movements. Then, all posts from the entities identified were extracted with Crowdtangle. This query returned a total of $\approx$ 751k, of which $\approx$ 250k are English-language posts. Indeed, the decision of limiting the posts analysed to those in English significantly limits the breadth of this study; however, this step is aimed at maximising the interpretability of the results of the textual analysis that will follow. It should be further emphasised that these posts only include original content from the two movements, defined as content created or shared by Pages or Groups containing the movement's name, hence excluding text published as a response to these posts by members of the public, or other posts published by individuals not speaking on behalf on the movement.

1.4.4 Data Analysis

Given the complexity of the phenomenon being analysed, this thesis will resort to a combination of methods from natural language processing and computational social sciences. The use of multiple methods is expected to allow the exploration of the research question from different perspectives and produce more robust results than in a single-method study (Brewer and Hunter, 2006; Collier and Elman, 2008). This Section will present two core methodological approaches that will be used throughout the thesis, although several other methods of data organisation, filtering and analysis will be used to support the research process.

The first core method that will be used extensively in this thesis is content analysis of textual data, which can be briefly defined as the systematic and objective analysis of the characteristics and content of a message. This research method can help quantify and analyse the presence, meaning and relationship of words and concepts and make inferences about the messages within a text (Neuendorf, 2017). In this study, content analysis will be used to document and analyse communications from radical climate movements, analysing their main narratives, communicative frames, and noise-reduction strategies. Several examples exist of how content analysis can be used to identify a group's intentions, draw out communicational trends, and even detect the existence of propaganda (Abd Kadir and Abu Hasan, 2014; Dotson et al., 2012; Metag, 2016; Neuendorf, 2017). This work will primarily focus on quantitative content analysis through topic modelling, an approach to statistical modelling that extracts topics from collections of text. In terms of approach, topic modelling will be applied through Latent Dirichlet Allocation (LDA), a fully unsupervised algorithm for topic extraction (Blei et al., 2003). As an unsupervised machine learning algorithm, LDA does not - in principle - require labelled data or model-pre training. Instead, the data is simply fed to the model, which is then tested and tuned for accuracy, finally outputting results on topics distribution and co-occurrence. Topic modelling is extremely valuable when annotated data is unavailable, which is a significant research advantage, as most online data is not pre-labelled. However, as it will be evident in the analysis contained in Chapter IV, novel approaches to topic models such as SeededLDA also allowed for the integration of supervision within topic modelling. At its most superficial level, LDA models assume that every document fed to the model is a mixture of topics, and every topic is a mixture of words, and through mathematical modelling, identifies the topics present in a document and what words are associated with each topic (Silge and Robinson, 2017).

The second core method used throughout this research is sentiment analysis, which is the computational analysis of opinions, attitudes, and sentiments contained in a text (Liu, 2020; Medhat et al., 2014). Sentiment analysis is particularly relevant in analysing the online communication of radical climate movements, as it allows for the analysis of the emotions triggered by certain narratives and the polarisation effect produced by the circulation of specific arguments (Zamir, 2017). Sentiment analysis classification of social media data can be carried out at two different levels. The first level is word-level sentiment analysis, where the data is converted into a matrix with one word per line, and each word is independently assigned a sentiment score. While this approach minimises categorisation error, it has a critical flaw of missing interactions among words in a sentence, often misinterpreting the overall sentiment. The second approach involves performing sentiment analysis at the sentence level, using algorithms capable of extracting the main sentiment and emotions from

a complete sentence, and analysing the interactions between sentiment words, amplifiers and negatives to compute a sentiment score. This approach is quite dominant in the literature, and because of its accuracy and versatility, it will be used throughout this thesis. In practice, sentiment analysis will be applied within the open-source software environment R, using the package SentimentR (Rinker, 2017). SentimentR uses a lexicon-based approach to sentiment analysis, which involves calculating the sentiment from the semantic orientation of words within a text (Jurek et al., 2015). This approach requires a dictionary of positive and negative words, where a sentiment value is assigned to each word. Then, a combining function is applied, considering individual sentiment scores, negators and amplifiers to produce a sentence-level sentiment score. Lexicon-based approaches require the choice of a sentiment lexicon, and the lexicon used through this work will be the Jockers-Rinkers sentiment which presents the highest accuracy among currently available lexicons with an average sentiment accuracy of 77.7% (Rinker, 2017). This lexicon uses a scoring scale ranging from -2, for highly negative sentiment, to +1 for extremely positive sentiment.

Finally, this Section presents an overview of two core methods used in this PhD. It should be noted that this segment only presented the foundations of the core methodologies of this research, along with the motivations for using them in this work. Each of the following analytical chapters will add to this research's methodological framework, describing in greater depth the processes used and that were not included in this Section, such as model tuning and results from validation methods.

1.5 Structure of the Thesis

This thesis consists of three self-contained analytical chapters investigating the emergence of a new wave of radical climate activism, and its role in reducing the circulation of online disinformation and misinformation. The choice of research questions was informed by the theoretical bases outlined in this Chapter, and this work will be structured as follows.

Chapter II presents an in-depth analysis of the two radical climate movements studied in this research: Fridays for Future and Extinction Rebellion. First, Chapter II provides an overview of the past tradition of climate change movements and how this new wave of radical activism emerged from previous forms of climate organisations. Then, the Chapter offers a quantitative assessment of the two movements' communication and epistemic activism using methods from natural language processing and computational social sciences. These include a geographical analysis of posts' origin for the two movements, the main topics, narratives, and themes emerging from their online communication - focusing on disinformation and

misinformation - their composition, goals, and overall social media presence. Lastly, this part includes a network analysis aimed at understanding intra-movement influence dynamics.

Chapter III analyses the radical climate movements' use of online naming and shaming of information polluters as a technique to act as a counterpoint to the circulation of disinformation. Naming and shaming is an ad hominem argument that consists in publicly stating that an organisation has engaged in illicit or downright harmful behaviour, and within this work, naming and shaming will be analysed in light of its potential to expose extractive industries and climate change denial networks and their wrongdoings to the public, opening their disinformation campaigns up to public scrutiny. Exposure to these campaigns and the interests guiding disinformation narratives is expected to weaken their legitimacy and overall circulation. Using the data set described above, posts containing naming and shaming were identified through a two-step filtering approach based on the training of a *word2vec* model. Naming and shaming posts are then analysed to extract their most common targets and content and their overall sentiment and development over time.

Chapter IV turns to an indirect approach to addressing the circulation of misinformation and disinformation: the creation and circulation of science-based counternarratives. Drawing from Tuck (2016), science-based counternarratives are defined as a message that offers an alternative to climate change misinformation and denial through scientific evidence, *de facto* contrasting the diffusion of contrarian and anti-science rhetorics through the use of scientific arguments. Using techniques from natural language processing and computer-assisted data analysis, this Chapter assesses how scientific arguments are used by the radical climate movements under analysis.

Finally, Chapter V combines and integrates the results of this research with the theoretical framework outlined in this Chapter to assess the implications of this thesis for climate change communication and the advancement of the understanding of the role of radical climate movements in the circulation of disinformation and misinformation on climate change. It concludes by examining how bottom-up approaches to noise reduction are particularly well suited to contrast the circulation of false information in the current social and political environment and analyse the prospects of climate activism in the fight against disinformation and misinformation.

Chapter 2

A 'New Wave' of Radical Climate Activism: A Critical Assessment of Extinction Rebellion and Fridays for Future

2.1 Introduction

In their seminal work *Institutions for the Earth*, Haas et al. (1993) conclude that if there is one key variable in accounting for policy change, it is the degree of domestic environmentalist pressure in major industrialised democracies, not the decision-making rules of the relevant international institutions. In fact, over the last decades, domestic and international environmentalism, primarily in the form of citizen mobilisations, has played an increasingly decisive role in the public debate on environmental protection (Hale, 2010; Rootes, 2014). This bottom-up pressure from activists has often served to make up for an evident lack of political ambition on various causes, ranging from acid rain to air pollution and climate change (Hajer, 2005; Piggot, 2018).

Since the emergence of climate change as a critical policy element in the international agenda in the 1990s (Zillman, 2009), concern on the issue has manifested itself in several organised efforts worldwide, which have often been recognised in the relevant literature for their role in creating and disseminating knowledge, mobilising masses, and holding key actors accountable for their actions (Gunningham, 2018; Hestres and Hopke, 2020; Kluttz and Walter, 2018). These mobilisations have involved thousands of organisations

globally, ranging from neighbourhood associations to international advocacy groups, varying significantly in pressure tactics, group identity and movement culture (Caniglia et al., 2015; Freudenberg and Steinsapir, 1991). Today, as the difficulties in raising political ambition on climate change through conventional political processes are increasingly evident, we face a new development in climate change activism, resulting in the emergence of what can be defined as a new wave of radical climate movements. This turn in climate activism is exemplified by the emergence of novel movements of the likes of Extinction Rebellion and Fridays for Future, which established themselves as some of the world's most active campaign groups, enlisting the support of thousands of activists globally (Taylor, 2020). In a significant breakthrough with the recent tradition of climate advocacy, these movements propose a new vision of environmental activism based on radical, no-frills and often emotion-ridden messaging centred on concepts such as truth, survival and existential risk, paired with high-pressure, online and offline protest tactics aimed at bringing the public spotlight on the urgent need for climate action.

The emergence of a new generation of radical climate activism is a novel and unexplored phenomenon, and while the importance of bottom-up activism in climate change governance is now widely recognised (Dietz and Garrelts, 2014; Nulman, 2016), the relevance of this shift in the tactics and principles of organised activism is far from understood. Given this research gap, the objective of this Chapter is threefold. First (1), it aims to provide an in-depth understanding of the events that led to the emergence of a new generation of radical climate change activism and how Extinction Rebellion and Fridays for Future acted as a catalyst for change within the environmental movement, bringing newfound energy and momentum to climate activism. Second (2), this Chapter aims to comparatively assess the identities of the two movements, with a particular focus on organisational and ideological traits that distinguish each movement and set them apart from past forms of activism, such as leadership structure, ideological tenets, stated goals and main protest tactics. Third (3), this Chapter seeks to empirically quantify the online presence and communication of the two movements, assessing the magnitude of this presence, the content of their Facebook posts, and their networks of communication.

Ultimately, gaining a detailed understanding of the two movements' identities, communication ecologies, and protest tactics is quite crucial for two reasons. First, this would allow to contextualise and frame this novel social phenomenon, presenting new information on its characteristics. Second, this step allows drawing information on how this innovative form of activism is attempting to bring about change within the debate on climate and how this change may spill over into the communicative side of activism, influencing the circulation of disinformation and misinformation, thus setting the groundwork for the following chapters.

To answer these questions, this Chapter is structured as follows. Section 2 presents an overview of the history of environmental and climate activism, assessing where Extinction Rebellion and Fridays for Future may be placed within a rich tradition of activism. Section 3 describes movement identities, using original sources from the two movements to analyse their main organisational and identity-related traits. Section 4 presents a quantitative analysis of the Facebook communication of the two movements using an original data set of $\approx$ 250k Facebook posts, analysing the main characteristics of their online communication through natural language processing and machine learning techniques. Finally, section 5 discusses the main findings, outlining conclusions on how the findings of this Chapter link to the research questions that drive this work.

2.2 Environmental Activism, Social Movements and Climate Change: A Historical Review

Environmentalism has a rich and diverse history, which over time, generated vast amounts of scholarly literature. Reconstructing the history of environmentalism is no easy task, as the very word environmentalism is an ill-defined one, covering different ideas on nature, society and material resources, as well as different forms of activism. As Armiero and Sedrez (2014) noted, environmentalism is not a monolithic movement, and reducing it to a single, univocal entity may ultimately be misleading. With this in mind, this Section provides an overview of the different phases that characterised environmentalism and the environmental movement over time, focusing on how environmentalism emerged and progressively evolved, changing its epistemological scope and practices. The history of environmentalism is analysed in parallel with the growth of climate activism, finally assessing how a new generation of radical climate movements came to life and how the latter relates to the previous tradition of environmentalism. Notably, as the focus of this thesis is the analysis of English-language posts produced by the two movements, this section discusses the history of the Anglo-American environmental movement. However, it should be specified that analysing the environmental movement from an Anglo-American perspective has evident limitations, as this does not take into account the diverse range of perspectives and experiences of environmental activism from other cultural and geographical backgrounds. The environmental movement is a global phenomenon that includes different histories, motivations and priorities in different parts of the world, many of which are not captured in this section. For simplicity, going forward, with the term 'environmental movement', I will be referring to the specific subset of the Anglo-American movement.

While environmental concern has a long history, the Anglo-American environmental movement itself has no clear origin, as there is no single event that led to its emergence and no individual country from which it spread (McCormick, 1991). Instead, the emergence of the environmental movement can be considered a gradual process, which over several decades reflected profound, society-wide changes that revolutionised the way individuals think about the environment. To provide an overview of the most significant evolutions in the environmental movement, the development of environmentalism and environmental activism will be broadly divided into four generations, each with critical differences in terms of scope, type of participation, informational strategy and movement structure: a first generation focusing on nature conservation; a second generation leading to the exponential growth and institutionalisation of the environmental movement; a third generation characterised by the rejection of mainstream environmentalism, leading to the rise of grassroots activism; and a fourth, new generation of environmental movements characterised by youth-driven radical climate activism. It should be noted that the four generations analysed in this characterisation are not mutually exclusive, but rather, several organisations from each generation still coexist today.

2.2.1 The First Generation of Environmentalism: Conservation and the 'Cult of Wilderness'

The first generation of Anglo-American environmentalism emerged between the late 19th to mid 20th century in the United States through the conservation movement, which sought to protect natural resources from exploitation and degradation. This strand of environmentalism, defined by Guha and Alier (2013) as the 'cult of wilderness', presents the most traditional approach to environmental protection, emphasising the importance of wilderness, 'untouched nature', and protecting natural resources from human activity. This form of environmentalism was so dominant prior to World War II that the term 'environment' was hardly ever used when discussing the protection of nature, and the emphasis was consistently placed on the preservation of water, forests, soils and game (Hays, 1982). According to Hays (1999), the conservation movement was characterised by a 'gospel of efficiency', where environmental concern was guided by the possibility of a loss of productivity through exploitation, which led environmentalists to argue for more efficient use and management of natural resources to guarantee their preservation and long-term productivity.

In terms of information strategy and epistemic impact, this phase of the environmental movement was characterised by campaigns that refrained from mass public communication

and instead focused on spreading their message through local clubs, books, newspapers, and public speeches, often targeting ruling elites rather than the general public. For example, analysing the influence strategy used by the National Coast Anti Pollution League, a conservation campaign launched in the United States in 1922 to protest oil dumping in the ocean, it is clear that the efforts of this campaign were driven mainly by two political figures Gifford Pinchot and Teddy Roosevelt, and their public speeches (Fales, 1927), which were only aimed at creating regulatory momentum among elected officials, rather than raising public awareness.

Finally, it should be mentioned that while the scope of this early form of environmentalism was limited - and certainly did not include climate change - the first generation of environmental activism was nonetheless impactful (Carter, 2018). In fact, during this phase of the environmental movement, key conservation groups still active today, such as the Sierra Club, the Royal Society for the Protection of Birds (RPSB), and the World Wide Fund for Nature (WWF), were founded. These organisations were, and still are, quite traditional in their influence tactics. Nevertheless, they continue to have a visible impact on nature's conservation.

2.2.2 The Second Generation of Environmentalism: Growth and Institutionalisation

The second generation of Anglo-American environmentalism emerged after World War II, marking the transformation of environmentalism from an ideology to a modern, fully-fledged social movement (Carter, 2018; Silveira, 2000). Tracing a temporal distinction between the era of conservation and that of the modern environmental movement is challenging, as the transition between the two generations was rather gradual. Perhaps the most common position here is that the publication of Silent Spring, which shed light on the harmful environmental effects of the use of pesticides, represents the key trigger for the development of modern environmentalism (Lutts, 1985; Lytle, 2007), exposing the public to the critical, previously unseen side of economic and technological developments. However, others, such as Gottlieb (1963), attribute reduced importance to the publication of Silent Spring, claiming instead that it is only in the 1970s that modern environmentalism emerged, primarily concerned with issues such as species protection, wetlands preservation, industrial pollution, clean air and water, and hazardous waste.

While both stances have their merits, it is ultimately more likely that the transition from conservationism to a more comprehensive approach to environmental protection was

the synthesis of several high-profile events and society-wide changes that, from the 1960s onwards, interacted to lead to the emergence of the modern environmental movement. These certainly include the publication of Silent Spring, which was instrumental in highlighting the destruction of the natural environment, along with other societal changes such as the rise of student movements and radical activism, and postmaterialism, which led swathes of individuals to view nature as an essential provider of recreational activities (Silveira, 2000). Furthermore, high-profile environmental catastrophes such as the 1969 Santa Barbara Oil Spill, which released an estimated 3 million gallons of oil into the ocean and killed thousands of birds, fish and sea mammals, certainly contributed to an overwhelming perception that the natural environment was at risk as a result of human activity (Clarke and Hemphill, 2002), strengthening the bottom-up pressure for the rise of modern environmental activism.

The organisations that emerged during the second generation of environmentalism that followed the events of the 1960s and 1970s presented three innovative organisational and epistemic characteristics. First (1), these organisations are primarily committed to an ideological paradigm of ecological modernisation, according to which environmental problems can be resolved politically, economically and technologically within existing institutions in a way that is compatible with economic growth (Dietz and Garrelts, 2014). As a direct consequence of this paradigm, second-generation organisations are highly institutionalised, often exhibiting a vertical structure where, while they boast mass membership, members enjoy limited democratic rights, with little to no power to influence the organisation's activities. Further, second-generation movements often reject - with some exceptions - confrontational participation and instead use their vast economic budgets to perform lobbying, disseminate information, and use the legal system to protect the environment (Carter, 2018).

Second (2), in contrast with the previous generation of environmentalism focusing on conservation, this second phase of environmental activism relies on an epistemic paradigm of mass communication and public awareness. During this period, organisations such as Greenpeace significantly innovated the communication landscape pertaining to environmental protest, setting new standards for mediatic activism through numerous large-scale, well-funded campaigns aimed at popularising environmental protection through mass media (Lowe and Morrison, 1984). In particular, during this period, the first campaigns based on spectacular feats and emotional language made their appearance, often focusing on raising awareness of environmental degradation by causing fear and empathy (Shelton and Rogers, 1981) in the information receiver. For example, a prototypical instance of this type of communication is Greenpeace's 'Save the Whale' campaign, where the organisation made extensive use of explicit photos and video footage of whales being slaughtered with harpoons to harness social and political support for a moratorium on whaling (Suter, 1981). As we

will later see, the use of emotional messaging will remain a vital pillar of the communication of the environmental movement over time.

Third (3), second-generation environmentalism adopted, for the first time, a more comprehensive approach to environmental protection in terms of both issues coverage and geographic coverage. On the one hand, this generation of movements views environmental quality as a social problem and emphasises the importance of broader - and ultimately more political - environmental issues such as pollution, energy generation, climate change, and the right to a healthy environment (Mertig, 1992). On the other, recognising the transnational nature of modern environmental problems where environmental harm often crosses national borders, several organisations established during this time, such as Friends of the Earth and Greenpeace, quickly developed into transnational organisations with offices in multiple countries. The recognition of the transnational nature of environmental harm and following internationalisation of environmental politics is a central element of modern environmentalism (Doherty and Doyle, 2006), which will continue to solidify in the following decades concerning many environmental concerns such as ozone depletion and climate change.

Finally, it is worth noting that it is within the second generation of environmentalism that the environmental movement started to include climate change among its fundamental causes. After years of growing scientific and political interest in the risks posed by climate change, in 1989, environmental organisations in Europe and the United States converged to launch a network to contrast climate change known as the Climate Action Network (CAN). CAN originated from the cooperation of some of the most prominent organisations that emerged within the first two generations of environmentalism: the World Wide Fund for Nature (WWF), the Environmental Defense Fund and Greenpeace International, and initially comprised 63 environmental non-governmental organisations from 22 countries (Newell, 2006; Nulman, 2016). CAN emerged as a platform for environmental organisations to discuss climate change and share strategies for influencing international negotiations, perfectly embodying the paradigm of ecological modernisation that characterises the second generation of environmentalism, where the approach to activism is an essentially institutional one aimed at exerting pressure at the political level (Duwe, 2001).

From the early stages of the international climate change regime, environmental organisations were involved quite heavily in the negotiations, providing organisations such as CAN an ideal forum to attempt to exert political pressure. By Earth Summit 1992, when the United Framework Convention on Climate Change (UNFCCC) was opened for signature, over 3,000 NGO representatives attended the meeting in Rio de Janeiro (Adams, 2003). These organisations were granted an ad-hoc forum of discussion named the Global Forum,

where environmental organisations brought their unique contribution to the debate. While environmental organisations failed to reach their goal for Earth Summit 1992, which was to obtain the approval of hard emission reduction standards (Nulman, 2016), their contribution in influencing the conference outcome on less controversial and arguably minor issues is often considered a crucial one (French et al., 1992; Parson et al., 1992), and according to Van Rooy (1997), the presence of environmental organisations left an indelible mark on the Earth Summit proceedings.

While new forms of climate activism developed over time, this form of institutional activism based on the paradigm of ecological modernisation remains relevant today (Bailey et al., 2011), as older organisations such as CAN continue to work alongside new ones, such as the Climate Group and the Climate Coalition, to attempt to bring about change in the climate change regime from within, particularly by lobbying international negotiations within the UNFCCC Framework and using their means of communication to raise awareness on climate change.

2.2.3   The Third Generation of Environmentalism: Grassroots Activism

While the large, transnational and professionalised organisations that emerged during the second generation of environmentalism have dominated the environmental movement since the 1970s, the environmental movement has always included a small number of grassroots components (Staggenborg, 2020). According to Carter (2018), a grassroots movement can be broadly defined as a bottom-up, decentralised movement with fewer members and financial resources than a mainstream organisation.

In the early stages of the development of the environmental movement, grassroots components were minimal, and activism was mainly translated into political pressure in institutional settings (Shabecoff, 2003). However, during the 1980s and 1990s, the grassroots component of the environmental movement began to significantly strengthen, taking up an increasingly large share of the movement. Two main developments contributed to this shift. First, during the 1980s, neoliberal administrations opposed to environmental protection, such as the Reagan administration in the United States, started to ascend to power in Western countries, and the economic hardships of the late 1970s brought a renewed focus on the need for economic growth, making restrictions on pollution harder to promote (Almeida and Stearns, 1998; Mihaylov and Perkins, 2015). Second, parts of the environmental movement began to critique the professionalisation and lack of effectiveness of the institutional and mainstream organisations attempting to bring about environmental change within existing political

structures. For example, David Foreman, founder of the first-ever radical environmental movement Earth First!, is quoted as saying, 'The people who started Earth First! We'd all been in the mainstream groups, we were solid conservationists. But we were frustrated by making too many compromises' (Mongillo and Booth, 2001). Similarly, Shellenberger and Nordhaus (2009)'s seminal essay 'The Death of Environmentalism' criticised mainstream environmental organisations, claiming that they failed to go beyond lobbying activities and address major environmental issues such as climate change effectively.

Ultimately, these conditions led to widespread discontent with existing environmental organisations, triggering a third generation of environmentalism, characterised by a more direct and often confrontational approach to activism carried out by grassroots activists. The history of grassroots environmentalism is a complex and non-linear one, and to facilitate the task of describing this generation of activism, the latter will be described using a characterisation proposed by Carter (2018), according to which grassroots environmental movements can be divided into three categories: 1) small local groups, 2) radical movements and 3) grassroots coalitions.

The first and earliest category of grassroots environmentalism consists of local activism and what are often referred to as 'not in my backyard' (NIMBY) groups. Historically, local activism has often been a response to high-profile environmental catastrophes and locally unwanted land uses (LULUs), leading individuals and communities to mobilise against the adverse environmental and health impacts they were directly experiencing. The first highly influential instance of local grassroots activism emerged as a response to the infamous Love Canal environmental disasters (Beck, 1979; Freudenberg and Steinsapir, 1991; Szasz, 1994). After discovering harmful levels of chemicals in the soil and water beneath the homes and schools of Love Canal, local citizens, led by 27-years old Lois Gibbs, began assembling to protest the situation, using unconventional pressure methods such as street demonstrations and blockades. For the first time in the history of the environmental movement, Love Canal represents the appearance of a highly confrontational style of activism, culminating in two US Environmental Protection Agencies being held hostage for two days by Love Canal activists in order to publicise the dangers of the pollution of the area. After the Love Canal protests, the local grassroots component of the environmental movement continued to grow in relation to several causes. For example, the 1979 Three Mile Island nuclear accident triggered widespread grassroots anti-nuclear mobilisations (Culley and Angelique, 2010; Walsh, 1981). Similarly, the designation of a small predominantly African-American community as a hazardous waste landfill in Warren County, North Carolina, in 1982 became the hotbed of local protests against environmental racism, leading to the arrest of hundreds of protesters (McGurty, 1997).

Even though NIMBY activism has often been criticised as a selfish type of activism merely concerned with local environmental protection, the latter was instrumental for the maturation of grassroots activism, as many such groups progressively expanded to began to address broader ranges of issues and adopted a 'not in anyone's backyard', or NIABY stance, eventually forming a vital pillar of the environmental justice movement (Freudenberg and Steinsapir, 1991; Gerber et al., 2020). Further, early local activism brought critical innovations in the composition of the environmental movement. While second-generation organisations were predominantly white, well-educated and relatively affluent middle-class professionals, NIMBY grassroots groups brought new parts of the population together to protect the environment, cutting across class, ethnicity, gender and educational lines. Grassroots activists were often regular citizens who lived in an unhealthy environment and decided to take action to protect their health and their rights without any intention to compromise.

While NIMBY groups were highly influential in opposing LULUs and getting governments to take action on local unwanted environmental harm, many within the environmental movement remained unsatisfied by the overall lack of action on broader environmental matters at the national and international levels (Rootes, 2007). By the end of the 1970s, this discontent started to manifest through the emergence of grassroots environmental organisations' second category: radical environmental movements, a category in which Extinction Rebellion and Fridays for Future fit very closely. Notably, the term radical can have significantly different meanings across English-speaking countries. For instance, while this term is commonly used in the United Kingdom to describe individuals or groups who are advocating for drastic measures to achieve social or environmental justice, in the United States, this term has a largely negative connotation, as it has been often weaponized by right-wing voices to discredit the efforts of activists. However, this term is often used in the literature on environmentalism and environmental movements (for example, see Corry and Reiner 2021), and adhering to the first definition presented, this term will be used in this work to describe the two movements under analysis.

Traditionally, the centrepiece of radical environmentalism is that the ecological apocalypse is imminent, so aggressive and high-risk direct action is justified. In addition, radical environmentalists often reject human superiority over other species and blame capitalism and endless economic growth for the current environmental degradation (Liddick, 2006), including a strong ideological element in environmental activism. One of the first high-profile radical environmental movements, the short-lived EarthForce Environmental Society, was formed in 1977 after its founder Paul Watson was ousted from the Greenpeace board, where his positions on direct activism were considered too extreme and confrontational

(Kawashima, 2013). Shortly after, EarthForce Environmental Society evolved into the Sea Shepherd Conservation Society (SSCS), a still existing grassroots organisation that uses innovative direct-action tactics to expose illegal activities on the high seas. SSCS uses violent and confrontational methods such as throwing smoke flares, harassing, boarding, ramming and sinking whaling vessels to prevent whaling (Bondaroff, 2011). Following the footsteps of SSCS, through the 1980s, several highly confrontational radical environmental groups were founded, including EarthFirst! and the Earth Liberation Front. These movements often exhibited highly anti-institutional activism, ranging from civil disobedience to violent ecotage, guerrilla and monkeywrenching, attracting notoriety for their semi-illegal status and theatrical stunts (Lange, 1990; Short, 1991; Standing, 2012). Interestingly, these movements were often leaderless organisations with a highly decentralised structure organised into small individual cells made up of a handful of activists, an innovative organisational structure that was devised to avoid breakdown by law enforcement (Williams, 2019). While, according to Taylor (1998), early radical environmental movements never intended to hurt the people they opposed, these movements often caused discontent amongst the moderate public and were labelled by the media and mainstream environmental organisations as eco-terrorists (Badolato, 1991; Loadenthal, 2013).

Over time, radical environmental movements continued evolving, and while they remained faithful to their radical ideologies, their protest tactics progressively softened. In fact, in the 2000s, we note the emergence of a new generation of radical environmental movements, characterised by less violent direct action, often focusing on climate change and air pollution. Key organisations in this generation include Plane Stupid, a group opposing airport expansions (Nulman, 2015), Rising Tide Network, a direct-action group fighting for a fossil-fuel-free world, and Camp for Climate Action, an organisation dedicated to sit-ins against high-emission activities. These groups represent a de-escalation phase after the years of early radicalism. Indeed, they continue to hold radical values, often seeing oil consumption as an offshoot of capitalism and aiming to dismantle the modern economic system based on highly polluting activities (Saunders and Price, 2009). However, they largely refrain from violent action, resorting to more mild forms of direct action through marches, sit-ins and occupations. Nevertheless, these groups still exhibit critical elements of grassroots activism. They are essentially founded on anarchist principles such as the opposition to traditional top-down governance (Clark, 1978), lack a clear leadership structure, have no financial budget, and are critical of the current economic system.

The third and last category of grassroots environmental organisations is that of coalitions of environmental groups. Over time, many grassroots groups began recognising the limitations of working in isolation and started building networks of collaboration with like-minded

organisations, leading to the creation of several loosely organised coalitions of grassroots groups (Carter, 2018). The formation of coalitions containing heterogeneous groups can happen at various levels of institutionalisation. In some cases, coalitions are informal networks of information exchange and collaboration, while in other cases, they can evolve into fully transnational social movements based on a shared identity (Foyer and Kervran, 2015). While grassroots coalitions emerged from the same deep-seated discontent with the mainstream environmental movement that characterises all instances of grassroots environmentalism, their protest tactics differ significantly from those of NIMBY and radical groups. Grassroots coalitions represent a middle ground between radical values and moderate protest ecologies, mainly refraining from the use of violence.

Grassroots coalitions are particularly relevant to climate change activism, as some of the earliest manifestations of this type of organisation converged to fight against climate change. For example, the Environmental Justice Leadership Forum on Climate Change, initiated in 2008, is an institutionalised coalition that brings together 45 grassroots organisations working on climate to share scientific and technical evidence on the causes and impacts of climate change. Furthermore, the second example of a grassroots coalition, this time a non-institutionalised one, is the climate justice movement, a broad network of hundreds of organisations that criticise the mainstream environmental movement for ignoring the impacts of environmental degradation on poorer, often non-white communities. The climate justice movement has been instrumental in bringing issues such as class, poverty, race and gender to the forefront of climate activism, claiming a deep, inevitable correlation between climate justice and social justice (Pettit, 2004; Schlosberg and Collins, 2014).

Indeed, the characterisation presented here is not rigid, as grassroots movements tend to be fluid in their characteristics, and in some cases, coalitions have shown elements of both radicalism and NIMBY activism. For example, the climate justice movement is, in principle, a grassroots coalition, yet it also exhibits radical ideas, often calling for dismantling the capitalist system that produced the current injustices (Dawson, 2010). Similarly, 350.org, one of the largest active grassroots coalitions on climate, holds radical ideas on the immediate end of fossil fuel use and has often participated in highly localised protests using disruptive protest tactics, such as the Keystone XL protests aimed at stopping a pipeline project bringing oil from Canada to the United States (Brightman, 2014; Hestres, 2017; McKibben, 2015). As these example shows, the categories outlined in this Section are general guidelines that do not include possible contaminations and hybrids that can happen within a highly fluid movement, such as the environmental movement. Nonetheless, many of the key information presented here will prove fundamental in the characterisation of the two radical climate movements under analysis.

2.2.4 The Emergence of a New Generation of Radical Climate Activism: Post-Paris Agreement and Beyond

Finally, the fourth and last generation of environmental activism identified in this taxonomy is the innovative grassroots radical climate movements that have emerged since 2018, which in many ways, represent a synthesis of the previous three generations. To comprehensively understand the events that led to the rise of a new wave of environmental activism, this Section will first provide a brief overview of the events that have characterised the environmental movement since 2009. Then, it will proceed to analyse the main characteristics that set this new generation of movements apart from previous forms of activism.

By 2009, environmental activism, and particularly climate change activism, had reached an initial peak (Kössler, 2014; Tokar, 2014). After the mixed results obtained by the 1997 Kyoto Protocol (Aichele and Felbermayr, 2013; Durand, 2012; Rosen, 2015), the world approached the UNFCCC's 15th conference of parties (COP) held in Copenhagen in 2009 with high expectations, as in the lead-up to the conference, many were optimistic about the prospects of a binding treaty on emissions reduction (Bodansky, 2010). COP 15 represented the climax of climate activism, marking the largest number of participants at any COP, an estimated 30,000 and 45,000 members, with NGO observers accounting for more than two-thirds of the conference participants (Nulman, 2016). Outside of the conference, up to 100,000 people gathered to demonstrate. In Copenhagen, organisations from the three generations of environmentalism described above merged to call for the common goal of adopting a binding treaty on greenhouse emissions reduction. However, despite a historical organisation of bottom-up pressure, Copenaghen failed to deliver a new climate treaty. Instead, world leaders approved the Copenhagen Accord, a non-binding statement merely endorsing the continuation of the flawed Kyoto Protocol.

The failure of Copenhagen was compounded by an additional historical event in the evolution of the environmental movement: the Climategate scandal. In late 2009, emails from a server at the Climate Research Unit at the University of East Anglia were released, with some parts of the public claiming that such emails revealed that climate scientists had manipulated or suppressed data in order to strengthen the case for human-caused global warming. Even though subsequent investigations by various organisations including the UK Parliament found that the scientists involved had not manipulated or suppressed any data, climategate opened the doors to dozens of conspiracy theories on the manufacturing of evidence on climate change (Bricker, 2013).

According to Leiserowitz et al. (2013), the impact of the Climategate scandal was highly significant, causing a decline in the trust in scientists and scientific research. The impact of Climategate was also far-reaching in the media, and Telegraph columnist - and established climate sceptic - James Delingpole (Delingpole, 2009) described Climategate as the final nail in the coffin of anthropogenic global warming. In many ways, the Climategate events created a rift in the relationship between climate movements and information providers, which were at the time quite hostile to the movement (Hellsten and Vasileiadou, 2015). Through the combination of these events, the momentum that had characterised the environmental movement for nearly five decades began to wane, and from 2009 onwards, environmental activism weakened significantly.

Environmental activism remained weak between 2009 and 2015, and international climate negotiations continued without producing noticeable results. It should be mentioned that this decline in activity is specific to the environmental movement – while the level of activity of the environmental movement declined, other forms of activism, such as such as that of the anti-austerity movements and the occupy movement, increased sharply in these years (Berglund, 2018; Gamson and Sifry, 2013).

However, 2015 marked a new turning point in climate negotiations, with the approval of the Paris Agreement, the first legally binding treaty on climate since the 1997 Kyoto Protocol. Hailed as a historic agreement destined to change the climate change regime, the Paris Agreement set new targets on temperature increase and proposed a wholly new approach, relying on bottom-up, flexible and voluntary plans named Nationally Determined Contributions (NDCs), where each participating country has to draw, communicate and maintain the contributions in emissions reduction that it intends to achieve (Clémençon, 2016; Doelle, 2016; Viñuales et al., 2017). Initially, it appeared that this softer approach may have produced better results than the more binding approach attempted with the Kyoto Protocol. However, by 2018, it was apparent that the Paris Agreement was not going to change the climate change regime radically, and in the first set of NDCs, only two countries presented levels of ambitions that were consistent with the Agreement's temperature increase targets (Tollefson, 2019).

Despite its evident shortcomings, the Paris Agreement was instrumental in laying the foundations for the fourth and last generation of environmental activism. The Agreement's failure to produce visible impacts on the climate change regime brought new life to a waning environmental movement, eventually triggering the emergence of a new, highly transformational generation of environmental activism which synthesises traditional elements of grassroots activism with novel elements such as a high-density of youth activists and

strong social media usage. The origin of this new generation of radical activism can be traced
back to the foundation of the Sunrise Movement in the United States in April 2017 from a
group of young activists who had left more mainstream organisations such as the Sierra Club
and 350.org to pursue radical activism fuelled by ideals that are highly critical of the current
economic system, arguing for a bottom-up reconstruction of the US economy, moving away
from market fundamentalism in favour of a more just and democratic system(Movement,
2022). While the Sunrise Movement remains primarily focused on the United States, its
emergence was rapidly followed by the larger-scale, international movements that form
the centre of this analysis Extinction Rebellion, Fridays for Future, along with dozens of
issue-based campaigns of hashtag activism such as #ExxonKnew.

While the key characteristics of Extinction Rebellion and Fridays for Future, will be
analysed in-depth in the remainder of this Chapter, it is crucial to outline the main elements
that set this new generation of activism apart from the three generations described earlier in
this Section. Three high-level elements of innovation make this group of movements and
organisations novel enough to suggest the emergence of a new generation of activism: 1) An
innovative paradigm of revolution and reform, 2) A high density of younger activists, and 3)
A robust and innovative use of social media platforms and hashtag activism.

Perhaps the most innovative element of this generation of radical activism is a new influ-
ence paradigm that unites the traditionally opposed ideals of revolution and reform (1). Past
environmental movements tended to adhere strictly to philosophical foundations and protest
tactics based on revolutionary paradigms, such as confrontational grassroots movements
of the likes of EarthFirst!, or to a more institutional paradigm of reform and ecological
modernisation, such as Friends of the Earth or the Sierra Club. New-generation radical
climate movements differ in this respect, adopting a paradigm that unites practices from
the second and third generations of environmental activism - mixing revolution and reform.
While these movements are generally relatively horizontal radical, grassroots groups highly
critical of the current economic and political system, they consistently liaise and interact
with elected representatives and existing institutions. For instance, the Sunrise Movement
was instrumental in organising several large-scale protests and blockades (Alzamora, 2020;
Bowden, 2021) while at the same time contributing to bringing the Green New Deal to the
United States Congress (Gunningham, 2019). Similarly, Extinction Rebellion, while being
listed by the British terrorism police as an extremist ideology (Dodd and Grierson, 2020),
has been repeatedly supported by members of the British Parliament (Taylor, 2019) and a
'Climate and Ecology Bill' drafted by the organisation is currently at its second reading in the
House of Commons, backed by several Members of Parliament (Ares, 2021). The embedded-
ness of new-generation radical environmental movements within traditional institutions is a

significant shift in the structure of environmental activism. Through this change, radical ideas of environmental protection are finally permeating traditional policymaking, reaching levels of public attention that have been rarely seen in the past. A higher acceptance of radical ideas within mainstream institutions is expected to shift the Overton Window in the public debate (Beck, 2010), in time leading to a broader acceptance of radical environmental ideals to the point that they may become mainstream.

Further, a distinctive element of this new generation of radical climate activism lies in their high density of younger activists (2). In the past, youth activists infrequently found political opportunity structures that allowed for their involvement in environmental movements (Järvikoski, 1995). However, new-generation movements have reversed this trend, exhibiting very high percentages of youth activists among their members. According to Han and Ahn (2020), a key reason for this demographic shift in the composition of environmental organisations was driven by the principle of intergenerational equity and the realisation that climate inaction is going to disproportionately affect younger generations, as they may experience much direr effects of climate change during their lifetimes (Eskenazi et al., 2020). The ample presence of youth activists is visible in all new-generation radical climate movements. For example, the March 2019 Global Strike for Future, organised by Fridays for Future, which mobilised 1.6 million activists, saw an overwhelming presence of activists in the 14-19 years bracket (Wahlström et al., 2019).

Furthermore, Extinction Rebellion, albeit showing a more diverse age profile, includes an influential youth arm composed of activists between 16 and 30 years of age (Murray, 2019). Nisbet (2010) notes that youth participation in environmental activism is essential as young activists do not represent someone else's agenda, and their messaging is direct and unfiltered. Young activists can bring the perspective of underrepresented generations to the forefront of discussions on climate change and can say things that older activists cannot say, facilitating radical messaging based on environmental and social justice concepts.

The third element of innovation of the new generation of radical climate movements is the enhanced use of online communication in their protest activities (3). In the last decade, the internet has transformed activism, playing a fundamental role in the rise of historical protest movements such as the Occupy Movement and, more recently, the Black Lives Matter movement (Croeser and Highfield, 2014; Freelon et al., 2016; Ince et al., 2017). While online platforms have been effectively used in the past by environmental movements such as Greenpeace (Özdemir, 2012), 350.org (Hestres, 2015) and the Sierra Club (Hestres and Hopke, 2017), through the new generation of environmental movements, online activism reached unprecedented levels (Han and Ahn, 2020). Since their early stages, movements

falling under the new generation of radical activism have shown a profound and far-reaching social media presence, increasingly blurring the line between online and offline activism, where online activism is often as important as an in-person protest for the diffusion of the movements' message. Movements such as Extinction Rebellion and Fridays for Future have heavily resorted to pressure and engagement strategies such as digital climate strikes (Sharp, 2020), where activists share pictures with signs containing pro-climate action messages, hashtag campaigns, where movements circulate hashtags on specific causes, such as the #Exxonknew campaign used to highlight Exxon Mobil's role in spreading disinformation on climate change, and online informational events, such as zoom seminars to raise awareness on climate change (Yoder, 2020).

These strategies have been particularly relevant during the Covid-19 pandemic, allowing activists to continue exerting bottom-up pressure during global lockdowns (Hunger and Hutter, 2020). From the perspective of the environmental movement, the internet served as a critical instrument in democratising activism, helping shift the balance of power from traditional, institutionalised movements toward young people with limited access to institutional movements while also providing an ideal platform for spreading the movement's message to a wide and varied audience (Jackson et al., 2020). The increasing reliance on online activism has also been instrumental in the rapid internationalisation of these movements, allowing activists from all over the world to cooperate and protest together (Vinter, 2021), and today, movements such as Extinction Rebellion and Fridays for Future have groups of online activists in dozens of countries all over the world (Watts, 2018).

2.3   Extinction Rebellion and Fridays for Future: A Comparative Overview of their Key Traits

Since their emergence in 2018, Extinction Rebellion and Fridays for Future have often dominated the news on climate change, successfully mobilising hundreds of thousands of activists globally (Taylor, 2020). Through sustained protest, direct action and far-reaching online campaigns, the two movements have rapidly established themselves as some of the world's most active bottom-up campaigning and pressure groups (de Moor et al., 2021). In order to assess the two movements' key characteristics and distinctive elements, this Section turns to the analysis of a variety of text sources produced by Extinction Rebellion and Fridays for Future, including web pages, books, social media posts and public speeches. This process contributes to creating a comprehensive understanding of the identity of each movement and

their role as epistemic activists, while also assessing the main differences between Extinction Rebellion and Fridays for Future. While this process only partially relates to the study of the two movements' information practices, understanding the critical elements of the movements' identities is fundamental for the analysis presented in this work, as this allows to set the groundwork for the empirical analyses that follow in the rest of the research project. The key traits analysed in this Section include the two movements' origins and history; leadership and organisational structure; geographical presence; founding principles; demands, and protest tactics.

2.3.1   The Emergence of Extinction Rebellion and Fridays for Future

Extinction Rebellion and Fridays for Future emerged almost simultaneously in 2018, with only three months separating the foundation of the two movements. However, the events and motivations that led to their formation differ significantly. This Section will briefly expand on the sequence of events that led to the rise of each of the two movements.

Extinction Rebellion

Extinction Rebellion defines itself as a non-violent climate movement that uses direct action and civil disobedience to demand world governments take action on climate change, stop bio-diversity loss, and minimise the risk of social and ecological collapse (Extinction Rebellion, 021a; Taylor, 2018). The movement was founded in the United Kingdom in May 2018 and held its first major protests in October 2018 in London, with more than activists attending. The history of Extinction Rebellion is quite an unorthodox one, as its emergence cannot be considered entirely spontaneous. Instead, Extinction Rebellion represents the culmination of the work of a small group of radical activists that set out to create a movement that could catalyse widespread social discontent on the ongoing environmental degradation (Taylor, 2020).

Before Extinction Rebellion's formation, its founders Roger Hallam, Gail Bradbrook and Simon Bramwell had for long engaged with various instances of radical activism, such as EarthFirst, the Occupy Movement, and Plane Stupid, from which Extinction Rebellion later borrowed several of its protest practices. Disillusioned with the lack of change achieved through their experience in environmental activism, in 2016, the group created their own organisation, known as RisingUp, which initially acted as an umbrella organisation for

multiple campaigns of peaceful civil disobedience. According to Taylor (2018), it was only
in April 2018 that the idea of Extinction Rebellion finally took shape.

Meeting at Extinction Rebellion founder Gail Bradbrooks' home in the Cotswolds, 15
long-time campaigners from RisingUp decided that the time had come for what they defined
as 'the big one', a campaign that could truly shift public opinion and create a long-lasting
impact on climate change policy. Through Bradbrook's expertise in building online platforms
for environmental activism and Hallam's research on civil disobedience theory[1], the group
conceived its initial plan for a groundbreaking campaign based on a harsh, unsettling style of
communication, which the group agreed to call 'Extinction Rebellion'. Extinction Rebellion's
principles and ideological foundations were summarised in a 49 minutes Youtube video
where Bradbrook outlines the urgency of the ongoing ecological emergency, a video known
within the movement as 'the talk'. This video, titled 'Heading for Extinction and What to do
About it', is still accessible on Youtube.

In the following months, RisingUp members began canvassing British communities
describing the principles of Extinction Rebellion, progressively building the public support
and activist base that later proved to be instrumental to the movement's global success.
This process involved giving talks in various venues such as libraries, pubs and town halls
and convincing audience members to join Extinction Rebellion. Finally, after months of
preparation, on 31 October 2018, the movement formally launched its campaign with a
'Declaration of Rebellion' (Extinction Rebellion, 021b) against the UK Government in
Parliament Square in London, in front of a group of around 1,000 activists, including well-
known environmentalists such as Greta Thunberg, George Monbiot and Green Party MP
Caroline Lucas (Extinction Rebellion, 2018).

In the time that followed, Extinction Rebellion continued growing its base, and in April
2019, the movement launched the protest it had been working towards since its foundation.
For almost two weeks, an estimated 6000 activists caused widespread disruption in London,
occupying several critical sites of the capital and blocking five major bridges across the
Thames. As activists glued themselves to subway trains and buildings such as the Stock
Exchange, 1,000 000 arrests were carried out, attracting a spur of national and international
media coverage (Gunningham, 2019). The April protests, the biggest act of civil disobedience
that London had seen for decades, marked the true establishment of Extinction Rebellion as
a central element in the environmental movement, significantly reinforcing the movement's

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[1] At the time, Hallam was working towards a PhD on how people use civil disobedience to achieve social
change at King's College London. In 2019, Hallam also published a book titled 'Common Sense for the 21st
Century', where the author claims that nonviolent civil disobedience is society's only way at countering the
climate emergency.

international standing and elevating Extinction Rebellion to a key force of change in the global climate change regime (Ginanjar and Mubarrok, 2020).

Fridays for Future

Exhibiting a growth trajectory that differs significantly from Extinction Rebellion's, Fridays for Future emerged spontaneously as a youth-led school strike, progressively evolving into an organised global climate movement. 15-year-old Swedish activist Greta Thunberg laid the foundations for Fridays for Future in August 2018, when the young activist began her school strike for climate outside the Swedish Parliament. For three weeks leading to the Swedish political elections, Thunberg sat in front of the Riksdag - the Swedish legislature - holding a handwritten sign stating 'school strike for climate' - in an effort to draw attention to the climate crisis. Thunberg's strike rapidly caught the interest of the Swedish media, and a small number of young activists began joining the strike.

The first turning point for the development of Fridays for Future occurred on the 8th of September 2018, when at the end of the initial three weeks of Thunberg's 'school strike for climate', the activist was invited to speak in front of a crowd of over people at the People's Climate March in Sweden. In a speech that may be seen as a broad programmatic statement for what later evolved to be Fridays for Future, Thunberg claimed:

> We will go on with our school strike every Friday, as from now we will sit outside the Swedish parliament until Sweden is in line with the Paris Agreement. We urge all of you to do the same. Sit outside your parliament or local government wherever you are until your country is on a safe pathway to below 2-degree warming target. Time is much shorter than we think. Failure means disaster[...].

After this event, Thunberg and a growing group of young activists who had joined her protest created the hashtag #FridaysforFuture, encouraging youth worldwide to join the strike every Friday, marking the informal beginning of Fridays for Future as a social movement. From September 2018 onwards, Fridays for Future school strikes continued expanding across European countries, with small protests in the Netherlands, Germany and Italy. However, at this stage, the movement lacked formal organisation and mainly consisted of Thunberg, who regularly attracted significant media attention, and activists spontaneously striking across Europe.

At COP24, held in Poland in December 2018, Fridays for Future took a crucial step towards the movement's full institutionalisation. Thunberg was invited to the conference

as a speaker and gave an extensively circulated speech against the ongoing lack of decisive
policy on climate change, where she accused global leaders of not being mature enough to
'tell it like it is' (Sutter, 2018). During this event, Thunberg met an instrumental figure in the
growth and institutionalisation of Fridays for Future, Luisa-Marie Neubauer. The 22-year-old
german activist rapidly became the German face of the movement (Kühne, 2019) and acted
as a global organiser for the #FridaysForFuture, allowing the campaign to rapidly evolve into
a full-fledged global environmental movement.

In 2019, thanks to its growing popularity and more solid structure, Fridays for Future
organised four Global Climate Strikes, with the largest mobilisation taking place in September,
ahead of the United Nations Climate Action Summit. The September strikes are evidence of
Fridays for Future's potential in mobilising young masses, with protests spanning over 185
countries with over 6000 events and a record-breaking 7.6 million participants (Chase-Dunn
and Almeida, 2020; De Moor et al., 2020). During the September strikes, Thunberg led a
street march in New York City with an estimated 250,000 demonstrators, while the largest
protest was registered in Montreal, Canada, where up to 500,000 protests participated in the
strike (De Moor et al., 2020). Since 2018, Fridays for Future has become internationally
recognised for its iconic, youth-led climate activism. In the past years, members of the
movement have continued to take the streets and social media platforms to raise awareness
of climate change and urge global political leaders to adopt more ambitious climate policies,
making Fridays for Future one of the world's most successful instances of climate activism
(Beckh and Limmer, 2022).

2.3.2   Leadership and Organisational Structure

Extinction Rebellion and Fridays for Future present visible differences in terms of leader-
ship and organisational structure. Such characteristics are critical to understanding social
movements, as they are key predictors of protest practices, decision making, and ultimately,
a movement's effectiveness (Morris, 2002).

Extinction Rebellion

In terms of leadership, Extinction Rebellion follows the structure of several past radical
environmental movements that emerged in the third generation of environmental activism,
and it can be defined as a leaderless movement, where no individual univocally represents the
movement and its ideological stance (Mansfield, 2020). While co-founders Gail Bradbrook

and Roger Hallam are widely seen as the intellectual driving force behind the movement, the two are infrequently seen in public events and regularly avoid acting as spokespeople for the movement. Furthermore, Extinction Rebellion does not admit to having any formal leadership. Instead, it affirms that the movement is organised in small, autonomous groups distributed worldwide, producing a fully participatory, decentralised, and inclusive movement (Extinction Rebellion, 2021)

According to the movement's Constitution, Extinction Rebellion's structure is based on the principle of a 'Self Organising System (SOS)', a governance method that enables the movement to 'harness group wisdom while remaining agile and able to respond quickly to emerging situations' (Extinction Rebellion, 021d). Following this organisational model, the movement is divided into numerous self-contained circles, each with a clearly defined mandate, procedures and accountability (Berglund and Schmidt, 2020). For more intensive roles, each circle may create sub-circles, which will in turn self-organise following the same structure. The SOS organisational system follows a doctrine of full horizontalism, where all circles have the same level of influence, and no circle has more power than the others. This innovative system of movement organisation has been adopted by several recent social movements, such as the Occupy Movement (Sitrin, 2012), the 2011 Egyptian Revolutionary Movement (Chalcraft, 2005) and the El Salvador anti-Mining Movement (Spalding, 2014).

Figure 2.1 shows an organisational chart from Extinction Rebellion UK's website, allowing a fuller understanding of the SOS organisation. In the Figure, it is seen that Extinction Rebellion UK is composed of several geographical circles, such as London, South East and South West; non-geographical circles such as XR Youth, Scientists, and XR Charged Defendants Groups; and the central 'brain' of the organisation, the Rebel Hive. According to the movement's Constitution, the Rebel Hive is the broadest circle and contains representatives from all regional and national circles. The Rebel Hive, previously named the Anchor Group, also contains central figures such as Hallam and Bradbrook, and within the movement's horizontal structure, the Rebel Hive may be seen as a more hierarchical element, acting similarly to a leadership council. The latter holds collective responsibility for the whole of Extinction Rebellion International, and any changes to a circle's mandate or the formation of new circles must be approved by this organ of governance.

It should be noted that the Rebel Hive's Operations Circle contains two information-related subgroups that are fundamental to the movement's online communication. The first is the Digital Rebellion circle, which is in charge of the movement's orchestrated digital campaigns, such as the anti-HS2 and anti-CEE Bill campaigns; and money rebellion, a campaign targeting banks who sponsor fossil fuels expansion. This group is instrumental
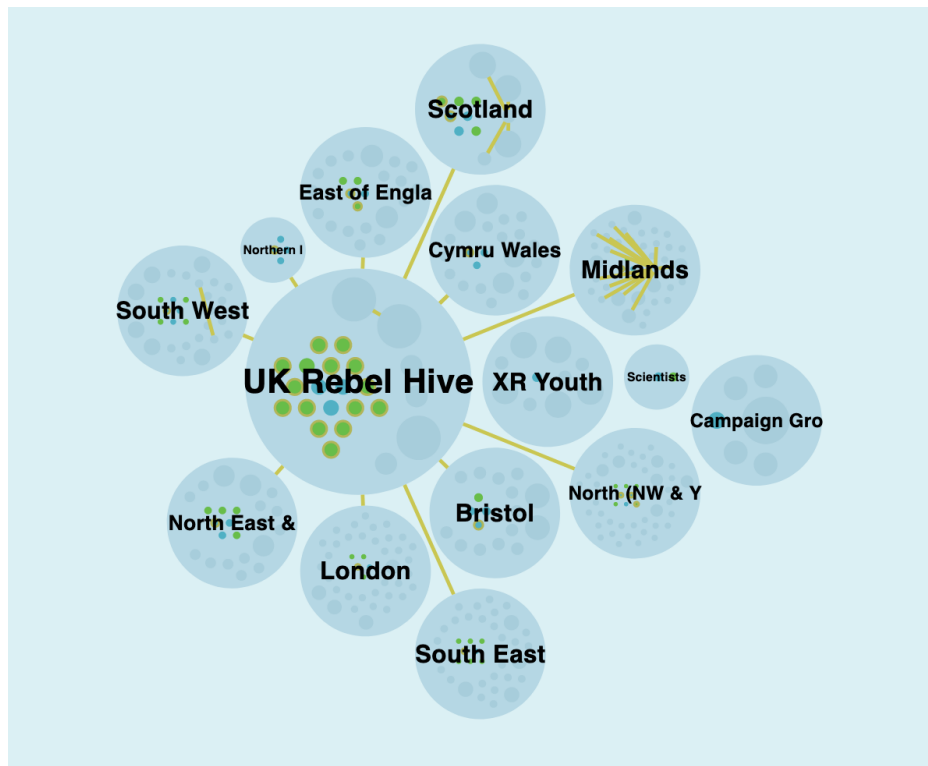
Fig. 2.1 Organisational Chart of Extinction Rebellion UK

for the movement's online presence, and was particularly important during the Covid-19 pandemic, when the majority of activism was forced to move online. The second is the Media and Messaging circle, which contains a variety of subgroups such as Press, Social Media, Web Content and Livestreams. The presence of such highly specialised communication sub-circles within Extinction Rebellion's structure is a significant finding, as it indicates that the movement's communication is centralised and planned. This is also apparent in the list of the Media Circle's key responsibilities, where the movement states that the group's key accountability is, among others, to 'work out key framings, arguments and point and find and brief people to speak to the media.' It should also be mentioned that within the movement's organisation, the Media and Messaging Circles is directly linked to the UK actions sub-group, suggesting a high degree of integration between these two fundamental branches of the movement.

While very complex and multi-layered, Extinction Rebellion's SOS-based structure has been instrumental to the movement's success for two main reasons. First, the high level of decentralisation provided by the SOS structure has left Extinction Rebellion activists with a significant amount of freedom to engage in protests in any way they find suitable, with no limits to their creativity. This principle is clearly stated on Extinction Rebellion's website,

where it is clarified that anyone can engage in activities in the name of the movement without asking for permission, as long as they agree with the movement's principles and values. In an essay contained in Extinction Rebellion's book 'This is Not a Drill', Professor Danny Burns and Cordula Reimann highlight the importance of this organisational element for Extinction Rebellion's movement-building effort (Extinction Rebellion, 019a), stating that:

> While it is possible to build activism with a centralised 'strategy', it is not possible to build a mass movement that way. People act on what they believe in. If the strategy deviates from their perspective even a small amount, they tend to lose motivation and fall away from the movement.

Second, in instances of direct action, Extinction Rebellion's decentralised organisation and lack of a chain of command allow protesters to react quickly to changing situations. At the same time, the absence of any formal leadership makes it more difficult for the police to repress spontaneous actions and to identify the organisers of such activities. As reported by Berglund and Schmidt (2020), an Extinction Rebellion member pointed out in an interview setting that movement's dissipated communication channels where no one person has all the information make it very difficult for the police and government agencies to prevent acts of protest, ultimately facilitating the success of disruptive direct action.

Fridays for Future

While Extinction Rebellion presented a detailed and highly organised structural framework supported by the SOS model, the structure of Fridays for Future is much less clear-cut, as no webpage, constitution, or official document clearly outlines the movement's structure. This Section uses secondary sources to reconstruct Fridays for Future's structural development, highlighting the organisation underlining the movement's activities.

Like Extinction Rebellion, Fridays for Future is generally considered a leaderless movement, where no individual has significant control over the movement and its actions (Radel, 2021; Tasker and Collin, 2021; Western, 2021). However, in contrast with Extinction Rebellion, Fridays for Future is not a 'faceless' movement. Instead, its mobilisation potential strongly relies upon the actions and influence of Greta Thunberg, who represents the movement globally, acting as its figurehead (Wandzilak, 2020). This duality produces a hybrid structure of movement organisation, where Fridays for Future acts as a fully decentralised network of activists while having in its ranks a clear figurehead that acts as a binding element for activists worldwide, as well as a significant catalyst of media coverage for the movement as a whole (Ryalls and Mazzarella, 2021).

Assessing the main features of Fridays for Future's structure, it emerges that the movement consists of the aggregation of several loosely linked subgroups that are spread across the globe and act mainly at a local scale (Eggelsmann, 2021). According to Van der Heyden et al. (2020), the movement's expansion is always spontaneous, where the first person from a city or town that wants to start striking would launch a local Fridays for Future simply by creating a WhatsApp group and spreading the word about any protest events. Through this spontaneous process, over time, Fridays for Future came to have independent groups in over 110 countries (Fridays for Future, 2021). Within Fridays for Future's structure, each subgroup has equal weight and no control over other groups, making the movement fully horizontal.

However, it should be noted that Fridays for Future lacks a formal organ of governance that connects, coordinates and oversees local groups - similarly to Extinction Rebellion's 'Rebel Hive'. Consequently, local groups are free to determine their leadership and organisational structure, which means that in practice, the principles of a horizontal, leaderless movement are often not mirrored within local groups. For example, one of the oldest national subgroups, Fridays for Future Belgium, chose a more centralised and vertical governance structure with a core team of members with clearly defined responsibilities who make decisions for the whole subgroup. On the other hand, Fridays for Future Germany adopted a layered and highly structured approach, where hundreds of local groups are coordinated by weekly telephone meetings where each group sends delegates. Fridays for Future Germany even hosted a national congress in August 2019 to democratically discuss the movement's organisation and program (Fridays for Future Deutschland, 2021; Maier, 2020).

Moreover, Fridays for Future UK adopted a fully anarchic approach where the movement has no leader, face, and formal organisation and organises exclusively through social media and word of mouth (Van der Heyden et al., 2020). As these examples demonstrate, while the movement is indeed, in principle, horizontal and with no formal leadership, this lack of organisation accounts for significant structural variability within subgroups, with governance models that may deviate from horizontalism, with alternatives ranging from vertical decision-making to horizontal and loosely organized systems. This aspect of the movement's organisation is quite relevant in understanding its information practices, as it implies that Fridays for Future's communication may often not be coordinated, lacking centralisation. On the contrary, Extinction Rebellion's SOS system, even where information may not always be centralised, exhibited a higher degree of organisation, suggesting that information strategies may, on average, be more planned and centralised.

2.3.3   Geographical Presence

Extinction Rebellion and Fridays for Future define themselves as international movements (Richardson, 2020), and local ramifications of the two movements are present in dozens of countries worldwide (Watts, 2018). However, at the time of writing, neither of the two movements publishes data on the various online subgroups that grant them an international presence, and it is hence quite complex to infer the scale of Extinction Rebellion and Fridays for Future's geographical coverage of online activism. The following part of this Section uses geographical data contained in the previously described data set of $\approx$ 250k Facebook posts to provide insights into the international presence of the two movements, with a focus on where the majority of the posts contained in the data set originate from. Before proceeding further, it should be clarified that the data set used in this analysis only includes English-language posts, which will indeed skew the distribution towards English-speaking countries. However, as the data below shows, it is clear that pages from all over the world still engage in communication in English, perhaps as this is considered the primary language of communication for both movements. Furthermore, it is important to specify that Facebook's geolocalisation data is often inaccurate, as the platform's geolocalisation can be easily bypassed through the use of tools such as VPNs. For this reason, the geographical evidence presented in this section should only be considered a high-level summary of the geographical distribution of the two movements' Pages and Groups, as the robustness of this geographic data cannot be guaranteed.

To extract data on the country-by-country presence of each movement, I isolated data produced by Facebook Pages connected to the two movements, excluding posts published by Facebook Groups. This is because Crowdtangle, Facebook's data monitoring and collection tool, only provides geographical information for Facebook Pages. This information is provided through the location of the Page Admin, which serves as a proxy to determine the location of the Page (Crowdtangle, 2022). However, a small number of Pages do not contain geographic information due to such Pages being too small to be part of the Page Transparency feature on Facebook (Crowdtangle, 2022). In order to handle missing location values, the Page Name for each row with missing values was matched with a list of world cities and countries to extract its location. This step resolved over 95% of missing values, leaving a number of empty rows below 0.2% of the data set size. Before proceeding to the analysis of this data, it should be noted that while this list is quite granular and specific, it is non-exhaustive, as some local groups may not have an online presence on Facebook. This is particularly true for countries where Facebook is not a widespread social network, such as
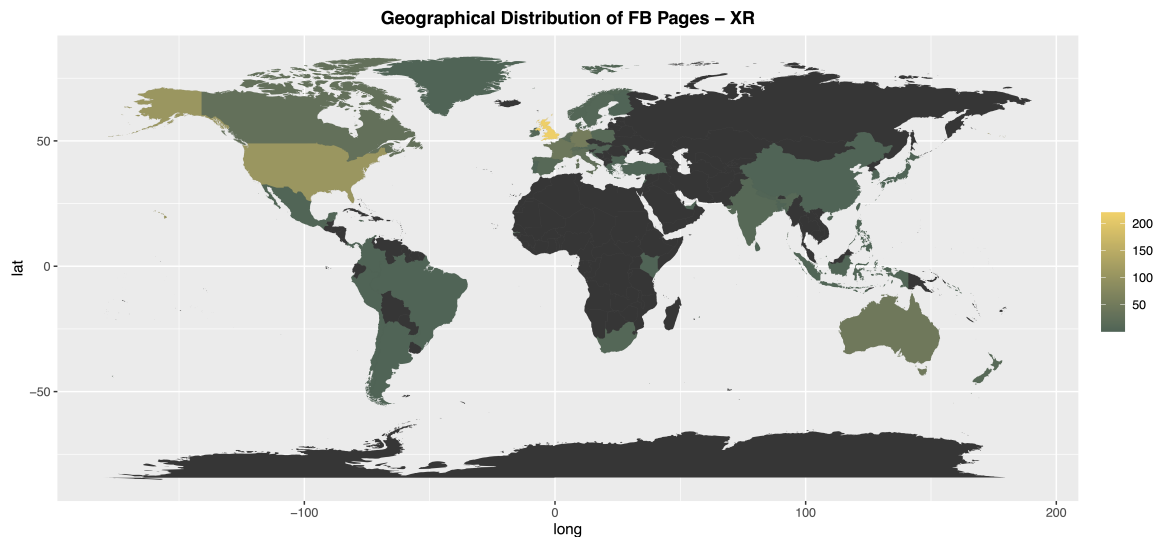
Fig. 2.2 Estimated Online Geographical Presence of Extinction Rebellion

Russia and China (Prins, 2020). The results of this analysis are presented in Figures 2.2 and 2.3

Analysing the geographical information stored in the data set , it emerges that as of the 1st of June 2021, Extinction Rebellion's online presence on Facebook consisted of 707 unique local Facebook Pages distributed across 59 countries. At first glance, it is evident that the movement is heavily concentrated in the United Kingdom, where it originated. In fact, 216 Facebook Pages, accounting for 30% of the movement total, are found within Great Britain and Northern Ireland. The movement also exhibits an evident concentration in English-speaking countries, which account for 59% of all location entries in the data set. Despite this lopsided international distribution, it is nonetheless evident that Extinction Rebellion does have an extensive global presence, with local groups spanning four continents. However, this coverage is at times uneven, with the movement being scarcely present in select geographical areas, with visible gaps in the African continent, where Pages were only identified in 2 out of 54 countries, Eastern Europe and Western Asia.
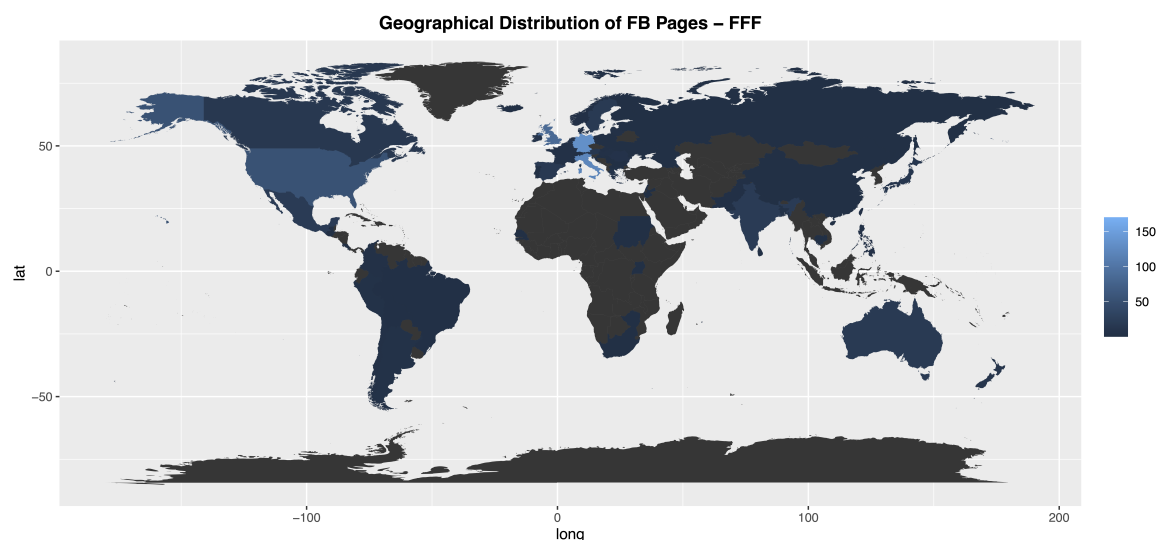
Fig. 2.3 Estimated Online Geographical Presence of Fridays for Future

Regarding Fridays for Future, the movement's Facebook presence comprises 659 local Pages distributed across 70 countries, exhibiting a more extensive global coverage than Extinction Rebellion. Analysing the local concentration of Pages, it arises that Fridays for Future local Pages are primarily found in Italy and Germany, which account for 35% of the movement total, the United States and India. In terms of international coverage, Fridays for Future exhibits somewhat spotty coverage, similarly to Extinction Rebellion. While the movement shows a strong presence in Europe and the Americas, it also lacks a grassroots presence in Africa and Western Asia. However, the highly loose and decentralised nature of Fridays for Future may suggest that compared to Extinction Rebellion, this presence is more likely to be underestimated.

Finally, it should be mentioned that despite possible uncertainties regarding the robustness of Facebook's geolocalisation data, mapping the geographical coverage of the data set is useful for the analysis of this Chapter as well as the entire research project, as it provides insight into where the information generated from the two movements tends to stem from. This element provides crucial information to understand the content of the two movement's communication and narrative priorities. For example, a heavy concentration of pages based

in North America and the European continent may lead to greater interest in disinformation
and misinformation, which are highly debated issues in these geographical areas.

2.3.4 Founding Principles

Extinction Rebellion and Fridays for Future present evident differences in the founding
principles that sustain and motivate the two movements' activism. This Section analyses these
differences, using original movements' sources to assess the principal founding principles of
each movement.

Extinction Rebellion

Extinction Rebellion is deeply rooted in a tradition of radical social movements that span from
the anti-inequality Occupy Movement to the confrontational environmental activism of Earth-
First (BBC, 2018). The rich heritage that supported the movement's rise ultimately meant that
Extinction Rebellion developed into an ideologically complex movement, with ideals beyond
merely calling for more decisive action on climate change and environmental degradation.
Instead, the movement proposes a comprehensive vision for a fairer, more functional society,
where fighting environmental degradation also entails addressing various social, political and
economic issues. These principles underlie the movement's communication activities and
social media presence, and as such deserve further attention.

Ultimately, Extinction Rebellion's founding principles can be said to revolve around three
central pillars, which are commonplace in the movement's communication and activism.
The first such pillar is (1) the concept of extinction and the urgency of reversing an ongoing
ecological crisis. The use of emotionally loaded apocalyptic warnings on the risk of mass
extinction is a critical founding element of Extinction Rebellion (Higgins, 2021) and is
commonly found in the movement's writings and public statements. For example, Extinction
Rebellion's handbook, 'This is Not A Drill' (Extinction Rebellion, 019a), a collection of
essays published as an ideological manifesto of the movement, opens with a reflection on
how the world is facing a mass extinction, and risks social collapse. This passage states that:

> The life on this planet, and our own future, is under severe threat. We are living
> through the sixth mass extinction, driven by the limitless greed of the 1 percent,
> their blindness to the ecological limits the Earth sets and the limits set by social
> justice and human rights. We forget that we are one humanity on one planet.
> There is no planet B. This is where we will live, or go extinct as a species, with

the millions that have been driven to extinction by the violence and carelessness of the brute force misleadingly called the economy.

Understanding the importance of extinction-related messaging is crucial to understanding Extinction Rebellion's entire motivational and operational system, as this very sense of danger motivates and justifies the movement's disruptive style of activism. In fact, the feeling that a catastrophe is incoming acts as both a motivation and a justification for the movement's activities. Facing a mass extinction, a confrontational and law-breaking style of activism characterised by blockades and arrests appears morally justified (Berglund and Schmidt, 2020; Guardian, 2018). This point is clearly delineated on the movement's website, where it is stated that Extinction Rebellion :

> Is made up of people who also have jobs and responsibilities and we do not want anyone to be inconvenienced or worse as a result of our actions. But the reality is we will all suffer because of government inaction on climate collapse and biodiversity loss. They are failing us and it's putting all our lives, jobs and homes at risk (Extinction Rebellion, 2022).

The second key pillar of Extinction Rebellion's founding principles (2) is the call for a large-scale, systemic reorganisation of political systems favouring a more direct and inclusive democracy. This profoundly political argument stems from a critique of modern democratic systems, which according to Extinction Rebellion, have proven incapable of dealing with society-wide problems such as rising economic inequalities and climate change. This central tenet of the movement's founding principles is clearly expressed in the 'Declaration of Rebellion', which reads:

> The wilful complicity displayed by our government has shattered meaningful democracy and cast aside the common interest in favour of short-term gain and private profits. When government and the law fail to provide any assurance of adequate protection, as well as security for its people's well-being and the nation's future, it becomes the right of its citizens to seek redress in order to restore dutiful democracy and to secure the solutions needed to avert catastrophe and protect the future (Extinction Rebellion, 021b).

As is evident from this passage, the movement cultivates a strong criticism of modern democratic political systems - and in this case of the British government - which are accused

of failing to provide adequate protection to its people, to the point of shattering meaningful democracy. Furthermore, this extract contains an additional recurrent critique of political systems, often labelled by the movement as 'short-termism' (Extinction Rebellion, 021b). This concept refers to the idea that short electoral cycles, such as the five-year British electoral cycle, discourage governments from addressing long-term issues such as climate change and incentivise them to work on short-term gains to win re-election. Because of this, the movement claims, common interest has been abandoned in favour of short-term gains. It should be noted that this argument is not a novel one, as it is often found in the literature on democratic systems' capacity in contrasting climate change (Berglund and Schmidt, 2020; Boston and Lempp, 2011; Fiorino, 2018), where the political disincentive to tackle long-term problems is often considered a key element in the lack of decisive action on climate change.

The third and last (3) founding principle of Extinction Rebellion is its rejection of current economic systems and their ingrained inequalities. However, the details of such critiques are sometimes blurred. For example, parts of the movement have voiced criticism of the current economic paradigm that relies on a trajectory of continuous economic growth, which appears unattainable on a planet with finite resources and is increasingly approaching its boundaries of resource exploitation (Smiles and Edwards, 2021). For example, a 2021 Twitter post shares a variety of sources on the need for degrowth, claiming: 'We live in a society addicted to growth, yet on a planet with finite resources. Something needs to give.'

These calls for degrowth have often captured the imagination of right-leaning media outlets, which have abundantly criticised Extinction Rebellion for this stance. For example, Dominic Lawson, son of established climate change sceptic Nigel Lawson, dedicated this topic an article in 'The Times' titled 'An Inconvenient Truth for Extinction Rebellion: Growth Saves Lives', harshly criticising Extinction Rebellion's calls for degrowth (Lawson, 2021). However, while critiques of economic growth are sometimes mentioned in the movement's alternative forms of communication such as social media posts and protest slogans, this is not widely shared across the movement, and is never contained in the movement's official communication

Although in a more veiled way, some parts of the movement have also relied on anti-capitalist rhetoric to support their calls for degrowth and a re-imagination of the current economic system. Officially, the movement does not define itself as anti-capitalist, as, according to Berglund and Schmidt (2020) , this may be unwise for a movement that seeks broader appeal. However, anti-capitalist arguments are sometimes seen amongst Extinction Rebellion supporters, offshoots and members. For example, in 'This is Not a Drill', Sam Knights writes (Extinction Rebellion, 019a):

> The problem is capitalism. The problem is Colonialism. The problem is Power.
> The problem is inequality. The problem is greed, and corruption, and money,
> and this tired, broken system.

Furthermore, while anti-capitalist narratives are not commonplace in the movement's official communication, Smiles and Edwards (2021), in their study of Extinction Rebellion Norwich, found that many movement members expressed a strong belief that capitalism is not compatible with finding solutions to climate change, and degrowth was the most commonly identified alternative. However, this evidence comes from a limited sample of a local Extinction Rebellion Group. Ultimately, it can be said that parts of the movement view capitalism and degrowth as a central elements of the idea of systemic change, yet this idea is not uncontroversial within the movement itself, and is opposed by many activists and movement organisers.

Fridays for Future

Given its nature as a largely spontaneous, non-organised movement founded by young activists, Fridays for Future's founding principles were initially less developed and clearly stated than Extinction Rebellion. Nonetheless, the movement has, over time, shown a coherent system of ideas that is increasingly seen in the movement's activities and communicative narratives. Analysing direct and secondary sources produced by the movement, its founding principles can be broadly summarised in three central pillars.

The first such pillar (1) is the movement's emphasis on the need to trust science and the idea that governments should directly cooperate with scientists, integrating them into climate-related decision-making processes (Fridays for Future, 021b). This element is quite pervasive in the movement's communication and is often found in Fridays for Future's official sources (Kern and Opitz, 2021). According to the movement founder Thunberg (2019), Fridays for Future's foremost goal is to unite society behind the findings of climate science, endorsing policies designed to restrict global warming to under 1.5 °C in line with the Paris Agreement.

The movement's unconditional trust in climate science, paired with governments' tendency to ignore expert advice on climate, is often identified as a critical driving force behind the very existence of Fridays for Future (Kern and Opitz, 2021; Marquardt, 2020). In fact, these elements are frequently mentioned as a deep-seated motivation for the movement's protest activities. For example, in a web page outlining the reasons that led to the emergence of Fridays for Future, it is stated that:

> Scientists have been demanding this for 50 years and haven't been listened to,
> and that is why we are taking to the streets. Non-violent protesting is an effective
> way to bring change.

As is evident from this claim, the lack of attention paid to scientific advice is considered a justification for the movement's protest, claiming that in this scenario, non-violent protesting is an effective way to bring change. Furthermore, the movement's emphasis on the need to trust science should also be viewed as a critical determinant for the movement's mobilisation potential. Research by Cologna et al. (2021) demonstrated that trust in science positively correlates with mobilisation, suggesting that the higher the trust in science, the more likely someone will participate in a protest.

The second founding principle of Fridays for Future (2) is the view of climate justice as a matter of intergenerational justice. This concept lies at the very heart of the movement and emphasises that older generations have a duty to mitigate climate change to preserve the rights of future generations (Maier, 2020), as ultimately, children are the ones who bear the costs of the environmental destruction that older generations are responsible for (Hayes and O'Neill, 2021). This founding principle is a rather adversarial one, where older generations are often blamed for the ecological consequences of their allegedly selfish and irresponsible lifestyles (Ellerich-Groppe et al., 2021).

This principle is powerfully presented in a variety of movement sources and speeches. For example, in her speech at the United Nations COP24 in December 2018, Thunberg (2019) addressed the audience, stating that:

> Even when the only sensible thing to do is pull the emergency brake. You are
> not mature enough to tell it like it is. Even that burden, you leave to us children.
> [...] You are stealing our future in front of our very eyes.

Similarly, this generational clash between younger and older generations is evident in Thunberg's speech at the 2019 United Nations Climate Action Summit, where the young activist opened her speech with the now famous words (Staff, 2019):

> How dare you! You are failing us. But the young people are starting to understand
> your betrayal. The eyes of all future generations are upon you. And if you choose
> to fail us, I say: We will never forgive you.

Ultimately, the view of climate change as a matter of intergenerational justice acts as a strong ideological motivator for young activists to engage in protests, as this concept implies

that the youth did not cause the current crisis and that systemic change is indeed possible through the pressure and innovative force that young generations can bring (von Zabern and Tulloch, 2021). According to Hayes and O'Neill (2021), the concept of intergenerational justice is particularly powerful as it draws on the purity and innocence of children yet presents the youth as confrontational and active rather than passive recipients. Within this scenario, the youth feels ready and motivated to rebel against an environmentally harmful status quo imposed by older generations.

The third and last (3) founding principle of Fridays for Future is the adherence to the ideals of intersectional environmentalism. The expression intersectional environmental describes the understanding that environmental problems, particularly climate change, do not exist in a vacuum. Instead, other crucial issues such as racism, sexism and income inequality amplify the climate crisis and vice versa (Amorim-Maia et al., 2022). Consequently, the fight for climate justice is essentially tied to a range of highly interlinked social and political issues, none of which should be addressed individually.

Within Fridays for Future's system of ideas, the principle of intersectional environmentalism essentially revolves around the realisation that the impacts of climate change are unevenly distributed, with oppressed minorities often facing the most significant burden of the climate crisis (Almeida, 2019). As a consequence, measures aimed at mitigating the impacts of climate change should reflect this, striving for a future where no one is left behind (Fridays for Future, 2021c). In movement communications, minorities are often referred to as MAPA (Most Affected People and Areas), which include all territories in the Global South and other marginalised communities, such as BIPOC, women and LGTBIA+ (Fridays for Future, 021c).

The idea of intersectionality is visible in many of the movements' recent campaigns and protests. For example, on the organisational web page for the September 2021 Global Climate Strike, attended by over 800,000 activists, it is stated that:

> MAPA are experiencing the worst impacts of the climate crisis and are unable to adapt to it. This is because of the elite of the Global North who have caused the destruction of the lands of MAPA through colonialism, imperialism, systemic injustices, and their wanton greed which ultimately caused the warming of the planet. With both the COVID, climate, and every crisis in history, overexploited countries and marginalised sectors of society are systematically left behind to fend for themselves.

As this extract shows, the idea of intersectionality brings a wide range of new perspectives
to the fight against climate change, where reducing GHG emissions also entails addressing
deeper political issues such as colonialism, imperialism and historical systemic injustices.
Furthermore, the idea of intersectionality is clearly discussed in the movement's key demand
of uprooting the system (Fridays for Future USA, 2021), where it is mentioned, among
other things, to recognize climate as an intersection of all systems of oppression and to hold
wealthy former colonial powers accountable for perpetrating destruction.

Interestingly, in the movement's early stages, intersectionality was not commonly seen
among Fridays for Future's demands and founding principles, and movement demands were
primarily limited to reducing GHG emissions. The increasing prevalence of intersectional
narratives in Fridays for Future's communication demonstrates a trajectory of growth for the
movement, where the focus is shifting towards more complex ideals that include a whole
reimagination of society's core values that goes beyond calling for action on climate change.

2.3.5   Demands and Protest Tactics

This Section discusses two of the most essential and characteristic elements of the two
movements under analysis: their core demands and the strategies and tactics they use to
achieve their goals. As radical climate movements, Extinction Rebellion and Fridays for
Future broadly adopt parallel demands and a similar approach to influencing climate policy
based on large-scale mobilisations. However, at a closer look, several significant differences
can be identified between the two movements.

Extinction Rebellion

According to Extinction Rebellion's website, the movement has restricted its goals to three
broad demands (Extinction Rebellion, 021a). These requests are:

- Tell The Truth - Governments must tell the truth by declaring a climate and ecological
  emergency, working with other institutions to communicate the urgency for change.

- Act Now - Governments must act now to halt biodiversity loss and reduce greenhouse
  gas emissions to net zero by 2025

- Go Beyond Politics - Governments must create and be led by the decisions of a Citizens'
  Assembly on climate and ecological justice.

The first demand is of particular importance to this research, as it touches upon the concept of truth in climate policymaking, demanding governments to tell the truth by declaring a climate and ecological emergency. The movement's web page dedicated to this demand is linked to a video titled 'The Truth', where an Extinction Rebellion activist discusses how current modelling predictions from peer-reviewed scientific literature and IPCC reports underestimate the risks linked to climate change and urges governments to stop lying to the public by declaring a climate and ecological emergency (Youtube, 2019). This point is particularly interesting in relation to the concepts of disinformation and misinformation, as the movement appears to imply that the truth is willingly being hidden by governments and corporations in order to delay regulation on climate change, a phenomenon that was explored at length in Chapter I of this work.

The second demand, summarised as 'act now', is instead a call to action, highlighting the urgency of the climate crisis, demanding governments to halt biodiversity loss and reach net zero by 2025. It should be noted that this demand is extremely ambitious by current standards. For example, the United Kingdom has pledged to reach net-zero by 2050, 25 years later than Extinction Rebellion's demand (UK Government, 2021a).

Finally, the third and last demand, 'go beyond politics,' is perhaps the most politically significant. In line with the previously mentioned distrust of current political systems, deemed unable to solve the climate crisis, the movement requests the creation of a Citizens Assembly to address climate change (Extinction Rebellion, 022b), defined as:

> A 'mini public' of ordinary people to investigate, discuss and make recommendations on how to respond to the climate emergency. Similar to jury service, members will be randomly selected from across the country. The process will be designed to ensure that the Assembly reflects the whole country in terms of characteristics such as gender, age, ethnicity, education level and geography.

Within Extinction Rebellion's political vision, the Citizens' Assembly is expected to take over governments' decision-making role on climate, making swift and decisive action possible while preserving a range of democratic elements. According to the movement, assembly members would hear balanced information from experts and those most affected by the emergency, and together, they would work through their differences and draft and vote on recommendations. Through the Citizens' Assembly, the movement attempts to present a new idea of participatory democracy centred around the direct political involvement of a representative sample of the population. Among the numerous elements of innovation contained in this concept, a point of particular relevance regards the integration of scientific

advice in climate-related policymaking. According to the words of the movement co-founder Gail Bradbrook (Youtube, 019a): 'it shouldn't be left to politicians, and it shouldn't be left simply to experts, it needs the voice of the people'

This discursive element is significant as it implies that decision-making should not be left to experts, just like it should not be left to politicians. Instead, the movement views the voice of the people as a critical element in any political decision regarding the environment, and Citizens Assemblies serve to create a new model of decision-making where the voice of the public is central. As we will see further in this Chapter, this element differs from Fridays for Future's view, where scientists' opinions are considered the ultimate guidance for political action on climate.

For what regards the protest tactics that the movement uses to achieve these demands, the founders of Extinction Rebellion have often indicated that they see their protest approach as being rooted in a tradition of mass civil disobedience, which, according to the movement, is the only way that can bring about important and inspiring change on the scale that is needed (Extinction Rebellion, 2022). Mass civil disobedience is broadly defined as a type of large-scale peaceful political protest where citizens may refuse to obey specific laws, often leading to mass arrests. In 'This is Not a Drill', Hallams writes at length on the reasons for the choice of using disruptive protest methods (Extinction Rebellion, 019a), explaining that:

> We have to be clear. Conventional campaigning does not work. Sending emails, giving money to NGOs, going to A-to-B marches. Looking at thirty years of appalling failure, the reason is clear. The rich and powerful are making too much money from our present suicidal course. You cannot overcome such entrenched power by persuasion and information. You can only do it by disruption.

Interestingly, Extinction Rebellion's disruptive protest tactics are primarily grounded on the scientific research of social movement theorists such as Gene Sharp and Erica Chenoweth (Kinniburgh, 2020). For example, the movement takes inspiration from Sharp's idea of 'civil resistance', which consists of achieving change by mobilising a dedicated minority of the population to undertake nonviolent civil disobedience and face mass arrests, a formula widely used by activists such as Gandhi and Martin Luther King Jr (Sharp, 2011). Further, the movement recurrently mentions the '3.5% rule', an idea proposed by Erica Chenoweth in a 2013 Ted Talk, according to which, once 3.5% of the population of a state is mobilised in sustained protest, the success of the campaign is guaranteed (Extinction Rebellion, 2022).

Moreover, Extinction Rebellion' absolute refusal of violence is also partly based on scientific evidence from Stephan and Chenoweth (2008), who have shown nonviolent campaigns

to be significantly more successful than violent campaigns, a finding that is often found on the movement's website. Hallam also discusses the movement's refrain from using violence in 'This is Not a Drill', claiming that the refusal of violent protest tactics is not only an ideological choice but also a pragmatic one (Extinction Rebellion, 019a), as:

> As soon as you allow violence into the mix, you destroy the diversity and community basis upon which all successful mass mobilizations are based. The young, the old and the vulnerable will leave the space.

A final element characterising Extinction Rebellion's protest tactics is its commitment to localised, sustained action. According to Hallam, for any protest to be effective, it has to be continued for an extended period of time to impose a real economic cost. This approach, defined as 'dilemma action', creates a dilemma for the authorities, who have to address or repress the protest. When you create this dilemma, Hallam claims, you open up a political opportunity space that was previously not there. Within that space, you can get noticed, speak truth to power, negotiate, and more (Extinction Rebellion, 019a). However, this protest need not be global. In fact, in its explanation of the movement's protest tactics, Hallam claims that thanks to the 'demonstration effect', a social phenomenon first described by (Minkoff, 1997), action in one country is enough to create a global movement, as when the news spread, millions of people will start protesting all over the world.

Fridays for Future

Fridays for Future's official demands were first agreed upon at a 5-day movement meeting held in Lausanne, Switzerland, in August 2019. At the meeting, attended by over 400 activists from 38 countries, the movement presented three essential demands to fight the climate emergency. These are:

- Keep the global temperature rise below 1.5 °C compared to pre-industrial levels.

- Ensure climate justice and equity

- Listen to the best united science currently available

While these demands remain vague (Svensson and Wahlström, 2021), they offer a high-level framework of what the movement intends to achieve through its activities. The first demand presents a commitment to the ambitious 1.5 °C targets contained in the Paris

Agreement, a staple in the movement's activism (Van der Heyden et al., 2020). Since its foundation, the movement has emphasised how the Paris Agreement fails to deliver its promises, even launching a popular hashtag campaign called #FightFor1Point5 (Fridays for Future, 2022). It should be noted that this demand differs significantly from Extinction Rebellion's call to halt biodiversity loss and net zero by 2025. Fridays for Future does not request a specific level of emissions reduction but instead reiterates the need to commit to containing the temperature increase to below 1.5 °C.

The second demand presented by Fridays for Future is a broad call for climate justice and equity, in line with their ideological adherence to the principles of intersectional environmentalism. This short demand is more ideologically loaded than it may initially appear, as in practice, this demand translates into a wide array of social demands, such as the protection of MAPA and other marginalised communities, the safeguarding of democracy by ensuring popular participation in decision-making, and even divesting from fossil fuels (Fridays for Future, 021c).

The third and last demand presents instead a call for governments to listen to the best united science available, a characteristic point of Fridays for Future's communication. This demand largely overlaps with Extinction Rebellion's request for governments to 'tell the truth' about the climate emergency. The movement's protest activities often contain a variety of scientific references, highlighting the role of science in policy-making, blaming climate sceptics, or simply promoting the findings of the latest scientific research on climate change (Buzogány and Scherhaufer, 2022). According to Kern and Opitz (2021), the movement's use of scientific demands is key to the movement's diagnostic and prognostic framings and serves to provide the movement with a high degree of concreteness.

Regarding the protest tactics through which Fridays for Future aims to achieve its goals, the movement's primary strategy relies on mobilising youth worldwide to protest outside their local parliaments and city halls (Fridays for Future, 2022). However, as a highly decentralised and spontaneous movement, little theoretical backing exists as to the movement's protest tactics, and the latter can only be inferred from the protest actions that the movement has performed so far.

In principle, Fridays for Future's protest strategy is based on the organisation of low frequency, high magnitude non-violent protests aimed at mobilising a very high number of young activists globally. Since 2018, the movement has organised eight global climate strikes. The largest of these strikes, held in September 2018, mobilised over 3 million activists in 155 countries. These events are typically limited in time, lasting anywhere from one day to a week, and often take place around high-profile political events such as UNFCCC Conferences

of Parties and UN Climate Action Summits. What distinguishes Fridays for Future from the protest tactics of previous and current radical climate movements is undoubtedly the use of school strikes as a pressure tactic (de Moor et al., 2021), which is an approach that has only been sparingly identified in the relevant literature (Raynauld et al., 2016; Richardson, 2020). This element is of great importance to the movement's strategy, as youth participation tends to increase protest sizes (Somma and Medel, 2019) through bloc recruitment, such as bringing entire schools to demonstrations, often producing staggering numbers of activists mobilised.

An additional element of innovation in Fridays for Future's protest tactics lies in using hashtag activism to further its protest agenda. Hashtag activism defines a phenomenon where a large number of posts appear on social media under a common hashtagged word, phrase or sentence with a social or political claim (Yang, 2016). Hashtag activism has often acted as a critical channel for marginalised groups to produce counter-narratives and build bottom-up pressure networks (Jackson et al., 2020). Fridays for Future resorted extensively to hashtag activism, particularly during coronavirus-related lockdowns that halted in-person protests (Haßler et al., 2021). The movement recurrently used hashtag activism and related techniques such as tweet storms and virtual protests (Fisher and Nasrin, 2021) to sustain its online pressure on policymakers to adopt bolder action on climate and maintain its activist base involved. The movement's use of online protests tactics has been analysed extensively in the literature (i Martí et al., 2020; Sorce and Dumitrica, 2021).

2.4 Extinction Rebellion and Fridays for Future: A Quantitative Measurement of their Facebook Presence

The past two decades have radically transformed how social movements engage in collective action (Hestres and Hopke, 2017). In particular, the rapid diffusion of peer-to-peer information technologies such as social media platforms has provided organised activists with new, direct and unfiltered channels of communication (Leong et al., 2019; Murthy, 2018). Extinction Rebellion and Fridays for Future, together with the new generation of radical climate activism they embody, represent the first such movements to fully emerge in the digital age. As a result, the two movements have made the use of social media an essential part of their influence strategy, recurrently using online platforms to achieve a number of their goals, such as rallying their bases, exerting bottom-up pressure on businesses and governments, and circulate knowledge (Fotaki and Foroughi, 2021; Jacqmarcq, 2021; Sepúlveda,

2022). To provide a comprehensive understanding of the two movements' use of digital
activism in their protest and communication ecologies, this Section empirically measures and
analyses the two movement's activities on the social media platform Facebook. The critical
traits analysed in this Section include the temporal evolution of the two movement's online
activism, the structure of their online networks, and the content of their communication. The
analysis presented in this Section serves two primary purposes.
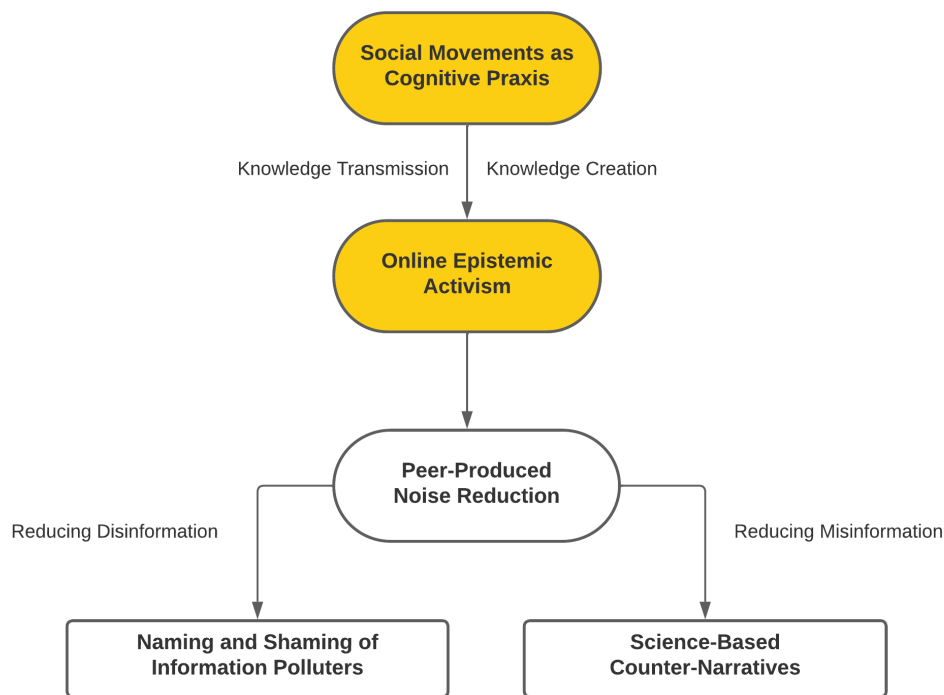
Fig. 2.4 Theoretical Framework Highlighted - Chapter II

On the one hand, analysing the temporal evolution, networks and post content of the
two movements, it helps to fully understand the characteristics of their online presence and
communication, offering valuable groundwork for the analysis of peer-produced forms of
noise reduction that will be presented in the following sections. On the other hand, it clarifies,
mainly through quantitative text analysis, the top part of the theoretical framework that
informs this research project - highlighted in Figure 2.4 - by providing insights into the role
of the two movements as cognitive praxis and online epistemic activists.

2.4.1 Temporal Analysis

This first part of this Section presents a temporal analysis of Extinction Rebellion and Fridays for Future's posting activity on Facebook, analysing any developments in the magnitude and frequency distribution of the two movement's digital activism. Temporal analysis is often used in the literature to provide insights into large-scale social media trends (Lai et al., 2017; Pond, 2016; Subirats et al., 2018), and in this Section, I apply this approach through two methodological strategies. First, I analyse the raw frequency of Facebook posts generated by pages and groups linked to the two movements, providing a general characterisation of the number of posts created and any high-level trends. Second, I use changepoints analysis through the R package '*EnvCpt*' (Killick et al., 2021, 2012) to detect the most significant changepoints in the temporal distribution, fitting a trend detection model to assess real-world events that may explain such changes in trends.
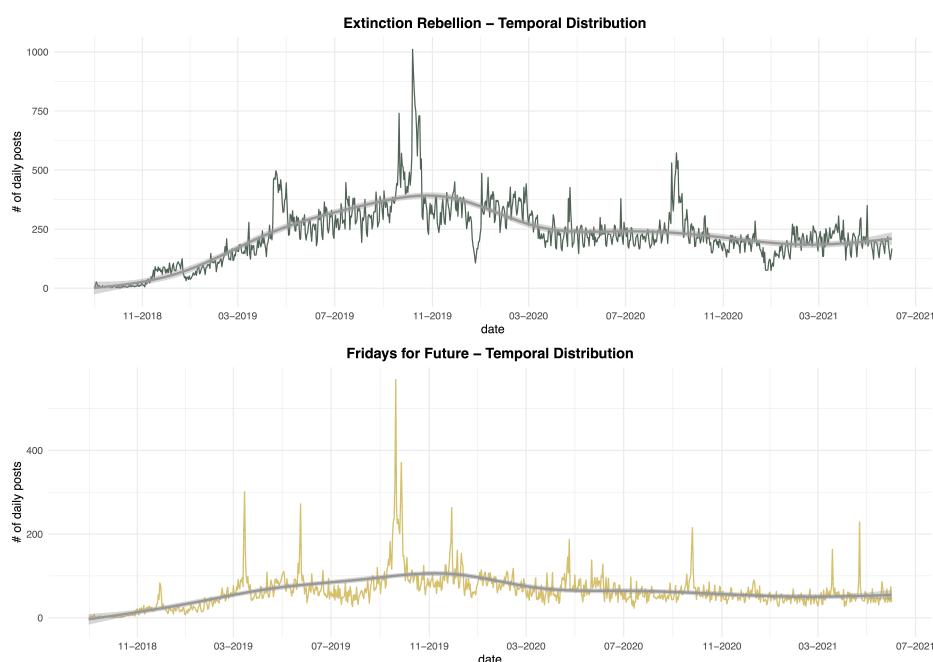
Fig. 2.5 Frequency Distribution of Extinction Rebellion and Fridays for Future's Facebook Posts

The results of the first step of the temporal analysis are visible in Figure 2.5, which shows the frequency of Facebook posts for the entire data set, including both pages and groups connected to the two movements. The first finding from Figure 2.5 is the significantly greater intensity of Extinction Rebellion's digital activism on Facebook in the three years under analysis. While Fridays for Future's groups and pages published an average of 63 posts per day, Extinction Rebellion averaged 227 posts per day, nearly a three-fold difference. It should

be noted that this disparity in posting intensity is not the result of differences in the number of pages and groups analysed. The data comprises, in fact, a similar number of entities, 750 for Extinction Rebellion and 686 for Fridays for Future, suggesting that this pattern results from a real difference in posting activity. However, this dissimilarity may be partly explained by the age difference in the activist bases of the two movements, suggesting that younger generations may be less active on Facebook than on other social media platforms such as Instagram and TikTok. Yet, no evidence currently exists on this matter, and more research is necessary to determine whether or not youth activists are more active in different social media platforms.

Further, analysing the smoothing line to detect any high-level trends in the frequency distribution, both movements show a similar temporal pattern characterised by sustained growth between their foundation and early 2020, to then set on a slowly decreasing trend. The decrease in posting activity is particularly evident from early 2020, which marks the beginning of the Covid-19 pandemic. This is interesting as numerous studies have noted how the two movements successfully adapted to the challenges of the pandemic, moving their protest activities online and even fitting covid-19 within their crisis narratives (Hunger and Hutter, 2020; Mocatta and Hawley, 2020; Mucha et al., 2020). However, this finding indicates that despite their attempt to adapt, both movements lost their momentum, and posting activity levels across groups and pages dropped significantly and did not appear to have recovered well into 2021. It should be noted that both distributions are characterised by prominent, sudden peaks of activity, which are normally linked to in-person protest events.

The second step of the temporal analysis consists in analysing trend-setting changepoints, which represent dates that initiate positive or negative trends in the temporal distribution of the two movements. Changepoints are detected through the R package '*EnvCpt*' using the PELT algorithm (Killick et al., 2012). Figure 2.6 portrays the main changepoints in Extinction Rebellion's temporal distribution.

Figure 2.6 shows that Extinction Rebellion's temporal distribution exhibits three main temporal trends, shown as separate rectangles in the Figure: two spurs of growth and a more extended period of stabilisation and degrowth. The first significant moment of growth spans from the movement's establishment in September 2018 through April 2019, with the highest peak of posting activity taking place on April 18, 2019. This growth phase - marked in the Figure as *Growth 1* - contains three changepoints representing a growing trend, with the most significant changepoints seen during the first wave of UK-wide protests in November 2018 and in the second wave of protests in April 2019. The second period of growth - tagged in the Figure as *Growth 2* - starts with a short period of degrowth, to then show a sustained,

Extinction Rebellion Changepoints
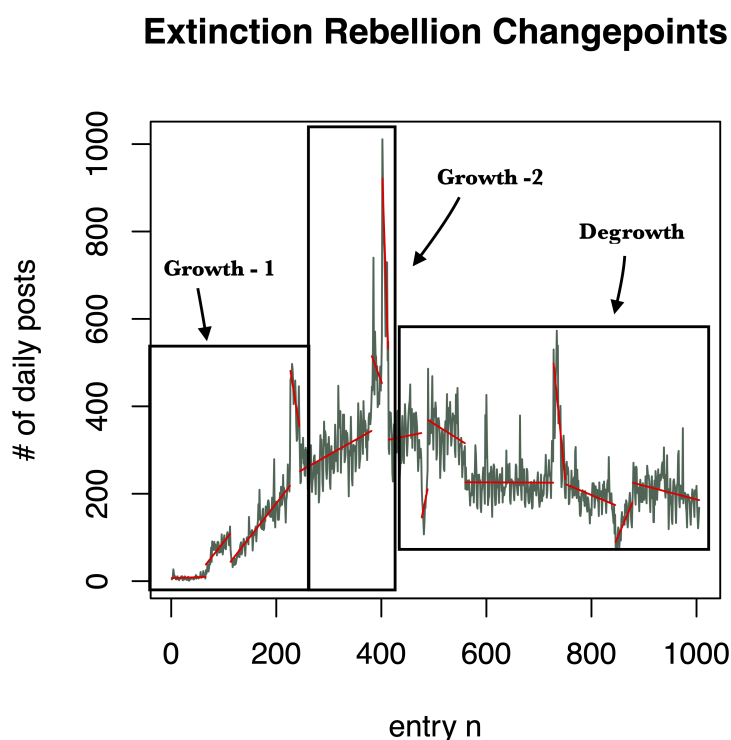
Fig. 2.6 Trend Changepoints of Extinction Rebellion computed through PELT

almost vertical growth through the 2019 Summer Uprising and the International Rebellion, the movement's largest-ever event held in October 2019. During this event, the movement reached its historical peak of posting activity, with 1011 posts in a single day registered on October 7 2019.

The third phase represents instead a moment of stabilisation and degrowth for Extinction Rebellion, and a critical changepoint in this Section is March 12 2020, the day following the World Health Organisation's announcement that Covid-19 had been classified as a pandemic. As noted in the analysis of the raw frequency above, after the Covid-19 pandemic, the movement's online activity slowly stabilised at a significantly lower level than what was seen before the pandemic. While other changepoints - such as the peak of activity in the third rectangle caused by the summer uprisings in 2020 - show the movement's online activity briefly rising again, the movement appears to struggle to reach pre-pandemic levels. Ultimately, Extinction Rebellion's changepoint analysis supports the trend noted in the frequency analysis above, suggesting that in-person protests strongly drive the movement's posting activity, and with the suspension of in-person activism during the Covid-19 pandemic,

the movement's momentum waned, and since then, as of June 2021, Extinction Rebellion failed to reproduce similar levels of online activity.

Moreover, Figure 2.7 the changepoint analysis for Fridays for Future's temporal distribution, which exhibits a growth and degrowth pattern that closely mirrors that of Extinction Rebellion, with two brief periods of rapid growth and a more extended period of degrowth and stabilisation.

Fridays for Future Changepoints
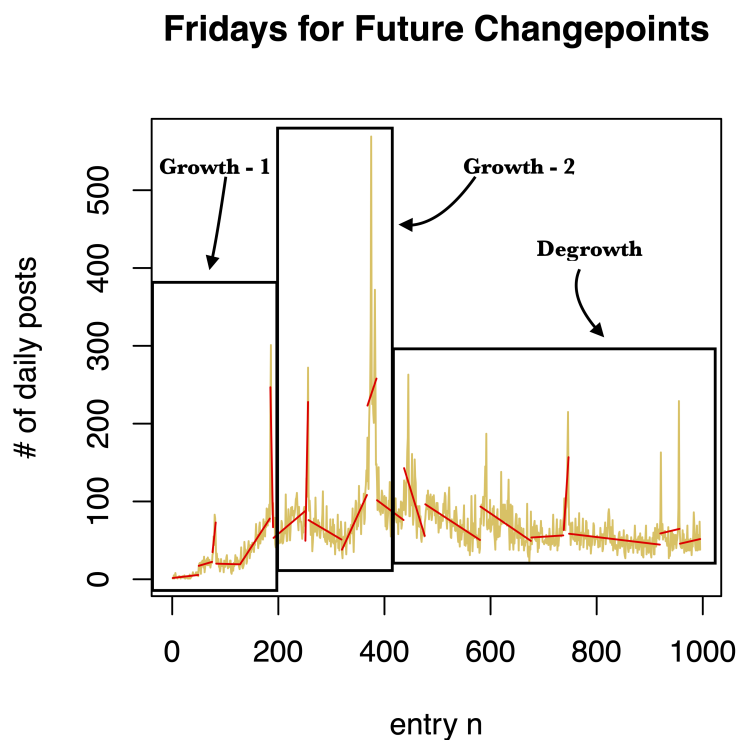
Fig. 2.7 Trend Changepoints of Fridays for Future computed through PELT]

Fridays for Future's first period of growth spans from the movement's foundation until March 2019, with a peak of activity visible on March 15, 2019 day of the movement's first global climate strike. During this period, the movement exhibits a series of positive trend changepoints. After a short period of degrowth, the movement entered a second phase of rapid growth, including the second global climate strike held in May 2019 and the third global climate strike between the 20th and 27th of September 2019. This moment represents, to date, the peak of the movement's Facebook activity, with 569 posts published on September 20 2019, the opening day of the third global climate strike. However, after a brief positive trend changepoint on November 29 2019 - the day of a worldwide climate protest - after the

end of 2019, the movement entered a phase of progressive slow down. In fact, in 2020, the movement exhibits low levels of posting activity, with an average of daily posts, produced similar to the numbers seen in 2018, with isolated peaks still observable around in-person protest events.

While the evidence presented in this Section suggests that the two movements are on a decreasing trajectory, this should not lead to the conclusion that Extinction Rebellion and Fridays for Future are bound to decline. Instead, this temporal analysis sheds light on the vital importance that in-person protest events play in the movement's capacity to remain active and relevant. Even as movements established in the digital age, this temporal analysis suggests that in-person protest remains the key driver of online activity and, consequently, of online influence. However, it should be noted that in the period following the end of the data collection process, with the end of Covid-19 restrictions, in-person protests have slowly resumed, possibly bringing new life to the two movements. This remains to be explored in further analyses.

2.4.2 Social Network Analysis

This Section presents a social network analysis (SNA) of Extinction Rebellion and Fridays for Future, assessing the unfolding of intra-movement interactions with particular attention to what pages and groups play a pivotal role in spreading the movement's communications. SNA can be broadly defined as a set of statistical and visual methodological tools for analysing structures and relationships within social networks (Bukhari et al., 2020; Cheong and Cheong, 2011; Tulin et al., 2018). SNA is a crucial technique in analysing social media data, as through this approach, we can map and understand interactions between entities in large and complex networks (Bello-Orgaz et al., 2017; Knoke and Yang, 2019). In graph theory, networks are typically represented with so-called 'nodes', which represent the entities in the network, and 'edges', which convey information about the connection between nodes (Gross and Yellen, 2003). Analysing movements' networks is particularly important when analysing their online communication, as it provides vital information on patterns of information sharing.

In this Section, I build separate networks for each movement using data from their Facebook posts. In each network, nodes represent Facebook groups, and edges represent link-sharing activity. While Facebook-based networks can be constructed using a wide array of edges (Bukhari et al., 2020; Peeters, 2019), drawing from Celestini et al. (2020), links were selected because of their capacity to provide a multi-dimensional understanding of

intra-movement interactions. Analysing link sharing activity, it is, in fact, possible to analyse patterns of interactions among nodes in the network while simultaneously assessing what content is more likely to go viral within the network.

Each network structure is built in the R environment with directed and weighted edges between a Facebook Page or Group α and a link μ, where the weight of an edge w counts how many times μ was shared by α. Then, the R network objects are plotted in Gephi, an open-source network visualisation and exploration software (Bastian et al., 2009). Before proceeding to the analysis of these networks, I apply two further essential methodological steps. First, I use a community-detection algorithm with standard modularity to extract any visible communities within the networks. This is done in Gephi, which uses an iterative community-detection algorithm developed by Blondel et al. (2008), particularly suitable for large networks. Second, I apply a force-directed layout to the network using the Force Atlas 2 algorithm (Jacomy et al., 2014). Force-directed algorithms are considered the state-of-the-art in network visualisation and follow a straightforward mechanism where nodes have a repulsive force driving them apart, while edges generate an attractive force between the nodes they connect. Consequently, the visualisation produced by force-directed layouts is a meaningful one, where nodes with direct relationships are closer in the network (Venturini et al., 2019).

Figure 2.8 shows the network visualisation for Extinction Rebellion and its communities. For this movement, the community detection algorithm detected 115 communities, of which the 10 largest are shown in the plot, covering 70% of all posts.

Analysing the Figure, it stands out that Extinction Rebellion's network is composed of two distinct sides. The first, visible in the top part of the network, is a densely connected cluster of UK-based nodes, with entities such as Extinction Rebellion Oxford (group), Extinction Rebellion UK and Extinction Rebellion Lincolnshire. The second, observable in the lower part of the network, is formed by three independent non-UK clusters, with communities from Canada, Australia and the United States. Keeping in mind that node proximity in the network plot implies similarity of content shared, it is interesting to note that the two sides of the network are quite distant in the two-dimensional space and are only connected by the page Extinction Rebellion, which acts as the centre of the network. This type of network structure indicates low levels of connection between the UK and non-UK communities, suggesting that the two sides of this network are nationally clustered and tend to share different types of links, although often converging around the content published by the main Extinction Rebellion page. This is important as it may result in topics of discussion being geographically clustered as well, with local groups prioritising local debates.
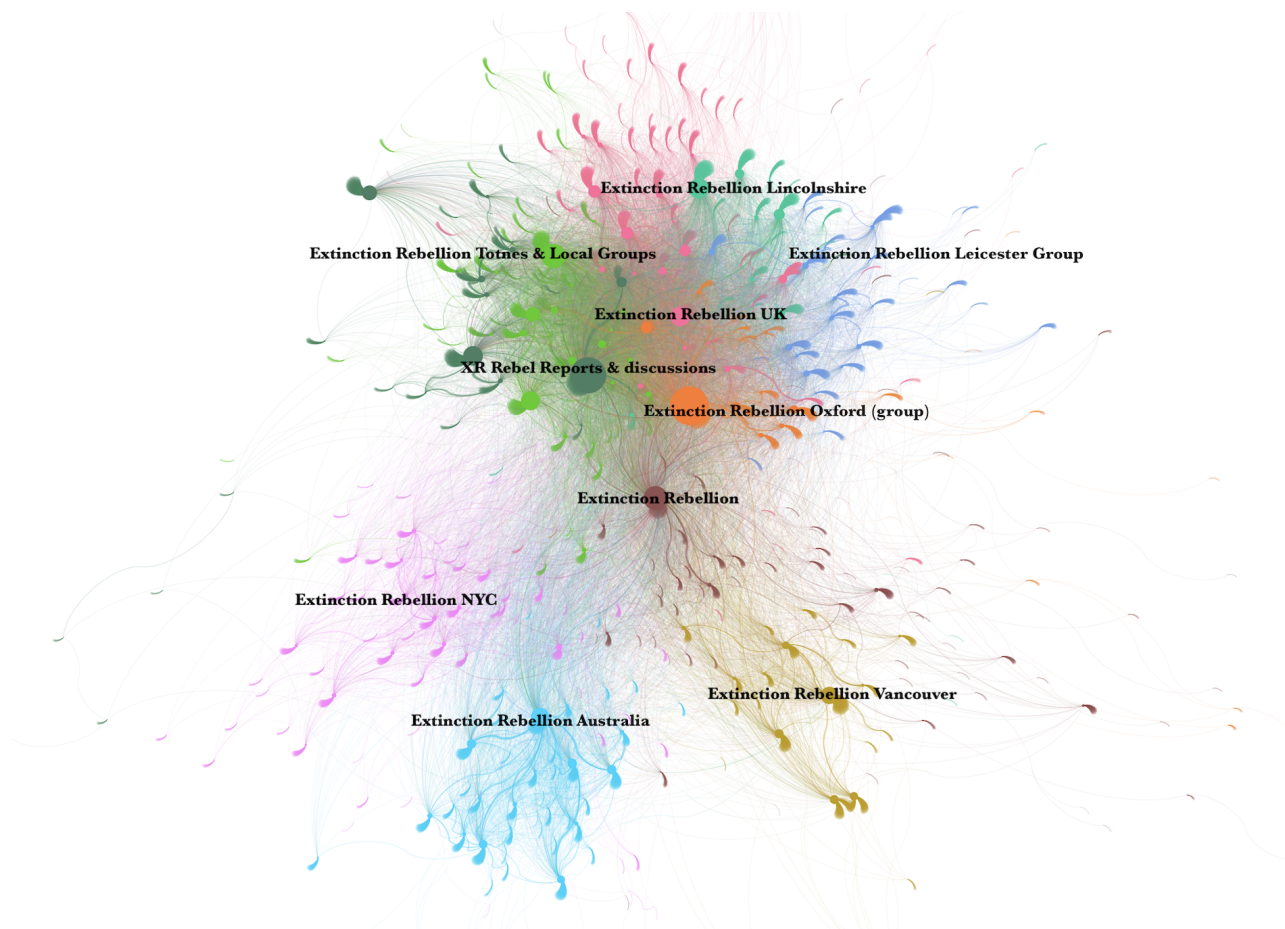
Fig. 2.8 Social Network Analysis Graph of Extinction Rebellion

This finding is further substantiated by the analysis of community connections, which shows that the communities detected in Extinction Rebellion's network tend to be very geographically clustered, indicating strong local intra-movement relationships. For example, the light-green community in the network plot, with Extinction Rebellion Totnes & Local Groups as the largest node, includes dozens of entities concentrated in the English southwest, such as local groups for Bath, Bristol, Cornwall and Devon. Similarly, the pink community with Extinction Rebellion Leicester Group as the largest entity contains an array of midlands and northern English groups, covering areas such as Bradford, Calderdale and Leeds. This pattern is also seen in the analysis of links shared, where the links shared within communities are often locally relevant. This evidence suggests that Extinction Rebellion's local groups and pages ultimately act as local hubs of grassroots activism, connecting protesters in relatively limited geographical areas. While local groups are still connected with the main Extinction Rebellion page, the latter is visually outside the main UK cluster, indicating that the movement primarily tends to associate and form communities at the local level.

Furthermore, in the network plot, the node size represents the number of posts published by each page and group, indicating that the two groups' Extinction Rebellion Oxford (group) and XR Rebel Reports & Discussions are the most active nodes in the network. This is noteworthy, as qualitatively assessing the two entities, it emerges that the two are relatively small public Facebook groups, with a total of just over 10k members. Despite their size, these groups are the most active entities in Extinction Rebellion's network, having published a total of nearly 14k posts, 6% of all posts collected, once again pointing to the highly decentralised and grassroots nature of the movement. Notably, the posts shared in these groups often include personal, emotional testimonies from individuals who participated in protest activities, describing their experiences being arrested or committing acts of civil disobedience. For example, XR Rebel Reports & Discussions summarises its purpose in a pinned post, which says:

> Welcome to all our new members! This group collects, collates and discusses rebel reports on progress, events, ideas, actions, blogs and opinions in regard to Extinction Rebellion. This is the largest XR Facebook group for collecting, disseminating and discussing such news, views, events and actions. Please read the About section and then feel free to share your stories, pictures and videos to this group, comment, discuss and like what you see and share widely, to spread the news and love and rage. Share especially to non-XR sites to spread our message and recruit rebels Let's make this rebellion massive!

Turning now to the sizes of the communities extracted by the model, results show the largest community for the number of posts produced is formed by Extinction Rebellion UK and several local London and South-East groups, with a total of 18,897 posts. Overall, this result highlights how the London area, where most Extinction Rebellion protest activities took place, forms a critical hotspot for the movement. Furthermore, out of the 10 communities analysed in the network, the 6 UK-based ones account for a staggering 78% of total posts, highlighting, once again, an evident prevalence of UK activists in the movement's composition. Amongst international communities, the Australian cluster is the largest, with 14k posts, equivalent to 8.8% of the network. These findings further support the results of the geographical analysis in Section 2.3, which showed how the movement's pages are largely concentrated in the UK. While this is not surprising considering the movement's history, this analysis adds a further layer to understanding the movement's internal composition, particularly regarding the movement's network patterns that tend to prefer local, decentralised and horizontal connections.

The next part of this Section moves on to the analysis of Fridays for Future's intra-movement networks, which can be seen in Figure 2.9. For this movement, the community detection algorithm detected 395 communities, of which the 10 largest are shown in the plot, covering 60% of all posts. Upon initial inspection, the visualisation reveals that Fridays for Future's network is significantly more sparse and less connected than Extinction Rebellion's, a visual feature that can be explained by the movement's lower levels of posting activity already noted in the previous Section. However, what is perhaps the most interesting characteristic of its network is its structure. While Extinction Rebellion's network was distinctly divided into a UK cluster and an international cluster with evident community-based grouping, Fridays for Future's network is more scattered and does not exhibit geographical clusters. Instead, the network gravitates around a clear centre where the majority of edges pass through, formed by the 3 nodes with the highest centrality in the network, School Strike for Climate Action, Greta Thunberg, and the group Fridays for Future Greta Thunberg #Climatstrike #FFF. These nodes are international pages that are not linked to any geographical communities.

Further, it is interesting to note that communities based on real-world locations appear distanced from each other in the bi-dimensional space. In particular, the communities of Fridays for Future Canada, Fridays for Future Toronto and Fridays for Future Ottawa appear distant in the network despite belonging to the same geographical area. This finding indicates that the movement's local communities are unlikely to share geographically relevant content and, instead, are more prone to interact with the larger international nodes in the network. This type of network topology casts some doubts on Fridays for Future's grassroots structure, as this social network analysis indicates that local groups are more likely to act as message spreaders for international groups rather than to form grassroots, on-the-ground networks. This pattern also emerges from the analysis of links, as local groups tend to mainly share content that is not geographically relevant, such as international campaigns and global online protests.

Turning now to nodes and community sizes, the network analysis for Fridays for Future shows that the movement's largest community is formed by the group Fridays for Future Greta Thunberg #Climatstrike #FFF and a range of smaller international groups. The former group acts, both visually based on Eigenvector Centrality scores (Ruhnau, 2000), as the core of Fridays for Future's network. Analysing the node, it emerges that it represents a public Facebook group acting as a platform of discussion for activists, with over 25k active members and a total of 10,438 posts in the period under analysis, $\approx 16\%$ of all posts collected. The second-largest community is formed by School Strike for Climate Action and its subgroups, with 5,168 posts. This is also a public group, with 7.5k members. Lastly, it should be noted that the 5th largest community in this network, shown in light grey in the Figure, stands
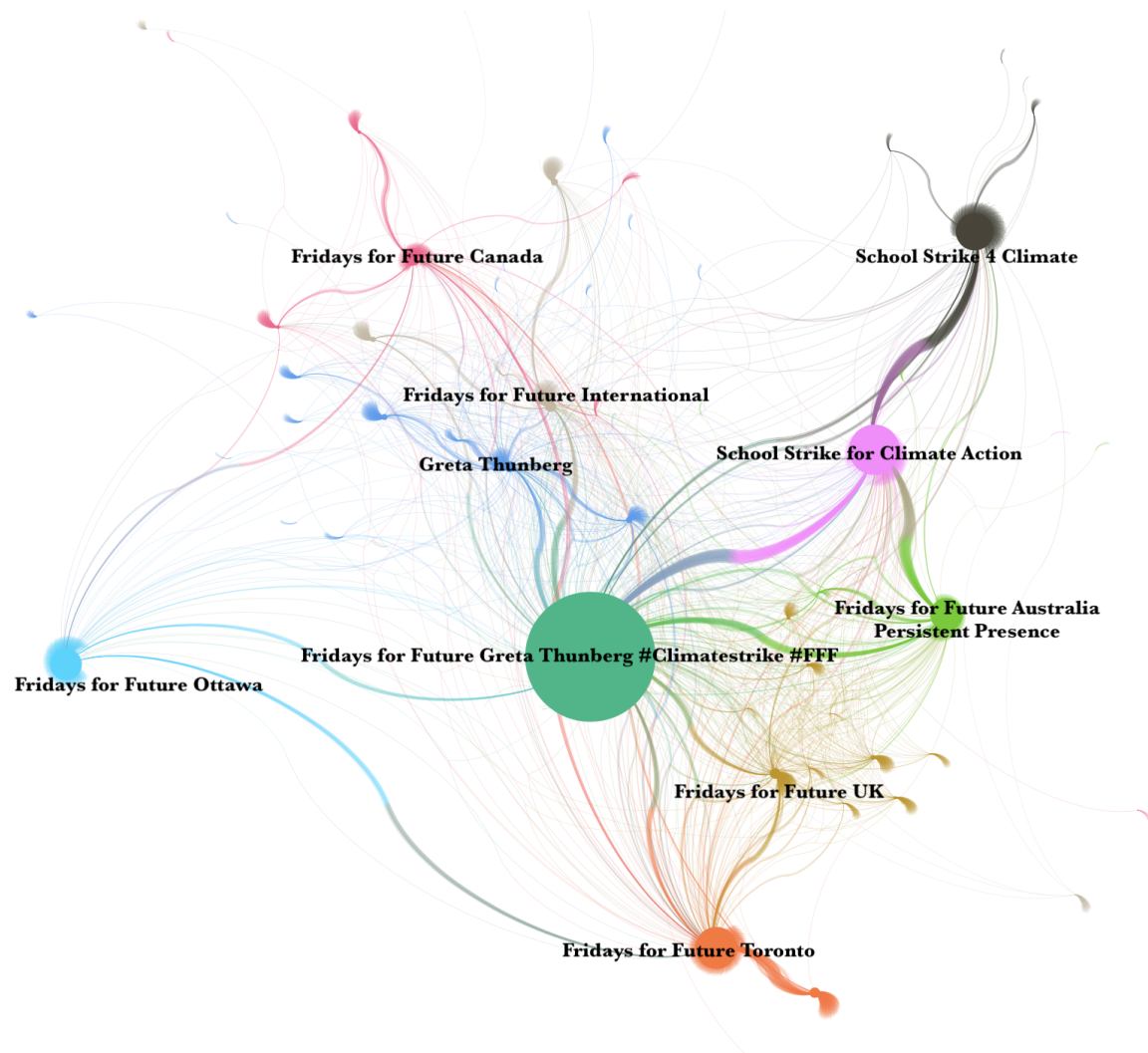
Fig. 2.9 Social Network Analysis Graph of Fridays for Future

out as an outlier with low size and high centrality. This is because this community includes
the node Greta Thunberg, which represents the Facebook Page belonging to the movement
founder. This node plays a very influential role within the network, with outgoing edges
circulating exponentially amongst other pages. For example, a February 2019 post where
Thunberg discusses the online hate she received on social media gathered over 1 million
interactions, indicating that despite a low number of posts created, the young activist is
crucial in engaging the various components of the Fridays for Future network.

Indeed, the findings presented in this Section provide vital insights into the two move-
ments' information-sharing patterns, a key element in their epistemic activism. Here, the
data showed that when disseminating information and interacting with groups within their
network, Extinction Rebellion and Fridays for Future display visible differences. On the one

hand, Extinction Rebellion's communication and activism are highly grassroots-based, with the majority of intra-movement interactions occurring at the local level, a feature reflected in the type of content shared. On the other hand, Fridays for Future's activism happens mainly at a higher, non-grassroots level, with the movement discussing broader and non-localised issues.

2.4.3   Quantitative Content Analysis

The last step of this analysis into the two movements that best embody the new generation of radical climate movements, Extinction Rebellion and Fridays for Future, consists of performing a quantitative content analysis of the text in their Facebook posts. In the context of this research, quantitative text analysis is applied through topic modelling, a probabilistic unsupervised machine learning technique used to extract latent topics that occur in a collection of text-based documents (Vayansky and Kumar, 2020). The existing literature on topic modelling is quite extensive and indicates that this approach is commonly used in research on social media data (Negara et al., 2019; Zhou et al., 2017), particularly in the analysis of large scale communication trends and public reactions to certain events. Several recent examples of such applications exist. For example, Giorgi et al. (2022) used topic modelling on Twitter data to analyse social responses to Black Lives Matter protests, while Kwon et al. (2022) used this approach to evaluate the circulation of misinformation on the Covid-19 pandemic. In this Section, topic modelling is used to gauge the main characteristics of the communication of the two movements, while also assessing their role as cognitive praxis and online epistemic activists.

While several approaches to build a topic model exist [2], in this project, I use the Latent Dirichlet Allocation (LDA) algorithm, which assumes that every document is a mixture of topics and every topic a mixture of words, and uses latent patterns of co-occurrence to detect semantic structures and clusters (Blei et al., 2003). According toAlbalawi et al. (2020), LDA is particularly suitable for analysing Facebook conversations, producing, on average, higher-quality and more coherent topics than other topic modelling methods. After a standard pre-processing of the text data [3] produced by the two movements, I applied the

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[2]For more on alternative approaches to topic modelling, such as Latent Semantic Analysis, Principal Component analysis and Random Projection see Albalawi et al. (2020); Vayansky and Kumar (2020)

[3]Preprocessing the data set included steps necessary to clean and prepare the data set for the LDA computation. These steps comprise removing all duplicate posts, special characters, numbers, punctuation and stopwords. Last, to reduce the morphological variation of words in the data set , I resorted to lemmatisation, which converts words to their original lemma. Token-based lemmatisation was applied in the R environment using the *textstem* package (Rinker, 2018). According to Balakrishnan and Lloyd-Yemoh (2014) , while

LDA algorithm within the R environment using the *text2vec* package by Selivanov and Wang
(2016), which relies on *WarpLDA*, a quickly scalable, robust and computationally efficient
LDA application (Bhadury et al., 2016; Chen et al., 2015).

A key feature of LDA-based topic modelling is that the quality of model implementations
is highly dependent on the *a priori* selection of the Dirichlet hyperparameters α (alpha) and
η (eta), and k where α controls the shape of the document-topic distribution, η controls the
shape of the topic-word distribution, and k controls the number of topics detected by the
model (Wallach et al., 2009). For the hyperparameters α and η I use the widely accepted
values of $\alpha = 50/k$ and $\eta = 0.1$ (Griffiths and Steyvers, 2004), while to determine the optimal
value of k, I use 5-fold cross-validation comparing the perplexity scores of different models.
Perplexity testing is a popular method of testing a topic model's validity, where the perplexity
value measures how well a model fits previously unseen data (Anupriya and Karpagavalli,
2015; Grün and Hornik, 2011). By computing and validating perplexity in folding subsets of
a training set, it is possible to estimate which value of k maximises the model's performance,
improving its generalisability. In this case, given the large size of the data set , I select the
optimal k by striking a balance as to where the marginal increase in perplexity does not justify
the added model complexity, and the chosen k values are $k= 72$ for Extinction Rebellion, and
$k= 52$ for Fridays for Future. The results of perplexity performance can be seen in Appendix
A.1. It should also be noted that while many LDA implementations require the selection of
the number of model iterations - where a higher number progressively leads to higher output
quality - *text2vec* uses an iterative sample algorithm that computes the model's log-likelihood
- a measure that describes how plausible the model parameters are given the data — at every
n iterations.

A further crucial step in topic modelling-based analyses is the interpretation of the model's
output. To explore and interpret the results of the models applied to the two movements, I
take a two-step approach. First, I extract FREX words for each topic, representing the top
words in each cluster ranked by a mix of exclusivity and frequency (Bischof and Airoldi,
2012; Roberts et al., 2014). The FREX metric offers an insightful two-dimensional summary
of topic content and has been proven to outperform similar measures of model interpretation
(Bischof and Airoldi, 2012). Second, I qualitatively analyse the posts with the highest
relevance in each topic in order to assess the existence of any visible and coherent topics.
Finally, it should be mentioned both models contain a small number of unintelligible or
boilerplate topics where a clear theme cannot be discerned (Maier et al., 2018). These
include linguistic artefacts, or commonplace structural webpage items. This is a common

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more computationally expensive than other approaches to reduce morphological variation, lemmatisation can
guarantee more robust results.

occurrence in topic modelling implementations, particularly so when working with large data sets (AlSumait et al., 2009).

Extinction Rebellion

Analysing the topic modelling output for Extinction Rebellion, which can be found in Appendix A.2, it emerges that out of the 72 topics extracted, 6 are boilerplate topics with no meaning or importance for this analysis, leaving a total of 66 relevant topics. Before proceeding to the analysis of the topic model output, each topic was qualitatively assigned to one of 12 broad thematic categories, which were detected by examining topic labels. The assignment of topics to macro-areas is a common practice in topic modelling analysis, as this step allows for a more comfortable analysis of a large number of topics. The 12 thematic areas and their corresponding percentage of total posts are shown in Figure 2.10 below.
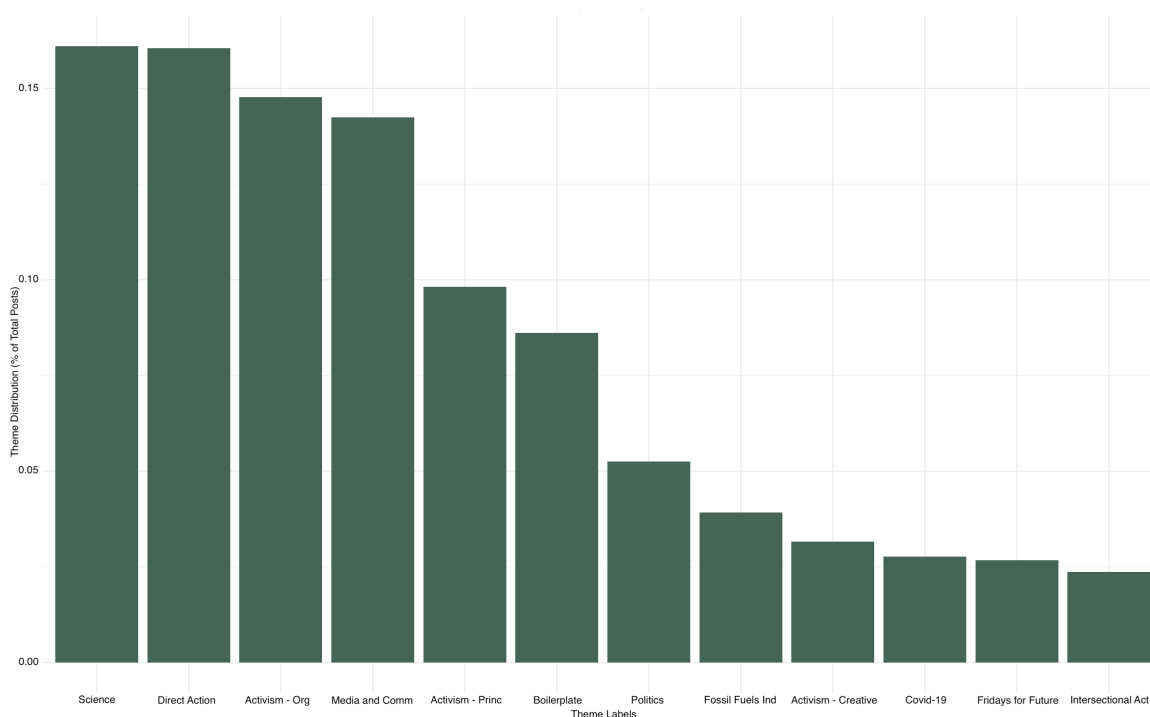
Fig. 2.10 Topic Modelling Results by Theme for Extinction Rebellion

Inspecting Figure 2.10, it is evident that four thematic areas, *Science*; *Direct Action*; *Activism - Organisation*; and *Media and Communication*, dominate the distribution, each appearing in ≈ 15% of the posts analysed. The first of these themes, labelled as *Science*, contains 12 individual topics discussing scientific evidence on the causes, impacts and solutions to climate change. The most common topic in this category (present in 1.72% of

posts) is '*Extreme Weather Events*', and discusses how worsening climate change leads to extreme weather events such as floods and droughts. Further topics in this category include discussions on scientific research, plastic waste, ocean pollution, air pollution, renewable energy, and green growth.

The substantial size of this theme, present in over 16% of posts, reveals how the activism of the new wave of radical climate activism under analysis is highly science-based, clearly relying on scientific evidence as a staple of its communication strategy. Qualitatively analysing the topic modelling data, it emerges that the movement uses scientific narratives with two primary purposes. On the one hand, confirming what was discussed in Section 2.3.4, climate change science is used to justify disruptive, radical activism, as the gravity of the situation is seen as a moral justification for a radical approach to protest. This concept emerges from several of the posts analysed. For example, a post within the *Extreme Weather Events* topic reads:

> Almost every day reports are available about extreme weather conditions arising around the world... Are the people in power doing enough? Are they paying attention? Extinction Rebellion is listening. We are paying attention. Change is coming. Let us make it the right change.

Furthermore, another post in the same topic cluster applies this reasoning to food security and world hunger, writing:

> 821 million people malnourished as food security fails and world hunger rises. 60 million people affected by extreme weather and climate events - floods, hurricanes, heat waves, and wildfires. 2 million people displaced due to disasters linked to weather and climate events. It's time to act. The International Rebellion begins 15 April and ends when we win. #rebelforlife

On the other hand, climate science is often used by the movement with an educational intent to inform the public on the solutions, current developments and understanding of climate change science. This type of online epistemic activism emerges clearly from numerous scientific posts. For example, a post in the *Sustainable Agriculture and Plant-Based Diets* topic summarises state-of-the-art evidence on water shortages as a result of cattle farming, stating that:

> A recent analysis published in Nature found cattle to be one of the major drivers of water shortages. Notably, it is because of water used to grow crops that are fed

to cows such as alfalfa and hay. Across the US, cattle-feed crops, which end up as beef and dairy products, account for 23% of all water consumption, according to the report. In the Colorado River Basin, it is over half. #DietForASmallPlanet

Similarly, an informational post within the *Scientific Research* topic contains claims on the current scientific consensus on climate change, arguing:

The scientific consensus that humans are causing global warming is likely to have passed 99%, according to the lead author of the most authoritative study on the subject, and could rise further after separate research that clears up some of the remaining doubts. #ClimateCrisis #ClimateChange #GlobalHeating

All in all, these insights into the use of scientific communication confirm the movement's unequivocal role as cognitive praxis (i.e. transmitting or creating knowledge) and as an online epistemic force of change (i.e. attempting to improve public understanding of climate change) demonstrating how science is used in an informational and educational way by the movement. This is fundamental for the analysis presented in this research, indicating that the dissemination of mediated, accessible scientific evidence is among the most common functions that the movement performs. This feature of the new generation of radical climate movements will be analysed in greater depth in Chapter IV of this thesis.

Furthermore, the second and third most common themes in the topic modelling distribution of Extinction Rebellion were labelled as *Direct Action* and *Activism-Organisation.* These two thematic areas are quite similar, discussing the movement's organisation practices, such as the planning of protest events and the occurrence of direct protest action. Here, the most common topic, present in 1.93% of posts, is *Meetings Planning*, which discusses the practical organisation of the movement's activists' meetings. Indeed, Extinction Rebellion is a radical climate movement based on third-generation protest tactics, and as such, it relies heavily on direct action, civil disobedience and grassroots activism. These themes reflect these characteristics, providing insights into how the movement organises and the type of protests it undertakes and suggesting that a considerable share of the movement's social media presence is directed at outreach and organisational activities. However, this macro thematic area does not contain new information on the movement's epistemic practices, as its nature is primarily organisational.

Moreover, the fourth most common thematic area that emerged from topic modelling was labelled as *Media and Communication.* This theme is essential to the aims of this research project, as it provides information on the movement's epistemic practices. This

theme contains ten unique topics of various natures, ranging from discussions on Facebook posts; videos and documentaries; and the media sector. While topics in this category mainly describe the movement's use of media sources such as newspapers, social media and podcasts to spread its message - often encouraging activists to engage in epistemic activism, once again pointing to the movement's role as an epistemic influence - it also contains a critical topic to this analysis on disinformation and misinformation, labelled as *Media and Truth*. This topic, present in 1.42% of posts, discusses climate change denial and the portrayal of climate change in the media, often accusing the media system of tainting the information environment by providing biased, inaccurate information on climate change. For example, a high-relevance post within this topic reads:

> 5 billionaires owning 80% of mainstream newspapers is not a free press.

In particular, posts modelled in this topic appear to target media outlets owned by Rupert Murdoch, such as The Sun and The Times; and the BBC, which are often accused of hosting climate change deniers. To best assess the characterising element of this topic, Figure 2.11 shows a voronoi treemap of the 15 most common words by frequency in this topic [4]. Analysing the Figure, it can be seen how the topics contain various keywords that are central to this research, such as *truth*, *media*, *false*, and *bias*, indicating that within this topic, activists are extensively discussing false information and media behaviour on climate change. However, it should be noted that the most common word in the Figure is the word *news*, suggesting that while discussing false information on this topic, the movement is mainly concentrating on news outlets' coverage of climate change. This topic provides an initial overview of the extent to which Extinction Rebellion discusses information and disinformation, a communication aspect that will be analysed in greater depth later in this project.

A further theme that deserves attention is the one labelled *Fossil Fuels Industry,* which is present in 4% of posts. While this thematic area is not as common as the ones that were just discussed, it is, nonetheless, quite significant, as it portrays the movement's communication towards the fossil fuels sector. This cluster contains three unique topics, labelled as *Pipelines on Indigenous Land*, *Fracking*, and *Fossil Fuels Funding*. The latter topic is the most common, appearing in 1.42% of posts. Within this topic, the movement discusses banks who finance polluters and climate change deniers, often naming and shaming such institutions. For example, a post in this topic reads:

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[4] A Voronoi treemap is a variation of the standard treemap that uses a Voronoi diagram to partition the data. This treemap is used to show the occurrence of specific words, but does word proximity does not indicate a relationship of co-occurrence between words
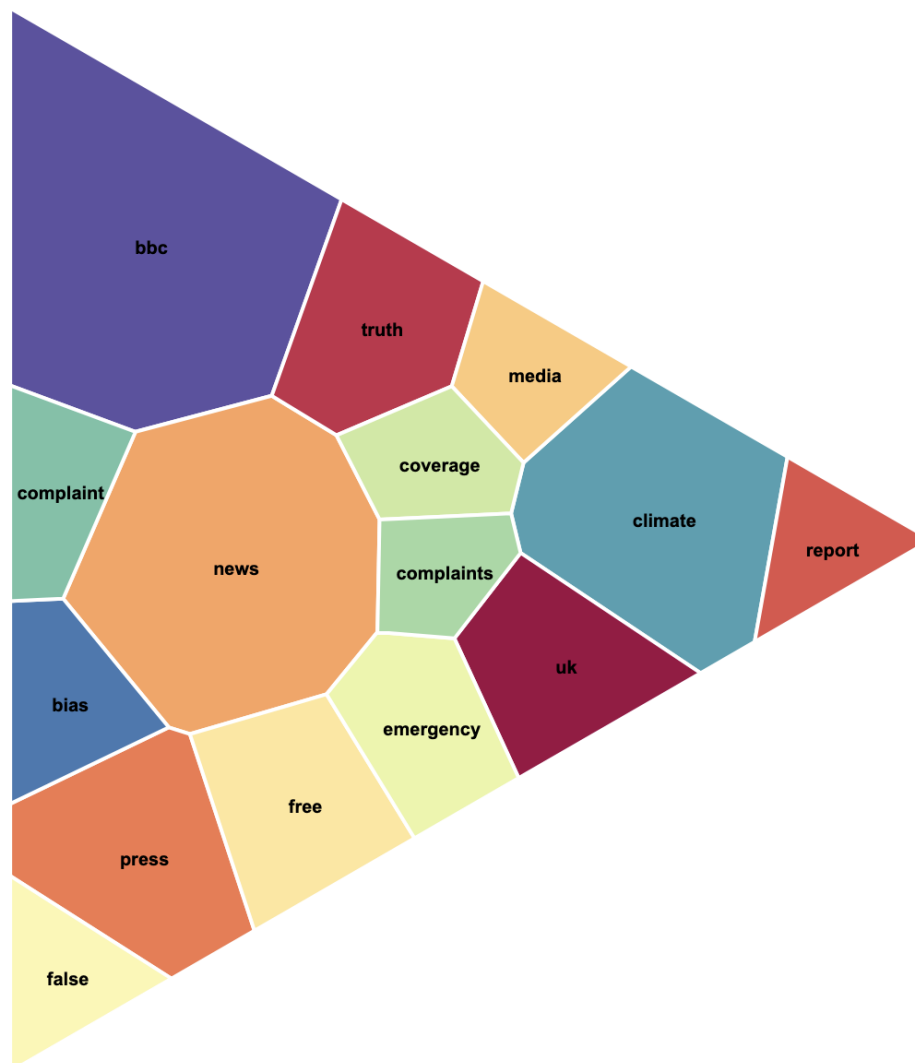
Fig. 2.11 Voronoi Treemap for Extinction Rebellion's 'Media and Truth' Topic

Barclays have invested £70 billion in fossil fuels and carbon-intensive companies since The Paris Accord was signed in 2015-they show no sign of stopping #Sharklays#Fossil Banks#Money Rebellion. Money—rebellion targeted Barclays with stickers castigating them for funding the climate crisis & deliberate destruction of the natural environment.

The naming and shaming of such institutions is a very interesting phenomenon, and it will be analysed in greater depth in Chapter III of this thesis.

Lastly, an insightful process allowed by topic modelling is the analysis of how topics and themes' frequency has changed over time. This step makes it possible to assess temporal trends in the communication of the movements under analysis. Detailed visualisations of temporal developments can be found in Appendix A.4. Analysing by-topic evolutions, it appears that several topics show consistent growth in the time period under analysis. These topics include a range of scientific topics such as *Renewable Energy* ; *Air Pollution*; and *Sustainable Agriculture and Plant-based Diets* along with topics linked to the fossil fuels industry, such as *Fracking* and *Fossil Fuels Funding.* On the other hand, several topics relating to the movement's organisation and principles, such as *raising awareness* and *Civil Disobedience*, appear to decrease in importance. As mentioned in the temporal analysis of Extinction Rebellion's post in Section 2.4.1., the data indicates that the movement was adversely affected by Covid-19, which weakened the movement's acquired momentum on in-person protests. Through this step, we can add to that analysis by noting that after the pandemic, the movement appears to have intensified discussions on scientific themes, increasing its epistemic activism, while raising its pressure on the fossil fuels industry, extensively discussing the role of this sector in the climate crisis, a strategy that will form the object of analysis of Chapter III of this thesis.

Fridays for Future

Analysing the topic modelling output for Fridays for Future, which can be found in Appendix A.3, it emerges that out of the 52 topics extracted, 6 are boilerplate topics with no meaning or no importance for this analysis, leaving a total of 46 relevant topics. Mirroring the procedure used for Extinction Rebellion, before analysing the model output, each topic was qualitatively assigned to one of 12 broad thematic categories. The thematic areas and their corresponding percentage of total posts are shown in Figure 2.12 below.

Inspecting Figure 2.12, it emerges that Fridays for Future's thematic distribution is skewed towards the theme *Activism- Organisation*, which is present in nearly 20% of the movement's posts, followed by *Science* and *Direct Action*, which are present in 12% and 11% of posts respectively. Similarly to Extinction Rebellion, the theme *Activism - Organisation* contains 17 individual topics discussing an array of organisational matters such as the planning of protests and strikes and broader calls to action. Interestingly, the most common topics in this cluster are *Fridays for Future Hashtags* and *Climate Change Hashtags*, present in 3.5% and 2.6% of topics, respectively.
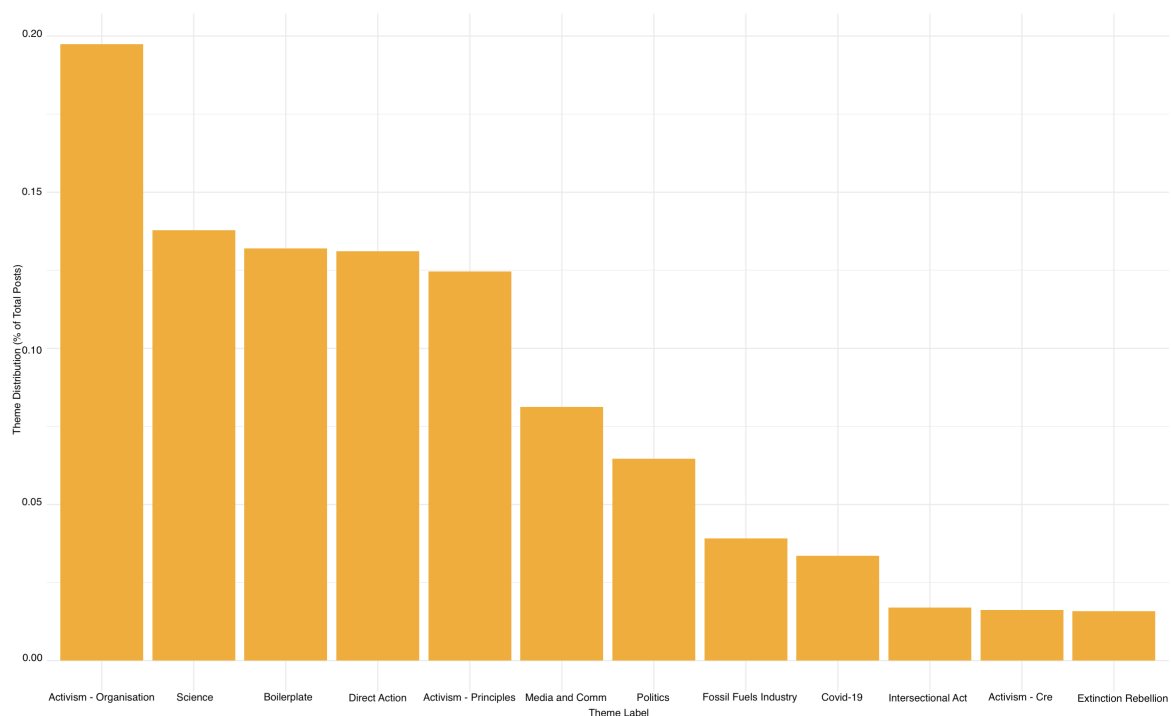
Fig. 2.12 Topic Modelling Results by Theme for Fridays for Future

The presence and prevalence of two unique topics on hashtags, with keywords such as '#climatejustice',' #climatechange', '#fridaysforfuture', and '#climatestrike' provides useful information on the movement's use social media as a form of communication, indicating that the movement is prone to extensively use hashtag activism to support its causes. Hashtag activism has often been proven to be effective in mobilising offline action while raising awareness and ensuring a movement's influence within the public discourse. Through hashtags, movements can, in fact, push specific issues and focus on maintaining issue relevance (Haßler et al., 2021; Simpson, 2018). The prevalence of hashtags is quite different between the two movements, as, in Extinction Rebellion's distribution, hashtags were mapped in only 1.8% of all posts. Other common topics in this category are *School Strikes - Parents*, which discusses the role of adults in the movement's activism, and *Community-based Activism*, which discusses the movement activism and aggregation at the community level.

Furthermore, the second most common thematic cluster, *Science* contains 8 individual topics discussing an array of scientific themes and is present in 13% of posts. This theme is clearly dominated by discussions on the existing scientific evidence on anthropogenic climate change, while discussing current impacts and potential solutions. The two most common topics in this category are *Temperature Increases*, discussing the risks of globally rising

temperatures, and *GHG Emissions*, discussing potential pathways to emissions reduction, such as expanded use of renewable energy. Similarly to Extinction Rebellion, posts in this thematic area appear to fulfil two key purposes: educate the public, and justify disruptive activism. However, while this aspect is not quantified in this study, qualitative analysis of high-relevance posts suggests that Fridays for Future's scientific content tends to lean more towards informational posts. For example, the highest relevance post in the *GHG Emissions* topic ($\theta = 0.92$) contains a highly technical discussion on emissions from mobility, stating:

> One piece of climate action is carbon free transport. The can be realized with electric mobility... charged with renewable energies. But it is also necessary to save energy and resources in the production of the necessary lithium-ion batteries. An eco-friendly recycling of EV batteries by Duesenfeld reduces the carbon footprint of a lithium-ion battery by 40%.

Similarly, a post in the *Scientific Research* topic, uses quite a technical language to discuss the existence of a scientific consensus on climate change. The post states:

> Please share what NASA has to say about Climate Emergency with your climate denier friends, if there are any: "Multiple studies published in peer-reviewed scientific journals1 show that 97 percent or more of actively publishing climate scientists agree: Climate-warming trends over the past century are extremely likely due to human activities. In addition, most of the leading scientific organizations worldwide have issued public statements endorsing this position. The following is a partial list of these organizations, along with links to their published statements and a selection of related resources."

A further common thematic area in the distribution is *Activism - Principles*, which is present in 12% of posts, and contains 7 individual topics outlining the movement's pillars and key narratives. The most common topic in this category was labelled as *Integenerational Equity* and contains discussions around the principle of intergenerational equity and how the climate emergency will disproportionately affect generations. For example, a high relevance post in this topic claims:

> It is high time for the future. What should the future look like? Do we still have a future? Yes we do and we have to have them, but only when we realise that money cannot be eaten, we cannot and certainly not our children and grandchildren.

The widespread presence of this topic was to be expected in line with the evidence presented in Section 3.4.2, which discusses Fridays for Future's ideological pillars. The second most common topic within this ideological cluster was labelled as *Urgency Narratives*. This topic debates the urgency of climate action, mainly claiming that we are running out of time to adopt decisive action on climate change, and the time for action is now. This topic is fascinating as it sheds light on the movement's use of the concept of time to support its calls to action and on how the movement views the current time frames for action as limited and potentially dangerous. This sense of urgency fully permeates from a high relevance post on this topic, which claims that: 'The time is NOW to act on Climate Change!'

Other key topics in this theme include *Climate Change Solutions* which contains calls to take action to find solutions to the climate crisis, and *Individual Impact*, which includes empowering language on how each individual can make a difference by both protesting and taking small individual actions. Moreover, it should be mentioned that while the theme labelled as *Fossil Fuels Industry* is as a theme only present in 4% of posts, the topic labelled *Fossil Fuels Sector* is present in 2.3% of posts and is the 6th largest topic in the model. This topic contains discussions on the role of the fossil fuel industry and its impact on the environment. For example, a post in this category reads:

> URGENT' #Shell plans to leave parts of old oil platforms with 1 tonnes of oil and toxic waste in the #NorthSea. We cannot allow them to poison the oceans and fuel the #climatecrisis anymore[...]

Finally, Fridays for Future's topic model also exhibits the presence of a theme labelled as *Media and Communication*. This thematic area is present in close to 8% of all posts, and contains four unique topics: *Media Outlets, Online Workshops*, *Facebook Posts*, *Youtube Videos*. Perhaps the most interesting topic here is *Media and Truth*, which is present in 1.8% posts, which exceeds the presence of the similar topic identified in Extinction Rebellion's model. A treemap showing the 10 most common words in this topic is shown in Figure 2.13 below [5]. Analysing this topic, it emerges that the language used is, similarly to Extinction Rebellion's, quite strong, often blaming the media sector for its representation of climate change. For example, a high-relevance post here reads:

> Rupert Murdoch uses his publications to advance a political agenda that will make him money. Oil features heavily in his motivations , and in order to sell it he has been lying to his readers about the Climate Emergency for decades.

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[5]The number of words in the treemap was limited to 10 - as opposed to Extinction Rebellion's 15 - because of the significantly smaller size of the topic dataset, which led to a smaller number of relevant words
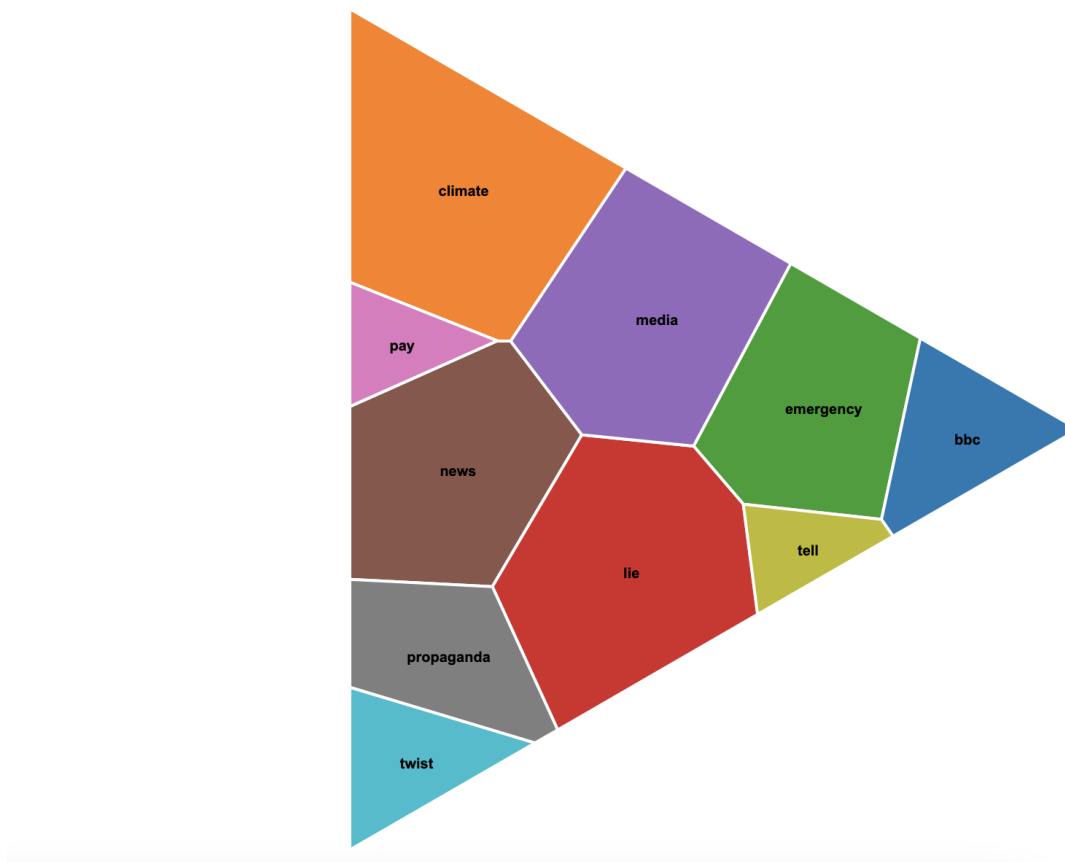
Fig. 2.13 Voronoi Treemap for Fridays for Future's *Media and Truth* Topic

Last, analysing by-topic temporal evolutions, which can be seen in Appendix A.5, several topics show clear evolutions over time, falling or growing in relevance. Among the topics showing the steadiest growth, we see the topic labelled as *Fossil Fuels Sector*, which has grown quite steadily since 2018 and reaching its peak in relevance by the end of the data set's range in 2021, indicating a progressive growth of discussion on the fossil fuels sector. This confirms what previously noted in the content analysis of Extinction Rebellion.

Furthermore, the two topics belonging to the theme *Intersectional Activism*, labelled as *Racism* and *Capitalism and Systemic Change*, exhibit significant growth in the period under analysis, once again indicating a growing relevance of intersectionality in the movement's activism. In particular, the topic *Racism* shows vertical growth, growing 10-fold in the period under analysis. While this rapid growth may be partly explained by the rise of the Black Lives Matter movement in early 2020, the data shows that this trend continued well into 2021. Lastly, the theme *Activism - Principles* shows noteworthy temporal developments. In particular, the theme *Declarations of Emergency* falls quite rapidly after peaking in late 2019, while the topic labelled *Common Resources*, which contains discussions on the collective

responsibility to protect common natural resources, shows exponential growth over time, marking a clear change in the ideological priorities of the movement. Information-related topics show no clear evolution during this period.

2.5   Discussion and Conclusions

In this Chapter, I set out to analyse the emergence of a new generation of radical climate activism, providing an in-depth understanding of the two movements that best represent this innovative form of bottom-up pressure, Extinction Rebellion and Fridays for Future. In order to frame and contextualise this novel social phenomenon, the two movements were analysed through a mix of methodological approaches. Circling back to the three research goals that guide this Chapter, the main findings can be summarised as follows.

2.5.1   The Rise of a New Generation of Radical Climate Change Activism

Analysing the literature on environmental and climate change activism, this work identified three historical generations of environmental activism. The first generation, which emerged in the United States in the late 19th century, focused on the 'cult of wilderness' and protecting natural resources. The second generation, which started in the United States in the early post-war period, saw the transformation of environmentalism from an ideology to a modern, fully-fledged institutionalised social movement. The third generation, first visible in the 1970s, sees instead the rejection of mainstream environmentalism in favour of radical activism.

After the progressive degrowth of the environmental movement from 2010 onwards as a consequence of the political failures such as the Kyoto Protocol and the Copenhagen Accord, interest in climate change began growing again after the landmark 2015 Paris Agreement. However, the increasingly evident failures and limitations of the Paris Agreement caused widespread unrest among the public, leading to the rapid growth of a new generation of environmental movements such as the Sunrise Movement, Fridays for Future and Extinction Rebellion. These movements present innovative traits that set them apart from the previous generations of environmental activism, indicating the emergence of a new generation of radical climate movements. In particular, this generation of movement is characterised by innovative traits such as a high density of youth activists, an influence paradigm of revolution and reform, and an enhanced online presence.

It is interesting to note that the emergence of this new generation of environmental movements has only been loosely identified and theorised in the literature. Until now, only a limited number of studies - for example, see Buzogány and Scherhaufer (2022), Friberg (2022), and Richardson (2020) - have identified the emergence of a new, multi-movement form of climate-focused mobilisation. However, no study has yet produced a comprehensive analysis of how this new generation of activism came to life and its main traits. Indeed, understanding the deeper motivators of any social movement is a crucial step in forming a detailed understanding of their activism practices and principles, and the answer to this research question contributes to forming an initial understanding of this point.

2.5.2 The Comparative Assessment of Extinction Rebellion and Fridays for Future's Identities

Qualitatively analysing the two movements' original sources, this Chapter presented an overview of the key identity traits of the two movements, focusing on aspects such as leadership, ideology, demands and protest tactics. These steps contribute to a complete understanding of the radical climate movements under analysis, setting the groundwork for the analysis carried out in the following Chapters.

The Role of Leaderlessnes

In regards to leadership, analysing movement sources it emerges that Extinction Rebellion and Fridays for Future adopt two different leadership styles and structures. Mirroring the choice of numerous past radical movements, Extinction Rebellion appears to be organised as a leaderless movement, where the founders and intellectual guides of the movements do not represent it publicly. Instead, the movement follows the highly decentralised principle of a Self Organised System (SOS), where the latter is composed of numerous independent circles, giving the movement high flexibility and dispersed accountability in cases of arrests, a principle of great importance given the movement's extremely disruptive practices.

On the other hand, Fridays for Future presents a different structure where the movement is technically leaderless but not faceless, as its mobilisation potential strongly relies upon the actions and influence of the movement's founder Greta Thunberg. Despite this characteristic, the movement remains very horizontal and decentralised, as no single individual controls the movement's decisions. This finding supports what is overwhelmingly seen in the literature, where it is observed that leaderless protest movements are common in cases of self-organised

networks with radical traits (Cox et al., 2021; Kow et al., 2020). In fact, similar leadership structures can be seen in movements such as the Occupy Movement and Black Lives Matter, where groups tend to have highly horizontal structures with no clear leaders with significant control. This structure appears to be very apt to modern, digital forms of activism, where activists prefer very horizontal, agile and networked structures to more institutionalised, top-down leadership (Gerbaudo, 2012).

Furthermore, from an information perspective, leadership structures present an interesting and unexplored phenomenon which deserves attention. In fact, a movement's leadership and organisational structure can be paramount to understanding and explaining its communication practices. For example, given the structures of the movements under analysis, it is clear that Extinction Rebellion's SOS structure produces communication that is more technical, informed and centrally planned, thanks to the presence of groups dedicated to the movement's communication, which produces social media content and supports direct action. On the contrary, Fridays for Future's more decentralised and loose structure is expected to lead to a more fragmented and less controlled communication, with implications for the movement's online epistemic activism.

System Change, Not Climate Change

On founding principles, the analysis of Extinction Rebellion's original sources indicated that the movement is founded upon three pillars: 1) the concepts of urgency and extinction, 2) the call for a large-scale reorganisation of political systems, and 3) a rejection of the current economic system and its ingrained inequalities. While the details of each pillar were analysed in depth in Section 3.4.1, what is perhaps the most important finding emerging from this analysis of ideological tenets is the focus on systemic issues that go well-beyond environmental protection. The focus on systemic change is a highly innovative element within the history of environmental movements, and it demonstrates how the Extinction Rebellion is a very ideologically complex movement which strives for a full reorganisation of society, rather than only asking for better standards of environmental protection. In several ways, ideologically, Extinction Rebellion is closer to movements such as the Occupy Movement than traditional environmental groups such as Greenpeace, often airing critiques of political systems, greed, capitalism, and detailing how the environmental crisis is merely a consequence of these systemic flaws. In the movement's ideological system, this entails that climate change cannot be solved in a vacuum, as all solutions will have to go through a large-scale reorganisation of society as we know it.

This type of principle also permeates, although on a lesser scale, from Fridays for Future, as the movement's main ideological pillars are: 1) the emphasis on the need to trust science, 2) the view of climate justice as a matter of intergenerational equity, and 3) the adherence to the principles of intersectional environmentalism. While Fridays for Future's ideology is indeed more centred on environmental protection, the movement is very comfortable in the discussion of intersectional themes such as racism, feminism, inequality and capitalism, indicating that the new generation of radical climate movements is clearly shifting towards a more complex environmental ideology driven by a broader critique of society. While the rise of systemic and non environmental elements within environmental activism is not entirely new, this aspect has been predominant in the two movements under analysis, and it is likely that future movement with similar radical traits may continue to attempt to influence political spaces that go well beyond environmentalism.

Different Perspectives on Climate Change Decision-Making

Furthermore, this Chapter presented findings on the two movements' core demands. Analysing this aspect of Extinction Rebellion and Fridays for Future's ideologies, the most interesting finding to arise regards their different perspectives on political decision-making and the role of science in decision-making processes. On the one hand, Extinction Rebellion's demand to 'go beyond politics' requests that governments create and be led by the decisions of a Citizens' Assembly on climate change. This new political body would be composed of a representative sample of the British population tasked with coming to a consensus on measures to contrast climate change. On the other hand, Fridays for Future does not request the establishment of an independent decision-making body but instead demands that governments listen to the best available science on climate change. In this sense, the two movements propose two radically different views on the hierarchies that should characterise climate change decision-making.

Where Fridays for Future limits its demands to better integration of existing scientific evidence in decision-making, Extinction Rebellion offers a more horizontal and radical solution, claiming that any decision should exclude governments who, according to the movement, are incapable of integrating climate change in their decision-making. While conveying a feeling of distrust towards politics, this point also leads to different considerations on the role of science in decision-making. Within Fridays for Future's ideological system, science is often portrayed as an end itself, while in Extinction Rebellion ideology, science is portrayed as an imperfect means to an end, which should be used to help inform bottom-up decision making. Indeed, from an information perspective, this raises questions on exposure to different types of information. While citizens' assemblies may be effective under

an assumption of perfect information, using a random real-world sample of citizens may lead to decision-making being endangered by disinformation, misinformation and political partisanship within the sample. These different perceptions of science are fundamental to understanding the movements' communication practices as, such different considerations on the role that science should play in society-wide decision making has evident implications for the movement's goals and overall relationship with the scientific world.

Differences in Protest Tactics: The Duality Between Radical Ideas and Radical Protests

Furthermore, analysing the two movements' protest practices, some key differences in their approach to activism emerged. In principle, both movements rely on nonviolent protest, with considerable numbers of activists taking the streets to demand that their goals be met by political action. However, movement-specific traits can be identified in the type of protest actions and protest frequency.

Extinction Rebellion's activism is based on disruptive mass civil disobedience and the concept of civil resistance, where activists routinely perform illegal forms of protest such as roadblocks and small acts of vandalism in order to create disruption and gain the public's attention. Within the movement's protest paradigm, pressure should be sustained over time, geographically widespread and disruptive, often relying on arrests to sensitise the public to the urgency of mitigating climate change. On the other hand, Fridays for Future's protests follow a different type of civil disobedience revolving around school strikes, speeches and more traditional marches, where high numbers of young activists simultaneously take to the streets in cities worldwide, calling for more significant action on climate change. However, Fridays for Future's protests refrain from illegal protest activities and mainly rely on global low frequency, high magnitude protests often held when high-profile political events - such as UNFCCC Conferences of Parties - are taking place. According to this evidence, it can be deduced that Fridays for Future is, in a traditional sense, a radical movement in terms of content and ideology but less so in terms of protest practices. On the other hand, Extinction Rebellion adopts more radical protest practices, often bordering on illegality, in line with the tradition of third generation radical activism. Indeed, it cannot be ignored that Extinction Rebellion is not a youth movement, while Fridays for Future is, and the age gap may partly explain this difference in protest radicalism, as young activists can hardly be expected to engage in illegal protest practices. However, data on movement demographics is currently not available, yet, this could offer a future avenue for research on the two movements. Finally, as noted by Pickard et al. (2021) and Richardson (2020), the main similarity between the two movements lies perhaps in their extensive use of digital activism, as the two movements

have, throughout their history, relied heavily on online communication as part of their protest ecologies.

2.5.3 The Measurement of Extinction Rebellion and Fridays for Future's Online Presence

Lastly, this work used a sample of ≈250k English-language Facebook posts to empirically measure the two movements' online presence, with a focus on their temporal evolution, network and communities, and content of published posts. The main findings are summarised below.

The Intensity of Online Activism is Largely Dependent on In-Person Activism

Analysing temporal data on the two movements' posting activity, perhaps the most surprising finding regards the temporal trajectory seen in Extinction Rebellion and Fridays for Future's changepoint analysis. Examining the data of the number of Facebook posts published, it arose that both movements followed a similar pattern characterised by two periods of steady growth leading to 2020, to then fall into a time of degrowth and stabilisation with the start of the Covid-19 pandemic in early 2020. On the one hand, this finding was surprising, considering, as Askanius and Uldam (2020) noted, both movements were quick to react to this new situation to move their activism to online platforms, approaching this an opportunity to strengthen their online influence. In this sense, a significantly higher number of Facebook posts could have been expected. On the other hand, it is evident that the two movements have built their communication strategies on the occupation of public spaces with visual and verbal messages, and forced isolation across the world was ultimately bound to diminish these groups' effort and ability to reach audiences (Mocatta and Hawley, 2020). In this sense, it appears that the halt of in-person protest led to an overall reduction of the movement's online activism and influence, indicating that both movements remain largely fueled by their in-person protests. Considering the role of forced online-only protests in the communication of the two movements, two elements clearly stand out. First, on-street protest is effective in reaching new audiences of citizens who are less politically sensitive to climate change, while in online spaces, reaching new audiences is often significantly harder. Second, traditional online protests cannot be disruptive, and cannot easily cause discomfort to uninterested individuals, significantly compromising the two movements' protest practices.

To conclude, analysing the data, it is evident that the two movements ultimately were negatively impacted by the pandemic, and by July 2021, still struggled to reach previous levels of online communication intensity. This finding suggests that the online communication generated by the two movement relies, at least partly, in their capacity to mobilise activists through in person protests. However, it should be noted that while slowing down their activity during the pandemic, both movements succeeded in remaining relevant while not fizzling out, and it can be expected that as soon as all restrictive measures are lifted globally, protest activities - and as a consequence online communication - may soon return to their previous levels.

Social Network Analysis: Different Levels of Grassroots-ness

Furthermore, this Chapter of this research project used social network analysis (SNA) to measure intra-movement interactions with particular attention to what pages and groups play a central role in spreading the movement's communication. The most relevant finding emerging from this analysis regards the two movements' grassroots structure. Extinction Rebellion's community analyses revealed a network structure where the movement is heavily clustered around local and national groups that hardly interact. For example, Australian groups are visually distant in the bi-dimensional space from British groups, showing very low levels of interaction and common content. Furthermore, this analysis shows that local groups are very densely connected on a geographical basis. This finding suggests that local groups and pages of Extinction Rebellion are much more likely to interact with geographically adjacent communities than distant ones, often sharing locally relevant content. This finding testified to the movement's truly grassroots nature, suggesting that Extinction Rebellion activists are first and foremost local activists. This is in line with what could be expected from Extinction Rebellion's self organised system (SOS) structure, which heavily favours and incentivises community-level aggregation.

On the other hand, Fridays for Future's network structure is more scattered and does not exhibit geographical clusters. Instead, the network gravitates around a clear centre where the majority of edges pass through, formed by the three nodes with the highest centrality in the network, School Strike for Climate Action, Greta Thunberg, and the group Fridays for FutureGreta Thunberg #Climatstrike #FFF. These nodes are international pages that are not linked to any geographical communities, and they appear to drive the majority of content within the movement's network. In addition, it was interesting to note that within Fridays for Future's network, geographically close communities often appeared distanced in the bi-dimensional space, indicating that the movement's local communities are unlikely to

share geographically relevant content and, instead, are more prone to interact with the larger international nodes in the network.

Ultimately, the analysis of network topologies shows two movements that are very different in their patterns of intra-network interaction. On the one hand Fridays for Future's local pages and groups are more likely to act as message disseminators for international groups rather than creating grassroots, on-the-ground networks. On the other hand, Extinction Rebellion's network structure indicates that the movement is primarily centred around grassroots, local connections. This is a fundamental point in the understanding of the two movement's epistemic activism and broader activism, as patterns of network sharing may impact the type of content produced by a movement. It should be noted that until now, only anecdotal evidence existed on the two movements' grassroots networks, and this Chapter presents the first SNA-based measurement of their networks on Facebook. However, further research using a more extensive network data set may help complement this analysis with more in-depth evidence.

Analysing Post Content: Cognitive Praxis and Epistemic Activism

Finally, the last step of the empirical measurement of the two movement's Facebook activity consisted in analysing the content of the posts contained in the data set through topic modelling. This step was primarily used to assess the movement's use of communication practices that indicate an effort towards cognitive praxis (i.e. transmitting or creating knowledge) and epistemic activism (i.e. attempting to improve public understanding of climate change). Here, two findings supported this understanding, supporting what was presented in the theoretical framework that informs this project.

First, the topic model showed that scientific communication is paramount to both movements, forming the largest thematic area for Extinction Rebellion and the second largest thematic area for Fridays for Future. Qualitatively assessing the top posts on each topic, it emerged that both movements use scientific communication for two primary purposes. On the one hand, the latter is employed to justify radical protest, discussing how the gravity of the warnings coming from the scientific community morally justifies disruptive and extreme forms of activism. On the other hand, science is often used to provide the public with scientific information to improve the public understanding of climate change. For example, two posts that embody this type of scientific communication discussed the existence of a scientific consensus on climate change and how climate change and animal agriculture impact water systems. This finding essentially indicates that the diffusion of mediated scientific evidence

on climate change is among the primary functions both movements perform, affirming their role as cognitive praxis and epistemic innovators in the climate change regime. The use of scientific evidence for the purpose of education and information correction is particularly important for the primary goal of this research and, for this reason, will be analysed in greater detail in Chapter IV of this work, which assesses the use of science-based counternarratives as a form of misinformation reduction.

Second, for both movements, the theme *Media and Communication* is quite widespread, representing the fourth largest theme for Extinction Rebellion, and the sixth largest theme for Fridays for Future. This theme is significant as it contains numerous topics clarifying the movements' epistemic practices - for example, demanding its activists to attend scientific workshops, online events and watch Youtube videos to gain a better understanding of the necessity to act on climate change - while also containing critiques on the circulation of false information in the media. The portrayal of the media sector within this theme is particularly interesting, as both movements appear to strongly criticise the media sector for its role in spreading false information, often going insofar as to name and shame media companies for their role in platforming false information. This feature of the movement's communication is also very relevant to understanding the role that radical climate movements play in contrasting false information and will be analysed in greater depth in Chapter III, which analyses the use of naming and shaming of information polluters as a form of disinformation reduction.

Moreover, a further information-related finding that deserves attention regards the use of hashtags in the communication of the two movements. Here, the topic modelling results showed that Fridays for Future's posts are significantly more likely to contain hashtags. Within Fridays for Future's posts, hashtags are seen in a total of $\approx 6.1\%$ of posts, while Extinction Rebellion uses hashtags in $\approx 1.8\%$ of posts. Surveying the literature, it emerged that hashtag activism has often been proven effective in mobilising offline action while raising awareness and ensuring a movement's influence within the public discourse while raising awareness on specific issues. In this area, the two movements differ significantly. This finding is quite surprising, as the more centralised nature of Extinction Rebellion's communication - which is in part dictated by the movement's structure - may have led to expect a greater and more coordinated use of hashtags from this movement. Instead, hashtag campaigns are more common for Fridays for Future. Nevertheless, some explanations may exist for this finding. For example, Extinction Rebellion's more decentralised and grassroots structure may lead to a loss of use of movement-wide hashtags, which may be instead favoured by Fridays for Future's less localised network.

Lastly, the topic modelling results offered an array of non-information-related topics that link directly to the movement identities discussed in Section 2.3, which were not discussed in depth here. For example, intersectional topics such as racism and intergenerational equity were detected by the model, as well as discussions on capitalism and environmental politics. While the scope of this research evidently limited the space dedicated to these topics, they are nonetheless very relevant to understanding the two movements' systems of thought and communication. Future research should be devoted to deeper analyses of these topics and themes.

2.5.4   Conclusion

Finally, this Chapter of this research project provided an in-depth analysis of the two movements that form the object of this thesis, Extinction Rebellion and Fridays for Future. This work summarised, through qualitative and quantitative analysis of original text sources produced by the movement, their history, evolution, and identities, to then proceed to measure their online presence. By providing a detailed account of the two movements, this Chapter fulfilled two key purposes. On the one hand, it set the foundations for the analysis that follows, providing information on the movement's identities and key communication strategies. On the other hand, it provided insights into part of the theoretical framework that informs this work, analysing the movements' role as cognitive praxis and epistemic activists and innovators.

Chapter 3

The Naming and Shaming of Information Polluters as a Form of Peer-Produced Disinformation Reduction

3.1   Introduction

In a time of widespread bottom-up mobilisations on a broad spectrum of social and political issues, the naming and shaming of those engaging in behaviours that pose harm to the collective well-being represent a vital instrument in exerting pressure, fuelling mobilisation and accelerating social change (Seidman, 2016; Snyder, 2020). Previous research has extensively observed how the use of naming and shaming, defined as the use of public exposure and condemnation to make a broader audience aware of certain norm violations (Hafner-Burton, 2008; Koliev, 2018), may create an effective deterrent against the harmful actions that are brought to the public's attention in areas ranging from deforestation to genocides (Cisneros et al., 2015; Krain, 2012; Murdie and Davis, 2012). While naming and shaming has historically been mainly used by activists to contrast widespread human rights violations and war crimes (Hafner-Burton, 2008; Schiffbauer, 2018), environmental movements are not extraneous to this communication strategy (Bondaroff, 2011; Eilstrup-Sangiovanni and Bondaroff, 2014). The naming and shaming of polluters and various other actors tied to the fossil fuel industry has, in fact, been a critical strategic tenet in the communication of several past and current climate change movements, including the Divestment Movement (Gunningham, 2017), the Climate Justice Movement (Chaudhuri, 2021), and recent grassroots campaigns of hashtag activism such as #Exxonknew, which is

attempting to shed light on how a handful of fossil fuel companies have been withholding information on climate change risks in an effort to delay regulations aimed at reducing greenhouse gases emissions.

Despite the frequent use that environmental activism has made of naming and shaming, its application within the communication of climate change movements has attracted limited academic interest. This is a crucial gap in the understanding of both modern climate change activism in broader terms and of peer-produced noise reduction strategies, as, in principle, naming and shaming may present an optimal approach to contrast false information, where activists use their communication channels to discredit the source of a false message (i.e. information polluters), exposing disinformation creators and their wrongdoings, and opening their actions up to public scrutiny, reputational damage and popular backlash.

To address this research gap, this Chapter uses the previously described Facebook data set consisting of $\approx$ 250k unique posts produced by Extinction Rebellion and Fridays for Future to isolate and extract through a two-layered hybrid filtering process based on a trained *word2vec* model and a keywords extraction approach, posts containing naming and shaming against information polluters. This process allows for a data-driven evaluation of how naming and shaming is being used against such actors and, consequently, of how this communication strategy may act as a peer-produced form of disinformation reduction in the toolset of the two radical climate movements under analysis. Figure 3.1 below highlights the part of the overarching theoretical framework that this Chapter addresses.

This Chapter sets out to fulfil three key objectives. First (1), it aims to empirically quantify the frequency of use, audience reach and temporal evolution of naming and shaming directed at information polluters in the communication of Extinction Rebellion and Fridays for Future, also considering how the two movements differ in the use of this communication strategy. Second (2), it endeavours to assess the main targets of these online naming and shaming campaigns analysing which individuals, organisations, and broader industry sectors are the most targeted by such campaigns. This step is complemented by the use of sentiment analysis to assess how message sentiment may vary across organisations and how different sectors may attract increasingly polarised communication. Lastly, (3) it strives to analyse the content of the anti-disinformation naming and shaming posts under analysis, using topic modelling to extract the critical topics contained in these posts.

Ultimately, the analysis presented in this Chapter is expected to contribute to advancing the understanding of how activism and bottom-up pressure may, through naming and shaming creators of disinformation, act as a peer-produced noise-reduction mechanism in the climate change discourse, where effective solutions to counter the circulation of false information
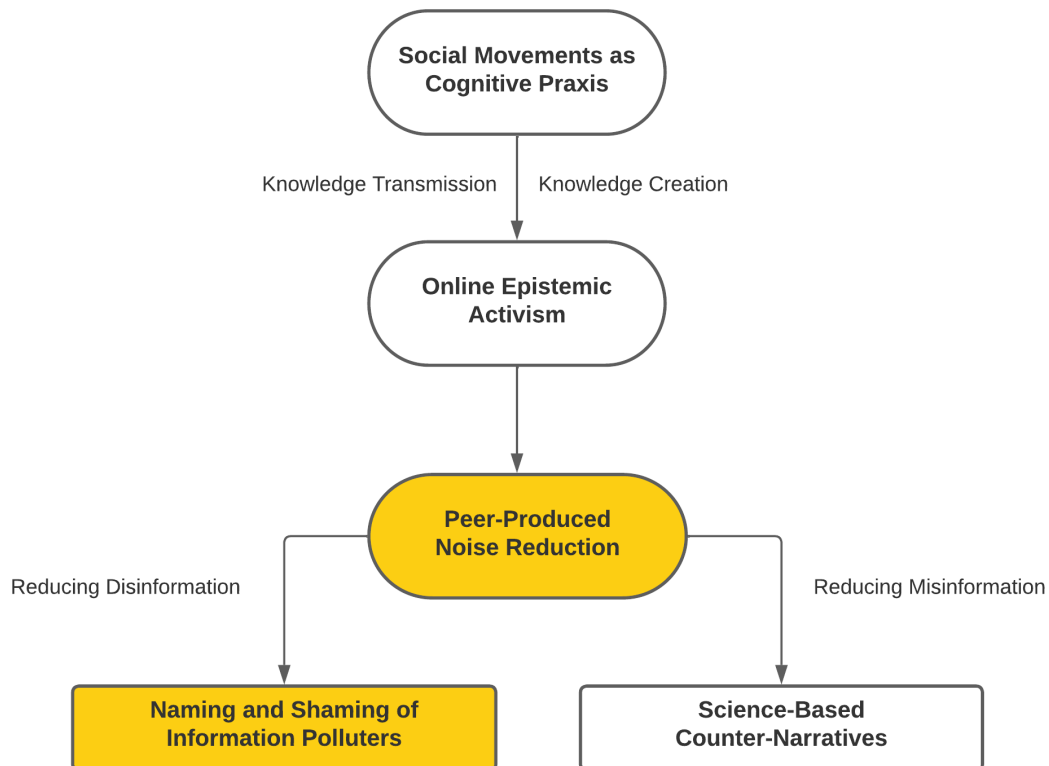
Fig. 3.1 Theoretical Framework Highlighted - Chapter III

are currently lacking. In particular, this analytical process is anticipated to provide insights into both the inner workings of online naming and shaming campaigns devised by Extinction Rebellion and Fridays for Future, and, at a higher level of abstraction, into how radical climate movements may act as false information watchdogs', holding creators and spreaders of malicious false information to account for their actions, and exposing them to higher standards of public scrutiny.

In order to address the objectives outlined above, Section 2 presents an overview of the history and theoretical foundations of naming and shaming campaigns, along with the key elements that have characterised previous environment-related campaigns. Section 3 outlines the main findings of this work, presenting the answers to each research question individually. Finally, Section 4 discusses the main implications of the findings, drawing conclusions from this Chapter and tying these to the broader goal of this PhD thesis.

3.2 Naming and Shaming and Social Change: Lessons from the Past

In Jean-Paul Sartre's preface to Frantz Fanon's *Wretched of the Earth*, a book on Western colonialism, the French philosopher prompts the reader to 'Have the courage to read this book, for in the first place it will make you ashamed, and shame, as Marx said, is a revolutionary sentiment'(Seidman, 2016; Tamdgidi and Samman, 2005). In this passage, Sartre refers to an 1843 letter where Marx discusses the importance of shame in the context of social uprisings and the role that this emotion may play in shaping social change (Marx and Engels, 1975). For Marx, shame is 'a revolution in itself', a feeling that can make or break social change (O'Donnell, 2017).

While Marx's account of shame and its role in society dates back nearly two centuries, it accurately captures the essence of strategic naming and shaming campaigns, where shame is constructively weaponised to induce bottom-up innovation. Even though naming and shaming campaigns are essentially expected to create a sense of shame in the perpetrator of a violation by making any detrimental actions known to the public (Rowbottom, 2013), the goal of such campaigns is rarely the feeling of shame *per se*, but rather, the social and behavioural innovation that this feeling may induce. In this sense, shame is a revolutionary sentiment capable of triggering change (Reader et al., 2020). It is this very aspect of naming and shaming campaigns that this Section will focus on, as this is expected to contribute to the understanding of how naming and shaming campaigns may be used to create a behavioural change in disinformation creators, ultimately reducing the circulation of disinformation on climate change.

Despite Marx's early reflections on shame as a 'revolutionary' emotion, the role of naming and shaming as a force of social change has for long failed to attract academic interest. In fact, until the 1980s, research on this strategy primarily focused on the latter's role in reproducing traditional moral frameworks and on how communities used shame to punish those who transgressed, reminding other community members that they must comply with these rules (Nash and Kilday, 2010; Seidman, 2016). It was not until the early 2000s that research on the strategic forms of naming and shaming finally prospered, as an increasing number of researchers began investigating how this communication approach may be used as a force of bottom-up social innovation (Koliev, 2018). Since then, research in this area has continued developing, particularly as the rapid diffusion of social media platforms has facilitated the online shaming of actors engaging in detrimental actions, leading to a rapid increase in shame-based online campaigning (Chakraborty, 2019; Oravec, 2020). Thanks

to this heightened academic interest, in recent years, numerous studies have analysed how naming and shaming campaigns can be successfully deployed with various goals, such as promoting new norms, values and moralities (Seidman, 2016) creating collective identities (Haenfler, 2004), amassing support for social change (Kim, 2015), and advancing higher accountability standards (Bartley and Child, 2014).

The rest of this Section will review the body of literature describing naming and shaming as a strategic communication tactic used to promote social change, clearly defining the term naming and shaming, and detailing recent evidence on the evolution of this communication strategy with its broader theoretical foundations. It will then examine how environmental activists have used naming and shaming to call for higher environmental protection standards. Ultimately, this literature review provides a solid foundation to analyse Extinction Rebellion and Fridays for Future's use of naming and shaming to contrast the circulation of disinformation on climate change, which will be carried out in the following sections of this Chapter.

3.2.1   A Definition Of Naming and Shaming

Despite its presence in an extensive body of literature, the term naming and shaming has long lacked a clear conceptualisation (Koliev, 2018), and this expression has often been used interchangeably with other similar terms such as 'stigmatisation' (Adler-Nissen, 2014; Shamai, 2015), 'boycotting' (Robbins, 2016; Seidman, 2016) and 'blacklisting' (Sharman, 2009). Several scholars have attempted to define the boundaries of the term naming and shaming, albeit often lacking precision and clarity in these definitions. For example, Pawson (2002) merely described naming and shaming as 'public disclosure to overcome recalcitrant behaviour', while Ilgit and Prakash (2019) broadly defined the concept as public criticism and condemnation. While these conceptualisations are helpful, they often lack clarity regarding the essential elements that set naming and shaming apart from similar public pressure strategies.

In this work, naming and shaming is considered a strategic, nonviolent communication strategy that uses public exposure to induce a behavioural change. More precisely, building on the broader definition presented at the beginning of this Chapter, naming and shaming will be defined as 'the use of public exposure and condemnation to make a broader audience aware of a certain norm violation with the goal of inducing a change in the behaviour that caused this violation'. The use of such a specific definition sheds light on four crucial aspects of naming and shaming.

First (1), it acknowledges that naming and shaming is essentially based on the concepts of public exposure and condemnation, where a detrimental action is willingly brought to the attention of the public in order to make a value judgement about such action. Second (2), it assumes the existence of a norm that is being violated. This norm may be either a moral or social standard or a clear legal obligation (Haufler, 2015; Van Erp, 2011). For example, divestment campaigns naming and shaming universities that have not divested from fossil fuels are based on a moral norm, that is, expecting educational institutions to hold high ethical standards, which translates into not investing in harmful practices and products. On the other hand, campaigns highlighting human rights violations often entail the violation of a full-fledged legal norm or widely accepted international standard.

Third (3), this definition specifies that naming and shaming is essentially a public act, and without a public, the latter would not be an effective strategy. In practice, naming and shaming is only effective because someone is listening, and it is the very act of making the public aware of a norm violation that makes this strategy effective, as this opens violators up to reputational risks, greater oversight and changes in public preferences (Haufler, 2015). This aspect of naming and shaming is crucial as it also suggests why this strategy has recently grown in importance thanks to developments in information technologies that have amplified the reach of naming and shaming campaigns (Dunsby and Howes, 2019). Lastly (4), it highlights that the ultimate goal of naming and shaming is to induce a change in the behaviour that caused the violation of the said norm. This strategy is not used to simply induce a sense of shame in the target but rather to use shame to trigger a behavioural change (Pawson, 2002).

3.2.2 Naming and Shaming as a Strategic Communication Tactic: Historic Evolution and Theoretical Foundations

A substantial number of studies have explored the theoretical underpinnings of naming and shaming strategies and described their evolution and historical effectiveness in influencing the behaviours of individuals, organisations and States. This Section will provide an overview of these studies, presenting a brief history of how naming and shaming has changed over time and discussing the elements that make naming and shaming a relevant tool for inducing bottom-up change.

The use of naming and shaming strategies has taken on new visibility in the era of globalisation and social media, as an increasing number of social movements resorted to this strategy as part of their campaigns (Bartley and Child, 2014; Petley, 2013). However,

as Seidman (2016) noted, activists realised much earlier than researchers that naming and shaming could be instrumental in promoting alternative moral frameworks and holding powerful actors accountable for their actions, and early examples of the use of this strategy can be identified as far back as the 18th century. For instance, in 1791, after the British Parliament refused to ban slavery, abolitionists launched a full-fledged naming and shaming campaign, publicly exposing parliamentary representatives and companies who supported and profited from slavery and, in particular, from sugar production (Carmichael, 2015; Hochschild, 2006; Holcomb, 2014). Much like modern naming and campaigns, abolitionists resorted to various forms of innovative visual and written communication to highlight the appalling reality of sugar production. For example, a widely circulated etching from the time, titled '*Barbarities in the West Indies*' (Fordham, 2011; Petley, 2012), depicts an infamous episode where a young black worker, sick and unable to work, was thrown into a copper of boiling sugar juice. While this episode predates the large-scale diffusion of media as a source of information, it presents all the elements of naming and shaming strategies, where slave-owner sugar producers are publicly shamed for their violent actions to induce people to challenge the institution of slavery. According to Holcomb (2014), this bottom-up campaign against slavery was instrumental in sparking a slow yet steady change that, in time, led to the abolition of slavery, and as Hochschild (2006) concludes, it gave ordinary people a way to demonstrate their commitment to a new morality, and to remind each other that any behaviour once considered acceptable, could be publicly challenged (Seidman, 2016).

Over the next two centuries, shame-based campaigns to re-discuss publicly accepted norms and hold powerful actors accountable for their actions continued to develop, taking a variety of shapes and forms. A further noteworthy early example of strategic naming and shaming comes from the many strands of labour activism that emerged between the 19th and 20th centuries (Seidman, 2016). For example, in 1891, activists in New York City launched a local campaign against sweatshops employing women at a salary below the living wage (Boris, 2013). This organised effort led to the creation of the Consumers League of New York, a group demanding that equal pay is given for work of equal value, irrespective of sex (Nathan, 2019). This organisation resorted widely to naming and shaming strategies, to the point that it developed a list, named 'The White List', of shops that failed to pay employees an adequate wage. This list was circulated as an advertisement in leading newspapers, publicly shaming sweatshops with the aim of changing their behaviour by inflicting economic and reputational damage (Sanville et al., 1909). At the time, anti sweatshops campaigns resorted widely to printed media, which were used to reach a broad audience of readers. According to the group, naming and shaming sweatshops would ultimately advantage those paying a fair wage while penalising unethical behaviours (Nathan, 2019). Interestingly, this kind of

practice is still common today. For example, the British Government often publishes lists of rogue employers who are named and shamed for failing to pay the legal minimum wage (UK Government, 2021b).

While these examples demonstrate how naming and shaming campaigns used for social change are a relatively old strategy which has been in use since at least the 18th century, the true flourishing of naming and shaming as a strategic communication tactic came with its spillover into the realm of human rights violations. During the 1970s, the relevance of naming and shaming strategies rose hand in hand with the growth of human rights protection regimes (Krain, 2012), and in time, this approach established itself as an essential nonviolent strategy to contrast human rights violations all over the world (Franklin, 2015).

Within human rights literature, the use of naming and shaming to highlight human rights violations was first described in Keck and Sikkink (1998)'s seminal work *Activists Beyond Borders*, where the authors present their theory depicting the boomerang effect. The boomerang effect model describes the shame-based social mechanism through which generating attention around human rights violations may build pressure, giving voice to the oppressed and holding the oppressors accountable for their actions (Thrall et al., 2014). Since the first accounts on the boomerang effect, several authors have analysed the use and performance of naming and shaming in the field of human rights activism (Ron et al., 2005; Wright and Escribà-Folch, 2009). For example, Favour and Folarin (2021) analysed Amnesty International's use of this approach to highlight human rights violations in Nigeria and how the organisation repeatedly called out the Nigerian Military for torturing civilians. Similarly, Franklin (2008) analysed the use of naming and shaming to reduce political repression in Latin America, finding that, in the presence of strong economic ties to other countries, such campaigns significantly reduce the risk of subsequent human rights violations.

But why do naming and shaming campaigns have an impact on inducing social change? Over time, authors have extensively discussed why this strategy may effectively create change, outlining potential pressure channels that make naming and shaming an effective strategy. Drawing from the work of Cisneros et al. (2015) and Koliev (2018), three main theoretical and empirical pressure channels that make naming and shaming a viable strategy can be identified.

The first such channel is the reputational damage (1) that naming and shaming campaigns may cause. Reputation is a crucial resource for States and private organisations alike, and a loss of reputational often translates into a loss of credibility, business opportunities and increased monitoring (Cisneros et al., 2015; Keohane and Keohane, 2005; Van Erp, 2011). Through this pressure source, reputational threats can act as a significant trigger for

behavioural change. For example, Bevan et al. (2019) describe how naming and shaming campaigns against the public health system in Zambia raised reputational concerns that led to a rapid reduction in maternal mortality.

The second pressure channel identified in the literature is the financial risk (2) posed by naming and shaming campaigns (Bagwell and Hall, 2020). As Klein (2009) noted, highly visible companies and corporate brands are particularly vulnerable to such campaigns, as their commercial success depends on their cultural appeal. Campaigns that hurt a corporation's image ultimately create financial damage through decreased sales, share value and business opportunities. This pressure channel can also apply to States, as the exposure of human rights violations can lead to reduced funding and humanitarian aid (DeMeritt, 2012; Esarey and DeMeritt, 2017)

The third and last avenue through which naming and shaming exert pressure is mobilising domestic and international interest groups (3). As indicated by Koliev (2018) and Murdie and Davis (2012), when a State or organisation is shamed, attention on the issue increases exponentially, enabling a wide array of national and international actors such as political parties, NGOs and reform groups to exert organised pressure, significantly increasing the level of public oversight.

However, while these pressure channels provide critical insights into the inner workings of naming and shaming, it should be noted that the literature is not univocal in accepting the effectiveness of naming and shaming campaigns. While the overwhelming majority of studies seem to find a positive correlation between naming and shaming campaigns and the reduced incidence of a norm violation (DeMeritt, 2012; Krain, 2012; Risse-Kappen et al., 1999), others have argued against its effectiveness. For example, Hafner-Burton (2008), analysing human rights practices for 145 countries over 25 years, finds that naming and shaming may have the accidental side effect of providing incentives for groups to orchestrate acts of violence large enough to attract the spotlight and that governments sometimes react to these security challenges by repressing human rights even further (Ausderan, 2014).

Furthermore, DiBlasi (2020) has argued that in some cases, naming and shaming may merely lead to a mutation in the form of a human rights violation and analyses how such strategy may lead repressive governments to create pro-government militias as a proxy to carry out human rights violations. Indeed, these studies should not be taken as a warning that naming and shaming is an entirely ineffective strategy but that its effectiveness may vary across contexts and scenarios. It should be specified, however, that the majority of studies finding adverse impacts of naming and shaming campaigns are situated in the field of human rights, while studies in other areas such as finance (Nance, 2015; Van Erp, 2008) and

LGBTQ+ rights (Linde, 2018) seem to show more evident results in favour to the positive effects of this communication strategy.

3.2.3 Environmental Naming and Shaming Campaigns

Over time, various environmental groups, from transnational environmental organisations to radical movements, have resorted to naming and shaming practices to influence environmental governance regimes (Eilstrup-Sangiovanni and Bondaroff, 2014; Skodvin and Andresen, 2003). The evolution of environmental naming and shaming closely resembles that of broader environmental activism described in Chapter II, with earlier campaigns mainly focusing on nature conservation to later extend to causes such as climate politics and climate justice.

Early instances of environmental naming and shaming can be found as far back as the 1970s and the 1980s, when Greenpeace started using this strategy extensively to contrast whaling. For example, DeLuca (2012) described a dramatic episode in which Greenpeace activists pursued a Soviet whaler in California waters and filmed the ship firing a harpoon over the activists' heads to kill a whale. The tape of this event was circulated on news outlets worldwide, intending to create a 'mass consciousness' regarding the ruthless nature of whaling practices (Hunter, 1971). This campaign is considered a pivotal moment in the creation of the political momentum that in 1982 led to the International Whaling Commission's approval of a global moratorium on whaling (Gkotsis et al., 2006; Pearce, 1996), showing for the first time that naming and shaming could be a viable way for achieving conservation goals through bottom-up pressure.

Since the 1970s, environmental activism has continued using naming and shaming to promote nature conservation efforts, often with a high degree of success. A salient example of these successes is Greenpeace's Carting Away the Ocean' campaign (Riehl and Fagan, 2011; Tzankova, 2014). In 2008, the organisation began ranking twenty of the largest U.S. supermarket chains according to the sustainability of their seafood, effectively shaming companies with inadequate sustainability standards. This naming and shaming campaign was notoriously successful in raising fishing standards across U.S. corporations. For example, Trader Joe's, one of the largest U.S. retailers, went from a sustainability score of 2/10 to a score of 7/10 after mounting pressure from its customers (Jacquet, 2014). A further example of successful shame-based conservation is described by Cisneros et al. (2015), who analyses how naming and shaming can be successfully used in forest conservation. In this work, the author assesses a Brazilian government policy that, since 2008, led to the regular publication of a list of critical districts with high annual forest loss. According to the author, naming

and shaming has a net positive impact on stopping deforestation, reducing its incidence by a range of 13% to 36%.

With the rise of climate change as a central issue in the public debate, the use of naming and shaming strategies began rapidly extending beyond the field of nature conservation. In recent years, the use of this strategy in climate change policy has grown significantly, and several applications of climate-related naming and shaming have been analysed in the literature. Reviewing these applications can be quite insightful, as this can provide an understanding of the foundations that inform anti-disinformation or misinformation campaigns from Extinction Rebellion and Fridays for Future. Surveying these studies, it emerges that this communication strategy has mainly been used to achieve three different goals: 1) influencing international negotiations and achieving compliance with climate treaties, 2) holding corporations into account for their actions, and 3) influencing individual behaviour. Notably, no studies have analysed the role of naming and shaming in reducing the circulation of disinformation or misinformation on climate change.

Historically, naming and shaming has played an essential role in the climate change regime, as this strategy has often been used to influence international negotiation and induce compliance with climate treaties (1). For example, Tjernshaugen and Lee (2004) described Norwegian NGOs' use of naming and shaming to influence international negotiations between 1995 and 2001, analysing how these organisations focused on publicly representing Norway as a 'climate villain', a petroleum-dependent economy only interested in protecting its economy. According to the authors, the naming and shaming campaign made the public aware of Norway's role in contributing to climate change and triggered an increasing degree of public mobilisation, asking the Norwegian government to agree to higher ambitions in the climate change regime. Furthermore, the use of naming and shaming has often been an integral part of the design of international climate treaties within the United Nations Framework Convention on Climate Change (UNFCCC). For example, the Kyoto Protocol's non-compliance mechanism used, as the first step for enforcement, a declaration of non-compliance, which is essentially a naming and shaming declaration aimed at damaging the reputation of the shamed party (Maljean-Dubois, 2009). This is even more evident in the Paris Agreement, as the treaty follows a framework based on voluntary pledges that can be compared and reviewed internationally in the hope that global ambition may be raised through naming and shaming parties showing insufficient ambition (Falkner, 2016; Leggett, 2020).

A second key application of climate-related naming and shaming that is widely identified in the literature is its use in holding corporations into account for their actions (2). These

campaigns have historically taken a variety of forms, ranging from calls for higher standards of corporate social responsibility (Jacquet, 2017) to calls for divestment from fossil fuels (Gunningham, 2017). For example, Kolk et al. (2008) describe the use of naming and shaming to call for greater disclosure of information on corporate greenhouse gas emissions, particularly through the Carbon Disclosure Project (CDP). Between 2004 and 2007, the CDP instituted a 'wall of shame' with the names of corporations who refused to share information on their emissions. According to this study, shaming unresponsive corporations was an extremely successful strategy, and businesses such as Morgan Stanley and Boeing rapidly responded to shaming campaigns by sharing the requested information in an effort to reassure the public and its investors. This finding on the success of corporate climate shaming is supported by Taebi and Safari (2017), who find that disclosure of non-compliance accompanied by naming and shaming is a strong driver of change in corporate behaviour. According to the authors, naming and shaming appear to be particularly effective against companies in direct contact with their consumers, as these companies are more vulnerable to reputational risk. This strand of climate-related naming and shaming is significant for this Chapter's objective, which analyses the use of naming and shaming against information polluters.

A further common form of corporate naming and shaming is divestment campaigns, which broadly refer to activist-led campaigns aimed at convincing large institutions to divest from companies operating in carbon-intensive sectors (Rajavuori, 2021). A global movement for divestment originated in 2012, when the climate advocacy group 350.org held rallies in several U.S. cities, making the case that fighting climate change requires large portions of fossil fuel reserves to be left in the ground and that large-scale divestment by shareholders could be a driver to achieve this goal (Jarvis, 2013). Since its inception, the divestment movement has commonly resorted to a rhetorical strategy of moral shaming, where the movement identified institutions with significant investments in fossil fuels and shamed them publicly, calling them to divest from fossil fuels (Gunningham, 2017). In the past decade, the divestment movement's naming and shaming campaigns have achieved sweeping successes, with several institutions ranging from the Australian National University to Stanford University, divesting from fossil fuels (Knuth, 2017).

A last, arguably less developed area of the literature on climate-related naming and shaming covers campaigns used to deter individuals from specific behaviours that are considered detrimental to the climate (3). While this area is relatively novel, an example can be found in the recent emergence of flight-shaming campaigns, where activists have publicly shamed consumers into refraining from flying (Gössling et al., 2020; Mkono, 2020). Flight shaming campaigns have mainly been seen on social media, and a clear example of this approach is

the use of naming and shaming by the Swedish Instagram account Aningslosa Influencers.
As described by Larsson (2019), this group often targeted Instagram influencers who are
viewed as normalising the excessive use of flying, going insofar as to post the number of trips
taken by each influencer and the CO_2 emitted in each trip. While the effectiveness of this
strategy has not yet been studied in-depth, as more people start to question the sustainability
of individual behaviour, this form of naming and shaming may become more relevant in the
future.

Finally, after reviewing the relevant literature, it is possible to say that naming and
shaming has been clearly identified in the literature as a significant force of social pressure
on a wide range of issues. In particular, studies such as Gunningham (2017) and Kolk
et al. (2008) have analysed how social movements can use naming and shaming to pressure
polluters into conceding higher standards of transparency to the public or refrain from a
behaviour considered detrimental to the environment. However, while the naming and
shaming of polluters has often been the object of research interest, this attention has not been
extended to information polluters'. In fact, no study has analysed how social movements may
resort to this communication strategy against creators and spreaders of disinformation to hold
these actors accountable for their actions and make the public aware of this norm-violating
behaviour. This is a significant gap in the literature, as analysing the use of bottom-up naming
and shaming as a form of disinformation mitigation can help assess climate movements' role
as both norm enforcers and false information watchdogs.

3.3 Extinction Rebellion and Fridays for Future's Naming and Shaming of Information Polluters

3.3.1 The Data Filtering Process

This Chapter aims to quantify and assess the use of naming and shaming against creators and
spreaders of false information (i.e. information polluters) in the communication of Extinction
Rebellion and Fridays for Future. For this purpose, this work resorts to a unique data
set of Facebook posts generated by the two movements. These posts were gathered from
Crowdtangle, Facebook's own platform monitoring tool and the data set is composed of
a total of $\approx$ 250k English-language posts, $\approx$ 200k originating from Extinction Rebellion
and $\approx$ 50k from Fridays for Future. Posts from the two movements were collected in the
period ranging from September 1 2018, to June 1 2021. The data provided by Facebook for

this study is highly granular, as the data set presents 30 descriptive variables for each post identified, providing a range of parameters such as a post's creation date, reactions received, media attachments and performance score.

To extract naming and shaming posts specifically targeting what I term information polluters - that is, creators and spreaders of malicious disinformation - this work adopts a two-layered filtering approach based on a mix of keywords selection and *word2vec* modelling. First, drawing from an approach proposed by Mittos et al. (2020), a set of keywords relating to large polluters and organisations engaged in producing and spreading disinformation was created. This list draws from DeSmog's Climate Disinformation Database (Desmog, 2021), a list of 196 individuals and organisations engaged in climate change denial, and Climate Action 100+'s list of the 167 world's largest polluters (Climate Action 100+, 2021). This list was then complemented with the names of organisations targeted by previous movement campaigns yet were outside this list. This process produced a set of 388 keywords.
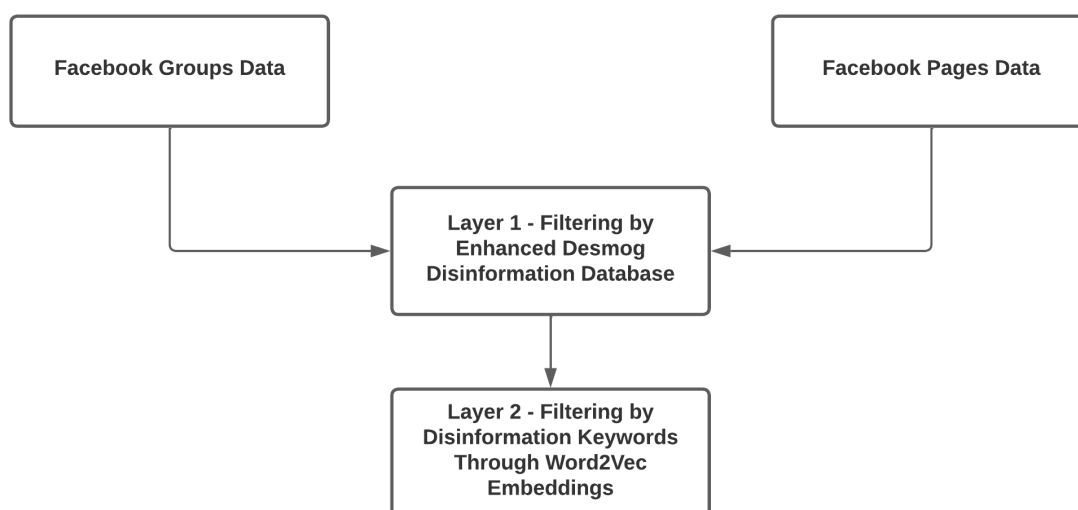
Fig. 3.2 Data Filtering Process for Naming and Shaming of Information Polluters

This set of keywords was then used to perform a first filtering process, producing a new data set of possible targets of naming and shaming campaigns. Then, this data set was used to train a *word2vec* model aimed at identifying the most common words with high similarity to terms, expanding outwards from the words *denier* and *disinformation*. *Word2vec* modelling offers a highly effective method to extract words with high similarity in a semantic context, and and such, is perfectly suited for this type of analysis. Finally, the results from these semantic embeddings, which included denial-related words such as *hoax*, *lie* and *propaganda*, were used to perform a second and last filtering process, extracting all

naming and shaming posts containing discussions on the circulation of false information on
climate change (n=6,470). A flowchart illustrating this two-layer filtering approach is shown
in Figure 3.2

Finally, a caveat should be specified. Throughout this work, the communication strategy
under analysis will recurrently be termed as naming and shaming of information polluters.
However, it should be clarified that this term is not used to merely describe the naming and
shaming of organisations that have, at some point, engaged in the diffusion of disinformation.
Instead, it describes the communication dynamic where actors are directly named and shamed
for their role in creating or disseminating disinformation. This is perfectly embodied by a
post resulting from the filtering process outlined above, which states:

> Since the early 80s, exxon knew exactly what was coming and instead of acting
> they actively spread misinformation to confuse the public while bringing us ever
> closer to climate catastrophy! still to this day the fossil fuel industry is pushing
> us towards extinction to make a few bucks![...]

3.3.2   Frequency Analysis

The first aspect that this chapter aims to evaluate is the extent to which Extinction Rebellion
and Fridays for Future resort to the naming and shaming of disinformation creators and
spreaders in their online communication. The answer to this question can be found in the
data filtering process described above, which provides insights into the proportion of naming
and shaming posts extracted from the original data set. This Section will focus on two main
aspects of the frequency of use of this communication strategy: 1) its use in both absolute
and temporal terms and 2) its temporal evolution through changepoint analysis. An overview
of the results of the filtering process output can be seen in Table 3.1 below.

Source Name	Naming and Shaming Posts
Extinction Rebellion - Facebook Pages	3,973
Extinction Rebellion - Facebook Groups	1,478
Fridays for Future - Facebook Pages	435
Fridays for Future - Facebook Groups	674

Table 3.1 Absolute Frequency of Posts Containing Naming and Shaming of Information
Polluters

Examining the absolute frequency of use of this communication tactic, the data shows that the naming and shaming of information polluters was identified in a total of 6,470 posts, corresponding to $\approx 2.55\%$ of the entire data set. While assessing the significance of a narrative frequency is always a complex task without comprehensive benchmarks, at first glance, this number can be considered rather high, particularly if we take into account the high-specificity of the filtering process. In addition, when comparing the two movements, it can be seen that they use this communication tactic at varying rates, with naming and shaming appearing in 2.72% of Extinction Rebellion posts and 2.21% of Fridays for Future's posts. This indicates that the former movement is, on average, more likely to naming and shame information polluters in its Facebook posts.

On the other hand, turning to inter-movement variations, we can see that Extinction Rebellion's naming and shaming campaigns directed at information polluters are more prevalent among Facebook Pages, with 3,973 posts, while being significantly less common among groups, with 1,478 posts. The opposite is true for Fridays for Future, where naming and shaming is more widespread in the communication of Groups, with 674 posts than in posts originating from Pages, with 435 posts. This structural difference is significant, as Facebook Pages are typically vertically managed by a movement's organisation, while Facebook Groups are loosely moderated, activist led platforms of discussion (Grömping, 2014; Sanfilippo and Strandburg, 2021), suggesting that Extinction Rebellion is more likely to engage in naming and shaming through its official or pseudo-official communications, while for Fridays for Future, this strategy is more common among its activists than the organisation itself.

Furthermore, the next step of this analysis consists in assessing how the use of naming and shaming has changed over time, providing insights into the fluctuations and overall temporal evolution of this communication tactic. This enquiry into temporal distributions is composed of two methodological approaches. The first relies on the use of a normalised distribution of daily posts for each movement to systematically assess any growth, decreases and over-time fluctuations in the use of this strategy, while the second approach relies on changepoint analysis through the R package *EnvCpt* (Killick et al., 2021) to detect the most significant changepoints in the temporal distribution, to then analyse real-world events that may justify such changepoints.

To perform the first step of this analysis, post timestamps are initially extracted from the previously described data set of naming and shaming posts. To guarantee the highest possible robustness of the results, posts are binned by day and then normalised, presenting them as a percentage of the total daily posts for each movement, an approach commonly used

in the literature (Zannettou et al., 2020). This step ensures that any peaks in the temporal distribution result from a raw increase in the use of this type of communication rather than an increase in Facebook activity by the two movements. Furthermore, a smoothing function is then applied to the distribution using a generalised additive method (GAM) to facilitate the analysis by providing a more explicit visual representation of temporal trends (Wood et al., 2016). The results of this process are shown in Figure 3.3.
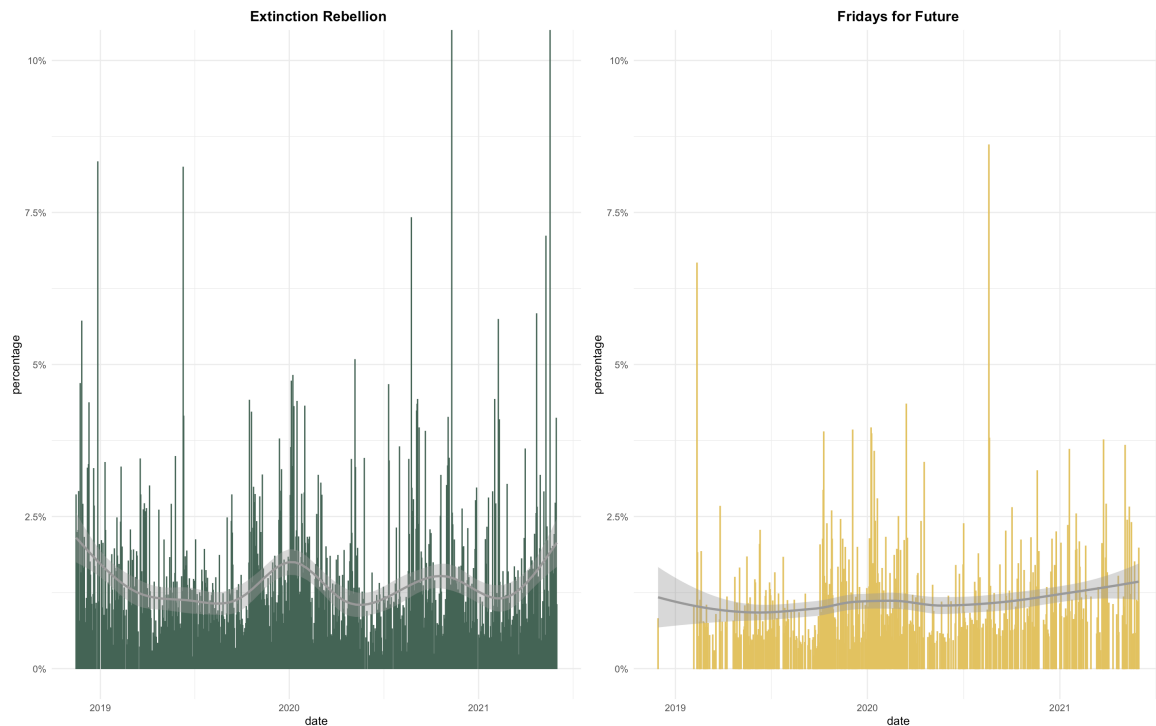
Fig. 3.3 Frequency Distribution of Naming and Shaming of Information Polluters

Visually inspecting Figure 3.3, it can be seen that Extinction Rebellion's temporal distribution does not show any stable, long-term growth, while Fridays for Future exhibits a trajectory of minimal growth in the period under analysis. However, the temporal distribution clearly shows recurrent spurs of growth rapidly succeeded by phases of plateau. Within this distribution, we see, in fact, the use of this communication strategy reach peaks as high as 10% of a movement's daily posts and then rapidly return to its base level. This finding is quite relevant in understanding the patterns of use of the naming and shaming of information polluters, as it points to the fact that the use this communication tactic tends to significantly increase on specific occasions or in response to particular events.

Considering the presence of visible fluctuations in the temporal distribution, the second step of this analysis consists in using changepoint analysis (Killick et al., 2012; Taylor, 2000), which assesses changes in mean and variance in a time series to find points where significant

changes are seen, to identify patterns of growth and decrease in the distribution. *EnvCpt* (Killick et al., 2021), a model originally developed to analyse environmental and climate time series, is used to apply 13 different models to the temporal distribution, extracting trends and mean, and then automatically infer the number of changepoints. Changepoints are then analysed considering real-world, movement-related events that could justify surges in the temporal distribution.

To identify real-world events that may correspond to the extracted changepoints, following an approach presented by (Mittos et al., 2020), events connected to the two movements are manually identified on the two movements' own websites. In cases where this process did not produce results, posts from the day of the peak were qualitatively analysed to assess the source of the changepoint. Lastly, it should be noted that this analysis focuses on the distribution's peaks to understand what type of events may drive increases in the naming and shaming of information polluters. Tables 3.2 and 3.3 show the results of this process for Extinction Rebellion and Fridays for Future, outlining the five most evident changepoints in the temporal distribution of the each movement.

Interestingly, data shows that the two most significant spurs of growth in Extinction Rebellion's use of naming and shaming against information polluters (10.9% and 10.6% of daily posts) correspond to two in-person protests against Royal Dutch Shell, one for the commemoration of the murder of the Ogoni 9 - a group of activists killed in Nigeria for opposing Shell's operations - and the other against the London Science museum's Shell-sponsored exhibition. An online protest event is also among the five most relevant changepoints in the temporal distribution. This event is a collaboration between Extinction Rebellion and Stop Ecocide International and discusses the environmental crisis created by fracking in the Okavango Delta. Ultimately, these findings suggest that for Extinction Rebellion, in-person protest events can be considered a critical indicator of growth spurs in the use of naming and shaming against information polluters, as this type of communication appears to often peak around such events, suggesting that online naming and shaming forms a core part of the movement's protest tactics, where in-person protest against companies such as fossil fuel giants is complemented by online naming and shaming regarding their role in creating or disseminating disinformation.

For what regards instead Fridays for Future, the most evident surge in the use of this strategy falls on the 19th of August 2020, when four of the movement's most prominent figures published an opinion piece in *The Guardian*, arguing that after two years of protests, the world is still in a state of climate denial (8.60% of daily posts). Other significant peaks can be seen on 8 January 2020, the day the *Brisbane Times* published an article calling out

Extinction Rebellion			
Date	**% Daily Posts**	**Event**	**Event Type**
10/11/2020	10.91%	10/11/2021: British Extinction Rebellion Activists protest in front of the Shell UK Headquarters to commemorate the murder of the Ogoni 9, a group of Nigerian activists that opposed Royal Dutch Shell's oil extraction operations. (Extinction Rebellion, 2020)	**In-Person Protest**
19/05/2021	10.65%	19/05/2021: BritishE xtinction Rebellion Activists protest at the London Science Museum against an exhibition titled 'our future planet', heavily funded by Royal Dutch Shell (Extinction Rebellion, 2021).	**In-Person Protest**
10/06/2019	8.25%	10/06/2020 : The Guardian publishes an article titled 'Extinction Rebellion's tactics are working. It has pierced the bubble of denial. (Matthew, 2019).	**News Coverage**
11/05/2021	7.12%	11/05/2021 : Extinction Rebellion Co-Founder Gail Bradbrook is arrested at her London home after attacks on HSBC and Barclays (Faulconbridge, 2021)	**In-Person Protest**
08/02/2021	5.74%	08/02/2021:Extinction Rebellion holds an online event titled 'Disaster Capitalism, Okavango Delta SOS, where Canadian company ReconAfrica obtained drilling rights with intent to frack 13,600 square miles of unspoilt ecosystems (International, 2021)	**Online Protest**

Table 3.2 Temporal Changepoints for Extinction Rebellion's Use Naming and Shaming of Information Polluters

the media's responsibility in spreading climate change denial (3.95% of daily posts), and 14 January 2020, when news broke that a NewsCorp employee publicly resigned from the company, arguing that they are willingly spreading climate change denial (3.92% of daily posts). Notably, all peak changepoints in Fridays for Future's use of naming and shaming coincide with events of external news coverage on climate change-related news. This finding outlines a critical difference between the communication of Extinction Rebellion and Fridays for Future. While Extinction Rebellion's changepoints are primarily linked to online and offline protest events, Fridays for Future's use of this strategy does not appear to be connected to protests but rather to news that may stimulate debates on climate change denial and the role of deniers in polluting the public debate on this issue.

		Fridays for Future	
Date	**% Daily Posts**	**Events**	**Event Type**
19/08/2020	8.60%	19/08/2020 : Fridays for Future's leaders publish an op-ed on the Guardian titled 'After Two Years of School Strikes, the World is Still in a State of Climate Denial' (Thunberg et al., 2020)	**News Coverage**
08/01/2020	3.95%	08/01/2020 : During the Australian bushfires emergency, the newspaper Brisbane Times publishes a commentary stating that the media must take some responsibility for climate change denial (Birmingham, 2020)	**News Coverage**
14/01/2020	3.92%	14/01/2020: A News Corp Employee leaves the company as a sign of protest against the company's support of climate change denial (Hornery and Zoe, 2020).	**News Coverage**
10/10/2019	3.89%	'The Guardian' publishes an article titled 'Half a century of dither and denial - a climate crisis timeline' covering how 20 fossil fuel firms have tried to spread doubt on climate change risks (Watts et al., 2019)	**News Coverage**
05/02/2020	3.81%	05/02/1010: The non-profit organisation Avaaz publishes a report uncovering how Youtube is spreading climate change denial videos (Avaaz, 2020)	**News Coverage**

Table 3.3 Temporal Changepoints for Fridays for Future's Use Naming and Shaming of Information Polluters

3.3.3   Named Entity Recognition

Naming and shaming is essentially based on the concepts of public exposure and condemnation, where a detrimental action of a specific actor is brought to the public's attention to make a value judgement about such action. To best understand the main characteristics of the naming and shaming of information polluters by Extinction Rebellion and Fridays for Future, it is thus of great importance to assess what individuals, corporations, and organisations are more commonly targeted by such campaigns. Analysing the targets of the two movements' naming and shaming campaigns is expected to shed light on who the two movements consider information polluters, i.e., actors responsible for producing or disseminating disinformation on climate change. The performance of campaigns against each target will also be analysed to infer which targets may be more attractive to the public, and hence generally more effective.

To extract which actors are most commonly targeted by the two movements, I use named entity recognition (NER), a widely used machine learning method to identify entities of interest in a text (Ritter et al., 2011; Wu et al., 2017). Several systems of application of NER exist (Shelar et al., 2020; Vychegzhanin and Kotelnikov, 2019), and in this work, NER is applied using the widely accepted *SpaCyR* package in R (Kleinberg et al., 2019; Krauer and Schmid, 2021), which uses neural networks to extract several types of entity, such as locations, dates, and names, from a text (Benoit et al., 2018). The results of the NER model are shown in Table 3.4, which also includes data on the average interactions obtained for each category. It should be noted that the names shown in Table 3.4 are not the ones originally found in the data, but rather those of the main organisations to which they can be traced. The NER model data were aggregated using approximate string matching, where, for example, entities such as Shell and Shell UK ltd. are grouped under the entry Shell. Before proceeding further in this analysis, a key caveat should be mentioned. Running the NER model, it emerged, in fact, that not all posts in the data set contained mention of entities. For example, several posts simply mention 'large corporations' or 'the fossil fuel industry' rather than naming specific companies.

In Extinction Rebellion's communication, results show that the most recurrent targets of noise-reduction naming and shaming posts are the oil majors Shell and British Petroleum (often shortened as BP), followed by the British Prime Minister Boris Johnson, confirming the prevalence of British activists and themes within the movement. Unsurprisingly, the posts in this category tend to be very negative, publicly exposing these companies for their role in contributing to climate change and for their responsibility in devising disinformation campaigns. For example, a widely circulated post from January 2020 discussing Shell's behaviour reads:

> Shell warns for climate change in 1991, then decides to go for profit and support climate deniers... #tellthetruth #actnow

As the post shows, Shell is here accused of knowingly misleading the public on climate change (i.e., disinformation) by first recognising the risks of climate change in 1991, to then start supporting climate change deniers. This claim refers to the now well-known fact that in 1991, the oil giant Shell produced a film for public release titled *Climate of Concern*, which warned about the impacts of climate change on the planet. However, since then, the company continued justifying the use of fossil fuels, expanding its production and widely financing climate change denial (Grasso, 2020; Li et al., 2022).

Extinction Rebellion				Fridays for Future			
Name	**N**	**Type**	**Avg Interactions**	**Name**	**N**	**Type**	**Avg Interactions**
Shell	473	Fossil Fuels	45.35	**Facebook**	78	Media & Info	40.09
British Petroleum	355	Fossil Fuels	40.37	**Youtube**	53	Media & Info	23.16
Boris Johnson	350	Politics	50.60	**Donald Trump**	52	Politics	30.32
Youtube	279	Media & Info	24.82	**NewsCorp**	49	Media & Info	43.56
Google	278	Media & Info	24.84	**ExxonMobil**	49	Fossil Fuels	21.87
NewsCorp	259	Media & Info	48.04	**Heartland Institute**	32	Politics	25.68
ExxonMobil	240	Fossil Fuels	39.98	**BP**	28	Fossil Fuels	16.75
Barclays Bank	196	Banking	36.75	**Shell**	27	Fossil Fuels	21.22
Donald Trump	159	Politics	38.76	**Google**	24	Media & Info	27.12
HSBC	101	Banking	39.57	**Koch Industries**	11	Fossil Fuels	29.72

Table 3.4 Naming and Shaming Mentions by Operating Sector

Other notable organisations detected by the NER model are media and information companies such as the tech giants Google and Youtube and the media conglomerate NewsCorp, an American mass media publishing company repeatedly accused of contributing to the diffusion of climate change denial (Gunster et al., 2018). Interestingly, ExxonMobil, the target of several academic studies that analyse its role in spreading disinformation on climate change (Kolmes, 2011; Supran and Oreskes, 2017), is only seventh on this list, appearing in 4.47% of all naming and shaming posts. At the bottom of the list, we find two banking institutions, Barclays and HSBC.

For what regards instead Fridays for Future, the most recurrent target of naming and shaming campaigns is Facebook itself, often criticised for prioritising money over truth, allowing advertisers to spread climate change denial on its platform. For instance, a post targeting this organisation reads:

> No fact-check for climate science deniers. Facebook now exempts climate change deniers from their fact checking programme, allowing them to spread disinformation on Facebook without having to worry about fact checks from climate scientists. Make no mistake, the existence of man-made climate change is not an opinion, it's a fact that has been confirmed by scientists for several decades over and over. For Facebook to tolerate this kind of content on their platform is to willfully collaborate in misinforming the public about a vital issue. We urge Facebook to rethink their policy and stop fake science!

Finding a social media company on top of the movement's naming and shaming mentions is a very interesting find, as, compared to fossil fuel companies, the role of social media companies in willingly facilitating the spread of disinformation is notoriously understudied.

Extinction Rebellion			Fridays for Future		
Sector	N	Avg Interactions	Sector	N	Avg Interactions
Fossil Fuels	1068	42.07	**Media and Information**	204	34.88
Media and Information	816	32.16	**Fossil Fuels**	115	21.21
Banking	297	37.18	**Politics**	84	28.55
Politics	251	43.14			

Table 3.5 Summary of Naming and Shaming Mentions Classified by Sector

Other notable names on the list include former US President Donald Trump, who has often cast doubts on the very validity of climate change science (De Pryck and Gemenne, 2017; Eilperin, 2016), the aforementioned media group NewsCorp, often accused of hosting climate change denial, and the oil major Exxon Mobil. Interestingly, the only organisation dedicated almost exclusively to climate change denial present on this list is the Chicago-based think-tank Heartland Institute (Medimorec and Pennycook, 2015), indicating that Extinction Rebellion and Fridays for Future are more prone to naming and shaming and inflicting reputational damage onto large corporations responsible for top-down disinformation rather than think tanks which are often bankrolled by such organisations to spread disinformation through their media channels.

Furthermore, Table 3.5 reports the number of mentions of naming and shaming for each movement grouped by operating sector. This analytical approach is important, as it allows for an assessment of which type of organisation is most commonly targeted by each movement, along with the performance, measured by the average number of interactions, of the posts targeting these categories. As seen in the Table, mentions from Extinction Rebellion are primarily directed towards organisations operating in the Fossil Fuels sector (21.58%), with the media sector following with 12.55% of posts. This is relevant because it suggests that Extinction Rebellion focuses on naming and shaming fossil fuels corporations for their role in creating or spreading false information far more than any other sector. The results are also significantly different for Fridays for Future, with the media sector being the most targeted, mentioned in 20.61% of all naming and shaming posts, and fossil fuels coming second with 12.44%. Last, it should be noted that no organisations from the banking sector emerge among Fridays for Future's targets, marking a key difference from Extinction Rebellion.

Moreover, analysing post interactions, two additional findings stand out. First, mentions data show that Extinction Rebellion's naming and shaming posts attract a significantly higher amount of interactions from Facebook users (mean= 38.63, sd= 4.36) than those from Fridays for Future (mean=2 8.21, sd= 5.58), suggesting that Extinction Rebellion activists may be

more interested in interacting with this type of communication. Second, the actors gathering the largest amount of public interactions are, for Extinction Rebellion, the former British Prime Minister Boris Johnson and the media conglomerate NewsCorp. For Fridays for Future, NewsCorp and Facebook are the top performers in terms of interactions. This is also reflected in the aggregate performance by sectors, where for Extinction Rebellion, Politics is the most interacted sector, while for Fridays for Future, Media and Information is.

3.3.4   Sentiment Analysis

This Section analyses the sentiment that emerges from the data set of naming and shaming posts directed at information polluters. This process is expected to provide insights into the overall polarity of the posts under analysis and information about which categories of organisations may attract more negative or positive discussions in the online communication of Extinction Rebellion and Fridays for Future. This analysis also aims to assess the emotions that naming and shaming posts cause in the readers, measured through Facebook reactions.

Sentiment analysis is a rapidly growing field of natural language processing and is broadly defined as the task of extracting sentiments and opinions about specific entities (Feldman, 2013). In the last two decades, the use of sentiment analysis has evolved significantly (Medhat et al., 2014), and several studies have resorted to this methodology to assess the emotions emerging from social media, and in particular, from Facebook data (Ahkter and Soria, 2010; Sandoval-Almazan and Valle-Cruz, 2018; Troussas et al., 2013). Sentiment analysis can be applied at several levels of granularity, ranging from document-level (Moraes et al., 2013) to sentence-level classification tasks (Jagtap and Pawar, 2013), and using a wide array of textual and non-textual data. In this work, sentiment analysis will be applied through two separate approaches: 1) a traditional sentence-level sentiment analysis through a lexicon-based approach (Khoo and Johnkhan, 2018; Taboada et al., 2011), and 2) a high-level analysis of the Facebook reactions from users to the posts in the data set (Tian et al., 2017).

A lexicon-based sentiment analysis (1) is applied at the sentence level to naming and shaming posts, where the semantic information from each sentence in a post is used to compute a sentiment score, to then calculate the average sentiment score of each noise-reduction post (Shirsat et al., 2019). This step was applied using the R package *SentimentR* (Rinker, 2017), which, through a sentiment lexicon, computes the sentiment value for each negative and positive word in a sentence, taking into account valence shifters and sentiment amplifiers. Lexicon-based approaches require the choice of a sentiment lexicon, and after accuracy testing, Jockers-Rinker, which uses a vocabulary of 11,000 words, appeared to

provide the highest level of accuracy in sentiment detection. A visualisation of the results of
this sentiment analysis is shown in Figure 3.4.below.

Several useful findings emerge from this sentence-level sentiment analysis. First, as
expected, it is evident that the sentiment arising from the naming and shaming posts under
analysis is strongly negatively skewed, with 85.11% of total posts returning a sentiment score
below 0. While this holds for both movements, Extinction Rebellion exhibits, on average
more posts with a score below 0, with 87.34% of posts matching this criterion against Fridays
for Future's 82.88%. The computation of posts' average sentiment for each movement
produced similar results. In fact, the mean sentiment score for Extinction Rebellion's posts
is -0.32 (sd = 0.33), while Fridays for Future's mean sentiment score was -0.25 (sd = 0.31),
confirming that, on average, Extinction Rebellion posts express more negative sentiments
than Fridays for Future, and indicating that Extinction Rebellion may be engaging in a more
verbally aggressive form of naming and shaming than its counterpart.
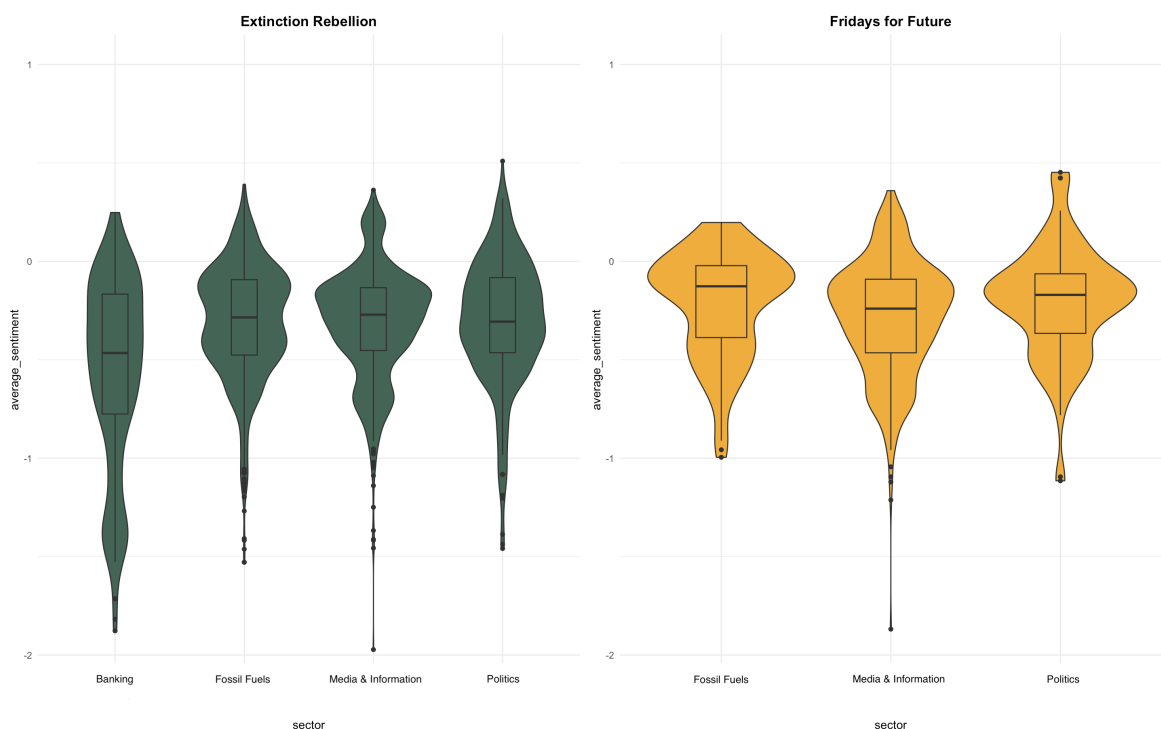
Fig. 3.4 Sentiment Analysis of Naming and Shaming of Information Polluters - This figure
shows both the density of each sentiment value in the violin plot and a boxplot with the upper
and lower quartiles, along with the median value.

As regards the sentiment of specific industry sectors, the media and information sector
emerges as the most polarising one for both movements, containing the posts with the lowest
sentiment scores across the board and exhibiting the widest sentiment range across all sectors.

The post with the lowest total sentiment score (-2) comes from Extinction Rebellion and is an attack directed at NewsCorp, the multinational media company that controls news outlets such as The Sun, Fox News and The Wall Street Journal, often criticised for its role in spreading disinformation on climate change (Gunster et al., 2018; McKnight, 2010). The post reads:

> The toilet paper shortage may have boosted New Corps' sales, but their climate denial remains criminal. Join us for the march against Murdoch on Friday 13 March.

This post uses a verbally aggressive tone to name and shame NewsCorp for engaging in climate change denial, assimilating the organisation's newspapers to toilet paper and inviting activists to participate in a march against its owner, Rupert Murdoch. Furthermore, among Extinction Rebellion's posts, the banking sector shows, on average, the most negative sentiment, with a mean sentiment score of -0.54, suggesting that Extinction Rebellion is particularly negative in the coverage in this sector. The lowest scoring post in this category (-1.77) states:

> Hsbc and barclays uk fund propaganda and commit a massive amount of criminal damage & fraud against our planet, and life on it, our collective future. But let's arrest Gail Bradbrook on that charge for crack a few of their window to wake people up to their crimes. This is what passes for justice?

This post described the arrest of Extinction Rebellion's co-founder Gail Bradbrook in May 2021, an event also previously detected as a critical change point in the movement's temporal distribution of posts. The arrest followed Extinction Rebellion's 'Money Rebellion' campaign against various financial institutions, including HSBC and Barclays. As part of this campaign, movement activists attacked several UK banks, vandalising buildings and breaking windows to shed light on the detrimental behaviour of such financial institutions. Here, it is interesting to note that the movement denounces how HSBC and Barclays are, as part of their actions to support the fossil fuels industry, funding propaganda.

Moreover, the media sector shows the second-lowest average sentiment (mean = -0.30, sd = 0.28), with the fossil fuels coming third (mean = -0.28, sd= 0.26). Interestingly, the sentiment analysis function returned posts with a score exceeding +0.5 in the fossil fuels sector. These posts are not positive *per se* but merely contain no negative language. For example, the most positive post in this group (+0.80) reads: 'Cambridge accepts a £6m Shell donation'.

Further, Fridays for Future's sentiment scores closely resemble those of Extinction Rebellion, with the media and information sector showing the widest sentiment range and showing the overall lowest average sentiment value (-0.29), followed by the fossil fuels sector (-0.21) and the politics sector (-0.20). Here, the most negative post from the media and information sector targets, once again, the media conglomerate NewsCorp and its founder Rupert Murdoch, and claims:

> rupert murdoch is a climate criminal. he has been funding climate denial for decades and delaying action. we want our journos to be able to #tellthetruth. news corp, set your journos free!

This finding completes and provides a further dimension to the results of the previous analysis into the targets of Fridays for Future's noise-reduction campaigns, where the movement emerged as being quite prone to naming and shaming organisations working in the media sector for their complacency in spreading climate change denial. It should be mentioned that the sentiment distribution exhibited by the two movements is quite surprising if we consider the current literature on climate change denial, which largely focuses on fossil fuels industry. However, results show that the two movements have a far more negative attitude towards the media and information sector, which is deemed responsible for the circulation of disinformation on climate change.

The second step of this sentiment analysis assesses the sentiment emerging from the users' reactions to the noise-reduction naming and shaming of Facebook posts in the data set (2). Reactions are emoji-based extensions of the like button, which allow Facebook users to show their sentiment towards a post. The range of possible reactions includes 'Love', Wow', 'Haha', 'Sad',' Angry', and 'Care'. Assuming that users' reactions reflect their feelings towards a post, we can use such reactions to infer the sentiment caused by the posts under analysis. Facebook reactions have previously been used extensively in the literature to analyse the sentiment caused by social media posts (Basile et al., 2017; Sandoval-Almazan and Valle-Cruz, 2018; Tian et al., 2017). The results of this process are shown in Figure 3.5, which presents the percentage split of reactions for the noise-reduction posts for each sector.

Notably, users' Facebook reactions differ significantly between the two movements. As we can see from Extinction Rebellion's reactions, the 'Love' reaction is the most common, forming 48.86% of all data, with the frequency of other reactions ranking as 'Angry' (26.9%), 'Sad' (12.4%), Wow (4.8%), Care (3.7%) and Haha (3.1%). Qualitatively analysing the data in search of insights that may explain this characteristic distribution, it appears that the majority of posts attracting a large number of 'Love' reactions are about acts of anti-
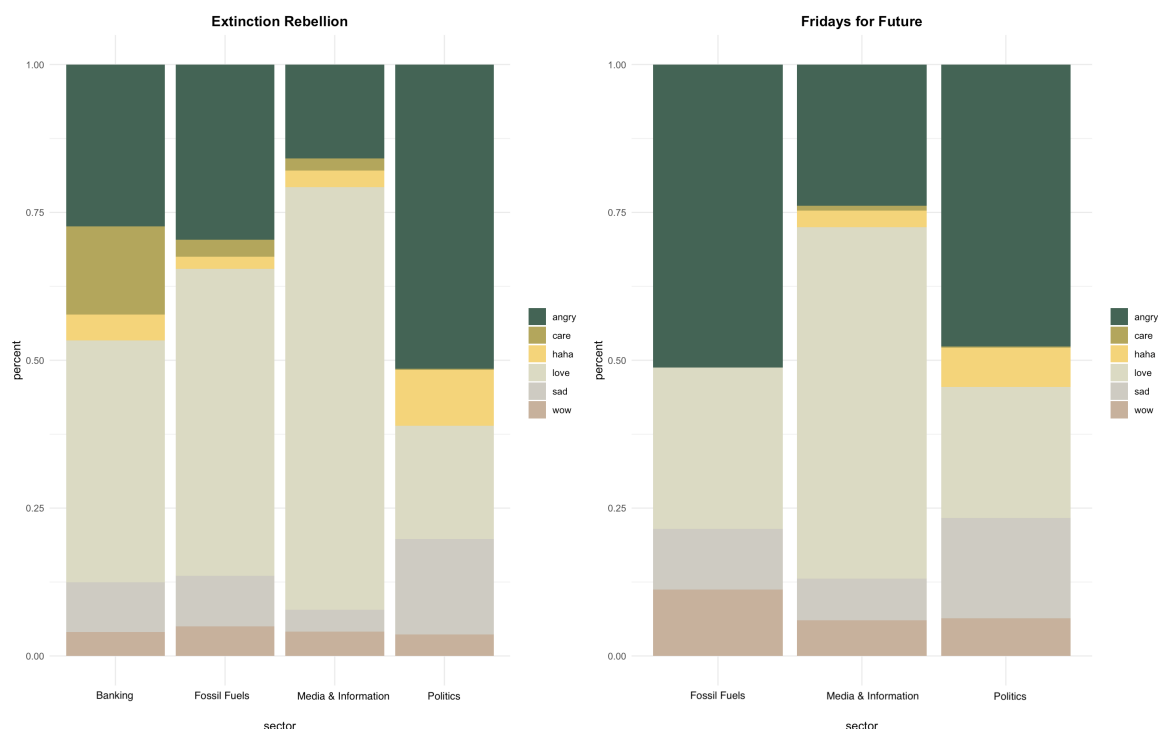
Fig. 3.5 Facebook Reactions of Naming and Shaming of Information Polluters

disinformation protests by Extinction Rebellion activists and may hence suggest a show of
support from other activists. For example, a post that attracted 776 'Love' reactions in the
media sector states:

> Breaking - live: youtube headquarters, King's Cross, several of the snowflakes
> are participating in a shutdown of youtube, expecting multiple arrests. We are
> with Extinction Rebellion youth to demand action on the huge amount of videos
> containing misinformation, climate denial and climate skepticism on youtube's
> platform[...]

'Love' reactions are particularly prevalent in posts against the media sector, while the
politics sector is the one with the most negative reactions, with over 65% of posts showing
negative emotions through either angry or sad reactions. Results for Fridays for Future
present a different picture, where the distribution is characterised by more frequent use of
the 'Angry' reaction. This is quite an expected finding, particularly if we consider that the
sentiment of Fridays for Future's naming and shaming posts tends to be less negative than
those of Extinction Rebellion. However, this effect may be consistent with what emerged in
the previous Section, where the naming and shaming of information polluters by Fridays for

Future is more often triggered by news describing the actions of deniers rather than protest events. This may explain a higher percentage of 'Angry' reactions in Fridays for Future's posts in comparison with Extinction Rebellion.

3.3.5 Quantitative Content Analysis

The final step of this analysis into the use of naming and shaming against information polluters by Extinction Rebellion and Fridays for Future consists in performing a quantitative content analysis of the posts in the data set. This step provides critical insights into the main topics that emerge from the two movements' naming and shaming posts.

Quantitative content analysis refers to the process of analysing textual data using statistical procedures to systematically extract content from a large volume of texts (Neuendorf, 2017). This research method will be applied to a corpus of 6,570 naming and shaming Facebook posts by Extinction Rebellion and Fridays for Future using LDA-based topic modelling to extract the main topics emerging from the previously described data set of Facebook posts. Topic modelling is a probability-based unsupervised machine learning technique used to identify latent content-based clusters in text data (Jacobi et al., 2016; Kherwa and Bansal, 2020; Purver et al., 2006). This model offers an effective and computationally efficient method to extract semantic content from extensive collections of text data. In this work, topic modelling is performed through the widely accepted Latent Dirichlet Allocation (LDA) algorithm, which assumes that every document is a mixture of topics and every topic a mixture of words and uses patterns of word co-occurrence to detect latent semantic structures (Blei and Lafferty, 2007; Blei et al., 2003).

LDA is applied to the posts of each movement individually in the R environment using the *text2vec* package by Selivanov and Wang. (2018), which uses the high-performance WarpLda sampling algorithm. The most significant challenge in creating an effective topic model consists in fitting the model to the data, selecting values for the Dirichlet hyperparameters α (alpha), η (eta) and k, where α controls the shape of the document-topic distribution, η controls the shape of the topic-word distribution, and k controls the number of topics that the model is instructed to detect (Hutter et al., 2014; Wallach et al., 2009). To determine the optimal hyperparameters for the topic models of Extinction Rebellion and Fridays for Future, I used perplexity testing through k-fold validation, a popular method of testing the validity of a topic model (Newman et al., 2009,?). This approach is based on the computation of a perplexity score which describes how well a model fits previously unseen data (Grün and Hornik, 2011). For this purpose, perplexity was tested using a test-set of holdout data

composed of 25% of all the posts in the data set of each movement. This process reveals that for Extinction Rebellion, the best optimal tuning uses the parameters $\alpha = 0.43$, $\eta = 0.03$, $k=$ 16 , while for Fridays for Future, optimal tuning results from the parameters $\alpha = 0.21$, $\eta = 0.02$, $k=12$. This choice of parameters offered an optimal statistical fit for the model as well as the greatest interpretability of the topics. Lastly, it should be noted that, contrary to several similar packages, the *text2vec* package does not require the selection of the number of model iterations but instead uses an iterative sample algorithm that computes the model's log-likelihood — a measure that describes how plausible the model parameters are given the data — at every n iterations.

After tuning the model, the latter is applied to the naming and shaming data set. To identify what topic each cluster of words represents, a two-step process was adopted. First, following the approach used by Roberts et al. (2014), FREX words, defined as the harmonic mean of a word's rank probability and exclusivity, are extracted and qualitatively analysed to assess whether or not they formed a clear topic of discussion. Then, the topics are visualised through the R package *LDAvis*, a web-based interactive visualisation tool for topic modelling in order to further assess the existence of consistent topics (Sievert and Shirley, 2014). *LDAvis* is a key tool in topic interpretation of topic modelling, as it allows us to overcome the limits of interpreting topics only through plain probability. In fact, *LDAvis* allows the setting of the lambda (λ) parameter for relevance, hence visualising the LDA topics not only in terms of their probability of happening in the full data set, but also looking at their relative inter-topic probabilities. The results of the topic model distributions for both movements are shown in figures 3.6 and 3.7 while the full topic model results can be found in Appendix B.

In Extinction Rebellion's naming and shaming of information polluters, the most common topic was labelled as *Calls to Action* with the highest relevance words such as *tomorrow*, *march* and *everyone*. This topic is present in 8.11% of posts and fully embodies Extinction Rebellion's style of activism heavily centred on direct action. This post shows that even while naming and shaming information polluters, the movement's communication remains primarily based on inciting direct action. This confirms what emerged from Section 3.3.2, where it was noted that temporally, the movement's naming and shaming practices are strongly linked to direct action.

The second most common topic in the distribution was labelled as *Oil and Gas Industry*, and contains keywords such as *oil*, *gas*, *fuel* and *companies*. This topic's prominence confirms the finding from the NER model, where the fossil fuels industry emerged as the most targeted sector by Extinction Rebellion. As expected, this post contains critiques of the oil and gas industry's role in spreading disinformation, and a high-relevance post in this category reads:

> We're in a climate emergency. Oil companies got us into it, and they're digging
> us deeper every day by continuing to drill for oil and gas. At the same time,
> they're bombarding us with ads trying to convince us they're not climate wreckers
> [...]
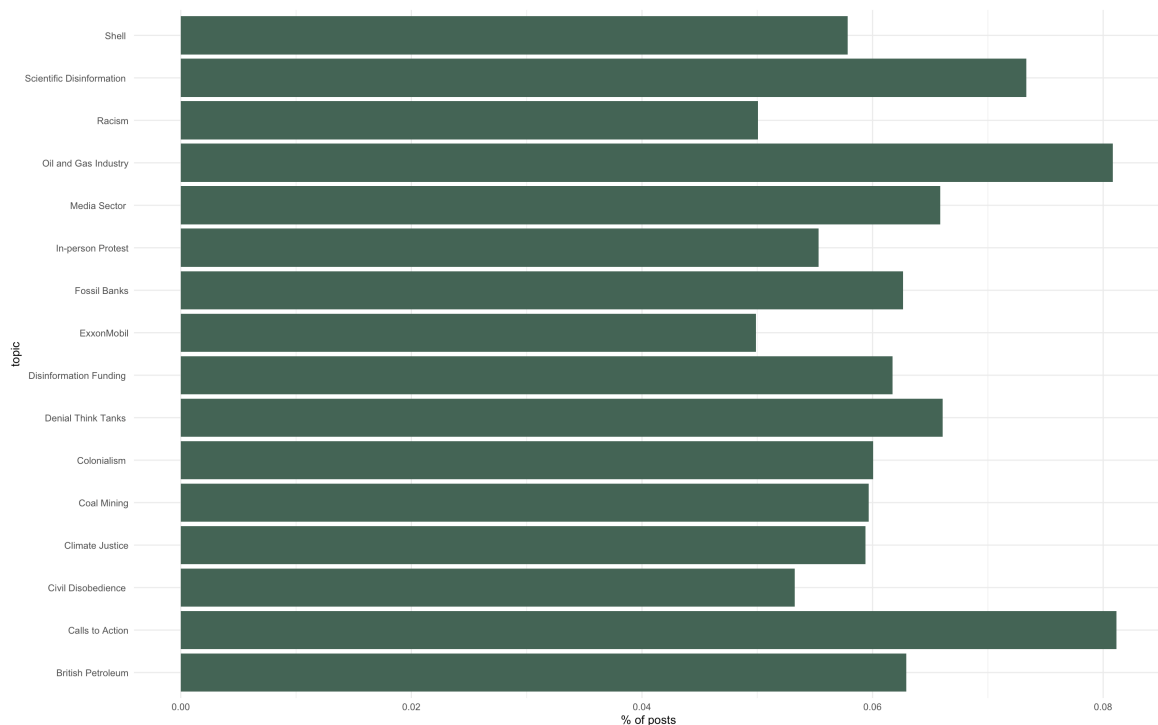
Fig. 3.6 Topic Modelling Results for Extinction Rebellion's Naming and Shaming of Information Polluters

This post perfectly sums up the communication tactic under analysis, showing how the movement is publicly shaming the entire oil and gas sector for 'bombarding us with ads trying to convince us they're not climate wreckers', in short, disinformation.

Moreover, the third most common topic in the model was labelled *Scientific Disinformation* and contained keywords such as *deniers*, *spread* and *misinformation*. While this topic was labelled quite broadly, posts in this category discuss the existence of scientific disinformation on climate change, while trying to raise awareness of the tactics and motives that drive the climate change denial industry. For example, a post on this topic states:

> A little information on how disinformation and climate change science denial is
> spread by the fossil fuel industry: https://www.bbc.co.uk/news/stories-5364038

Specifically, this post contains the link to a 2020 article by BBC titled 'How the oil industry made us doubt climate change', which describes some of the strategies organisations such as ExxonMobil used to spread doubts on climate change by weakening the perceived reliability of scientific evidence. It should be noted that this post is presented as an informational one aimed at making the public aware of the dynamics of climate change disinformation, confirming the movement's influence as an epistemic activist noted in Chapter II. This topic is very interesting as it syntheses two parts of the theoretical framework that informs this work. On the one hand, the movement is clearly acting as an epistemic innovator informing the public on the strategies that fuel climate change denial, on the other hand, it is doing so by publicly shaming those reponsible for devising these strategies.

Furthermore, it is worth noting that the model output also shows the presence of individual topics on fossil fuels companies such as Shell and ExxonMobil, and a whole topic on banks that are accused of fuelling climate change, with keywords such as *barclays*, *bank*, *stop*, *funding*. Turning back to figure 3.6, it can also be seen how the model produced an entire topic on think tanks engaged in climate change denial. Posts on this topic often describe how disinformation creators used think tanks to disseminate false information on climate change. For instance, a post in this category reads:

> for years, exxon mobil prolifically funded climate denier groups like the heartland institute and competitive enterprise institute. under pressure, the company pledged to stop funding deniers in 2007, although it kept bankrolling politicians who deny the reality of the climate crisis.

Lastly, it is interesting to point out that Extinction Rebellion's model shows two topics relating to intersectional climate activism, *Colonialism* and *Racism*. These topics demonstrate that the naming and shaming of purveyors of false information tends to be quite nuanced, including a wide variety of topics that go far beyond simply claiming that a corporation is spreading or financing disinformation. To gather additional insights on these topics, we can examine a high-relevance post in the racism category, which states:

> Shell is guilty of centuries of exploitation and racial violence, and decades of attacking science. Shell has done it all! Shell = guilty!

Turning now to Fridays for Future, the data shows that the most common topic was labelled as *Media Sector*, which appears in 9.98% of posts in the naming and shaming data set. Once again, this is consistent with the results from the NER model applied in Section
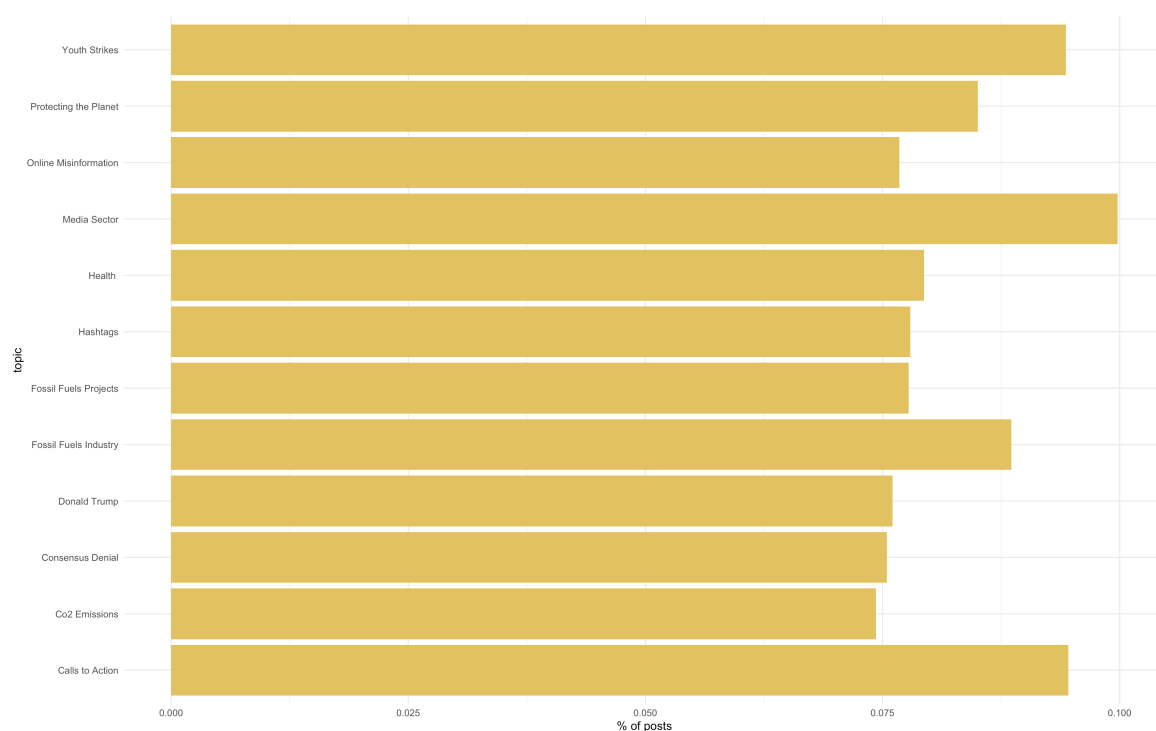
Fig. 3.7 Topic Modelling Results for Fridays for Future's Naming and Shaming of Information
Polluters

3.3.4. Posts in this sector mainly contain attacks on both social media and traditional media
for their role in platforming disinformation. An example can be found in a high-relevance
post on this topic, which states:

> Many of the news outlets that are still around have ignored or misreported the cli-
> mate story and failed to counter the tsunami of deceptive propaganda unleashed
> by fossil-fuel companies and the mercenaries, ideologues and politicians who do
> their bidding.

As this post confirms, it is clear that Fridays for Future is particularly keen on using its
Facebook posts to attack media sources above all other potential naming and shaming targets.

Furthermore, the second most common topic was labelled as *Calls to Action*, and is
dominated by posts inciting activists to take part in Fridays for Future's protests and school
strikes. This closely mirrors what was highlighted in Extinction Rebellion's distribution and
confirms the finding that while naming and shaming disinformation creators and spreaders,
the two movements often integrate such posts with calls to take direct action.

Additionally, it is interesting to note that Fridays for Future's topic model exhibits an entire topic dedicated to consensus denial, with keywords such as *science*, *consensus*, *denier* and *doubt*. A high relevance post in this category reads:

> it's interesting how merchants of doubt are testing the effectiveness of their permanent misinformation. it's clear that the fact of a scientific consensus is the biggest threat to pseudoscience and to merchants of doubt

This finding is quite relevant to this analysis as, as seen in the climate change denial taxonomy in Chapter I, consensus denial is among the four most common forms of scientific climate change denial. Thus, it is interesting to note that this form of denial is addressed directly by Fridays for Future, targeting the 'merchants of doubt', a term coined by (Oreskes and Conway, 2010) in their seminal book, which analyses how fossil fuels interests worked behind the scenes for decades to weaken scientific consensus on climate change. At the same time, it should be noted that a similar topic did not emerge from Extinction Rebellion's topic model, indicating a clear difference between the two movements in this respect.

Lastly, the movement also exhibits an entire topic dedicated to former US President Donald Trump, who is often accused of denying climate change and criticised for its role in mainstreaming climate change denial. For example, a high-relevance post on this topic claims:

> Trump is the leader of the world's second largest greenhouse gas emitter and a well-known climate crisis denier. it's therefore very fitting that there'll be a climate bloc at the protest against his state visit next week.

3.4   Discussion and Conclusions

This Chapter of the PhD set out to empirically analyse the role of naming and shaming posts targeting creators and spreaders of disinformation, who were termed information polluters, in the communication of Extinction Rebellion and Fridays for Future. Several findings contribute to understanding the role of radical climate movements as a force of peer-produced noise reduction, which are summarised below.

3.4.1 The Drivers of the Naming and Shaming of Information Polluters

First, perhaps the most important question that drove this Chapter is whether or not the two movements engage in the naming and shaming of information polluters and, if yes, the frequency and extent to which they do so. Results from this analysis indicated a moderate presence of this communication strategy in the communication of Extinction Rebellion and Fridays for Future, with the two movements naming and shaming disinformation creators and spreaders on average in 2.55% of the data set. This percentage is relatively high, considering the width and breadth of the communication of the two movements and the filtering specificity of this communication tactic. In this sense, it can be concluded that the naming and shaming of information polluters forms an integral part of the communication practices of both movements.

Furthermore, results showed that in the five years under analysis, the use of this form of naming and shaming has not increased significantly. Instead, posts showed a variable temporal distribution with numerous peaks and falls. The use of changepoint analysis applied to these peaks allowed for an understanding of what type of events drive increases in the use of naming and shaming against information polluters. Here, it emerged that increases in the use of naming and shaming are often correlated with different types of real-world events.

For Extinction Rebellion, peaks in the use of this communication tactic often correspond to protest events - mainly in-person protests - while for Fridays for Future, peaks are more often caused by news on climate change, or more specifically, on climate change disinformation. This point is crucial to understanding how the two movements deploy this strategy, as it suggests that for Extinction Rebellion, naming and shaming of information polluters is part of its in-person protest tactics and, as such, is often intensified by in-person protest events. This finding partly confirms what was noted in Chapter II, where it emerged that the two movements' capacity for mobilising online activism is highly dependent on in-person mobilisations.

On the other hand, in Fridays for Future's communication, this strategy does not appear to be part of the movement's protest toolkit. Instead, naming and shaming-based discussions are usually triggered by news coverage of climate policy and climate change denial. This finding has implications for the long-term impact of naming and shaming as a bottom-up form of disinformation reduction, suggesting that, as a core protest tactic, this communication strategy may be used more consistently over time by Extinction Rebellion. On the other hand, these findings also suggest that Extinction Rebellion's use of this strategy may be more readily impacted by occurrences that prevent in-person activism - such as the Covid19

pandemic, while on this flank, Fridays for Future may be more resilient, as its use of naming and shaming is mainly driven by online events.

3.4.2   The Targeting of Information Polluters

Furthermore, in this Chapter, I used a named entity recognition model to extract the most common targets of the naming and shaming of information polluters in the communication of the two movements. Here, the results showed that the two movements generally see individuals and organisations operating in four categories as information polluters. These categories are fossil fuels, politics; media and information; and banking.

Interestingly, the list of organisations produced by this process is quite comprehensive and includes a range of organisations commonly identified in the literature on disinformation, such as ExxonMobil and the Heartland Institute, as well as organisations not traditionally identified in the literature as key forces of disinformation creation or dissemination, such as Google, Barclays and HSBC. Nonetheless, it is fascinating to note that the two movements adopt a broad view of who is responsible for spreading or creating disinformation, with some unconventional organisations falling among their targets. It should be noted, however, that the primary targets vary between the two movements; for example, banks only appear among Extinction Rebellion's main targets.

Furthermore, in terms of targeting intensity, results show that the most recurrent targets of naming and shaming campaigns are fossil fuels companies for Extinction Rebellion and media organisations for Fridays for Future. While the presence of fossil fuel companies was expected also taking into account the relevant literature, media organisations topping Fridays for Future's targets was surprising, indicating that the movement is particularly focused on shaming enablers of disinformation diffusion, such as right-wing media groups and social media platforms, while Extinction Rebellion remains more concentrated on shaming fossil fuels majors for their role in polluting the information environment on climate change.

All in all, these findings are very significant for the research question that guides this work, as they indicate that the new generation of radical climate movements adopts a very broad approach to naming and shaming information polluters, where they do target traditional information polluters such as ExxonMobil and Shell, but also focus on organisations whose role in spreading disinformation is more unexplored, such as HSBC and Google. This approach is a very interesting one, as it suggests that the movements may act as an avant-garde force in pressuring non-standard organisations into raising their information standards. For example, as the majority of activists and commentators continue - and rightfully so -

to focus on calling out fossil fuel majors, it is indeed very benefitting for the debate that a movement like Fridays for Future is strongly calling out social media companies such as Facebook for their role in refusing to moderate disinformation in their platforms.

3.4.3   The Content of Naming and Shaming Posts

Finally, in this Chapter, I applied quantitative content analysis through an LDA-based topic modelling to extract the content of the naming and shaming posts produced by the two movements. While this analysis did not produce surprising results, some elements of the movements' content stand out.

First, confirming once again the importance of direct action in driving the movements' online participation and communication, both movements exhibit a very widespread topic labelled as *Calls to Action*, where the two movements incite their activists to take the streets to protest. This finding indicates that the call to action remains perhaps the most fundamental communication aspect of both movements, and as such, it tends to underline all types of communications, including naming and shaming.

Second, the topic models for both movements exhibit the presence of a large number of topics discussing the role of various organisations, particularly fossil fuels companies and media companies, in producing and spreading misinformation. Here, perhaps the most interesting topics were labelled as *Scientific Disinformation*and *Consensus Denial*, which contain a variety of discussions on how malicious actors have tried to weaken the public understanding of climate science, a finding that is often discussed in the literature (For example, see Freudenburg et al., 2008; Oreskes and Conway, 2010). These topics are, on many levels, essential for the analysis performed in this Chapter, mainly as they appear to have a clear epistemic component, where actors are shamed with a sort of educational goal of informing the public on all the most common tactics that climate deniers have used to muddy the waters on climate change. For example, a post in the *Scientific Disinformation* topic Extinction Rebellion shared a BBC article outlining a history of how climate science has been attacked over time, while in a Consensus Denial Post, Fridays for Future discussed how the 'merchants of doubts' are testing the effectiveness of permanent misinformation. These topics are very interesting, as they show how both movements integrate naming and shaming narratives, aimed at creating reputational risk, with more educational narratives, aimed at informing the public on the inner mechanisms of disinformation and misinformation.

Lastly, it should be mentioned that the analysis of post content also identified several topics linked to intersectional activism, such as *Racism* and *Colonialism*. Once again,

these topics testify to how the two movements hardly ever approach any discussion themes in a vacuum and instead tend to take a very broad approach to communication where synergies between problems are often discussed. For example, numerous posts show the two movements shaming fossil fuels companies for spreading disinformation on climate change and violating local populations' human rights while exploring for oil and gas. While this feature of the movements' communication sometimes complicates its analysis, it is crucial as it shows that information problems are often addressed in a synergetic manner while taking into account various social and political factors.

3.4.4 Conclusion

To conclude, the results of this Chapter show that ultimately, Extinction Rebellion and Fridays for Future do resort to the use of naming and shaming creators of information polluters in their Facebook communication, acting as watchdogs by calling out the actions of large corporations involved, in various ways, with climate change disinformation. This confirms what is proposed in the theoretical framework that informs this work, as the two movements engage in a form of naming and shaming that creates clear reputational risks for information polluters. However, this happens in a way that is far more nuanced than expected. In fact, the traditional naming and shaming that has been widely analysed in the literature is often a targeted, on point strategy aimed at leading to the termination of a specific phenomenon. In the communication of Extinction Rebellion and Fridays for Future, naming and shaming is often used in a complex context, side-by-side with calls to take streets to participate in protests, to defend oppressed minorities, call out racial injustice, and even instructing the public about the strategies used by disinformation creators to spread doubt on the very existence of climate change. This characteristic of this communication strategy is of great interest, as it suggests that naming and shaming, when used, appears to be embedded in the communication of the two movements rather than a self-standing strategy.

Furthermore, the choice of target-organisation provides significant insights for the future understanding of climate-related naming and shaming. In fact, the relevant literature has largely focused on the role of fossil fuel companies, and its network of think tanks and other research institutions, in spreading disinformation and misinformation on climate change. However, Extinction Rebellion and Fridays for Future appear to have a much broader definition of what a climate change denier is, targeting a wide array of organisations ranging from heads of governments, banks, and social media platforms. The role of these types of organisations in slowing down on climate change is far less explored, and further research should be devoted to this theme. For example, very limited literature exists on the role of

banks and of large social media organisations in spreading or platforming climate change denial.

The results also provided key insights into how the two movements resort to this strategy differently, and it could be said that in this analysis, Extinction Rebellion emerges as a more adversarial movement, prone to naming and shaming, and more likely to produce posts with very negative sentiment and text connotations. On the other hand, Fridays for Future emerged as more balanced in its communication, and generally less prone to use adversarial, direct communication tactics.

Chapter 4

The Use of Science-Based Counternarratives as a Form of Peer-Produced Misinformation Reduction

4.1 Introduction

False information on climate change, both online and offline, has traditionally relied heavily on spreading doubt about the reliability of scientific data, downplaying the risks associated with climate change. Numerous studies have documented how the disinformation industry has for long been threatening science and scientists with targeted attacks, producing well-funded, sophisticated and ultimately effective approaches to reduce the perceived robustness and reliability of research-based evidence on climate change (Dunlap and McCright, 2011; Freudenburg and Muselli, 2013; Lewandowsky et al., 2015; Washington, 2013). Clearly, such organised efforts to spread doubt about the reliability of scientific data form a strategic and theoretically informed approach. Empirical research has, in fact, demonstrated that the acceptance of science, and particularly of the existence of a scientific consensus on climate change, are critical predictors of support for regulation (Ding et al., 2011). Hence, by mobilising informational capital to weaken the public's trust in science, malicious actors can influence public opinion and significantly delay environmental policy processes (Björnberg et al., 2017)

The previous Chapter of this research analysed the use of naming and shaming as a direct, peer-produced approach to disinformation reduction, where radical climate movements contrast disinformation by creating a reputational risk to disinformation creators. In this

Chapter, I turn to the analysis of an approach to contrasting horizontal misinformation on climate change within online spaces: the use of science-based counternarratives. Drawing from Tuck (2016), Lundholt et al. (2018), and Chung et al. (2021), I define science-based counternarratives as 'any narrative that offers an alternative to false or harmful scientific information through fact-bound arguments or alternative viewpoints, *de facto* contrasting the diffusion of contrarian and anti-science rhetorics through the diffusion of scientific arguments'. Within this work, this peer-produced informational dynamic is analysed in light of two supporting theoretical underpinnings. First, as documented by Goldberg et al. (2019), exposure to scientific evidence and science-based information cascades can improve acceptance of climate science, and it follows that an enhanced presence of scientific evidence can reduce the circulation of false information (Scheufele and Krause, 2019). Second, mass scientific counternarratives can serve as a form of pre-bunking and inoculation, enabling the public to better identify false information and to spot valid information, ultimately resulting in an improved information quality and reduced circulation of false information (Compton et al., 2021; Maertens et al., 2020; van der Linden, 2019).

Perhaps because of their volatility and ill-defined nature, science-based counternarratives as a form of misinformation reduction have been given little attention in the literature, both within and without the realm of climate change communication. This is a crucial gap in understanding the epistemic function that climate movements play, and in particular, in understanding how peer-produced counter information, whether science-based or not, could be used as a force of misinformation-reduction. To address this research gap, this Chapter returns to the previously described data set of $\approx$ 250k unique English-language Facebook posts produced by Extinction Rebellion and Fridays for Future, using techniques from natural language processing to isolate, measure and analyse the use of counternarratives to the four most common forms of scientific climate change denial. Ultimately, this process allows for an assessment of this communication tactic as a form of indirect misinformation reduction in the online communication of the two movements. Notably, this study into the use of science-based counternarratives will not rely on a general search of this communication strategy. Instead, this communication strategy will be mapped by training a SeededLDA model to recognise counternarratives to the four most common strands of climate science denial: trend, attribution, impact and consensus. The part of the theoretical framework that this Chapter addresses is highlighted in Figure 4.1.

This Chapter aims to fulfil three essential research objectives connected to the theoretical framework that informs this work. The first objective (1) is to quantify how the two movements under analysis integrate science-based counternarratives in their online communication. This involves filtering science-based counternarratives and measuring their overall
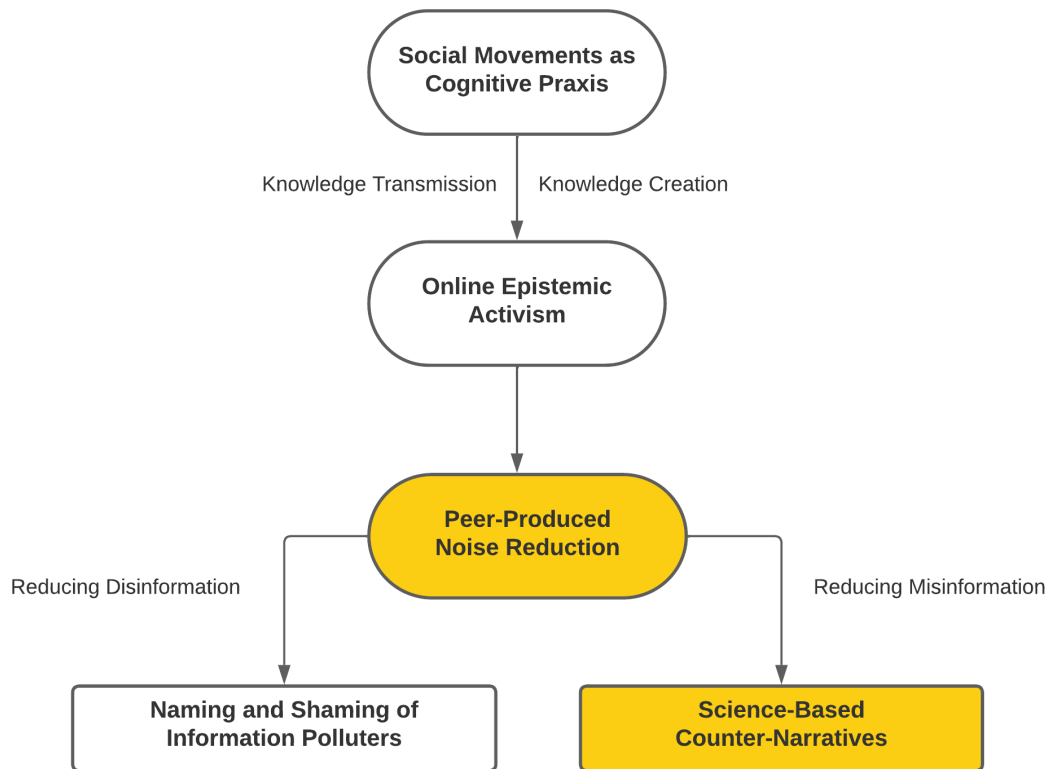
Fig. 4.1 Theoretical Framework that Informs this Work

frequency. The second objective (2) consists of assessing the performance and sentiment of each science-based counternarrative, mapping which such arguments perform better among the message receivers, i.e. the public, and what is the sentiment that emerges from this form of communication. The third and final objective (3) is to form an in-depth understanding of the content of posts containing science-based counternarratives. Ultimately, answering these three questions will provide an initial comprehensive measurement of how radical climate movements resort to science-based counternarratives in their communication, and by connecting such findings to the current theoretical understanding of frameworks of misinformation reduction, it will be possible to draw broader conclusions on the potential effectiveness of such strategy as a form of misinformation reduction, an element which is not quantitatively measured in this work.

In order to address the objectives outlined above, this Chapter is structured as follows. Section 2 presents a detailed overview of the definition of science-based counternarratives to then highlight the theoretical foundations that suggest that such narratives may act as a form of peer-produced misinformation reduction. Then, Section 3 proceeds to the primary

analysis of this work, detailing the extraction approaches used and illustrating the empirical findings relating to each of the three research questions. Finally, Section 4 discusses the most significant findings of this analysis, offering conclusions on how analysing this mechanism completes the understanding of the theoretical framework presented in Chapter I.

4.2 Science-Based Counternarratives and Scientific Climate Change Denial: An Overview

With the advent of the internet age, the diffusion of easily accessible platforms of peer-to-peer information diffusion has made it increasingly easy for online users to aggregate, share information and form epistemic communities around topics of interest (Jeffres et al., 2012; Vähämaa and West, 2014). The convergence of users into epistemic communities is somewhat embedded within the very architectures of social media platforms, which are often devised to drive aggregation, incentivising users to form informational communities within online spaces (Dolata and Schrape, 2016; Wischmeyer, 2019). Ultimately, this shift, triggered by the emergence of free platforms of horizontal information sharing, led to an evident democratisation of information acquisition processes, where users are increasingly exposed to information derived from peers rather than from more vertical sources (Das and Ahmed, 2020; Taylor and Gibson, 2017).

In itself, this epistemological development is a welcome one, as, in principle, increased peer-to-peer information diffusion can improve public knowledge, information pluralism and even information quality (Cao et al., 2013). However, several authors have noted the threats presented by this historical shift in information acquisition, as social media users can now be exposed to potentially unlimited amounts of unverified information with various levels of accuracy (Alcott and Gentzkow, 2017; Lee, 2019). Eventually, this development turned social media platforms into a modern informational battlefield, where competing sources and types of information clash. On the one hand, accurate information can circulate, improving access to information (Boyd, 2010; Tucker et al., 2017). However, at the same time, malicious actors can compete to influence individuals' attitudes and behaviours through misleading, false information (Latimore, 2018; Peters, 2018).

In light of this conceptual framework of an ongoing information war (Blank, 2008; Miller, 2019) in recent years, the use of social media to horizontally spread false information has garnered significant attention (Haigh et al., 2018). In particular, studies have outlined how climate change contrarians have devised and disseminated sophisticated and rhetorical

narratives on social media, using this strategy to increase public buy-in in numerous false arguments. These include the claim that climate change policies would do more harm than good (Coan et al., 2021; Dunlap and McCright, 2011; Haltinner and Sarathchandra, 2021) and that climate science is inconsistent or unreliable (Allen and McAleer, 2018; Treen et al., 2020).

However, while the characteristics of this informational threat are evident, far less is known as to how such misinformation flows can be contrasted within social media platforms through competing information, that is, by circulating valid and reliable information. Nevertheless, the idea that bottom-up information flows - particularly through activism - could build counternarratives to challenge misinformation is not a far-fetched one. This dynamic has been analysed extensively outside the discipline of climate change communication, where several authors have studied how online communities - particularly marginalised ones - can effectively use social media to produce counter-information flows, challenging narratives considered detrimental to the public (Jackson et al., 2020). For example, Reynolds and Mayweather (2017) analysed how marginalised black students used online counternarratives to challenge racism and repression in a University setting, while Van Eerten et al. (2017) have assessed the use of online counternarratives to prevent radicalisation, suggesting a high-effectiveness for this approach. Moreover Williams et al. (2015) highlighted how activists are particularly effective communicators compared to sceptics, with significant potential to reach vast audiences and effectively shape information environments, a theory that is clearly endorsed and reinforced by Jackson et al. (2020).

The rest of this Section will be dedicated to reviewing the literature on counternarratives and scientific climate change denial, assessing the current status of this field, and drawing conclusions on the main research gaps. First, this Section will clarify the meaning of narratives and counternarratives in order to develop a working definition of science-based counternarratives used in this work. Second, it will present the current evidence of the use of counternarratives as a positive epistemic force that triggers informational and political change. Third, this Section will present the theoretical foundations that explain the impact of this communication strategy as a form of misinformation reduction. Finally, it will outline the four historically most relevant narratives of scientific denial of climate change that shape the subsequent empirical analysis. This will provide a solid basis for measuring Extinction Rebellion and Fridays for Future's use of science-based counter-narratives, which will be carried out in the rest of the Chapter.

4.2.1 Defining Narratives and Counternarratives

Over the last three decades, there has been a growing interest in studying the use of narratives by individuals and groups (Goodson and Gill, 2011), in what many social scientists call the 'narrative turn' '(Czarniawska, 2004; Polkinghorne, 1988). However, despite increasing interest in the social use of narratives, the conceptualisation of this term remains notoriously controversial, as the term narrative is often used differently in several areas of literature (Ryan, 2007).

Over time, several authors have tried to develop a high-level generalisation of this term, leading to a wealth of different definitions. Labov (2010), for example, defines narratives as 'one method of recapitulating past experiences by matching a verbal sequence of clauses to the sequence of events that actually occurred', while Abbott (2021) defines narratives as 'the representation of events consisting of story and narrative discourse, where a story is an event or sequence of events, and narrative discourse is those events as represented'. While delving into the definitional intricacies of the concept of narrative is beyond the scope of this work, it is essential to provide some insights into what most of such definitions share to create a broad outline of what constitutes a narrative.

Ultimately, a review of the literature reveals that many definitions of the term narrative are founded on the principles of sequence and consequence (Riessman and Quinney, 2005; Taylor, 2006). To form a narrative, events are selected, organised, connected and evaluated as meaningful for a particular audience (Hinchman and Hinchman, 1997; Riessman and Quinney, 2005). In this sense, a narrative is dynamic, not static, as a narrative cannot be a simple description of events but rather a sequential and consequential view of one or more events. For example, as explained by (Franzosi, 1998), sentences such as 'Joan took her plane at 5 pm' and 'Peter drove to the airport at 8 pm' would not constitute a narrative but a simple description of facts. However, if a logical connection is established between the two sentences, such as 'They had both been looking forward to spending the weekend', the consequential and logical connections would make these sentences into a narrative. In view of this, it is now possible to converge on a working definition of this term, which, based on Czarniawska (2004), is hereby defined as 'a spoken or written account of an event/action or series of events/actions that are chronologically and logically connected.'

Having defined the term narrative, it is now possible to turn to the analysis of the term counternarrative, which is the focus of the communication strategy examined in this Chapter. Traditionally, a counternarrative is intended to be the opposite of a dominant narrative (Given, 2008). Mora (2014), for example, defines counternarratives as 'the narratives that arise from

the vantage point of those historically marginalised, and according to the author, 'counter'
implies a space of resistance against traditional dominance. This view of counternarratives
as opposition to a dominant narrative is often found in the literature. Mauro (2020), for
example, uses this conceptualisation of narratives and counternarratives to examine how
sports celebrities can use social media to challenge the mainstream racialisation of immigrants
in sports. Similarly, Abebe et al. (2021) use this conceptualisation to discuss and challenge
mainstream narratives focusing on Africa's lack of education, training and technological
resources.

In recent years, however, a new perspective on what constitutes a counternarrative has
made its way into academic research. In this view, a counternarrative is often seen as any
narrative aimed at deconstructing or delegitimising another narrative, even if the target
narrative is not dominant (Tuck, 2016). This new vision of what makes a counternarrative
is perfectly summarised by Lundholt et al. (2018), who define a counternarrative as 'a
narrative that takes meaning through its relationship with one or more narratives'. While this
relation is not necessarily oppositional, it always involves a stance toward another narrative.
Hence in this view, any narrative based on a relationship to another narrative is considered a
counternarrative, no matter the dominance of the target narrative in the public discourse. This
novel view offers an optimal framework to study harmful online content and misinformation,
focusing more on a narrative's effects rather than its dominance. In fact, it can be argued that,
on various social and political matters, false and harmful narratives are not *per se* dominant
in the sense that they are not shared by the majority of the online community. Nonetheless,
the impact of these narratives on society's democratic order is significant.

Following this interpretation of what constitutes a counternarrative, I propose the fol-
lowing working definition of the object of this research: science-based counternarratives.
Drawing from the work of Tuck (2016), Lundholt et al. (2018), and Chung et al. (2021),
science-based counternarratives are here defined as 'any narrative that offers an alternative
to false or harmful scientific information through fact-bound arguments or alternative view-
points, *de facto* contrasting the diffusion of contrarian and anti-science rhetorics through
the diffusion of scientific arguments.' It is through the lens of this definition that Extinction
Rebellion and Fridays for Future's use of this strategy will be analysed in this Chapter. As
noted by Chung et al. (2021), counternarratives have great potential to offer a non-negative
response to harmful content, contrasting the target narratives through positive arguments.
Ultimately, science-based counternarratives can reveal an alternative view of the problem
and, ideally, lead to a new appreciation and rethinking of the topic.

It should be noted that in the literature on misinformation and harmful content moderation, the term countenarrative is used almost interchangeably with the term counterspeech, which is often described as a mechanism in which hate speech and harmful discourses are contrasted with more speech (i.e. counterspeech). The idea of counterspeech has been analysed in relation to numerous social issues such as genocide prevention (Benesch, 2014), the protection of ethnic minorities (Miškolci et al., 2020), and the contrast of violent extremism (Briggs and Feve, 2013).

4.2.2 Counternarratives as a Positive Epistemic Force: Lessons from the Literature

The study of counternarratives as a field of research is still young (Buerger, 2021), and surveying the literature, it appears that there is only a limited amount of existing research on counternarratives and counterspeech as a force of epistemic change on controversial scientific and political debates. This Section provides an overview of these studies, analysing the main examples of how counternarratives have been used to produce an epistemic change in the past and discussing the key elements that make counternarratives a relevant tool for contrasting misinformation. As mentioned in the previous Section, the terms counternarratives and counterspeech are often used interchangeably in the literature, and for this reason, this Section will analyse research resorting to any of these two terms.

As a starting point, it should be clarified that the majority of the work on counternarratives and counterspeech so far focuses on combating hateful or extremist speech on social media platforms (Munger, 2017). For example, Poole et al. (2019) used the conceptual framework of narratives and counternarratives to analyse the bottom-up contrasting of racial hate after the March 2016 terror attacks in Brussels, suggesting that on that occasion, the public successfully used hashtag activism and online counternarratives to contrast Islamophobic sentiment. Similarly, Schieb and Preuss (2016) used this approach to analyse racism and xenophobia on Facebook in Germany after the 2015 refugee crisis that hit the European continent and found that counternarratives can significantly reduce hate speech. In this study, the authors claim that counternarratives can not only prevent a particular online audience from drifting towards extremism but that it is even possible to influence the audience in the opposite direction, albeit only slightly. This finding is supported by Carthy and Sarma (2021), who found, in an experimental setting, that offering tailored anti-terrorism counternarratives can significantly reduce radicalisation.

While the study of counternarratives to contrast hate speech and violent extremism remains an active research field, in recent years, there has been a visible spillover of the study of this strategy in the realm of information and misinformation from both a theoretical and empirical perspective. Numerous scholars have noted the potential of this strategy in reducing false information. For example, Levinger (2018), in his exploration of political disinformation campaigns such as Russian propaganda, suggests that disinformation campaigns should be fought on their own turfs, 'not only by refuting falsehoods with facts but also by opposing the propagandists' master narratives with coherent and compelling counternarratives that can motivate constructive collective action'. Similarly, in his analysis of how to improve security in the post-truth era, Vasu et al. (2018) recommend that counternarratives that challenge fake news 'must be released expeditiously, as fake news can spread en masse at great speed due to technology.'

From an empirical perspective, perhaps the earliest analysis of counternarratives to reduce misinformation comes from Khaldarova and Pantti (2016), who assessed how the internet allowed the Ukrainian public to create counternarratives to challenge and debunk false narratives created by the Russian state-owned media. Specifically, the authors analysed the *StopFake* campaign and how the latter produced numerous counternarratives against Russian propaganda, although this study does not measure the impact of such narratives. Furthermore, several studies have researched anti-misinformation counternarratives generated around the COVID-19 pandemic in the past two years. For instance, Gupta et al. (2022) used a computational approach to analyse counterspeech as a way of curbing the COVID-19 infodemic, finding that this approach has significant potential to expose social media users to real news, enhancing their desire to acquire and spread correct information. Similarly, Hoyle et al. (2022) analysed COVID-19 disinformation originating from Russian media, concluding that the tailored use of counternarratives can bolster societal resilience to misinformation. While the use of counternarratives to contrast false information has clearly gained popularity in recent years, notably, no study has applied this conceptual framework to climate change disinformation or misinformation.

Furthermore, after describing the historical use of counternarratives, it is worth spending some time describing the critical points that, according to literature, make this strategy a viable and valuable tool for combating harmful online content. First (1), as noted by Wright et al. (2017), counternarratives 'require neither law nor institutions', and can be practised by almost anyone. In this sense, this approach offers a cost-effective, democratic channel to contrast the diffusion of harmful content (Bartlett and Krasodomski-Jones, 2015; Swannie, 2021), which requires no regulatory planning and implementation. Indeed, this does not

mean that regulatory interventions should be frowned upon, but rather that this approach could provide a supplementary effort in contrasting this phenomenon.

Second (2), reducing the circulation of harmful content through counternarratives and counterspeech poses minimal ethical implications compared to many regulatory alternatives (Schieb and Preuss, 2016). For example, according to Howard (2019), top-down regulation of information flows often opens up the possibility of abuse of state power, where states are left to decide which content should be allowed on online platforms. On the other hand, contrasting harmful content through counternarratives and counterspeech preserves freedom of expression, avoiding the ethical complexity of top-down regulation of information environments.

Third (3), the literature shows that counternarratives can contrast harmful speech while shifting attitudes away from polarising and extreme communicational behaviours (Bromell, 2022). Tuck (2016) suggest, for example, that the work of YouthCAN (Youth Civil Activism Network) in creating counternarratives against hate speech has succeeded in visibly reducing the drift towards extreme positions. Similarly,Borrelli et al. (2021) found in their analysis of how counternarratives shape affective polarisation - defined as the extent to which opposing groups disagree - that this approach can effectively reduce polarisation around political debates, especially if it is implemented quickly after harmful information begins to circulate.

Fourth (4), numerous authors noted how counternarratives offer an optimal channel to integrate peer-produced knowledge to contrast harmful or misleading content, allowing the public to (re)shape online debates. For example, Trevisan (2017) discusses how advocacy techniques can involve creating counternarratives by crowdsourcing information, organising and disseminating information online, while Rizzo (2019) describes how marginalised migrant communities can build crowdsourced counternarratives to contrast negative public perceptions. Through this mechanism, online communities can form shared knowledge and use it to influence online debates (Bruckman, 2022). Further, it should be noted that social movements can be a particularly effective vector of counternarratives, as they are naturally equipped with the structure to gather crowdsourced knowledge as well the epistemic power and practises to disseminate counternarratives (Burke, 2018; Grabe and Dutt, 2015; Parsloe and Holton, 2018).

Last, a final reflection should be dedicated to the relationship between counternarratives and social media platforms, with particular attention to the platforms in which counternarratives have been identified and analysed. As previously mentioned, most of today's harmful and misleading content circulates on social media platforms (Scheuerman et al., 2021), and it is only natural that the study of counternarratives should focus on such platforms.

Nevertheless, it is important to discuss which platforms have historically been the focus of counternarratives research. At first glance, it is evident that most studies on counternarratives and counterspeech focus on Twitter. For example,Khaldarova and Pantti (2016)'s study of the Ukrainian Stopfake movement concentrates on Twitter, as well as other studies such as Morrison (2019), Parsloe and Holton (2018), and Boullier et al. (2021), to mention a few. It is interesting to note that Twitter itself published a blog post in 2016 discussing the power of positive counternarratives to improve online debates (White, 2016), suggesting that the platform may view this channel as a promising one to contrast the circulation of harmful content. In this post, Twitter's head of public policy, Karen White, writes that:

> Counter-narratives tell a positive story. They point to a brighter path for those who feel isolated and disillusioned with their lives. They create a sense of community. Moreover, counter-narratives can have a big impact, as attested to by the United Nations this month in their Action Plan to Combat Extremism.

On the other hand, Facebook, the platform analysed in this research, has only sporadically been the target of counternarratives research. Studies using Facebook data include Speckhard et al. (2018), who analyse how counternarratives on Facebook have contributed to delegitimising ISIS, while Van Eerten et al. (2017) analyse how counternarratives on Facebook contribute to counter radicalisation. However, research on the latter platform has been infrequent in comparison with Twitter. While the causes for this difference may be multiple, it should be noted that until recently, Twitter offered significantly easier access to data, as Facebook only introduced a programme to guarantee data access for research in 2020. This may partly explain the difference in research interest between the two platforms. Finally, other platforms have occasionally been used as the object of counternarratives research, including Instagram (Skrubbeltrang et al., 2017), Reddit (O'Neill, 2018) and Youtube (Speckhard et al., 2018).

Before turning to the examination of science-based counternarratives as a form of bottom-up misinformation reduction, it is necessary to provide the theoretical groundwork for why this communication approach is expected to contrast the spread of false information. Notably, the bulk of research on techniques to combat online misinformation has been conducted in the field of cognitive psychology, which studies how people react to misinformation and attempts to correct it (Lewandowsky et al., 2012; Treen et al., 2020). In their review of the current research on solutions to address online misinformation, Fernandez and Alani (2018) identify four broad approaches to contrast this phenomenon. These approaches are: inoculating against misinformation (1), responding with facts and correct information (2),

early detection of malicious accounts (3), and the use of ranking and selection mechanisms (4). Strategies 1 and 2 are fundamental to understanding science-based counternarratives and will be used as a starting point for understanding why counternarratives could serve as a channel of misinformation reduction.

Over the past 50 years, inoculation theory (1) has emerged among the most consistent and reliable methods to create resistance to persuasion and propaganda (Banas and Rains, 2010; McGuire, 1970), and more recently, the idea of using inoculation to protect the public against online misinformation has been proposed extensively in the literature (Traberg et al., 2022). In particular, authors have suggested using this approach to reduce online misinformation in areas such as public health (Compton et al., 2016; Motta et al., 2021; Scott, 2021) and climate change (Cook et al., 2017; Maertens et al., 2020). In principle, the idea behind pre-bunking and inoculation is that, similarly to biological vaccines, exposing people to a weakened dose of misinformation together with a compelling counterargument can slowly build up cognitive resistance against misinformation. Within this communication paradigm, communicators recognise the potential for the public to be misinformed about an issue and attempt to provide them with information to the contrary (Maertens et al., 2020).

While the use of inoculation and pre-bunking to reduce misinformation has never been tested on a large scale and has mainly been studied in experimental settings, numerous studies have produced promising results on the potential of this approach to reduce misinformation. For example, Maertens et al. (2020) measured consensus acceptance in an experimental setting by using inoculation-based interventions, finding that after a week from the exposure to inoculation, inoculation provides almost complete protection against misinformation. Similarly, Roozenbeek and Van Der Linden (2019) tested the idea of gamified inoculation (Basol et al., 2020) by developing a 'fake news game' where participants are tasked with creating a news article on a highly politicised issue using misleading tactics from the perspective of fake news producers. Results from the study proved that exposing users to the misleading tactics used by creators of false information significantly reduces acceptance of false information. Further, studies have demonstrated that inoculating the public against misinformation can also enhance perceived interest in a topic and the treatment receiver's interest in the topic (Compton and Pfau, 2009; Parker et al., 2016).

Of course, inoculation should be seen as a broad approach rather than a fixed formula, and in this sense, scientific counternarratives fit into this framework as an open and proactive way to fight online misinformation. For example, this view is proposed byAstuti et al. (2022), who write that counternarratives can 'be part of inoculation strategies to enable people to identify hoaxes/misinformation and spot valid information'. In this scenario, counternarratives can

create consistent information flows to mass-inoculate the public, with the potential of yielding results similar to the experiments mentioned above (Van Eerten et al., 2017). Furthermore, various authors have examined the best routes of communication for delivering inoculation treatments, and social media is frequently cited as a potentially effective avenue (Islam et al., 2021; Vraga et al., 2019). This is because, as noted by Vraga and Bode (2020), through this approach, it is possible to simultaneously reach individuals who hold false beliefs as well as more general audiences that merely witness a correction on social media without being directly engaged in the interaction. This can occur, for example, when individuals see someone sharing misinformation being corrected by another user. Ultimately, it can be said that in this scenario, social movements are situated in an ideal position to mediate scientific ideas to mass-inoculate the public on scientific issues such as climate change. However, at the moment, research on the intersection between social movement studies and inoculation is quite limited. Yet, this connection was recently analysed by Waling (2022), who discussed how the #Metoo movement could act as a channel to inoculate the youth against toxic masculinity.

The second broad approach relating to how counternarratives can reduce misinformation was labelled by Fernandez and Alani (2018) as 'responding with facts and correct information' (2) and, in this case, refers to the function that science-based counternarratives play in spreading large volumes of mediated scientific knowledge. Specifically, research shows that being misinformed is a function of a person's ability and motivation to spot false information (Scheufele and Krause, 2019), a concept known as motivated reasoning (Druckman and McGrath, 2019), but also of numerous other group-level and societal factors that increase the chances of citizens to be exposed to correct and corrective information. Amongst these group-level and societal factors, exposure is a key one, as it is known that exposure is a significant predictor of individual beliefs, suggesting that the content to which we are most exposed clearly shapes our thinking (Hwang and Jeong, 2021; Lee et al., 2020; Lewandowsky, 2021). In this context, epistemic communities, such as social media ones, can, by exposing individuals to varying types of information, influence individual-level beliefs.

As Jardine (2019) pointed out, in this type of information scenario, meeting misinformation based-messages with scientific counternarratives can positively affect internet users' perceptions. For example, the public's likelihood to believe in climate change misinformation is reduced if exposure to that misinformation is quickly compensated by countering narratives that point to the climate change consensus that exists within the scientific community (Cook et al., 2017). Theoretically, this type of mechanism is at least partially explained by the phenomenon of information cascades, an epistemic heuristic where within social media platforms, individuals make similar decisions in a sequential manner (Galuba et al., 2010;

Jalili and Perc, 2017). For example, whenever a highly influential node in a given network spreads misinformation, it is likely that via information cascades, many other notes within the network will adopt the same belief. In this scenario, however, the opposite also holds true. As Vicario et al. (2019) suggested, counternarratives can produce positive information cascades, potentially leading to successful misinformation containment via 'good cascades' that compensate for the circulation of 'bad cascades'. Clearly, science-based counternarratives can play into this framework, increasing the chances of citizens being exposed to corrective and corrective information, creating positive information cascades that can reduce the circulation of misinformation within online epistemic networks.

A final theoretical point that connects to the idea of contrasting misinformation with the circulation of facts and correct information is the concept of information insufficiency. According to this theory, the extent to which an individual seeks or avoids acquiring information is influenced by the perception of information insufficiency, that is, the perceived gap between one's current knowledge and what the individual perceives should be known on a given topic. Normally, whenever individuals feel they are no longer information insufficient, they will stop actively seeking new information - and often, they will attempt to avoid information altogether - reducing the probability of any changes in their beliefs (Hwang and Jeong, 2021; Kim et al., 2020; Lee et al., 2021). In this scenario, the mass circulation of science-based counternarratives is essential, as it increases the chances that online social media users will incidentally be exposed to correct information before they are exposed to misinformation, increasing the chance they will feel 'information sufficient' before being exposed to significant amounts of misinformation. This point is especially important concerning scientific narratives, as scientific acceptance is considered a key gateway belief on climate change. For example, Van der Linden et al. (2015) and Van der Linden et al. (2019) demonstrated that acceptance of an existence of a scientific consensus on climate change is a crucial predictor of support for climate action.

4.2.3   Four Master Narratives of Scientific Climate Change Denial

Finally, before turning to the assessment of how Extinction Rebellion and Fridays for Future use science-based counter-narratives, it is necessary to present the main arguments and rhetorical techniques that have been historically used by climate science deniers, as these very narratives will be used to identify and extract science-based counternarratives. Indeed, the denial of the scientific basis that supports the existence of anthropogenic climate change is not an unstudied phenomenon in academia, and there is a large body of literature that examines these narratives (Dunlap and McCright, 2011; Moser, 2010; Treen et al., 2020).

In principle, it should be noted that, historically, a large portion of climate change misinformation - though as discussed in Chapter I, not all of it - has been scientific in nature. For example, in their most recent taxonomy of climate change denial, Coan et al. (2021) identified five master narratives of climate change disinformation and misinformation, which can be summarised as follows: 1) Climate change is not happening, 2) Humans are not causing climate change, 3) Climate impacts are not bad, 4) Climate solutions won't work, 5) Climate science is unreliable. Notably, four of these five narratives are based on science, while only one, claiming that climate solutions won't work, is based on policy, indicating that the majority of false narratives about climate change still revolve around disputing science. While Coan et al. (2021) 's taxonomy excludes a wide range of political denial arguments that have emerged in recent years and that were previously discussed in Chapter I, it still provides a valuable overview of the relevance of scientific denial in the climate change debate.

However, while science denial has been constant over the history of the public debate on climate change, the latter has also evolved and expanded its scope quite significantly over time. An effective starting point to discuss the main narratives of scientific climate change denial is Björnberg et al. (2017)'s review of the history of climate change denial, in which, drawing from previous studies such as Matthews (2015), Poortinga et al. (2011) and Engels et al. (2013), the authors identify the four main narratives of scientific climate change contrarianism, which are also very similar toCoan et al. (2021)'s taxonomy.

The first such broad narrative is *trend denial* (1), which is the oldest form of climate denial (Rahmstorf, 2004), and describes the claim that no significant climate change is taking place. This is perhaps the least common form of scientific climate change denial amongst the public. For example, the most recent Yale Climate Opinion Map (Ballew et al., 2019) in the United States found that 72% of US Citizens believe that global warming is indeed happening, while 14% were convinced of the opposite. Further, studies have analysed the prevalence of trend denial in countries such as Germany, where its presence was estimated at around 5% (Engels et al., 2013), and the United Kingdom (Poortinga et al., 2011), where its prevalence was identified amongst 20% of survey respondents.

The second form is *attribution denial* (2), which represents the claim that if any changes to the climate system are taking place, these are not of anthropogenic nature. As previously described in Chapter I, those who endorse attribution denial often claim that climate change is natural and that the climate has changed before and, as such, will always change, ignoring the impact of greenhouse gas emissions on atmospheric balance. Some of the most common arguments used to support this narrative are that climate change is caused by the sun or that the heating we are experiencing now is merely the heating phase of a natural cycle. This

form of denial remains relatively common, and the latest European Social Survey (Survey, 2022) found that in the European Union, 45% of the interviewed sample claimed that climate change was caused equally by natural and non-natural processes, while in the United States, 32% of the Yale Climate Opinion Map sample claimed that climate change is an entirely natural phenomenon (Ballew et al., 2019). Similarly, in Poortinga et al. (2011)'s analysis of climate change perceptions in the United Kingdom, the authors found that only 14% of respondents believed that climate change is mainly anthropogenic.

Further, the third form of scientific denial identified in these taxonomies is *impact denial* (3), which embodies the claim that while climate change is happening, this is ultimately good news, as such changes will positively affect life on earth. Impact denial often highlights the positive consequences of climate change, such as extending agriculture into higher latitudes, while ignoring the downsides that would come with it. For example, a common argument reflecting impact denial is the claim that CO_2 is 'plant food', and the higher the concentration in the atmosphere, the better. Indeed, this claim has been debunked, and studies showed that a high concentration of CO_2 in the atmosphere hurts key crops more than it helps. As mentioned in Chapter I, there is currently no survey data on impact denial, although anecdotal evidence suggests it remains common nowadays. For example, a 2020 CFACT (2020) article titled 'Watching CO_2 feed the world' claimed that CO_2 is the essence of the global food supply and that our meat, fruit and vegetables are built almost entirely from carbon dioxide and water.

Finally, the fourth form of scientific denial can be described as *consensus denial* (4) and refers to the claim that there is no scientific consensus on the causes, consequences and overall impact of climate change. Consensus denial is perhaps the most studied narrative of climate change denial in recent years (Cook, 2016; Farmer and Cook, 2013; Treen et al., 2020), and its importance largely stems from the finding that consensus is a gateway belief for support for climate action (Van der Linden, 2021; Van der Linden et al., 2015). Broadly, consensus denial is rooted in the tradition of the so-called scientific certainty argumentation methods (Freudenburg et al., 2008), a communication tactic where those who want to oppose regulation play up the role of scientific uncertainty to delay any policy action. Indeed, science is never unambiguous, and by delaying regulation until it cannot be unambiguously justified, most policies can be defeated by simply claiming that the science is uncertain. This phenomenon has been analysed extensively in areas such as harm from smoking tobacco (Brownell and Warner, 2009; Samet, 2016), football-related brain injuries (Goldberg, 2013; Trimbur, 2021) and climate change (Carlton et al., 2015; Cook, 2016; Roper et al., 2016; Supran and Oreskes, 2017). Today, consensus denial remains very much a relevant denial narrative, and the latest Yale Climate Opinion Map found that in the United States, only

57% of respondents claimed that 'most scientists think that global warming is happening', indicating that this form of denial is still quite widespread.

Together, these four narratives of climate science denial offer a comprehensive representation of the narrative approaches used over the last 30 years to deny the scientific basis that supports the existence of climate change. Interestingly, these narratives are not mutually exclusive but have sometimes been described as different stages of denialism (for example, see Nuccitelli, 2013). For instance, it can be argued that, as evidence of the existence of climate change increased, deniers began to contest attribution, claiming that even if climate change occurs, it is not anthropogenic. Then, as evidence that climate change is anthropogenic increased, sceptics moved on to claim that no adverse impacts can be expected from such changes. However, consensus denial does not easily fit into this temporal progression but instead can be considered as a sort of meta-denial that partly underlies all three narratives, as each form of denial ultimately is based on the idea that the science is unsettled.

4.2.4 Gaps in the Literature

Finally, after examining the relevant literature on counternarratives and scientific climate change denial, it is now possible to briefly summarise the main research gaps that emerged from this review.

First, the literature suggests that counternarratives have been extensively used to contrast harmful content on social media. However, while misinformation is perhaps one of the most common forms of harmful content (Banko et al., 2020), research on how counternarratives can be applied to the reduction of misinformation is limited. In particular, several authors theorised that counternarratives could be effectively deployed to contrast misinformation (Levinger, 2018; Vasu et al., 2018), but empirical evidence on the use of this strategy is scarce. As a result, today, little is known about how counternarratives, targeted and generic, are being used to contrast the spread of online misinformation. This is indeed a significant gap, as, in a scenario where misinformation is increasingly challenging to keep under control, counternarratives may offer a cost-effective and regulatory simple channel to contrast this phenomenon.

Secondly, the role of social movements as a vector of bottom-up counternarratives has rarely been explored in literature, although interest is clearly on the rise. For example,Parsloe and Holton (2018), Coticchia (2016), and Grabe and Dutt (2015) all analyse the role of social movements in producing and disseminating crowdsourced counternarratives in areas ranging from women's rights and autism awareness. However, this dynamic has never been analysed

in relation to climate change, particularly climate change misinformation. Ultimately, the literature clearly points to the fact that social movements, through their online presence and mass communication, may deploy science-based counternarratives to contrast the circulation of misinformation, a dynamic theoretically explained by theories such as that of information cascades and inoculation. However, no study has assessed or measured this dynamic.

4.3   Science-Based Counternarratives as a Channel of Peer-Produced Misinformation Reduction

4.3.1   The Extraction Of Science-Based Counternarratives

This Chapter aims to measure Extinction Rebellion and Fridays for Future's use of science-based counternarratives as a form of peer-produced misinformation reduction. For this purpose, in this Chapter, I resort to the previously described unique data set of Facebook posts generated by the two movements. These posts were collected from Crowdtangle, Facebook's own platform monitoring tool, and the data set is composed of $\approx$ 250k English-language Facebook posts collected between September 1 2018, and June 1 2021.

In terms of research design, this Chapter sets out to develop a theoretically informed computational approach to the analysis of science-based counternarratives. In this type of analysis, the most significant methodological challenge always lies in extracting the target narrative, in this case, science-based counternarratives, from a large and multidimensional corpus of text data. For this purpose, I resort to a data filtering approach based on seeded Latent Dirichlet Allocation (Seeded LDA), a semi-supervised automated content analysis model (Watanabe et al., 2022). As several recent studies have demonstrated, this approach is ideally situated to perform theory-driven analyses of narratives extracted from large amounts of text data (Ramesh et al., 2015; Tatsuya et al., 2019,?). Through the use of a seeded LDA model, it will be possible to extract, with high accuracy and relatively low computational effort, the science-based counternarratives that the two movements under analysis used to respond and react to scientific misinformation on climate change on Facebook. A flow chart summarising the data filtering process can be seen in Figure 4.2

More specifically, the first step of this filtering approach consists of creating a dictionary of seed words that will be used to train a SeededLDA model to accurately identify responses to each of the four master narratives of scientific climate change denial identified in the previous Section. To minimise researcher bias, seed words were selected through a two-
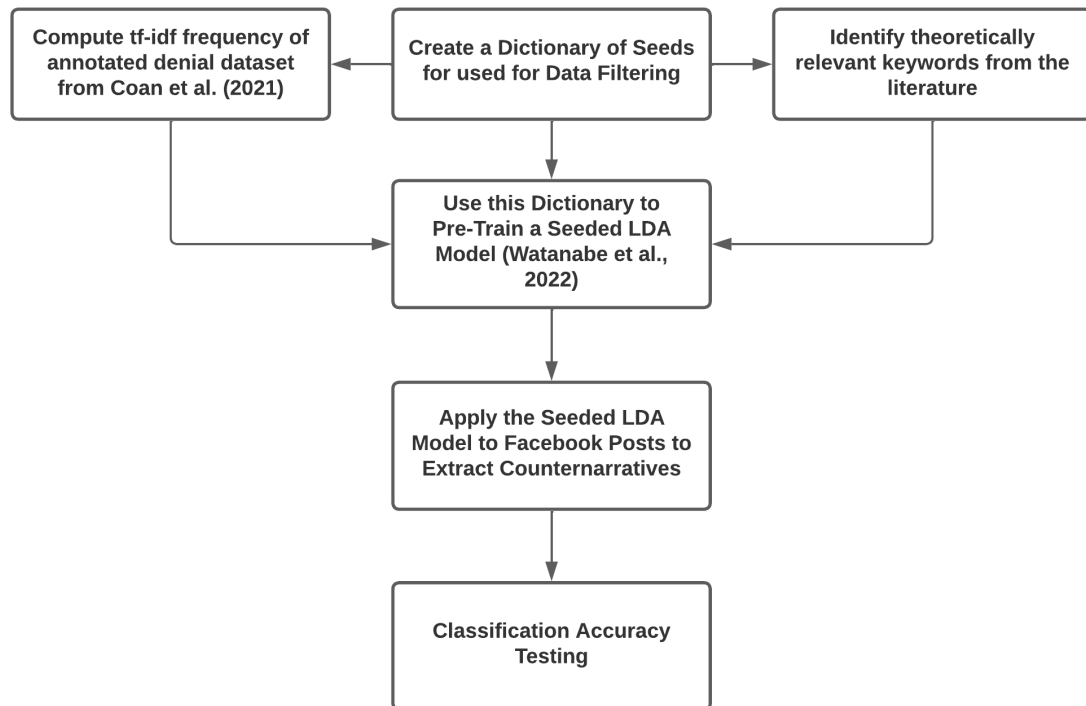
Fig. 4.2 Data Filtering Process for Science-Based Counternarratives

step process. First (1), I used an annotated data set of climate change denial narratives by Coan et al. (2021) to extract the most representative words for each narrative category. For each narrative, I computed the most representative words ranked by the highest term frequency-inverse document frequency scores (tf-idf). Tf-idf is a statistical measure used to augment simple word frequency, which allows for an assessment of the noise-free relevance of words within a collection of documents (Aizawa, 2003; Qaiser and Ali, 2018; Ramos, 2003). In practice, tf-idf is the combination of both the raw term frequency (tf) and the inverse document frequency (idf), which reduces the weight of commonly used words while increasing the weight of words not commonly used. By combining them, we can obtain the tf-idf score of a term, representing the frequency of a term adjusted by how rarely it is used.

The second step (2) consisted in integrating a list of words that were deemed theoretically relevant to identifying the target narratives, which were derived from surveying the literature on climate change denial (Björnberg et al., 2017; Cook, 2016; Krange et al., 2019). For example, I expected the word 'consensus' to be relevant to the narrative of consensus denial, although this was not classified as such in the tf-idf distribution, and in this case, the word was

Narrative	Seed Words
Trend Denial	'warming', 'hottest', 'record', 'hurricane', 'sea', 'ice', 'melting', 'storm'
Attribution Denial	'anthropogenic', 'ghg', 'greenhouse', 'mankind',' cause', 'warming', 'human', 'emissions'
Impact Denial	'impact', 'species', 'pollution' 'health', 'catastrophe', 'disaster', 'biodiversity', 'alarmist'
Consensus Denial	'consensus', 'doubt', 'models', 'reliable', 'scientist', 'denial', 'uncertainty', 'ipcc'

Table 4.1 Seed Words for Narratives of Scientific Climate Change Denial

added manually to maximise the model's accuracy. An overview of the keywords extracted through this process is shown in Table 4.1

After creating a training dictionary with the most important words for each narrative of scientific climate change denial, it is now possible to begin the data filtering process via Seeded LDA, which will be trained to recognise elements from the four aforementioned narratives of climate change denial in the communication of Extinction Rebellion and Fridays for Future: 1) trend denial, 2) attribution denial, 3) impact denial and 4) consensus denial.

However, as with all LDA-based models, the SeededLDA model must be tuned to fit the data before it is deployed. Yet, while traditional LDA requires fine-tuning of each Dirichlet Hyperparameter, usually through either k-fold cross validation of harmonic mean, in this case, the selection of hyperparameters can be quite liberal, as the algorithm is used to filter data rather than to build a topic model. For this reason, drawing from Ramesh et al. (2015), the Dirichlet hyperparameters α and η are both set at an arbitrary value of 0.01. Furthermore, it should be noted that in order to maximise the model's accuracy and specificity on a large data set , the Seeded LDA model is tuned to run with a high number of residual topics. This step is crucial as it informs the model that the narratives it seeks should only form a relatively small share of the total data.

Finally, the tuned Seeded LDA model is run in the R environment using the SeededLDA package by Watanabe et al. (2022), and this process outputs a theta (θ) matrix representing a distribution of topics over documents, where each θ score represents the percentage of a post that each topic takes. With this type of output, selecting a cut of θ value under which posts are not considered to sufficiently represent a narrative is fundamental. For example, it is evident that if a narrative only appears in 20% of a post, it might not be a good representation of such narrative. For this reason, following the best practice emerging from the literature, only posts where $\theta >= 0.51$ are considered in this analysis. Lastly, to verify the model's accuracy, 100 randomly selected posts are extracted for each narrative and are manually checked by the author using a binary classification method (0 if the post does not represent

	Classification Accuracy	
Counternarrative	**Extinction Rebellion**	**Fridays for Future**
Trend Denial	91%	89%
Attribution Denial	88%	90%
Impact Denial	93%	94%
Consensus Denial	91%	92%

Table 4.2 Accuracy Testing for the Extraction of Science-Based Counternarratives

the narrative it is assigned to, and 1 if it does fit into the correct narrative). Table 4.2 shows
the model's accuracy for both movements.

4.3.2   Frequency Analysis

The first goal of this Chapter is to quantify the extent to which the two movements under
analysis use science-based counternarratives in their online communication. This step is
critical to understanding how climate movements engage in online epistemic activism to
reduce misinformation, as it allows us to assess how frequently science-based counternarra-
tives are used and which particular counternarratives are more relevant to each movement.
The answers to these questions can be found in the data filtering process described above,
summarised in Table 4.3 below, which provides detailed insights into the proportion of
movements' Facebook posts containing science-based counternarratives. This Section will
focus on two main aspects of the frequency distribution of science-based counternarratives
(1) their aggregate use in absolute and temporal terms and (2) the occurrence and temporal
evolution of each unique counternarrative.

Counternarrative	**Extinction Rebellion**	**Fridays for Future**
Trend Denial	5,209	1,842
Attribution Denial	3,690	1,954
Impact Denial	4,516	1,388
Consensus Denial	1,693	1,070

Table 4.3 Number of Posts Extracted for Each Science-Based Counternarrative

The first point that should be addressed in the analysis of Extinction Rebellion and
Fridays for Future's use of science-based counternarratives regards the aggregate frequency

of use of this communication tactic (1). Remarkably, the output of the data filtering process shows that the two movements resort to science-based counternarratives in their online communication with moderately high frequency, as the SeededLDA model extracted a total of 15,108 posts for Extinction Rebellion (7.55% of all movement posts analysed) and 6,254 posts for Fridays for Future (12.40% of all movement posts analysed). Considering the width and breadth of the online communication of a global social movement, identifying this type of communication strategy in an average of nearly one in ten posts is quite impressive. However, this is not surprising, for, as seen in Chapter II of this research, both movements consider the integration of scientific evidence in their communication among the most fundamental pillars of their activism, which is clearly reflected in the data. It should also be noted that the frequency quantification presented in this work is a conservative one that tends towards underestimation, as, to guarantee the greatest possible methodological robustness and avoid narrative overlaps, only posts with θ values greater or equal than 0.51 were included in the data set .

Furthermore, on the point of aggregate frequency, it is essential to assess the temporal evolution of such frequency to determine how the use of science-based counternarratives has changed over time. However, before continuing to the analysis, a brief methodological clarification is necessary. To perform all temporal analyses in this Section, the timestamps of posts contained in the data set were binned by day and subsequently normalised, hence showing counternarratives as a percentage of the total daily posts for each movement, an approach commonly used when working with temporal data. Taking this precautionary step makes it possible to ensure that the temporal distribution is immune from peaks caused by increases in posting activity - such as on days with mass protest events - and instead, only show peaks that result from a raw increase in the use of this communication strategy. Furthermore, a smoothing function is applied to all temporal distributions shown in this Section using a generalised additive method (GAM) to facilitate the analysis by providing a clearer visual representation of temporal trends (Wood et al., 2016).

Figure 4.3 below shows the aggregated frequency of scientific counternarratives used in the communication of the two movements with annotations for some of the key events that characterise the most prominent peaks and lows in the distribution. A closer inspection of the figure - and particularly of the smoothed conditional mean lines - shows that, while displaying peaks and declines, Extinction Rebellion's use of this communication tactic has remained stable in the period under analysis, consistently averaging close to 7.5% of the movement's posts. On the other hand, Fridays for Future's use of science-based counternarratives has increased visibly since the beginning of the data collection process in 2018. From the chart, it can be seen that in September 2018, this communication strategy made up an average of

7% of Fridays for Future's posts, while by June 2021, this is up to 15%. These findings add a
further layer to the understanding of the aggregate data on counternarratives frequency, as it
highlights that Fridays for Future is not only more prone to use science-based counternarrative
in its Facebook posts but is also on a clear trajectory of growth, suggesting that this gap may
continue to widen over time (Wood et al., 2016).
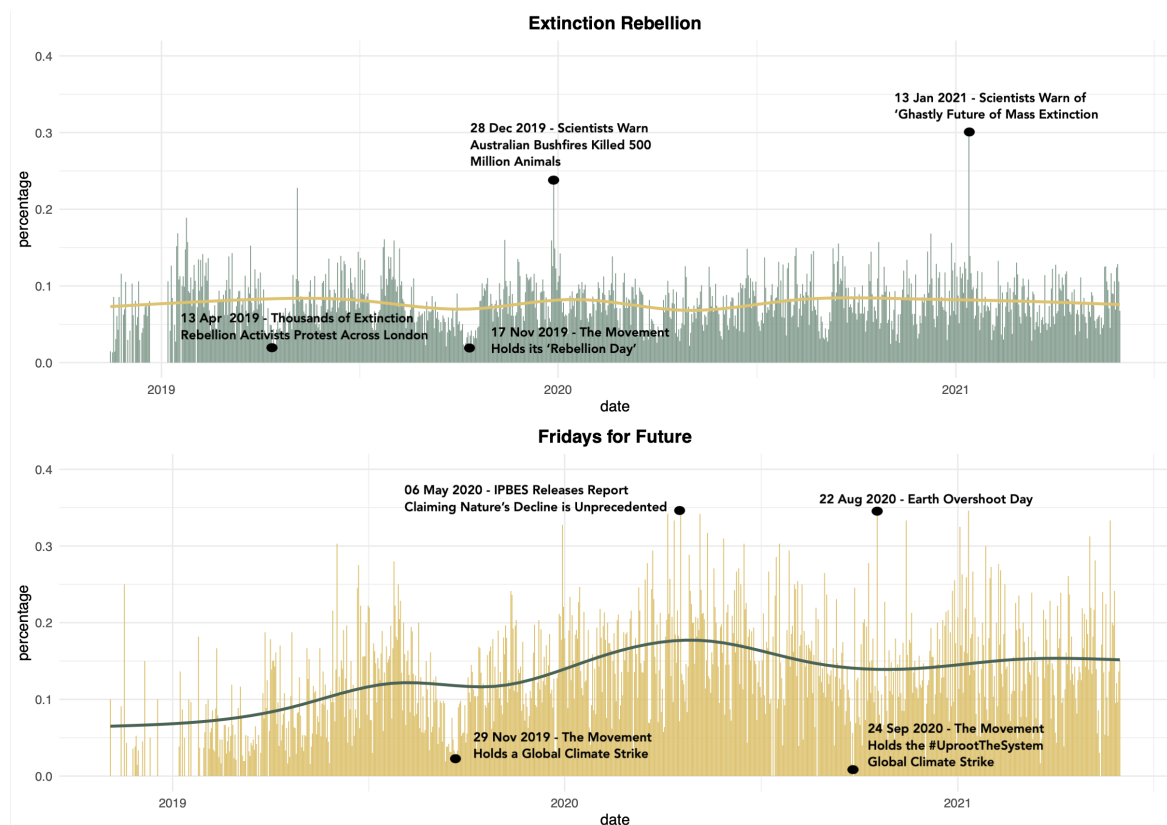
Fig. 4.3 Aggregated Frequency Distribution of Science-Based Counternarratives

Moreover, Figure 4.3 shows a large number of fluctuations in the temporal distribution,
which offer further possibilities to analyse the two movements' use of science-based coun-
ternarratives. While a full breakdown of the causes of each variation in the distribution is
beyond the scope of this study, this step of the analysis is used to briefly gauge the main
drivers of the most evident increases and decreases in the use of this communication strategy.
For this purpose, following an approach to temporal analysis outlined by Mittos et al. (2020),
the main peaks and dips in the distribution were annotated with corresponding real-world
events that happened one week before or after this temporal point. Such events were identified
by extracting the most commonly shared URLs on such dates to assess any key events being
discussed and shared by the two movements.

As can be seen from the figure, the highest frequency point in Extinction Rebellion's distribution was identified on January 13, 2021, when a staggering 30% of all posts by the two movements included scientific counternarratives. On this day, seven global climate experts, including Prof. Ehrlich from Stanford University, published a journal article warning the public about the risks of mass extinction driven by climate change, which gained considerable media attention. A further peak can be identified on December 28, 2019, when amidst a wave of deadly Australian bushfires, a group of scientists warned that such wildfires might have already killed 500 million animals. On the other hand, the lowest point in the distribution was registered on November 17, 2019, when less than 2% of all movement posts included science-based counternarratives. This date corresponds to the movement's 'Rebellion Day' when around 6,000 activists took part in a coordinated action to block London's five main bridges over the river Thames. Moreover, an additional low point was identified on April 13, 2019, the day of the movement's first full-fledged protest in London.

By contrast, the peak of Fridays for Future's distribution can be seen on August 22, 2021, which corresponds to Earth Overshoot Day 2022, representing the date when humanity has used all the resources that the planet generates in an entire year. A further peak was seen on May 06, 2020, when the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) published a daunting report claiming nature's dangerous decline is unprecedented as species extinction rates continue accelerating. On the other hand, the lowest points in the distribution can be seen on November 29, 2019, when the movement held a Global Climate Strike, and on September 24 2020, the day in which the movement held its '#UprootTheSystem' global climate strike.

Ultimately, it is interesting to note that both movement's fluctuations follow similar patterns, where science-based counternarratives are often stimulated by viral news on the adverse impacts of climate change, while at the same time, points of low activity correspond to mass protest events. This is significant, as it indicates that the use of science-based counternarratives is not common within protest events and might not form a central part of the movement's in-person protest communication.

Furthermore, the second part of this analysis consists of evaluating the occurrence and temporal distribution of each unique scientific counternarrative (2). This point of is of great importance, as it sheds lights on which forms of misinformation are more likely to be contrasted by the two movements' counternarratives. Delving into the individual model results shown in Table 4.3 above, it can be seen that in Extinction Rebellion's communication, counternarratives based on climate change trends (i.e. climate change is happening) and impacts (climate change has negative impacts) are the most common, with 5,209 and 4,516 posts

respectively. Counternarratives based on attribution (i.e. climate change is anthropogenic) come third in frequency with 3,690 posts, followed by posts on scientific consensus (i.e. scientists agree on climate change) with 1,693 posts. Turning now to Fridays for Future's distribution, it can be seen that attribution and trend-based counternarratives rank the highest with 1,954 and 1,842 posts, respectively, followed by discussions on impact with 1,388 posts and consensus with 1,070 posts.

As a whole, these findings on narrative frequencies provide a valuable overview of which scientific counternarratives are more relevant to each movement and contain some meaningful insights. First, it is interesting to note that trend-based counternarratives are quite common for both movements, indicating that both Extinction Rebellion and Fridays for Future's scientific conversations often focus on discussing the very fact that changes to the climate system are happening. Second, the data shows that impact-based counternarratives take a much larger share of total posts in Extinction Rebellion than it does for Fridays for Future. This could be expected as, as seen in Chapter II, the former movement places significant weight on concepts such as risk, urgency and extinction, which often translates into discussing the more adverse impacts of climate change. Third, perhaps the most striking finding regards consensus messaging, which ranks lowest for both movements. This finding suggests the two movements are far more likely to use their Facebook groups and pages to discuss the occurrence, causes and impacts of climate change than to focus on reducing the so-called consensus gap. This conclusion is noteworthy as it shows that, despite the fact that consensus denial remains one of the most prevalent types of climate change contrarianism (Coan et al., 2021), Extinction Rebellion and Fridays for Future seldom contrast this sort of denial with scientific counternarratives.

Turning to the temporal evolution of the individual science-based counternarratives, Figures 4.4 and 4.5 provide an overview of how the frequency of use of this communication tactic changes in the communication of Extinction Rebellion and Fridays for Future, respectively. Analysing Figure 4.4, it can be seen that while no counternarrative shows very strong temporal evolutions, out of the four science-based counternarratives used by Extinction Rebellion, attribution shows the most significant increase in the frequency of use in the period under analysis, reaching, by June 2021, a daily average of 2.6% of all posts, with peaks up to 9% of daily posts. This temporal evolution indicates that the movement is increasingly discussing greenhouse gas emissions - and possibly emitters - and how growing emissions impact the climate system, and this increase is particularly evident from the second half of 2020 onwards. Furthermore, confirming what was noted above, discussions on consensus are clearly the least common among the four narratives while also showing a steady decrease in use over time. In fact, in the early stages of the movement's development, discussions on
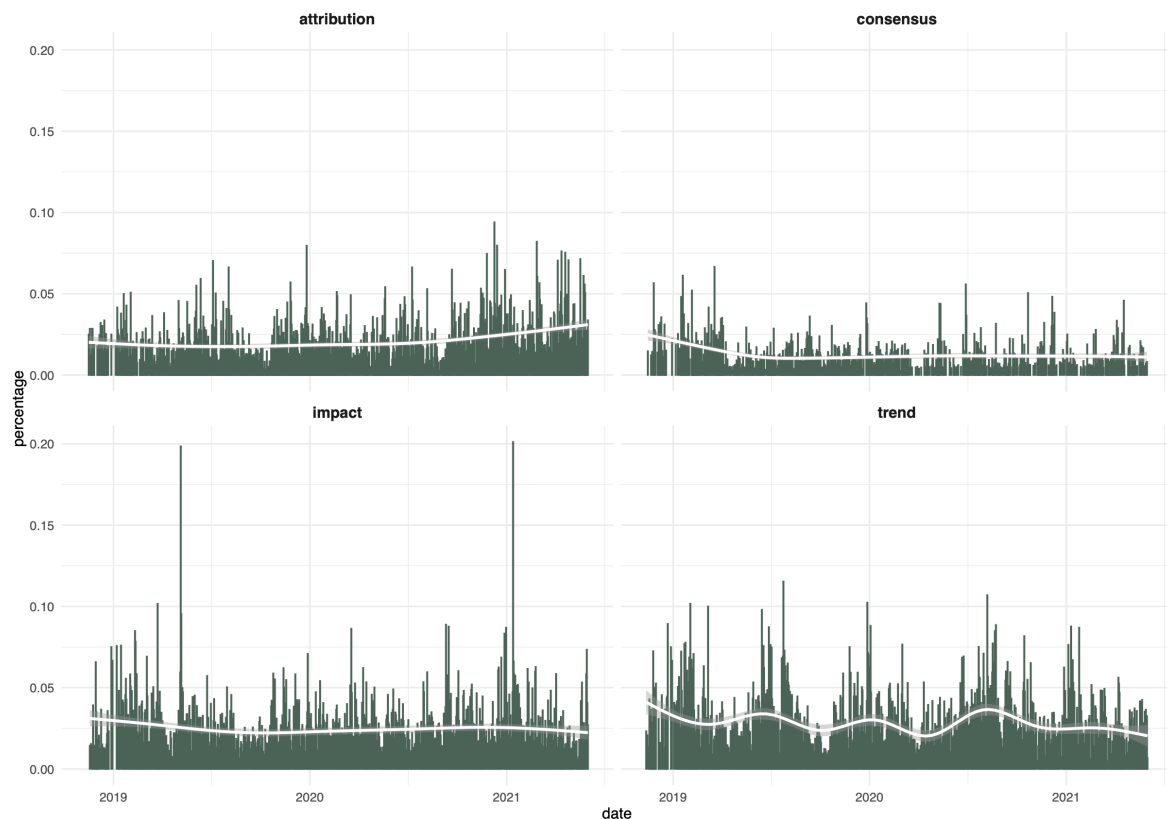
Fig. 4.4 Individual Frequency Distributions of Science-Based Counternarratives for Extinction Rebellion

consensus appeared in an average of $\approx 3\%$ of daily posts, while by 2021, this is down to $\approx 1\%$, indicating that this counternarrative is significantly losing popularity within movement activists.

In the lower side of the figure, we can see the temporal distributions for counternarratives based on impact and trend denial, which show somewhat similar temporal trajectories. While trend-based counternarratives are marginally more common, both appear to be variable - significantly more so than attribution and consensus - with distributions characterised by several sudden increases and decreases. Going back to the data and analysing the key events and URLs that characterise these peaks, it is evident that discussions on trend and impact are highly correlated with extreme weather events and new developments in climate science. For example, discussions on impact show two prominent peaks on January 13, 2021, when the aforementioned article warning about the risks of a mass extinction caused by climate change was published, and May 06 2021, when IPBES published its previously mentioned report on biodiversity and nature loss. In both cases, impact-based counternarratives reached 20% of the movement's daily posts. Furthermore, peaks in the trend counternarratives are

also very much driven by current events, and the highest peak in this quadrant, registered on July 25 2019, corresponds to the hottest July day ever recorded in the United Kingdom. While this will be outlined in greater detail later in this Chapter, the fact that the movement intensifies discussions on the impact of climate change in correspondence to extreme weather events is very significant, as it confirm the movement's role as epistemic activist, where the latter openly discusses the relationship between climate change and its impacts.

Fig. 4.5 Individual Frequency Distributions of Science-Based Counternarratives for Fridays for Future

Moreover, analysing the temporal distribution of Fridays for Future's counternarratives, it can be seen that the trajectory of attribution narratives closely resembles Extinction Rebellion's, as this counternarrative is steadily increasing over time, with peaks reaching over 20% of daily movement's posts. Once again, this confirms that both movements are increasingly discussing how greenhouse gas emissions are causing changes to the climate system and, as a result, the concept of climate-related responsibility. Furthermore, turning to the temporal distribution of consensus-based counternarratives, it can be seen how, after an initial decrease, the latter remains relatively constant over time while showing occasional peaks. On the other hand, discussions on impact and trend show once again a variable

distribution, with several highs and lows. Similarly to what was noted with Extinction Rebellion, these two counternarratives are particularly sensitive to climate science news and extreme weather events. For example, Fridays for Future's impact-based counternarratives distribution shows a dense peak in the summer of 2020, driven mainly by discussions on how extreme summer heat is melting arctic ice, indicating, once again, the movements' clear role a force of epistemic influence and misinformation reduction in the public debate on climate change.

4.3.3   Sentiment and Performance Analysis

The second goal of this analysis into the use of science-based counternarratives as a force of misinformation reduction is to assess the sentiment that each of the four counternarratives convey and to determine which counternarratives yield the best performance among the message receivers, i.e. social media users. These steps are essential, as they allow for an assessment of the emotional states that permeate from this form of peer-produced misinformation reduction, as well as a deeper understanding of which counternarratives perform best on Facebook and, as such, may be circulated and spread more widely.

In this Section, sentiment analysis will be applied at the sentence level through a lexicon-based approach (Khoo and Johnkhan, 2018; Taboada et al., 2011) to each counternarrative post extracted from the SeededLDA model. This step is performed using the R package *SentimentR* (Rinker, 2017), which, through a sentiment lexicon, computes the sentiment value for each word in a sentence while taking into account both valence shifters and sentiment amplifiers. Lexicon-based approaches require the choice of a sentiment lexicon, and after accuracy testing, Jockers-Rincker, which uses a vocabulary of 11,000 sentiment words to compute sentence-level sentiment, appeared to provide the highest level of accuracy in sentiment detection. A visualisation of the distribution of sentiment scores from both movements is shown in figure 4.6 below.

Analysing Figure 4.6, two findings immediately stand out. First, both sentiment distributions are negatively skewed, indicating that posts containing counternarratives are usually dominated by negative language. For Extinction Rebellion, 65% of all posts containing science-based counternarratives have a sentiment score below 0, while for Fridays for Future, the same applies to 58% of posts. This is generally expected, as such posts often discuss the causes and impacts of climate change, and both movements are known for their strong, urgency-based language. However, it is also visible that Extinction Rebellion's language is more extreme and potentially polarising than Fridays for Future's, with 48 posts scoring
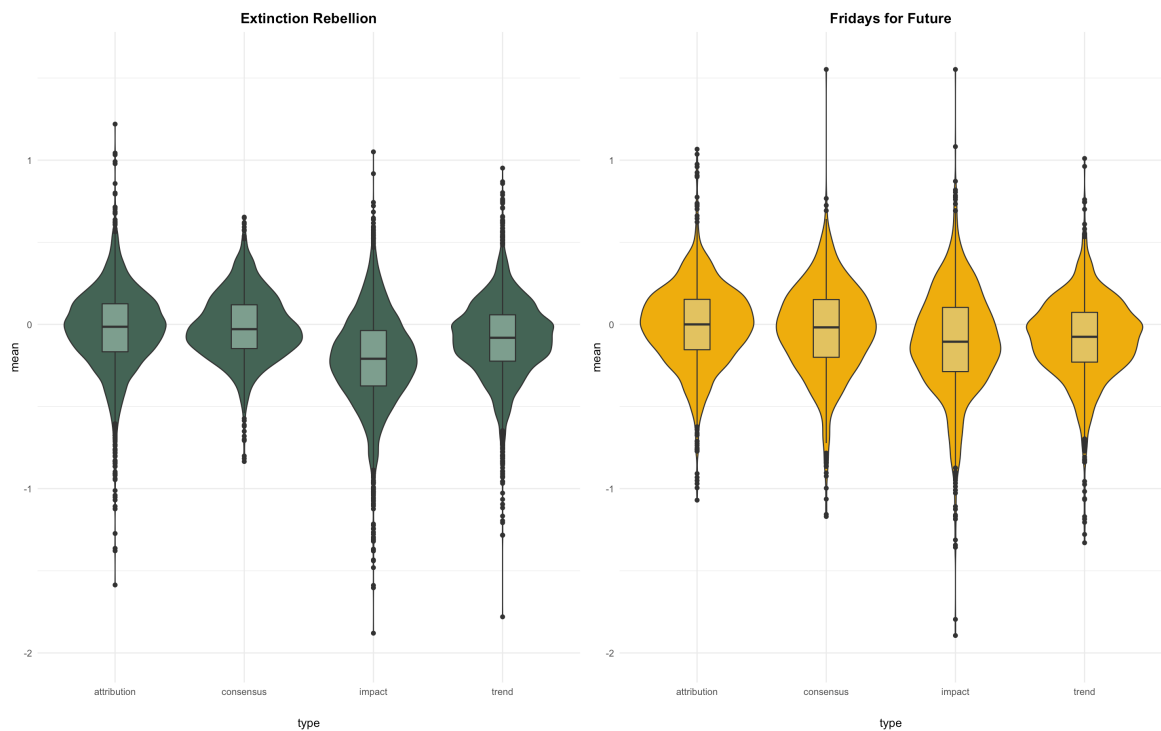
Fig. 4.6 Sentiment Analysis of Science-Based Counternarratives

less than -1.5, while 20 of Fridays for Future's posts achieved the same score range. This is significant as it indicates that Extinction Rebellion's language is potentially more polarising and more likely to cause negative emotions in the reader.

Second, the data shows that posts containing impact counternarratives exhibit the most negative sentiment across the two movements, with an average of -0.32 for Extinction Rebellion and -0.20 for Fridays for Future. As a benchmark to gauge the magnitude of this negative sentiment, it should be mentioned that Extinction Rebellion's average sentiment for the entire data set is -0.09, and the second most negative counternarrative, in this case, trend, has a sentiment of -0.16, while Fridays for Future exhibits a data set average of -0.04, and trend, the second most negative counternarrative, scores an average of -0.15. This suggests that the rate of negative sentiment of impact-based counternarratives is significantly higher than both the data set average and other science-based counternarratives.

In addition, the figure also shows that counter-narratives with impact denial exhibit the most apparent peaks of negative sentiment in the data analysed, with several posts with a sentiment score below -1.5. Qualitatively assessing these posts to understand the reasons that justify the low sentiment, it can be observed that one of the posts with the lowest sentiment

score, which comes from Extinction Rebellion, (-1.89) in this category discusses the locust
plagues that hit Africa in 20202. The post states:

> Climate induced locust swarms are putting 5 million people at risk of starvation
> - and that's without COVID-19! It's the most serious outbreak in 70 years. A
> crisis within a crisis

A further interesting negative post in the data, with a score of -1.65, this time from
Fridays for Future, discusses a study on the decline of global biodiversity. It reads:

> "Nature is under siege [and] most biologists agree that the world has entered its
> sixth mass extinction event," concludes the lead analysis in the package. "Insects
> are suffering from 'death by a thousand cuts' [and] severe insect declines can
> potentially have global ecological and economic consequences. Frightening'
> global decline is 'tearing apart tapestry of life', with climate crisis a critical
> concern

Closely analysing the text of both posts, it is interesting to observe that the negative
sentiment is the result of a negative depiction of the impacts of climate change through an
emotionally loaded language, with terms such as crisis, starvation, extinction, and frightening
to describe such impacts. While post sentiment usually is very sensitive to the use of profanity,
in this case, it is uniquely the result of strong emotional language.

Moreover, turning back to Figure 4.6 , it appears that attribution and consensus-based
counternarratives show similar patterns for both movements, where these two counternarra-
tives show the least negative sentiment, with respective average scores of -0.10 and -0.10 for
Extinction Rebellion, and -0.07 and -0.10 for Fridays for Future. Analysing the low-scoring
posts in these categories, it can be seen that compared to impact narratives, these posts are
more descriptive and scientific while still using a language that transmits urgency and distress.
For instance, a low-sentiment post in the consensus category from Extinction Rebellion (-1.1)
reads:

> We don't platform climate denial for the same reason we don't platform Flat-
> Earthism. We welcome sincere questions about the science, we welcome earnest
> critiques of our tactics, but the Earth is round, Mass Extinction is a problem,
> and Climate Change is real. Scientists who deny climate are not modern-day
> Galileos.

Once again, these posts show a clear intention to inform the public on elements of climate change science - in this case, that climate change is happening. All in all, this sentiment analysis provides critical insights into the tone and sentiment that emerges from the four science-based counternarratives under analysis, demonstrating how, in their use of science-based counternarratives, the two movements recurrently resort to emotional and negative language, particularly in the use of impact counternarratives, which represent an outlier in sentiment negativity.

Furthermore, the second step of the analysis presented in this Section assesses the post performance of science-based counternarratives. For this purpose, I use Crowdtangle's performance score, which is automatically computed for each post collected by the platform. According to Facebook's internal documentation, the post performance score is calculated by benchmarking how many interactions (shares, likes, comments and emojis) an account's posts usually get after set periods of time and comparing it with the current performance. In more detail, this process is represented by a computation where performance score = actual performance / expected performance. For example, if a post has gathered 100 interactions and its benchmark was 50, this is 100/50, yielding a performance score of 2.0x.

In this analysis, the average performance score of each of the four counternarratives used by the two movements is compared with each movement's average of the remaining data, assessing whether any such counternarratives significantly overperform or underperform. Furthermore, to ensure the integrity of the data and to reduce possible redundancies and outliers, performance data was centred and scaled using the *Caret* package in R. The results of this process for both movements and the mean sentiment scores for each counternarrative are shown in Tables 4.4 and 4.5 below.

Data	Mean Performance	Performance Sd	Mean Sentiment
Extinction Rebellion - Full	-4.32	13.28	-0.09
Extinction Rebellion - Attribution	-4.30	10.34	-0.10
Extinction Rebellion - Consensus	-7.22	13.25	-0.10
Extinction Rebellion - Impact	-3.66	12.07	-0.32
Extinction Rebellion - Trend	-4.19	11.24	-0.16

Table 4.4 Mean Performance Scores, Standard Deviation and Mean Sentiment for Extinction Rebellion - Full Data Set and Science-Based Counternarratives

Observing the two tables, it can be seen that for both movements, the performance balance of Facebook posts is negative, indicating that posts are more likely to underperform than they are to overperform. For Extinction Rebellion, the average performance value is -4.32,

while for Fridays for Future, this figure is -4.85. The poor average performance, paired with high standard deviation values, clearly indicates that the general post performance for both movements follows a pattern where a small number of posts overperforms significantly while the remainder of posts underperform.

Data	Mean Performance Score	Performance Sd	Mean Sentiment Score
Fridays for Future - Full	-4.85	14.39	-0.04
Fridays for Future - Attribution	-5.99	13.05	-0.07
Fridays for Future - Consensus	-7.19	16.07	-0.10
Fridays for Future - Impact	-8.25	14.96	-0.20
Fridays for Future - Trend	-5.23	14.09	-0.15

Table 4.5 Mean Performance Scores, Standard Deviation and Mean Sentiment for Fridays for Future - Full Data Set and Science-Based Counternarratives

Furthermore, analysing the individual performance of each narrative, it can be noted that in Extinction Rebellion's communication, impact-based counternarratives outperform the data set average by 15%, with a mean score of -3.66, indicating that the public is particularly likely to interact with this type of narrative. As previously mentioned, these counternarratives are also the ones with the lowest average sentiment, suggesting that in this instance, negative language appears to correlate with higher performance among the public. On the opposite side of the spectrum, consensus-based counternarratives significantly underperform, with a score of -7.22, which translates into -67% from the data set average.

Finally, the remaining two counternarratives, based on attribution and trend, closely mirror the data set average in both sentiment and performance, with marginal overperformances of +3% and +0.46%, respectively. These findings indicate that for Extinction Rebellion, impact and consensus-based counternarratives are two clear outliers, one positively and one negatively, indicating that while discussions on the adverse impacts of climate change show good performance among message receivers, consensus messaging appears to garner limited interest in the public.

Moreover, looking instead at Fridays for Future's post performance, it is interesting to note that all science-based counternarratives underperform the remainder of the data set by an average of -37.3%, indicating that the movement's post receivers are not, on average, prone to interacting with these posts. In particular, impact-based counternarratives yielded a mean score of -8.25, a -70% difference from the data set average. While this is indeed difficult to explain without deeper analyses of the content of individual posts, it should be noted that impact narratives exhibit the lowest average sentiment score, suggesting that within Fridays for Future's communication, negative sentiment bears the opposite effect than what

was noted above forExtinction Rebellion, where negative posts may discourage interactions among the movement's base. Finally, consensus is also a clear low performer, with a mean performance score of -7.19, a -48% deviation from the average.

Lastly, before moving on to the next Section, it is worth dedicating some space to discussing some of the characteristics of the posts containing counternarratives that tend to perform exceptionally well or poorly on Facebook. Going back to the data, it emerged that for Extinction Rebellion, the highest performing post (+364.37) was categorised as a trend counternarrative and contains an infographic discussing how industrial agriculture and climate change are reducing the world's biodiversity. This post, published by Extinction Rebellion Cumbria, was shared almost 10,000 times. Further, the second highest ranking post, classified as a trend counternarrative (+112.23), shares an article discussing the occurrence of climate change and reads:

> The level of carbon now in the atmosphere hasn't been seen in 12 million years, a
> Harvard scientist said in Chicago Thursday, and this pollution is rapidly pushing
> the climate back to its state in the Eocene Epoch [...]

Interestingly, on the other hand, the lowest ranking post for Extinction Rebellion (-202) is an impact counternarrative which shares an article titled 'Isn't Wildfires Good for the Environment?', discussing how wildfires, one of the most common impacts of climate change, may actually be beneficial for the environment. The article was most likely published to mock the author and performed very poorly. Therefore, for this movement, it is clear that the best-performing posts tend to discuss the adverse impacts of climate change.

Turning now to Fridays for Future, the movement's best performing post (+57.86) is a trend counternarrative discussing the impacts of the January 2020 bushfires published by the group Fridays for Future Greta Thunberg, and states:

> Around 480 million animals are feared to have died in the bushfires sweeping
> Australia, including nearly a third of the koalas in New South Wales's main
> habitat. Ecologists at the University of Sydney estimate around 480 million
> mammals, birds and reptiles have been killed, directly or indirectly, by the
> devastating blazes since they began in September [...]

Finally, the lowest performing post for Fridays for Future (-152) is a consensus counternarrative characterised by the widespread use of technical language. This discusses how the IPCC agrees that a total phase-out of coal is necessary to avoid human-induced global

warming and how scientists agree on the urgency for immediate action. Similarly to Extinction Rebellion, the qualitative analysis of overperforming and underperforming posts indicates that posts describing the worst impact of climate change are more likely to attract interactions and circulate widely among the online public.

4.3.4 Quantitative Content Analysis

Finally, the last step of this analysis into science-based counternarratives as a form of misinformation reduction consists in extracting and assessing the content-related information emerging from the posts under analysis. For this purpose, I apply a second layer of LDA-based topic model to the data, tuning and applying a separate model to each counternarrative used by the two movements for a total of 8 topic models.

A key feature of LDA-based topic modelling is that the quality of model implementations is highly dependent on the a priori selection of the Dirichlet hyperparameters α (alpha) and η (eta), and k, where α controls the shape of the document-topic distribution, η controls the shape of the topic-word distribution, and k controls the number of topics detected by the model (Wallach et al., 2009). For the hyperparameters α and η I use the widely accepted values of $\alpha=50/k$ and $\eta=0.1$ (Griffiths and Steyvers, 2004), while to determine the optimal value of k, I tune the models using 5-fold cross-validation comparing the perplexity scores of different models. Perplexity testing is a popular method of testing a topic model's validity, where the perplexity value measures how well a model fits previously unseen data (Anupriya and Karpagavalli, 2015; Grün and Hornik, 2011). By computing and validating perplexity in folding subsets of a training set, it is possible to estimate which value of k maximises the model's performance, improving its generalisability. In this case, the optimal k value is selected by finding the point where the marginal increase in perplexity does not justify the added model complexity. Further, as perplexity scores yielded very similar results within each movement, to maximise comparability, only one k value is selected for each movement, and these values are $k=12$ for Extinction Rebellion, and $k=10$ for Fridays for Future. The results of perplexity scoring processes can be seen in Appendix C.

Moreover, a further crucial step in topic modelling-based analyses is the interpretation of the model's output. To explore and interpret the results of the models applied to the two movements, I take a two-step approach. First, I extract FREX words for each topic, representing the top words in each cluster ranked by a mix of exclusivity and frequency (Airoldi and Bischof, 2016; Roberts et al., 2014). The FREX metric offers an insightful two-dimensional summary of topic content and has been proven to outperform similar measures

of model interpretation (Bischof and Airoldi, 2012). Second, I qualitatively analyse the posts with the highest relevance in each topic in order to assess the existence of any visible and coherent topics. The full topic modelling results can be found in Appendix C, while a visualisation of all model outputs is shown in Figures 4.7 and 4.8 below.

Analysing Figure 4.7, several findings on Extinction Rebellion's use of science-based counternarratives stand out. First, it can be seen that among trend counternarratives, the topics *Record Temperatures* and *Extreme Weather Events* are the most frequent, indicating that these two topics are the most commonly used to claim that climate change is indeed happening. Posts in these topics tend to focus on clarifying the relationship between climate change and adverse or extreme environmental impacts; for example, a high relevance posts within the topic *Record Temperatures* lists a series of the hottest ever months registered in 2019, stating:

> 2019: hottest June ever 2019: hottest July ever 2019: hottest August ever 2019: hottest September ever 2019: hottest October ever 2019: hottest November ever July 2019: hottest month ever recorded. This is an emergency.

While extreme weather events and record temperatures are the most used arguments to claim that climate change is happening, trend counternarratives also include perhaps less discussed indicators that prove that the climate is changing, such as the bleaching of coral reefs, the thawing of arctic permaforst, and the rise of global sea levels.

Second, turning to attribution counternarratives, it can be seen that the two most widely discussed topics in the data are *Net Zero Targets* and *Emission Reduction Targets*, suggesting that while claiming that humans are causing climate change, the movement largely focuses on discussing current targets and policies to limit anthropogenic emissions. A high relevance post on the topic *Emission Reduction Targets* states:

> What sort of targets did we bind ourselves to, when we ratified [the Kyoto protocol]? The main aim is the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would stop dangerous anthropogenic interference with the climate system. And the protocol sets out a timetable for the reduction of CO_2 emissions by 2020 (that's 15 months away, folks). Are we any closer to reaching this target? Seems like we're moving further and further away everyday as opposed to closing in[...]
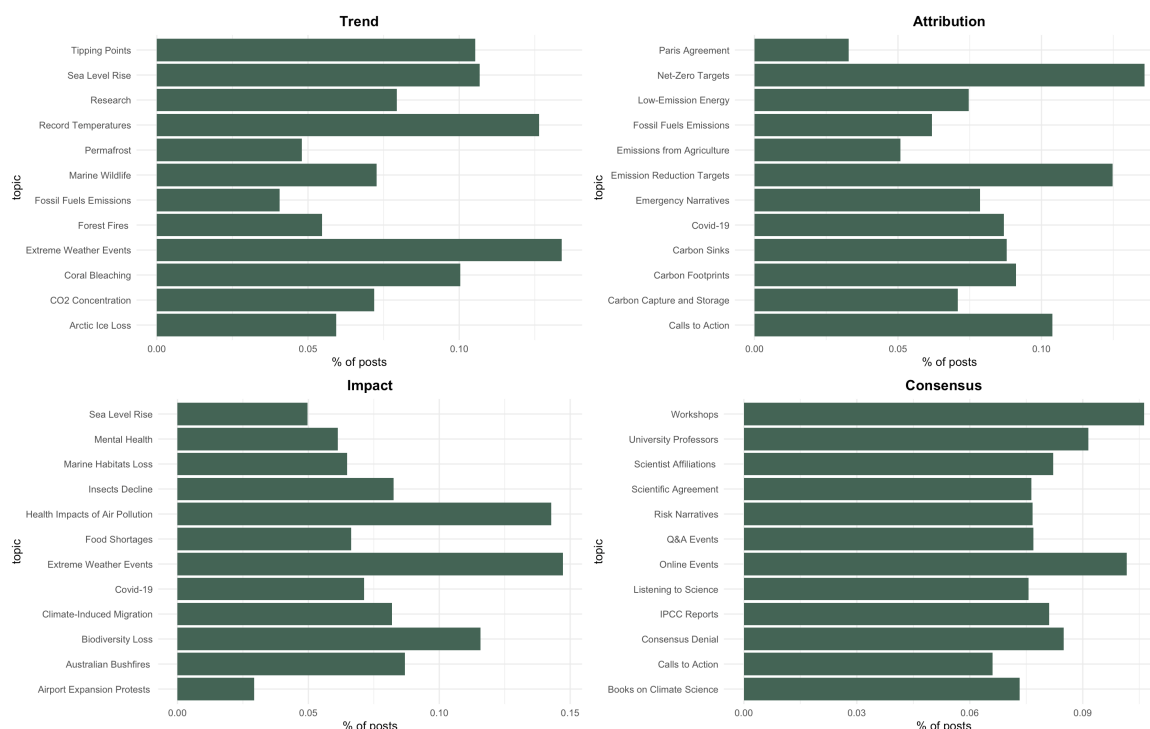
Fig. 4.7 Topic Modelling Results for Extinction Rebellion's Science-Based Counternarratives

This post clearly shows that, differently from what was noticed on trend counternarratives, attribution counternarratives tend to go beyond simply describing that greenhouse gas emissions cause climate change, and instead, also discuss policy options to reduce emissions.

Moving onto the content of impact counternarratives, it can be seen that the most discussed impacts of climate change in Extinction Rebellion's scientific communication are the topics labelled as *Extreme Weather Events* - which is the only topic to be repeated in the movement's topic model - and *Health Impacts of Air Pollution*. As expected, impact posts discuss the raw effects of climate change - on both people and nature - more than the fact that such events demonstrate the occurrence of changes to the climate system. For example, a high relevance post discussing extreme weather events states:

> At least 11 people are dead and 102 injured in a violent storm that hit eastern
> China on Friday evening. Those killed were blown into the Yangtze River or hit
> by falling trees and electricity poles, officials said.

The existence and characteristics of this topic are quite interesting, as they confirm a communication dynamic where the movement appears - in this case implicitly - to claim a direct relationship between extreme weather phenomena, such as a violent storm that hit

eastern China, and climate change. This type of counternarrative is crucial in the current communication environment, where the connection between extreme weather and climate change is increasingly under attack by climate change deniers. This communication practice was, as noted by (Levantesi, 2022), very common during the heatwaves that hit the United Kingdom in the summer of 2022, where a headline from 'The Times' went insofar as to say: 'Why can't the MET Office just tell us it's the weather, instead of spreading alarm and scolding us with doom-laden lectures?'. In this scenario, as climate change deniers continue to claim that no relationship exist between extreme weather phenomena and climate change, the present of these counternarratives offer a particularly useful channel to contrast the circulation of misinformation from the bottom-up.

A further interesting finding in this category relates to the existence of a topic on mental health as an impact of climate change, present in 6.13% of impact posts. This topic, with keywords such as *health*, *doctor*, *mental* and *depression*, provides information on the increasingly important discussions on the psychological impacts of climate change, a concept sometimes defined in the literature as eco-anxiety or climate grief (Panu, 2020). This idea is evident in a high relevance post on this topic, which reads:

> The increasing visibility of climate change, combined with bleak scientific reports and rising carbon dioxide emissions, is taking a toll on mental health, especially among young people, who are increasingly losing hope for their future. Experts call it 'climate grief,' depression, anxiety and mourning over climate change. #DontMournOrganize #ClimateEmergency

Furthermore, other common topics discussing the impacts of climate change are biodiversity loss, the decline in insect populations, food shortages, and climate-induced migrations. The latter topic is also of particular interest, as it unearths how water shortages and droughts are causing waves of mass migrations of climate refugees. Finally, consensus counternarratives show a more balanced distribution of topics with no significant outliers, and the most common topics in the model are informational ones such as *Online Events* and *Workshops*. This indicates that while discussing scientific consensus, Extinction Rebellion largely focuses on events to inform the public on climate change science, such as workshops and Q&A sessions, once again pointing to clear epistemic component that drives the movement's activism.

Turning now to Fridays for Futures' topic distribution, it can be seen that within trend counternarratives, the two most frequent topics were labelled as *Record Temperatures* and *Ocean Temperatures*. While the former closely mirrors the same topic seen in Extinction
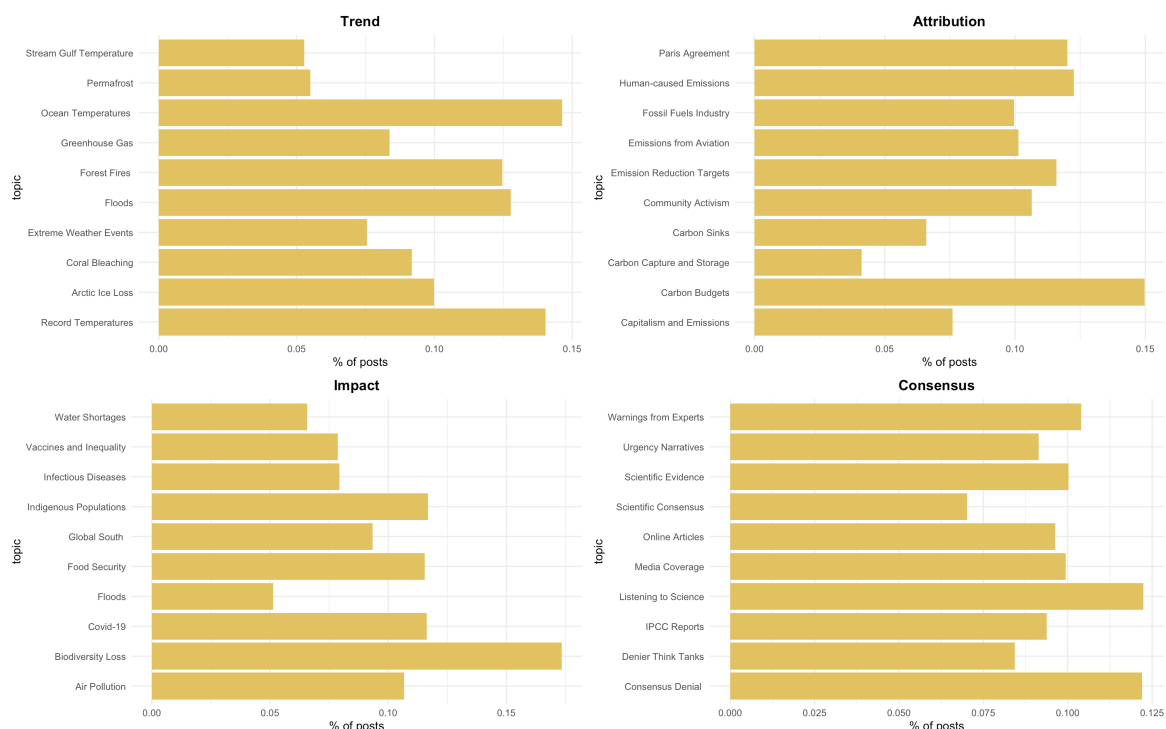
Fig. 4.8 Topic Modelling Results for Fridays for Future's Science-Based Counternarratives

Rebellion's model, discussing record surface temperatures, the latter presents an interesting deviation, discussing how rising sea temperatures are evidence that the climate is changing. A sample post within this topic reads:

> Ocean waters hit their highest temperature ever last year, and the rate at which they are warming is speeding up, a new study has revealed. Researchers called the new data further proof of global warming

All in all, the prevalence of discussions on temperatures within trend narratives is to be expected, as temperatures increases - both land and water - are perhaps the clearest sign of climate change. Yet, this is very important to contrast the circulation of misinformation, as the existence of ocean warming has often been attacked by climate skeptics. For example, a widely circulated March 2022 post by the climate change contrarian Facebook Page named 'Climate Change is Crap' claimed that oceans are a heat sink, and as a consequence, any degree of ocean warming is no proof of climate change (Petersen, 2022).

Additional topics discussed among trend counternarratives include further evidence of ongoing changes to the climate system that have historically been often under attack from

climate change deniers, such as arctic ice loss, increased floods, and the aforementioned phenomenon of coral bleaching.

Turning now to attribution counternarratives, it can be seen that the two largest topics in this category were labelled as *Carbon Budgets* and *Emission Reduction Targets*. While the latter overlaps with Extinction Rebellion's homonym topic, the former does not and is unique to Fridays for Future. Analysing posts contained on this topic, it is clear that these contain discussions on remaining carbon budgets, their geographical distribution, and the need to quickly limit greenhouse gas emissions to limit global warming. Furthermore, an interesting topic in this category is labelled as *Capitalism and Emissions*, which is present in 7.6% of attribution posts. This topic reflects what was seen multiple times throughout this thesis, that is, the two movements' tendency to criticise capitalism as a system and its role in causing climate change. For example, a post in this category reads:

> It is clear that we must end capitalism in order to drastically cut emissions and save the Earth. There can be no meaningful climate action in a toxic system where profit is prioritised above planet and where the environment is commodified. While individuals' actions such as going vegan or cutting down on energy use are commendable, we need systemic change to stop climate change.

Once again, in this post, we see movements discussing the incompatibility between climate action and capitalism, claiming that in a system where profit is priorities above the planet, climate action will never be decisive enough. While this type of narrative is not strictly related to misinformation, it is nonetheless interesting to note how the movement's communication may be quite varied and based on intersectional activism even when discussing scientific evidence.

Turning now to Fridays for Future's impact counternarratives, it can be seen that, similarly to Extinction Rebellion, discussions on impacts focus on a mix of human and environmental impacts of climate change. Here, the most frequent topic is *Biodiversity Loss*, followed by *Indigenous Populations* and *Food Security*. The latter two are of particular interest as they discuss some of the less conventionally understood impacts of climate change. Specifically, *Food Security* discusses how climate change impacts the resilience of foods systems, and a post in this topic reads:

> Many farmers probably haven't read the new report from the United Nations warning of threats to the global food supply from climate change and land misuse. But we don't need to read the science — we're living it." - Alan Sano, Farmer (via The New York Times)

This topic is important to understand the movement's potential to contrast misinformation, as discussing climate change's impacts on food chains serves to debunk a widely circulated myth that rising temperatures may favor crop production. For example, an article from the Heartland Institute expressing this form of climate change denial writes:

> The evidence is overwhelming that rising atmospheric carbon dioxide levels have will continue to help plants thrive, leading to greater biodiversity, shrinking deserts, expanded habitat for wildlife, and more food for a growing human population.

Last, analysing consensus counternarratives, it can be seen that the two most frequent topics were labelled as *Listening to Science* and *Online Climate Change Denial*. The latter is particularly interesting, as it directly discusses the occurrence of the denial of a climate consensus, with FREX words such as *fossil*, *industry*, *denial*, *consensus* and *online*. A high-relevance post in this topic states:

> The opponents of the scientific consensus on the influence of human technologies on global warming are disproportionately better present in the public and the media than those scientists who agree to the consensus. The consensus is 99% in August 2019. This is the state of affairs published by the scientific service of the German Bundestag [...]

As the post shows, this topic is concerned with discussing the existence of a scientific consensus on climate change while also describing some of the tactics used by climate change deniers: in this case, disproportionately appearing in the media. The overrepresentation of climate change deniers is a key component of consensus denial, and it is something that has been analysed widely in the literature (Boykoff, 2013; Debrett, 2017).

4.4   Discussion and Conclusion

Chapter IV of this research project set out to empirically measure and analyse the use of science-based counternarratives as an indirect force of misinformation reduction in the online communication of Extinction Rebellion and Fridays for Future. For this purpose, I designed an *ad-hoc* filtering approach based on the use of a semi-supervised machine learning model through SeededLDA. This filtering method proved effective in extracting the four target

narratives and did so with high accuracy, with an average of 91%. While SeededLDA is a relatively new approach to topic modelling and has only seldom been used in the literature, this work presents a novel and highly effective use of this approach, where a SeededLDA with high residual value is used to filter data for further analysis, which can bode well in similar theory-based studies. The results of this filtering approach were then analysed using techniques from natural language processing. Several findings emerged from this analysis.

4.4.1 The Frequency of Use of Science-Based Counternarratives

The first objective of this Chapter was to quantify how the two movements under analysis integrate science-based counternarratives in their online communication, and the answer to this question is found in the results of the filtering approach. Analysing the data, it emerged that science-based counternarratives are used frequently in the communication of the two movements, appearing in close to 1 in 10 posts. As seen in Chapter II, the communication of a global climate movement is often complex and multidimensional, and includes communication on a wide variety of different topics. While there is no single benchmark that can be used to assess the magnitude of this number - except for the use of naming and shaming seen in Chapter III - this number is evidently quite high, indicating that for both movements, epistemic activism through the dissemination of scientific information is indeed a key function. All in all, this confirms what was proposed in the theoretical framework, that is, that both movements do use science-based counternarratives in their communication.

The filtering process also shows an evident disparity in the use of science-based counternarratives between the two movements, with Extinction Rebellion using this form of communication in 7.55% of posts, and Fridays for Future using it in 12.40% of posts. This finding is particularly interesting in relation to movement profiles, as it suggests that, in percentage, the latter movement is more prone to include scientific evidence in its communication. This confirms the findings of Chapter II, where it emerged that *Fridays for Future* places more importance on the communication of scientific evidence. Furthermore, these differences were also confirmed by the aggregate analysis of the movements' temporal distributions, which showed how Fridays' for Future's use of science-based counternarratives has constantly been rising over time, while Extinction Rebellion's has remained largely stable, suggesting that the existing gap between the two movements may continue to grow over time.

Moreover, to better understand the use of science-based counternarratives as a form of indirect misinformation reduction, the results of this Chapter also provided information as to which individual counternarratives were most common for each movement. This point is crucial to this analysis, as it points to which type of information is more likely to be circulated by each movement, and as a consequence, which forms of misinformation are more likely to be contrasted.

Here the data showed that for Extinction Rebellion, trend and impact counternarratives are most frequent, while for Fridays for Future, attribution and trend are the most common. This indicates that while disseminating scientific information, both movements tend to focus on spreading information on the physical basis of climate science, such as the occurrence of climate change, its impacts, and its causes.

However, what is perhaps more interesting here is that for both movements, consensus counternarratives show a low frequency of use. This is somewhat surprising, considering that in the last two decades, discussions on consensus have formed a large part of the literature on climate change denial, particularly in virtue of consensus' role as a gateway belief on climate change. However, to be effective in their epistemic activism, social movements need to produce content that engages the public and has the potential to circulate widely, and consensus counternarratives seem to consistently show poor performance among message receivers, and this may contribute to the movement's reluctance to discuss this topic. The analysis of temporal distribution also added key information to this analysis, indicating that consensus narratives are declining in frequency over time, while at the same time, attribution counternarratives are rising steadily over time.

The growing interest in attribution counternarratives is also an interesting finding. While this topic discusses how greenhouse gas emissions lead to climate change, it also contains conversations on how emissions may be reduced. The growth trajectory of this topic suggests that - perhaps mirroring the trajectory of climate change denial - the two movements are progressively moving away from more traditional discussions on the occurrence and impacts of climate change and, giving these for granted, are discussing more of how emissions should be reduced.

4.4.2 The Performance and Sentiment of Science-Based Counternarratives

The second objective of this Chapter consisted of assessing the performance and sentiment of each science-based counternarrative, mapping which such arguments perform better among

the message receivers, i.e. the public, and what is the sentiment that emerges from this form of communication. Two main findings emerged from this analysis.

First, Extinction Rebellion's posts are, on average, more negative than Fridays for Future, and simultaneously, they always overperform the data set average. The opposite is true for Fridays for Future, where messages are on average more positive, and yet each counternarrative underperforms the data set average. This finding has significant implications for potential studies into the effectiveness of science-based counternarratives, suggesting that while, as a percentage, this communication strategy is less frequent in Extinction Rebellion's communication, it evidently performs better among message receivers. This is interesting, as it confirms what was noted in previous Chapters regarding Extinction Rebellion's language being generally more negative than Fridays for Future, while adding a new layer of understanding by demonstrating that in this case, this difference translates into a worse post performance.

Second, impact counternarratives exhibited the most negative sentiment for both movements, and yet, the performance impacts of this sentiment are the opposite. For Extinction Rebellion, impacts counternarratives have the lowest sentiment and highest performance, while for Fridays for Future, they have the lowest sentiment and lowest performance. This is also an important finding in understanding the movement's use of this strategy. This suggests that extremely negative content may have an opposite effect between the two movements, whereas for Extinction Rebellion, it improves post-performance, while for Fridays for Future, it hurts performance. While a final explanation cannot be provided with the data at hand, this may be linked to the younger age of Fridays for Future activists, who may be less attracted by very negative content using strong language.

4.4.3   The Content of Science-Based Counternarratives

Finally, the third and last objective of this Chapter consisted of analysing the content of science-based counternarratives posted by the two movements. Generally speaking, this content analysis did not yield surprising results, as the content of both movements' counternarratives seemed to be quite consistent with what could have been expected from the theory that informs these counternarratives. For example, for both movements, attribution counternarratives are dominated by discussions on carbon budgets, sources and sinks of emission, while consensus counternarratives show multiple calls to listen to science and scientists. However, some significant findings emerged from this analysis.

First, the topic model showed that trend counternarratives are heavily characterised by discussions on record temperature and extreme weather events, indicating that the two movements recurrently discussed the fact that climate change is happening in correspondence to high temperature and extreme weather. This finding was also confirmed by the temporal distribution noted in the temporal analysis of Section 4.3.2. This element of the movements' communication is important, as it suggests that both movements use the occurrence of extreme weather phenomena to reinforce the belief in the public that climate change is happening, suggesting that science-based counternarratives may act as a form of mass misinformation correction. As described in the Section above, climate change deniers have often attacked the direct relationship between climate change and extreme weather events, and by making this connection in their counternarratives, the two movements are contrasting false information with accurate information, which is the communication dynamic that drives the research presented in this Chapter.

Second, this informational effort also emerged clearly from the analysis of impact counternarratives, a common counternarrative for both movements. Here, it emerged that the two movements recurrently disseminate scientific information that counteracts known strands of climate change denial. For example, the movements discuss evidence on phenomena such as arctic ice loss, increased floods, and coral bleaching. Interestingly, the analysis also showed that the two movements engage in discussions on less-known impacts of climate change, such as those on food chains. This point is important, as, while climate change contrarians continue to find new elements to challenge the urgency to contrast climate change, it is important for social movements to contrast rising strands of false information.

Finally, similarly to what was noted in the previous Chapters, counternarrative-based communication is also characterised by a very broad view of environmental issues, often characterised by discussions on intersectional topics and unexplored impacts of climate change. For example, Extinction Rebellion's impact topic model showed the most common topic to be *Health Impacts of Air Pollution* while also containing topics on mental health and climate-induced migrations. Similarly, Fridays for Future's topic distribution exhibited similar results, with topics discussing the global south and indigenous populations. This finding shows that increasingly so, when the two movements are discussing the impacts of climate change, they are going well beyond the traditional nature-based understanding of this point and instead, often focus on discussing the human side of these impacts.

4.4.4 Conclusion

To conclude, the results of this Chapter show that Extinction Rebellion and Fridays for Future resort with high frequency to the use of science-based counternarratives in their Facebook communication, with significant potential of contrasting false information with accurate information.This Chapter presented a theory-informed analysis of science-based counternarratives, where a SeededLDA model was used to extract theoretically informed counternarratives to the four most common strands of scientific climate change denial identified in the literature. This analysis supports what was proposed in the theoretical framework that informs this work, demonstrating how the two movements engage in this strand of epistemic activism and peer-produced misinformation reduction.

Chapter 5

Conclusion

5.1 Introduction

This research project set out to explore a novel way in which societies can tackle online epistemic threats regarding climate change, where the public, through sustained mobilisation and online activism, can produce new channels of information circulation, improve information quality, and ultimately accelerate social change. This question was approached through a theoretical framework which posits that, through their bottom-up epistemic activism, social movements can provide a countering force to both vertical disinformation and horizontal misinformation.

Using an original data set of $\approx$ 250k Facebook posts, this thesis fulfilled two main research goals. First, it made contributions to the fields of climate change communication and social movement studies by analysing the emergence of a 'new wave' of radical climate change movements and the significance of the innovations brought by such climate movements. This point was addressed with the objective of both identifying characterising traits of this generation of climate movements and gathering insights into how such movements manifest their role as epistemic activists. By examining the key characteristics and distinctive elements of Extinction Rebellion and Fridays for Future, such as their founding principles, protest tactics, and the main topics emerging from their online communication, this work presented a large-scale social media analysis of this new generation of climate activism.

Second, working at the intersection between social media analysis and social movements studies, this thesis presented interdisciplinary empirical evidence on how the two radical climate movements under analysis can act - directly or indirectly - as a force of bottom-

up noise-reduction. The latter part of the thesis focused on quantitatively measuring and analysing the use of two communication strategies through which false information can be contrasted: the naming and shaming of information polluters and the mass diffusion of science-based counternarratives.

This Chapter of this research thesis will summarise the main findings and contributions contained in this work, to then briefly discuss the key limitations that characterise this research, along with avenues for future research.

5.2   Summary of Thesis Contributions

5.2.1   The Emergence of a 'New Wave' of Radical Climate Activism

The first significant contribution of this project regards the analysis of the emergence of a 'new wave' of radical climate activism, which was assessed by analysing the two movements that best represent this wave: Extinction Rebellion and Fridays for Future. This analysis served as the groundwork for the empirical research that followed in the rest of the research project, but also as an original contribution to the understanding of two of the most influential modern radical climate change movements. This investigation was not limited to assessing the two movement's epistemic activism. Instead, it presented a full picture of the movements' online presence, assessing their evolution as well as crucial identity traits such as their structures, protest practices and intra-movement networks.

While several findings emerged from this analysis, four deserve particular attention. First, the work contained in Chapter II presented an overview of the history of the environmental movement, discussing how a long tradition of activism converged, in the post-Paris agreement period, into a new generation of radical climate movements characterised by innovative traits such as a robust online presence, a high-density of youth activists, and an innovative paradigm of revolution and reform. These elements present a breakthrough with the previous tradition of environmental activism and serve to explain the popularity and influence of the two movements, as well as many of their communication choices.

Identifying and understanding the events that led to the emergence of this new generation of radical climate movements is of great utility, as these movements represent perhaps the most significant innovation that has struck the climate change regime in the past two decades. For this reason, understanding the type of events and social dynamics that may facilitate the rise of radical forms of activism - such as widespread public discontent, scientific consensus,

and an overwhelming sense of urgency - bears lessons on activism that can spill over from the realm of climate change policy.

Second, results from the temporal analysis performed in Chapter II showed that for Extinction Rebellion and Fridays for Future, the capacity of mobilising online activism is strongly dependent on in-person protests. Analysing the temporal trajectory of growth and degrowth of the two movements, results showed that despite their evident attempts to adapt to Covid-19 imposed lockdowns - for example, through holding online protests - both movements' intensity of online activism dropped dramatically as soon as in-person protests were forced to a halt. This finding evidences that the two movements have built their communication strategies on the occupation of public spaces with visual and verbal messages, and forced isolation across the world was ultimately bound to diminish these groups' effort and ability to reach online audiences. This feature is meaningful as it suggests that even within highly digital movements such as Fridays for Future and Extinction Rebellion, in-person activism remains a critical input for mobilisation. Ultimately, this finding indicates that radical movements thrive on radical and disruptive protest tactics, and in this sense, the two movements under analysis are no different. While every social movement may exhibit unique characteristics, this finding provides useful information applicable to similar modern hybrid movements where online and offline activism are vital parts of a movement's protest ecology.

Third, the comparative analysis of the two movements provided multiple insights into the intra-network patterns of Extinction Rebellion and Fridays for Future, mapping, for the first time, how the two movements interact within their own social media networks of groups and pages. Interestingly, this analysis highlighted how the two movements exhibit different network structures, with significant implications for their communication efforts. On the one hand, Extinction Rebellion showed a very geographically clustered grassroots presence, where different movement's chapters mainly interact at a local level, while Fridays for Future exhibited a structure dominated by large international elements, lacking clear grassroots components.

This finding sheds light on a fascinating structural difference between the two movements, indicating that while both movements define themselves as grassroots, the magnitude of their grassroots-ness varies significantly. However, the importance of this finding goes beyond the mere understanding of the movement's structure. In fact, understanding network differences also provide useful information on the movement's online communication, as mapping the network patterns through which the content generated by the two movements flows also provides insights into the type of content that is more likely to circulate.

It should also be mentioned that as modern social movements continue to grow their online presence - a trend that has been clearly observed in most social movements that emerged in recent years - for example, see Mundt et al. (2018) - the utility of social network analysis as a methodological approach is growing exponentially. In fact, this methodology - which has admittedly grown in relevance in recent years - can be applied to any social movement with an online presence to map intra-movement and inter-movement networks, providing a valuable tool better to understand social movement's patterns of interaction and communication.

Fourth, the content analysis through topic modelling of the Facebook communication of the two movements provided detailed information on the width and breadth of the topics covered by the two movements. In particular, this analysis highlighted a very strong presence of scientific topics, where two movements extensively discussed the science, impact and solutions to climate change, supporting the hypothesis that the two movements are quite focused on epistemic activism by disseminating information on climate change. Such a prevalent presence of scientific narratives in the communication of the two movements is an innovative trait that perhaps stems from the increasing weaponisation of science that has characterised the last decade. In fact, as science is increasingly under attack and as governments continue to ignore the latest scientific evidence on climate change, the two movements appear to respond by making science one of the pillars of their activism.

Moreover, this analysis also showed a variety of information-related topics clarifying the movements' epistemic practices - for example, demanding its activists to attend scientific workshops, online events and watch Youtube videos to gain a better understanding of the necessity to act on climate change - while also containing critiques on the circulation of false information in the media. The portrayal of the media sector within this theme is particularly interesting, as both movements strongly criticise the media sector for its role in spreading false information and acting as a mouthpiece to climate change deniers.

Lastly, a fascinating thematic area that emerged from analysing the movements' communication is the widespread presence of intersectional themes, with discussions on topics such as racism and inequality. While this thematic area has no direct implications for the circulation of false information, it does point to the rise of a new element within climate change activism, where climate change is no longer strictly an environmental issue, but rather, the latter is interpreted as a broader issue with wider societal implications. This thematic area is interesting from a research perspective as it provides a window into a wholly new view of environmentalism that permeates from the two movements under analysis.

In conclusion, the first significant contribution of this research project consisted in identifying, mapping and analysing the emergence of a new wave of radical climate activism, which is best represented by the transnational, radical and grassroots climate movements Extinction Rebellion and Fridays for Future.

The findings in this section provide an overview of the main traits that characterise the two movements and their online communication, setting them apart from previous forms of environmental activism. All in all, the importance of these findings stems from the social and political relevance that the two movements under analysis came to have since their foundation. Since 2018, through their disruptive online and offline protest tactics, Extinction Rebellion and Fridays for Future have deeply shaken the public debate on climate change, establishing themselves as some of the most influential forces within climate change communication and negotiations through a series of achievements ranging from sponsoring bills to speaking at the United Nations and mobilising millions of young activists.

Despite their evident influence, the online communication of the two movements had never been analysed - and while several excellent analyses of the two movements exist, for example see Berglund and Schmidt (2020),Wahlström et al. (2019), and Smiles and Edwards (2021) - these analyses typically focus on the movement's principles, theory of change, and protest tactics. This research turns to the investigation of a different aspect of the two movement's activism: their social media presence and online communication.

As innovative social movements with strong social media presence continue to emerge - Black Lives Matter is a great example of this type of movement - it is increasingly important for social sciences researchers to map and understand how radical social movements use their online channels of communication, particularly through social media, to promote their causes, transmit information and exert bottom-up pressure. This research presents an approach to analysing social movements' communication based on quantitative text analysis that can be easily reproduced and applied to other movements in order to assess their online structure, evolution and communication tactics.

5.2.2 Radical Climate Movements as a Force of Peer-Produced Disinformation and Misinformation Reduction

The second main contribution of this work stems from the analysis of how Extinction Rebellion and Fridays for Future may, through their online epistemic activism, contrast the circulation of disinformation and misinformation on climate change. Notably, the main goal of this investigation into false information was not to quantitatively measure an impact but

to quantify and assess the use of two potential channels of false information reduction: the naming and shaming of information polluters and the use of science-based counternarratives.

Before quantitatively analysing these channels of communication, the relevant literature provided insights into their potential as noise-reduction strategies. On the one hand, the literature on naming and shaming provided ample evidence that this strategy could be used to create a public reputational risk to information polluters, just like it does for environmental polluters, impacting the production of disinformation. On the other hand, the rich tradition that studies counternarratives and counterspeech confirmed that an increased circulation of accurate information could ultimately, through dynamics such as information cascades and inoculation, reduce the circulation of horizontal misinformation.

Reducing Disinformation: The Naming and Shaming of Information Polluters

In this work, naming and shaming was analysed as a potential channel of disinformation reduction, where activists used their communication channel to discredit the source of a false message (i.e. information polluters), expose disinformation creators and their wrongdoings, and open their actions up to public scrutiny, reputational damage, and popular backlash. To extract posts where the two movements name and shame information polluters, I used a hybrid filtering method based on keywords extraction and *text2vec* embeddings. The data set was then analysed using techniques from natural language processing. Several findings emerged from the quantitative analysis of this communication strategy.

The first noteworthy result regards the frequency of use of this communication tactic, which allows us to gauge how common it is for the two movements to publicly name and shame information polluters. Here, results show that this communication tactic is used, on average, in $\approx 2.5\%$ of all posts produced by the two movements. As previously mentioned, it is difficult to evaluate the significance of any communication tactic without clear narrative-based benchmarks. However, given the specificity of the filtering process, this communication strategy appearing in over 1 in 50 posts represents quite a high frequency, suggesting that the two movements indeed engage in the naming and shaming of information polluters as part of their informational outreach. Thus, it can be concluded that the naming and shaming of information polluters forms an integral part of the communication practices of both movements. Furthermore, results showed that Extinction Rebellion is more likely to use naming and shaming against information polluters than Fridays for Future, and to do so with more negative language and sentiment.

Second, the analysis presented in this Chapter used a Named Entity Recognition (NER) model through *SpacyR* to assess the targets most commonly associated with information pollution in the communication of the two movements. Here, results showed that the most recurrent targets of naming and shaming campaigns are oil and gas companies for Extinction Rebellion and media organisations for Fridays for Future, with Shell and British Petroleum, and Facebook and Youtube, respectively, the top targets. While the presence of oil gas companies among the most common targets was expected from the literature, it is surprising to find media organisations topping Fridays for Future's targets, indicating that the movement places particular attention on shaming enablers of disinformation diffusion, such as right-wing media groups and social media platforms, while Extinction Rebellion remains focused on shaming fossil fuels majors for their role in polluting the information environment on climate change. In this section, a further interesting finding lies in Extinction Rebellion's targeting of the banking sector, with banks such as HSBC and Barclays being mentioned as information polluters. All things considered, these findings are very significant to understand the two movements' approach to disinformation reduction, as they indicate that the new generation of radical climate movements adopts a very broad approach to naming and shaming information polluters, where they target traditional information polluters such as ExxonMobil and Shell, but also focus on organisations whose role in spreading disinformation is more unexplored, such as HSBC and Google. This approach is innovative, and it suggests the movements may act as an avant-garde force in pressuring non-standard organisations into raising their information standards. In a way, this communication element of the two movements strengthens their potential role as a force of disinformation reduction, as their targets are clearly broader than what might have been anticipated.

Third, this section presented a sentiment analysis of the naming and shaming posts under analysis. Here, two main findings emerged. First, as expected, posts where the two movements name and shame information polluters are on average very negative, with 85% of posts exhibiting a sentiment score below 0. Post sentiment is more negative for Extinction Rebellion, which has the most negative sentiment on average and absolute terms, confirming, once again, that the movement is quite prone to using crude language in its posts. Second, quite surprisingly, the media sector showed very negative sentiment for both movements, as the two groups appear to often attack organisations in this sector with exceptionally harsh language. For example, a post described in this section goes insofar as assimilating NewCorp newspapers to toilet paper. It was also interesting to note that the sentiment analysis showed that for Extinction Rebellion, banks are generally the sector targeted with the strongest average language. This adds a further dimension to the understanding of the movement's targeting of 'unconventional' information polluters.

Fourth, this section of the research project contained an LDA-based topic modelling analysis, which was used to extract the most common topics that emerged from the naming and shaming posts data set. Here, many of the results supported the findings of the previous sections of the analysis, outlining how Extinction Rebellion and Fridays for Future exhibit different targets in their naming and shaming campaigns. However, two additional findings stood out. First, pointing once again to the importance of direct action in driving the movements' online participation and communication, both movements exhibit a prevalent topic labelled as *Calls to Action*, where the two movements incite their activists to take the streets to protest. This finding indicates that the call to action remains perhaps the most fundamental communication aspect of both movements, and as such, it tends to underline all types of communications, including naming and shaming. Second, the topic models for both movements exhibit the presence of a large number of topics discussing the role of various organisations, particularly fossil fuels companies and media companies, in producing and spreading disinformation. These topics contain a variety of discussions on how malicious actors have tried to weaken the public understanding of climate science, often exhibiting a clear educational component. For example, a post in the *Scientific Disinformation* topic Extinction Rebellion shared a BBC article outlining a history of how climate science has been attacked over time, while in a Consensus Denial Post, Fridays for Future discussed how the 'merchants of doubts' are testing the effectiveness of permanent misinformation. These topics are central to the goal of this research project, as they show how both movements integrate naming and shaming narratives aimed at creating reputational risk with educational narratives aimed at informing the public on the inner mechanisms of disinformation and misinformation.

Last, it is worth noting that, similarly to what emerged in the results of Chapter II, intersectional topics such as *Colonialism* and *Racism* emerged once again from the models, testifying to how while naming and shaming information polluters, the two movements still resort to their broader narratives, which are used to complement naming and shaming posts. For example, posts against oil companies sometimes show mixtures of accusations for both spreading disinformation and for violating human rights in developing countries as part of their exploration projects.

Finally, this section of the research project indicates how the two movements use the naming and shaming of information polluters in their communication, suggesting a clear role of this strategy in contrasting the diffusion of disinformation. In fact, by publicly shaming information polluters, the two movements create an immediate reputational risk to these actors, raising public awareness of their actions and increasing the probability they will refrain from this unwanted behaviour. Perhaps the most surprising finding in this section

regards *what type* of information polluters the two movement target, where a number of unconventional organisations such Google and HSBC are being targeted for their role in spreading misinformation. The analysis of these organisations in spreading disinformation specifically is clearly unexplored, and further research should determine their contribution to information pollution on climate change.

Reducing Misinformation: The Use of Science-Based Counternarratives

This work's last contribution relating to the reduction of false information comes from the analysis of how Extinction Rebellion and Fridays for Future resort to science-based counternarratives in their online communication on Facebook. In order to analyse science-based counternarratives, this section of the research project used a theory-informed filtering approach, training a SeededLDA model to recognise the existence of information relating to the four primary forms of scientific climate change denial identified in the literature: trend denial (climate change is not happening), attribution denial (it is not caused by humans), impact denial (it is happening, but it has no adverse impacts) and consensus denial (scientists disagree on climate change).

The results of the filtering approach provide the answer to the first aim of Chapter IV, which was to quantify how the two movements under consideration include science-based counternarratives in their online communication. Here the data showed that science-based counternarratives are often employed in the communication of the two movements, with, on average, almost 1 in 10 postings containing them. As was highlighted in Chapter II, the two movements' communication is frequently intricate and multifaceted, and it touches on a wide range of various subjects. Taking this into account, this figure is obviously quite high, showing that epistemic activism through the transmission of scientific knowledge is an important function for both groups. The results of the filtering procedure also reveal a clear difference between the two movements' usage of science-based narratives, with Extinction Rebellion utilising it in 7.55% of postings and Fridays for Future using it in 12.40%. This finding is particularly relevant when compared to movement profiles, as it shows that the latter movement is, on average, more likely to communicate using scientific evidence. This supports the findings of Chapter II, which showed that Fridays for Future gives the dissemination of scientific evidence more weight.

The findings of this Chapter also revealed which specific counternarratives were most prevalent for each movement, which helps better understand how science-based counternarratives are used as a method of indirect misinformation reduction. This point is essential to

the analysis as it identifies the kind of counternarratives that each movement is more likely to spread and, consequently, the types of misinformation that are most likely to be countered. Here, the data showed that for Extinction Rebellion, trend and impact counternarratives are most frequent, while for Fridays for Future, attribution and trend are the most common. This indicates that while disseminating scientific information, both movements tend to focus on spreading information on the physical underpinnings of climate science, such as the existence of climate change, its effects, and its cause, with a clear focus on claiming that climate change is happening. However, what is perhaps more interesting here is that for both movements, consensus counternarratives showed a low frequency of use, suggesting that, while consensus denial is still among the most common and most widely analysed forms of climate change denial, the two movements are often quite reluctant to discuss this. While no clear explanations emerged from the data, it can be theorised that movements prefer to discuss highly emotional - and as a consequence engaging - aspects of climate change, such as environmental catastrophe, rather than more technical and somewhat academic issues such as scientific consensus.

Finally, quantitative content analysis was used to assess the content of the two movements' science-based counternarratives. Here, some relevant findings emerged. First, the topic model showed that trend counternarratives are heavily characterised by discussions on record temperature and extreme weather events, indicating that the two movements recurrently discussed the fact that climate change is happening in correspondence to high temperature and extreme weather. This finding was also confirmed by the temporal analysis included in Chapter IV. This element of the movements' communication is important, as it suggests that both movements use the occurrence of extreme weather phenomena to reinforce the belief in the public that climate change is happening, confirming that science-based counternarratives may act as a form of mass misinformation correction. As described in the section above, climate change deniers have often publicly attacked the direct relationship between climate change and extreme weather events (see Levantesi, 2022), and by making this connection in their counternarratives, the two movements are contrasting false information with accurate information, which is the communication dynamic that drives the research presented in this Chapter. Second, this epistemic effort also emerges from the analysis of impact counternarratives, where it is evident that the two movements recurrently disseminate scientific evidence to counteract known strands of false information. For example, the movements discuss evidence on phenomena such as arctic ice loss, increased floods, and coral bleaching. Interestingly, the analysis also discusses how the two movements engage in discussion on lesser-known impacts of climate change, such as those on food chains. In the past, climate change contrarians have often denied any connections between climate change

and food scarcity, and it is interesting that through science-based counternarratives the two movements are attempting to debunk these narratives.

Ultimately, this section of the research project demonstrated how the two movements deploy science-based counternaratives to the four main strands of scientific climate change denial in their communication. The evidence presented in this section showed how the movements engaged quite frequently with this communication tactic, and provided information as to which types of counternarratives are more frequently used, along with their performance and content.

Final Considerations

Finally, this section summarised the findings relating to Extinction Rebellion and Fridays for Future's contribution to contrast the circulation of disinformation and misinformation, identifying and measuring the use of two potential peer-produced channels of false information reduction. The main contribution from this part of the research constitutes in providing a new understanding of how radical climate movements influence the circulation of online information, a phenomenon that has only received limited attention in the literature. These findings are important for several reasons.

First, while the phenomenon of false information on climate change has been studied extensively in the past decade, the current understanding of how online disinformation and misinformation can be contrasted is limited. In a complex regulatory scenario where effective solutions are still lacking, this study contributes to the understanding of false-information mitigation by proposing a third way to correct information disorders, where online communities, through their peer-produced communication, can reduce the circulation of false information. At present, several gaps exist in the understanding of how social movements could, through peer-produced communication, attempt to contrast information disorders. The results outlined here are significant, as they indicate that the two radical climate movements under analysis exhibit clear epistemic components that can effectively contrast the circulation of false information while incurring limited regulatory hurdles.

By contrasting false information from the bottom-up and in the same fora where they tend to appear and spread (i.e., social media), the two movements are, in fact, establishing themselves as a clear epistemic force, naming and shaming information polluters, and disseminating scientific evidence that counteracts scientific misinformation. Of course, it should be mentioned that differently from other forms of content moderation, the bottom-up, activism-driven reduction of false information cannot be controlled or used on demand.

However, by demonstrating that the two movements exhibit a clear bottom-up epistemic effort to reduce false information, these findings suggest, as a minimum, that this kind of epistemic effort could be leveraged or facilitated through policy action.

Furthermore, the importance of these results also lies in the urgency with which the information disorders outlined in this work must be addressed. In fact, as discussed in Section I of this project, the circulation of harmful false information can significantly influence social and political processes, ultimately pushing societies towards suboptimal outcomes. This is particularly evident in the public debate on climate change, where scientific research has, for decades, highlighted the risks posed by this phenomenon. Despite this, influential parts of the public continue to exhibit low trust in climate change science, often contesting findings such as the causes and impacts of global warming. High levels of scepticism and the overarching perception that climate science is unsettled can provide a barrier to implementing ambitious mitigation policies, particularly by undermining their perceived legitimacy. It follows that contrasting the circulation of false information can, in time, lead to significant society-wide change.

Finally, a key contribution of this work regards the growing impact and relevance of social movements as epistemic innovators, as findings in this area can easily spill over onto the analysis of similar modern movements with radical traits. In recent years, several movements with precise epistemic purposes emerged. These include movements such as the #MeToo movement and Black Lives Matter, both of which are attempting to change public perceptions on social or political debates. With this type of radical and often intersectional activism on the rise, it is of great importance for social science researchers to use cross-disciplinary tools to assess the characteristics of these mobilisations and to identify ways in which they may fundamentally shape online and offline debates. This work presented an approach through which theory-driven research can be complemented with innovative computational methods such as topic modelling and networks analysis to produce approaches that are easily scalable and replicable, offering opportunities for further research on movements with similar traits.

5.3 Connecting The Dots

Ultimately, at a higher level of abstraction, the main contribution of this work stems from the development of a theoretical framework used to understand how online epistemic activism can shape complex scientific and political debates such as that on climate change. In this research project, this theoretical framework was analysed empirically by measuring two channels through which radical climate movements can exercise their function as epistemic activists.

While these channels are clearly non-exhaustive, and many more could be identified in the future, this analysis provides an initial overview of the scale and magnitude of Extinction Rebellion and Fridays for Future's epistemic activism.

The concept of online epistemic activism, which refers to refers to the use of online platforms and communities to promote and facilitate the sharing of accurate and reliable information, particularly in the context of political and scientific debates, has great potential for application in the current political and scientific communication environment, where disinformation and misinformation, as well as other forms of harmful content, continue to be very common. On example of this is the public conversation around Covid-19 vaccines, which has been heavily influenced by false information. By acting as "information watchdogs," online epistemic activists can use their influence to shape these debates in a positive way, by promoting the transmission and creation of peer-produced, reliable information. The flexibility, speed, and lack of regulatory hurdles associated with online epistemic activism make it a potentially powerful tool for addressing the spread of false information and promoting safer information in digital age. This form of activism is increasingly present in the toolkit of modern protest movements – some clear examples are the MeToo and Black Lives Matter movements - , and it will be interesting to see how this research will travel to future movements in the digital age.

However, it is important to highlight that a lot is still unknown regarding this communication dynamic. For example, mass bottom-up information correction may lead to increase debate polarisation, particularly when this informational force is applied through radical styles of communication, and further research is clearly needed in this field. Yet, despite all the unknowns, this work presents a first step towards a better understanding of online environmental activism and the use of peer-produced information as a channel to contrast harmful false information.

5.4 Limitations and Opportunities for Future Research

Undoubtedly, this research has some limitations, which are also the basis of opportunities for future research. First, as previously mentioned, this research project focused on measuring the Facebook presence of the two radical movements under analysis, along with the occurrence of two communication strategies that can contribute to reducing the circulation of disinformation and misinformation. However, this study does not assess these communication strategies' impact as a bottom-up noise-reduction form. This decision was mainly guided by the lack of available data, as measuring impact would have - as a minimum - required the availability

of individual-level data in order to map disinformation and misinformation sharing patterns. Currently, Crowdtangle does not make individual-level data available to researchers, as only information from pages, groups and verified accounts are included in the platform's tracking activity. However, should this type of data become more available, future research should attempt to map the impact of bottom-up noise reduction communication strategies on Facebook.

Second, the scope of this research was evidently limited by the choice of one specific social media platform, in this case, Facebook. Currently, Facebook boasts 2.85 billion active users, representing roughly 36% of the global population (Statista, 2021), and thanks to its widespread popularity, this social media platform is also expected to grant the highest degree of representativity to the global population among all social media platforms. However, no social media platform is fully representative of the general population, and the use of several social media platforms in this type of study can potentially improve this shortcoming. However, given the inherent size limitations of a PhD project, the use of data from multiple social media platforms may have been too extensive for a single project. It is also important to mention that the past years have been marked by a small revolution in social media, with new platforms such as TikTok skyrocketing in popularity, further changing the social media landscape. Additional research is needed into Extinction Rebellion and Fridays for Future's use of social media to disseminate their message, and this research should pay particular attention to rising platforms.

Third, a further limitation lies in the inclusion of data from Facebook Groups in the dataset. In fact, Facebook Groups are normally like-minded groups of individuals who already support a cause. As people self-select into Facebook groups based on their interests and beliefs, discussions within a group may be skewed towards partisan viewpoints. This can create an echo chamber effect, where group members hear and reinforce each other's opinions rather than being exposed to external perspectives. Within this project, it was considered that given the public nature of these groups, their data could still be used to analyse an outwards-facing communication dynamic. However, it is important to keep this limitation in mind when evaluating data from Facebook Groups.

Fourth, the scope of this research was constrained by limiting the data analysed to English-language posts; indeed, assessing non-English communication could have provided additional insights into the two movements. However, the field of multi-language text analysis is still in its infancy and, as a minimum, requires the researcher to comprehend the content of natural language processing results in multiple languages. While this is clearly a weakness of this project, it should be mentioned that historically, most climate change disinformation

was produced and disseminated by English-speaking actors and entities, at least partially reducing this shortcoming. Nevertheless, future research into the two movements should focus on forming a multi-language understanding of their communication, concentrating, in particular, on the communication of strong international local groups such as Fridays for Future Germany and Fridays for Future Italy.

Finally, a last limitation of this work regards the approach used to perform sentiment analysis. While lexicon-based sentiment analysis – which was used in the analysis contained in Chapters 3 and 4 – may be useful in gaining a general understanding of post polarity, the validity of this approach has often been questioned in the literature. For example, in their benchmarking study covering several approaches to sentiment analysis, Hartman et al. (2022) found that lexicon-based methods have an average accuracy of 70.29%, significantly less than the more modern neural network-based approaches, which have an average accuracy of 85.75

5.5   Concluding Remarks

When I started writing this thesis three years ago, Extinction Rebellion and Fridays for Future were at their initial stages and had only held a small number of protests. Since then, a lot has changed. The two movements have developed extensively, growing into some of the largest mass mobilisations ever recorded. At the same time, the COVID-19 Pandemic happen, with an evident impact on the possibility of holding in-person protests.

Today, finding effective solutions to contrast the circulation of harmful online content remains a gigantic task. Nevertheless, this thesis shows that potential exists within civil society to contrast this threat. Movements like Extinction Rebellion and Fridays for Future can, in fact, play an important role as information watchdogs, providing an additional force to contrast the diffusion of false information. Indeed, these movements cannot do that alone. Contrasting a wicked problem such as false information requires the cooperation and coordination of several elements of society, and here, governments must and always will remain a driving force. Nonetheless, this work shows that this pressure is there, shedding light on the vast potential that social movements can have in positively shaping online debates.

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Appendix A

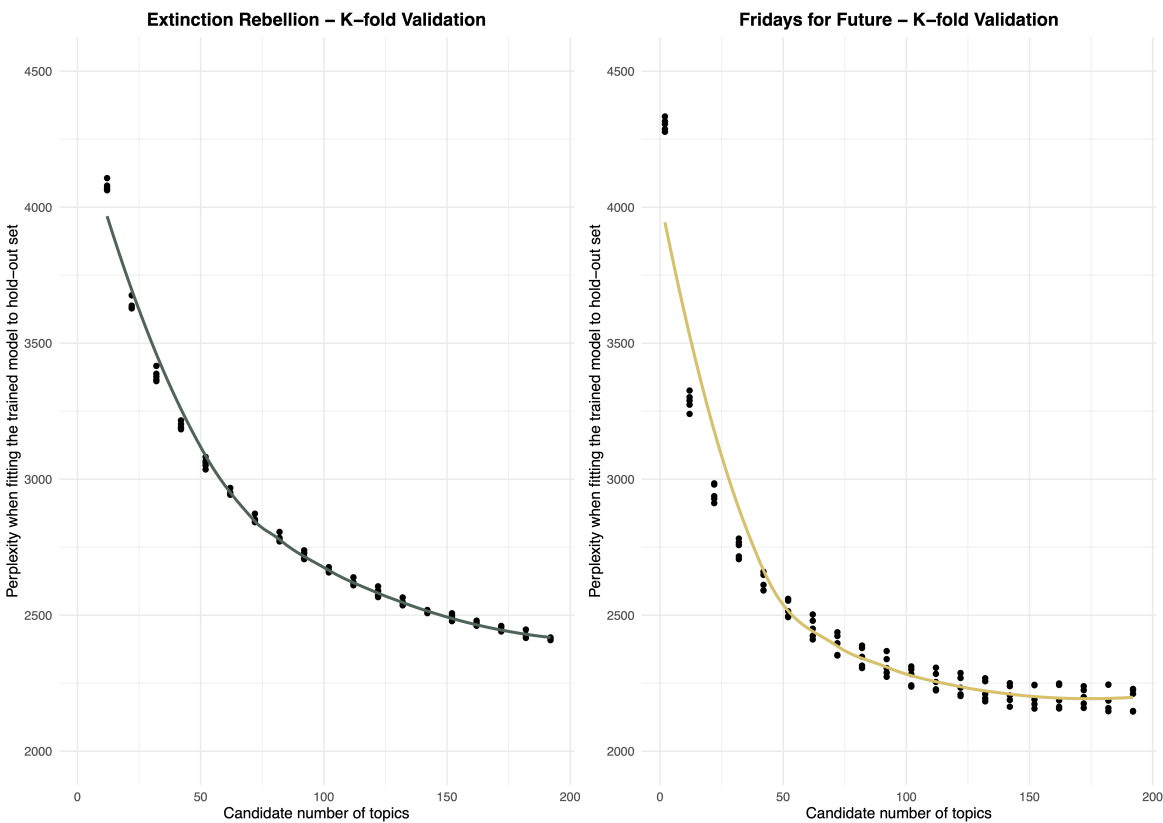# Chapter II - Topic Modelling

A.1 Perplexity Scoring

Fig. A.1 Results of the K-Fold Validation Process on the Full Data Set

A.2 Topic Modelling Results - Extinction Rebellion

Topic	FREX Words	Theme	Topic Frequency
Sustainable Agriculture and Plant-based Diets	Food, animal, farm, agriculture, vegan	Science	1.20%
Pipelines on Indigenous Land	Indigenous, pipeline, land, canada, territory	Fossil Fuels Industry	1.28%
Boilerplate 1	Year, last, old, ago, month	Boilerplate	1.26%
COP Conferences	Global, world, agreement, cop, paris	Politics	1.27%
Raising Awareness	Day, awareness, raise, tell, everyone	Media and Communication	1.38%
London Protests	London, October, bridge, square, April	Direct Action	1.70%
Scientific Research	Research, study, report, scientist, publish	Science	1.45%
Civil Disobedience	Civil, disobedience, mass, collapse, violent	Activism - Principles	1.38%
Calls to Protest	Get, involve, march, swarm, occupy	Direct Action	1.36%
Fridays for Future	Strike, school, youth, friday, student, hunger	Fridays for Future	1.36%

Hashtags	Extinctionrebellion, actnow, climatemergency, rebelforlife, tellthetruth	Activism - Organisation	1.86%
Rainforests Protection	Species, amazon, ecosystem, biodiversity, rainforest	Science	1.27%
Extinction Narratives	Life, planet, save, human, earth	Activism - Principles	1.49%
UK Elections	Party, vote, green, election, minister	Politics	1.33%
Local Politics UK	Council, city, county, cambridge, councillor	Politics	1.41%
Fracking	Oil, fracking, gas, shell, drill	Fossil Fuels Industry	1.23%
Media and Truth	News, bcc, media, truth, tell	Media and Communication	1.42%
Roger Hallam Speeches	Roger, hallam, understand, problem, solve	Activism - Principles	1.46%
Community-based Activism	Group, community, local, work, organise	Direct Action	1.37%
Urgency Narratives	Time, now, wait, fuck, act	Activism - Principles	1.47%
Protest Arrests	Arrest, block, charge, lock, protest	Direct Action	1.30%

Music	Song, grief, meditation, heart, sing	Activism - Creative	1.48%
Public Talks	Talk, question, science, panel, discuss	Media and Communication	1.32%
Renewable Energy	Energy, renewable, solar, technology, electricity	Science	1.33%
Green Growth	Economic, system, society, growth, transition	Science	1.39%
Meetings Planning	Meeting, welcome, weekly, tonight, tuesday	Activism - Organisation	1.93%
Greta Thunberg	Greta, activist, thunberg, young, future	Fridays for Future	1.32%
Facebook Events	Facebook, event, next, page, connect	Media and Communication	1.73%
US Politics	State, american, trump, organisation, president	Politics	1.25%
Town Halls	Town, hall, june, local, wales	Media and Communication	1.30%
Bristol Airport Expansion	Bristol, airport, expansion, plan, application	Direct Action	1.20%
HS2	Stop, protect, project, line, tunnel	Direct Action	1.25%

Boilerplate 2	Bay, tour, king, berlin, jan	Boilerplate	1.20%
Signatures Collection	Sign, petition, campaign, source, actionnetwork	Activism - Organisation	1.37%
Fossil Fuels Funding	Fuel, fossil, bank, fund, money	Fossil Fuels Industry	1.42%
Boilerplate 3	look , like, anyone, hello, hope	Boilerplate	1.68%
Books and Podcasts	Book, conversation, episode, podcast, professor	Media and Communication	1.38%
Net-Zero Targets	Emission, carbon, zero, net, target	TScience	1.40%
Events Registration	Ticket, workshop, register, eventbrite, train	Activism - Organisation	1.48%
CEE Bill	Bill, parliament, ceebill, cee, now	Direct Action	1.23%
Festivals and Performances	Art, music, print, festival, performance	Activism - Creative	1.68%
Pictures	Message, picture, send, tweet, photo	Media and Communication	1.23%
Right to Protest Bill	Police, protest, johnson, freedom, killthebill	Direct Action	1.42%
Red Rebel Brigade	Red, blood, brigade, image, rebel	Direct Action	1.29%

Citizens Assemblies	Assembly, emergency, citizen, demand, ecological	Activism - Organisation	1.51%
Newspaper Articles	Environment, theguardian, article, say, warn	Media and Communication	1.46%
Online Forms	Google, document, form, sharing, edit	Activism - Organisation	1.13%
Boilerplate 4	Know, let, sure happen, make	Boilerplate	1.49%
Inequality	Million, poor, country, india, farmer	Intersectional activism	1.26%
Boilerplate 5	Thing, think, really, maybe, lot	Boilerplate	1.69%
Racism	Black, woman, white, racism, refugee	Intersectional activism	1.12%
Covid-19 Safety	Wear, mask, distance, banner, outside	Covid-19	1.41%
Plastic Waste	Plastic, waste, fashion, buy, recycle	Science	1.20%
Intergenerational Equity	Child, mother, family, grandchild, future	Activism - Principles	1.43%
Scottish Protests	Scotland, fail, government, scottish, duty	Direct Action	1.25%
Boilerplate 6	One, zealand bear, common jersey	Boilerplate	1.29%

Wildlife Protection	Tree, plant, wildlife, bird, rewilding	Science	1.44%
Webinars	Zoom, link, online, webinar, click	Media and Communication	1.33%
Opinions Gathering	Survey, relevant, strategy, work, input	Activism - Organisation	1.38%
Parks and Walks	Park, walk, site, meet, hill	Activism - Organisation	1.24%
Protest Arrests - Legal	Court, law, case, rule, legal	Activism - Organisation	1.21%
Regenerative Culture	Culture, circle, regenerative, principle, empathy	Activism - Principles	1.27%
David Attenborough	Letter, write, david, attenborough, sir,	Activism - Principles	1.33%
Extreme Weather Events	Temperature, rise, warm, weather, flood	Science	1.73%
Donations	Help, please, support, donate, contact	Activism - Organisation	1.65%
Summer Uprising	Rebel, july, east, uprising, august	Direct Action	1.42%
Environmental Standards	Public, review, concern, standard, management	Science	1.28%

Australian Bushfires	Australia, fire, sydney, adani, nsw	Science	1.25%
Air Pollution	Air, pollution, car, health, cycle	Science	1.17%
Videos and Documentaries	Watch, youtube, film, video feature	Media and Communication	1.71%
University Protests	Justice, university, class, education, resistance	Direct Action	1.25%
Covid-19	Covid, pandemic, coronavirus, recovery, lockdown	Covid-19	1.35%

A.3 Topic Modelling Results - Fridays for Future

Topic	FREX Words	Theme	Topic Frequency
Facebook Events	Event, facebook, location, place, date	Activism - Organisation	2.02%
Common Resources	Human, world, common, share, resource	Activism - Principles	1.60%
Elections	May, vote, election, party, sure	Politics	1.65%
GHG Emissions	Emission, carbon, energy, gas, reduce	Science	1.97%
Intergenerational Equity	Child, give, life, hope, generation	Activism - Principles	1.97%
Environmental Policies	Government, law, environment, project, bill	Politics	1.70%
Media and Truth	News, article, read, announce, bbc	Media and Communication	1.88%
EU Environmental Politics	Green, europe, deal, parliament, commission	Politics	1.44%
Capitalism and Systemic Change	System, political, power, society, economic	Activism - Principles	1.57%

Climate Change Hashtags	International, climatechange, climatejustice, climateemergency, climatecrisis	Activism - Organisation	2.68%
Petitions	Petition, sign, source, campaign, online	Activism - Organisation	1.71%
Boilerplate 1	Say, think, even, now, like	Boilerplate	2.15%
Forests Protection	Forest, tree, plant, protect, area	Science	1.78%
Scientific Research	Report, science, study, research, university	Science	1.67%
Weekly Strikes	Future, strike, friday, join, front	Direct Action	2.28%
Adani Coal Mine	Australia, coal, adani, federal, government	Direct Action	1.93%
Calls for Action	Action, take, demand, call, join	Direct Action	1.87%
Urgency Narratives	Now, time, act,start, happen	Activism - Ideology	1.84%
Youtube Videos	Video, watch, youtube, feature, channel	Media and Communication	2.02%
Films and Art	Film, art, music, song, inspire	Activism - Creative	1.62%
Covid-19	Crisis, face, world, pandemic	Covid-19	1.78%

Temperature Increases	Warm, rise, temperature, level, increase	Science	2.02%
Boilerplate 2	Get, know, can, let, please	Boilerplate	2.18%
Green Jobs	Green, worker, economy, job, business	Science	1.57%
School Strikes and Marches	Everyone, join, march, politician, crisis	Direct Action	1.43%
Boilerplate 3	Please, help, form, send, google	Boilerplate	1.89%
Declarations of Emergency	Emergency, city, council, declare, local	Activism - Principles	1.82%
Covid-19 in Africa	Country, people, africa, covid, suffer	Covid-19	1.58%
Deforestation in the Amazon	Fire, burn, amazon, stop, rainforest	Science	1.50%
Community-based Activism	Community, group, work, learn, local	Activism - Organisation	1.75%
Global Climate Strikes	Global, strike, september, participate, international	Direct Action	1.96%
Boilerplate 4	Clima, piazza, italia, solo, ambiente	Boilerplate	2.62%
March Rallies	March, bring, park, rally, meet	Direct Action	2.23%
University Networks	Youth, movement, lead, universities, justice	Activism - Organisation	1.65%

National day against Gas	Action,day, gas, national, safe	Direct Action	1.40%
School Strikes - Parents	School, strike, student, support, parent	Activism - Organisation	2.35%
Individual Impacts	People, world, around, show, voice	Activism - Principles	1.80%
Fridays for Future Hashtags	Fridaysforfuture, climatestrike, fff, schoolstrikeforclimate, gretathunberg	Activism - Organisation	3.52%
Plastic Pollution	Plastic, waste, clean, can, buy	Science	1.68%
Greta Thunberg	Greta, thunberg, activist, old, swedish	Activism - Organisation	2.18%
Paris Agreement	Paris, unite, agreement, cop, leader	Politics	1.66%
Boilerplate 5	Today, week, thank, see, next	Boilerplate	2.54%
Online Workshops	Join, meet, talk, zoom, link	Media and Communication	1.93%
Pipelines on Indigenous Land	Canada, indignenous, land, pipeline, nation	Fossil Fuels Industry	1.59%
Facebook Posts	Facebook, post, story, media, page	Media and Communication	2.30%

Finding Solutions	Work, solution, find, challenge, help	Activism - Principles	1.86%
Boilerplate 6	Year, last, one, first, two	Boilerplate	1.82%
Racism	Justice, fight, struggle, racism, solidarity	Intersectional Activism	1.70%
Earth Day	Earth, day, planet, save, life	Activism - Organisation	1.87%
Extinction Rebellion	Extinction, rebellion, protest, london, mass	Extinction Rebellion	1.58%
Fossil Fuels Sector	Fuel, fossil, oil, company, industry	Fossil Fuels Industry	2.33%
Sustainable Agriculture and Plant-based Diets	Water, food, health, animal, agriculture	Science	1.59%

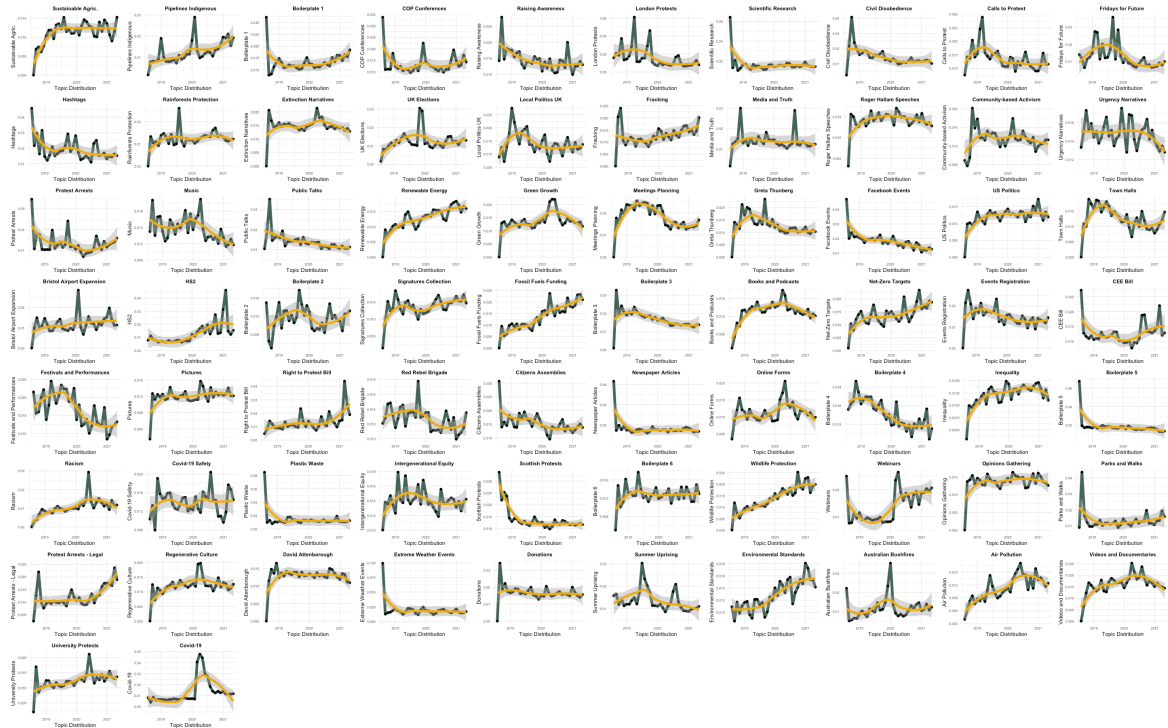# A.4 Temporal Evolution by Topic - Extinction Rebellion

Fig. A.2 Temporal Evolution by Topic for Extinction Rebellion

A.5 Temporal Evolution by Topic - Fridays for Future
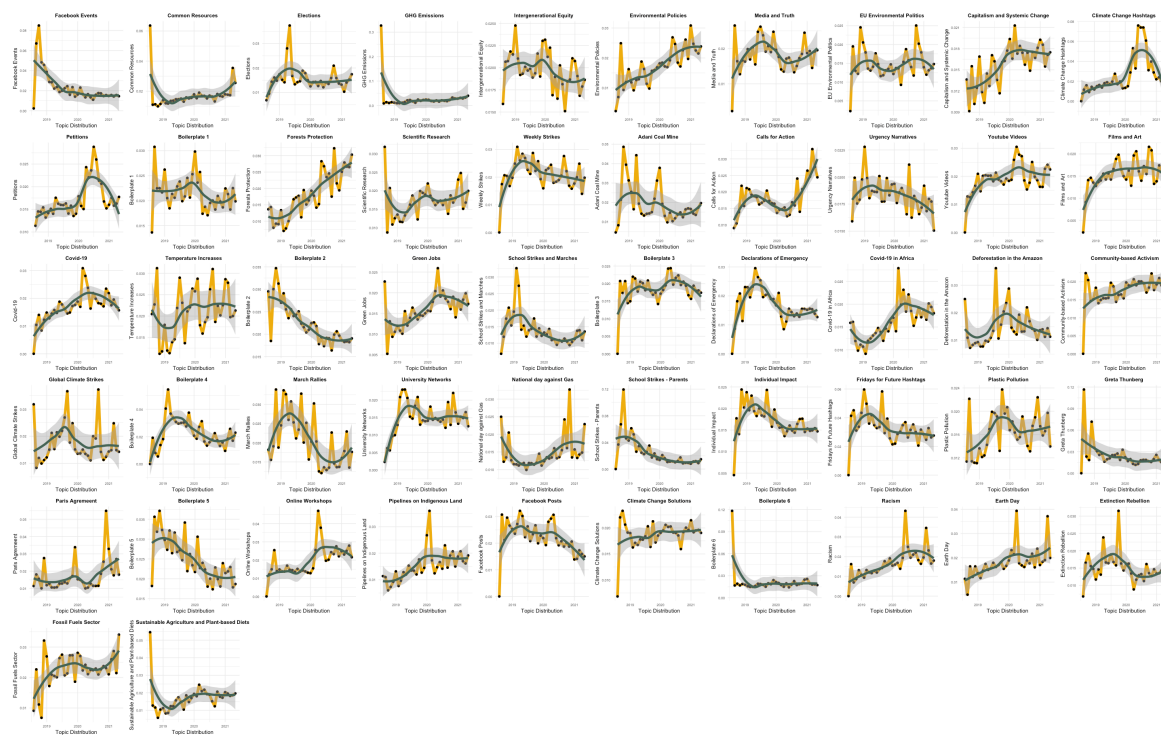

Fig. A.3 Temporal Evolution by Topic for Fridays for Future

Appendix B

Chapter III - Topic Modelling

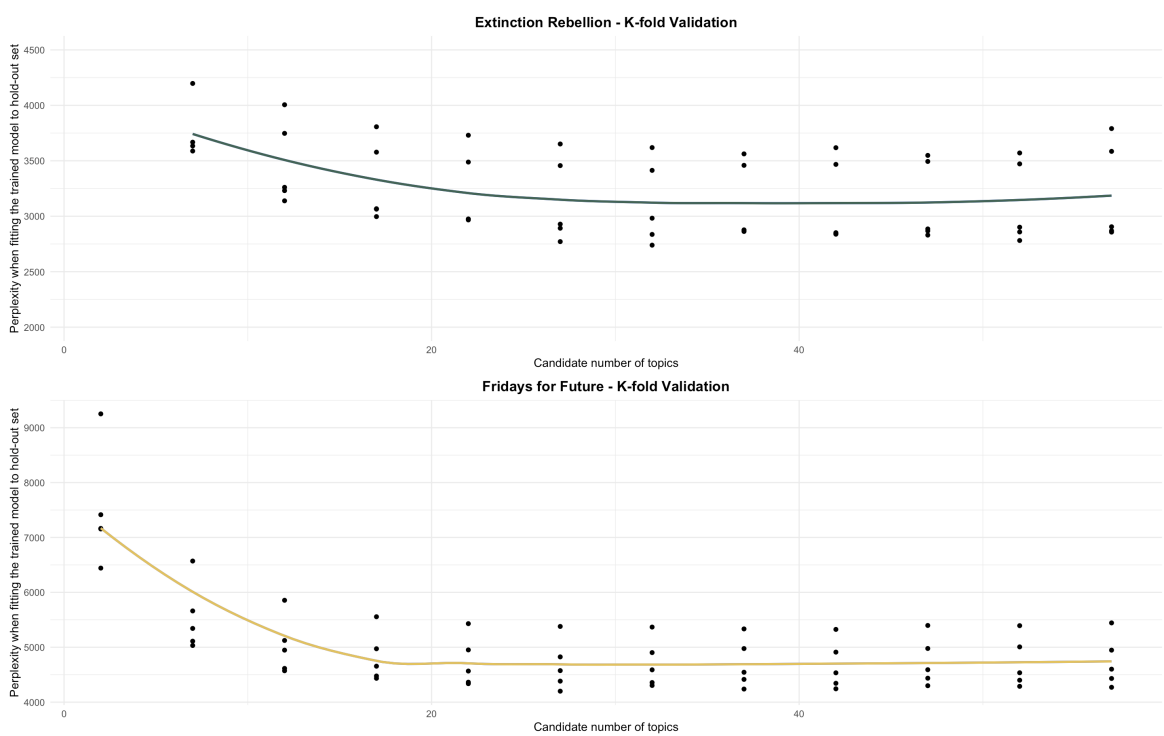## B.1   Perplexity Scoring

Fig. B.1 Results of the K-Fold Validation Process for Naming and Shaming of Information Polluters

B.2 Topic Modelling Results - Extinction Rebellion

Topic	FREX Words	Topic Frequency
Fossil Banks	Barclays, bank, stop, funding, hsbc	6.26%
Media Sector	News, media, murdoch, truth, lies, BBC	6.58%
Calls to Action	Tomorrow, march, everyone, local, meet	8.11%
In-person Protest	Today, rebels, parliament, round, square	5.55%
Climate Justice	Reparations, justice, global, solidarity, communities	5.93%
Racism	racism, group, black, systemic, power	5.00%
ExxonMobil	Exxon, company, oil, science, doubt	4.98%
Coal Mining	Coal, mine, business, new, adani	5.96%
Disinformation Funding	Money, lies, lobby, science, writers	6.17%
British Petroleum	Bp, must, responsible, stop, british	6.29%
Colonialism	Colonialism, international, fight, law, afrikan	6.00%
Scientific Disinformation	Misinformation, science, deniers, spread, disinformation	7.33%
Civil Disobedience	Civil, disobedience, direct, act, face	5.32%
Shell	Shell, science, decades, misinformation, pollution	5.78%
Oil and Gas Industry	Gas, fuel, companies, oil, industry	8.08%
Denial Think Tanks	Policy, institute, think, lobby, environmental	6.60%

Table B.1 Naming and Shaming of Information Polluters - Topic Model of Extinction Rebellion

B.3   Topic Modelling Results - Fridays for Future

Topic	FREX Words	Topic Frequency
Hashtags	Fridaysforfuture, climatestrike, climatemergency ,fridays, climateaction	7.79%
Consensus Denial	Science, consensus, denier, public, doubt	7.54%
Protecting the Planet	Future, planet, earth, protect, life	8.50%
Youth Strikes	Crisis, strike, school, join, youth	9.43%
Co2 Emissions	Oil, co2, emission, fossil, gas	7.43%
Calls to Action	Like, share, now, join, protest	9.45%
Fossil Fuels Industry	Fossil, fuel, companies, oil, industry	8.85%
Media Sector	Media, misinformation, news, truth, press	9.98%
Fossil Fuels Projects	Coal, company, land, project, destroy	7.77%
Health	Crisis, health, social, population, air	7.93%
Online Misinformation	Science, fake, news, facebook, misinformation	7.67%
Donald Trump	Trump, spread, lies, child, cold	7.60%

Table B.2 Naming and Shaming of Information Polluters - Topic Model of Fridays for Future

Appendix C

Chapter IV - Topic Modelling
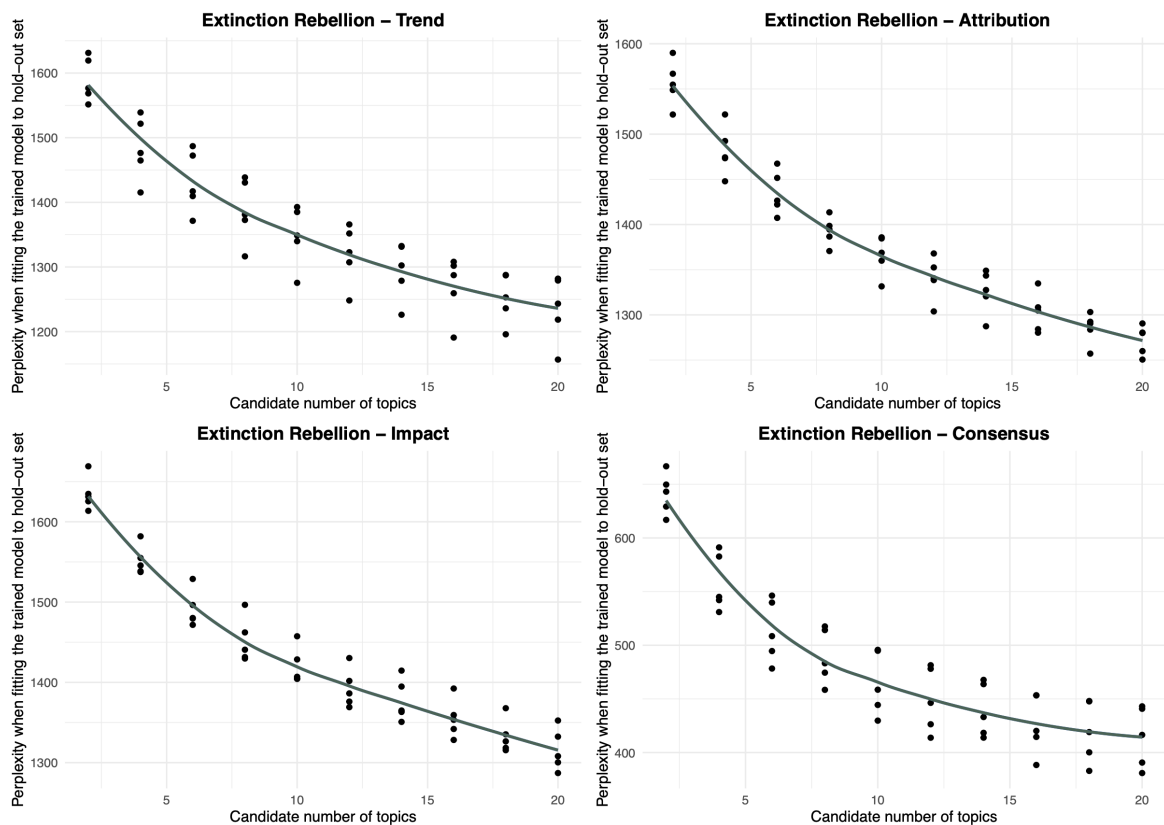
C.1 Perplexity Scoring

Fig. C.1 Results of the K-Fold Validation Process for Science-Based Counternarratives - Extinction Rebellion
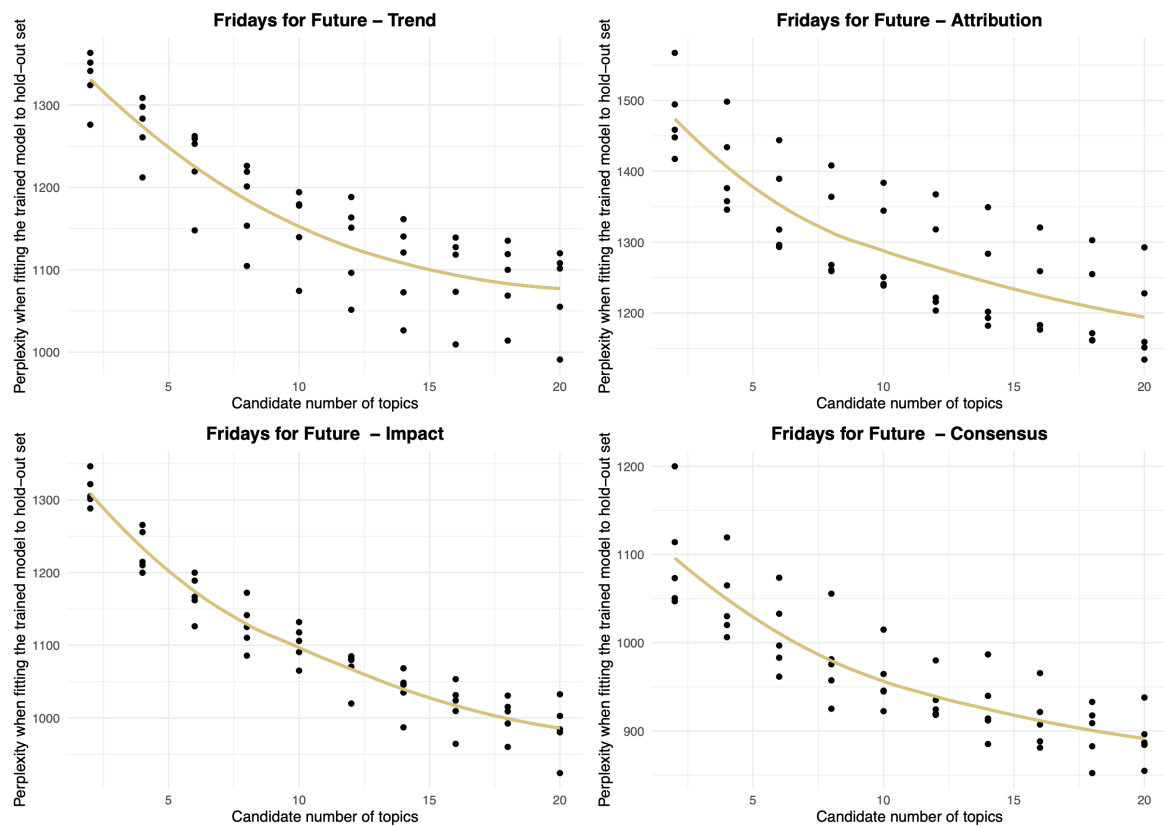
Fig. C.2 Results of the K-Fold Validation Process for Science-Based Counternarratives - Fridays for Future

C.2   Topic Modelling Results - Extinction Rebellion

Trend		
Topic	**FREX Words**	**Topic Frequency**
Fossil Fuels Emissions	Gas, fossil, fuel, greenhouse, atmosphere	4.06%
Sea Level Rise	Glacier, melt, sea, level, ice	10.67%
Research	Model, study, research, scenario, show	7.94%
Record Temperatures	Hot, heatwave, ever, heat, record	12.63%
Coral Bleaching	Reef, coral, bleach, degree, change	10.03%
Marine Wildlife	Ocean, species, ecosystem, marine, wildlife	7.26%
Tipping Points	Tip, point, system, epoch, earth	10.53%
Extreme Weather Events	Flood, storm, rain, weather, extreme	13.39%
Arctic Ice Loss	Ice, arctic, melt, loss, extent	5.92%
Permafrost	Permafrost, thaw, release, freeze, leak	4.90%
CO2 Concentration	Ppm, concentration, high, dioxide, carbon	7.19%
Forest Fires	Fire, forst, wildfire,burn, smoke	5.46%

Table C.1 Trend Counternarratives - Topic Model of Extinction Rebellion

Attribution		
Topic	**FREX Words**	**Topic Frequency**
Low-Emission Energy	Energy, renewable, electric, power, phase	7.46
Emissions from Agriculture	Food, land, agriculture, livestock, emission	5.07
Fossil Fuels Emissions	Fuel, fossil, burn, emission, methane	6.17
Net-Zero Targets	Target, government, net, policy, minister	13.59
Carbon Capture and Storage	Technology, offset, capture, storage, company	7.07
Covid-19	Drop, pandemic, coronavirus, lockdown, air	8.68
Paris Agreement	Paris, agreement, country, goal, finance	3.28
Calls to Action	Extinction, rebellion, join, act, now	10.38
Emergency Narratives	Rising, emission, declare, emergency, support	7.85
Carbon Sinks	Tree, forest, plant, remove, atmosphere	8.78
Carbon Footprints	Footprint, population, consumption, rich, poor	9.10
Emission Reduction Targets	Warm, limit, degree, reduce, emission	12.47

Table C.2 Attribution Counternarratives - Topic Model of Extinction Rebellion

Impact		
Topic	**FREX Words**	**Topic Frequency**
Australian Bushfires	Australia, bushfires, koala, extinct, fire	8.69
Sea Level Rise	Flood, sea, rise, level, coastal	4.96
Insects Decline	Insect, decline, pesticide, population, bee	8.26
Biodiversity Loss	Biodiversity, report, grasp, loss, collapse	11.57
Health Impacts of Air Pollution	Air, pollution, death, asthma, lung	14.28
Airport Expansion Protests	Airport, action, stop, london, civil	2.92
Climate-Induced Migration	Water, refugee, crisis, migration, drought	8.18
Food Shortages	Food, insecurity, risk, global, shortage	6.64
Mental Health	Health, doctor, mental, depression, effect	6.13
Marine Habitats Loss	Ocean, marine, fish, habitat, loss	6.48
Extreme Weather Events	Disaster, extreme, rain, flood, weather	14.72
Covid-19	Pandemic, disease, outbreak, coronavirus, destruction	7.12

Table C.3 Impact Counternarratives - Topic Model of Extinction Rebellion

Consensus		
Topic	**Frex Words**	**Topic Frequency**
Online Events	Zoom, register, online, meet, explain	10.16
Listening to Science	Rebel, listen, science, act, accordingly	7.55
Workshops	Speaker, discussion, host, science, tonight	10.62
Scientist Affiliations	Institute, research, impact, system, lead	8.21
Scientific Agreement	Science, agree, nature, collapse, warm	7.63
University Professors	University, prof, expert, director, panel	9.14
Risk Narratives	Risk, grave, disaster, happen, soon	7.66
Calls to Action	Invite, people, hear, evidence, encourage	6.60
Q&A Events	Event, professor, chair, answer, question	7.68
Books on Climate Science	Book, aim, tell, limit, emission, now	7.23
IPCC Reports	Ipcc, report, emission, detail, agree,threat	8.10
Consensus Denial	Denial, concern, save, consensus, earth	8.49

Table C.4 Consensus Counternarratives - Topic Model of Extinction Rebellion

C.3   Topic Modelling Results - Fridays for Future

Trend		
Topic	**FREX Words**	**Topic Frequency**
Arctic Ice Loss	Ice, sea, melt, arctic, sheet	9.98
Heatwaves and Record Temperatures	Record, hot, temperature, heatwave, ever	14.02
Floods	Flood, rain, river, water, heavy	12.76
Permafrost	thaw, loop, feedback, permafrost, accelerate	5.55
Forest Fires	Fire, wildfire, forest, burn, dry	12.47
Extreme Weather Events	Hurricane, storm, tropical, cyclone, strong	7.55
Stream Gulf Temperature	Stream, gulf, atlantic, surface, water, temperature	5.27
Greenhouse Gas	Carbon, gas, atmosphere, greenhouse, dioxide	8.37
Ocean Temperatures	Ocean, marine, temperature, change, rate	14.62
Coral Bleaching	Reef, coral, degree, extreme, heat	9.18

Table C.5 Trend Counternarratives - Topic Model of Fridays for Future

Attribution		
Topic	**FREX Words**	**Topic Frequency**
Community Activism	Sustainable, community, adaptation, support, resource	10.64
Carbon Sinks	Tree, plant, forest, offset, solution	6.59
Emissions from Aviation	Energy, flight, fossil fuel, aviation	10.13
Carbon Budgets	Budget, carbon, remain, within, percent	14.97
Capitalism and Emissions	Capitalism, rich, tax, profit, crisis	7.59
Human-caused Emissions	Earth, human, destroy, effect, emission	12.25
Fossil Fuels Industry	Oil, fossil, industry, plan, expansion	9.96
Carbon Capture	Capture, technology, emission,dioxide, carbon	4.11
Paris Agreement	Agreement, paris, pledge, zero, net	12.01
Emission Reduction Targets	Target, reduction, achieve, plan, policy	11.59

Table C.6 Attribution Counternarratives - Topic Model of Fridays for Future

Impact		
Topic	**FREX Words**	**Topic Frequency**
Biodiversity Loss	Biodiversity, species, nature, wildlife, loss	17.33
Floods	Flood, disaster, risk, damage, area	5.13
Vaccines and Inequality	Vaccine, country, receive, poor, rich	7.86
Air Pollution	Air, pollution, level, death, data	10.67
Covid-19	Coronavirus, pandemic, future, prevent, outbreak	11.63
Water Shortages	Water, risk report, million, scarce	6.56
Indigenous Populations	Indingeous, risk, fight, save, death	11.68
Infectious Diseases	Disease, human, animal, spread, infect	7.93
Food Security	Food, security, extreme, weather, agriculture	11.54
Global South	Woman, child, south, vulnerable region	9.34

Table C.7 Impact Counternarratives - Topic Model of Fridays for Future

Consensus		
Topic	**FREX Words**	**Topic Frequency**
Scientific Consensus	Scientific, consensus, evidence, show, fact	7.02
Listening to Science	Greta, thunberg, listen, science, truth	12.24
Scientific Evidence	Data, warm, global, research, study	10.02
Online Articles	Article, problem, explain, write, know	9.62
Media Coverage	Crisis, media, term, talk, important	9.94
Urgency Narratives	Emergency, action, face, risk, now	9.14
Denier Think Tanks	Institute, denier, scientific, fossil, group	8.43
Warnings from Experts	Warn, world, concern, expert, say	10.39
IPCC Reports	IPCC, report, release, read, today	9.37
Consensus Denial	Fossil, industry, denial, consensus, online	12.20

Table C.8 Consensus Counternarratives - Topic Model of Fridays for Future