Introduction

Social media platforms are playing an increasingly central role in communicating scientific and environmental information (Adams & Gynnild, 2013; Walter et al., 2017). They are criticized for serving the dissemination of climate change denial and enabling an environment in which sceptical views of climate science are validated (Bloomfield & Lake, 2015). Research on climate discourse suggests that users deploy rhetorical strategies to reinterpret and undermine climate research (Bloomfield & Tillery, 2018). Bloomfield and Tillery (2018) show how Facebook users misrepresent peer-reviewed climate research through hyperlinks and blogging. Peer-reviewed research is framed and expanded on to fit their accounts of climate change hoax, and scientific sources are used to come across as more legitimate.

Similar dynamics are likely to be present on Reddit. This is a social news aggregation and discussion website, where users submit posts consisting of titles and links or self-written content, which then become available for voting and commenting by the wider community (Medvedev et al., 2019). Unlike follower-based social media platforms, such as Facebook or Twitter, Reddit is organised around topic-specific communities (e.g. subreddits), which users follow rather than individual accounts. This platform structure, characterised by its user-generated submissions, extended comment threads and hyperlink- based evidence sharing, may uniquely shape the way climate debates unfold. Treen et al. (2022) find that Reddit climate discussions share phenomena with other social media platforms, including the presence of climate sceptic views, misinformation and affordances such as hyperlinks to (un)trustworthy sources. Reddit is a popular yet understudied locus of climate debate. Existing research has focused mostly on normative assessments of the discussion platform, polarization and reactions to opposing viewpoints (Freelon, 2015; Treen et al., 2022; Oswald & Bright, 2022), while far less attention has gone to the rhetorical techniques used to enable climate scepticism. The present study aims to fill this gap by asking: which neutralisation techniques are commonly used and adopted by Reddit users to downplay climate change? This study explores the use of neutralization techniques within Reddit posts from the subreddit r/environment, r/climatechange and r/climate.

Neutralisation theory, originally developed by Sykes and Matza (1957), is a framework for explaining how individuals justify norm-violating behaviour without rejecting dominant moral values. This theory identifies five neutralisation techniques individuals use to justify deviant behaviour: denial of responsibility, denial of injury, denial of the victim, condemnation of the condemner, and appeal to higher loyalties. Although developed in a criminological context to explain delinquency among youth, neutralisation theory has since been applied to a wide range of harmful yet socially contested behaviours. Neutralisation techniques have been thoroughly studied in relation to climate change countermovement organisations (CCCM) (McKie, 2018; Boussalis & Coan, 2015; Dunlap, 2025; Dunlap & Jacques, 2013). These organisations, initiated by fossil fuel corporations, carbon-dependent industries, and conservative political networks, have played a powerful role in shaping public debate and influencing climate policy agendas (Dunlap & Jacques, 2013; McKie, 2018; Dunlap, 2025). Prior research shows that counter climate movements use neutralisation techniques to justify climate inaction by denying responsibility, harm or legitimacy of actors attempting to address climate change (McKie, 2018). While this research

has advanced our understanding of climate change narratives by organizations at the meso-level, relatively little is known about how neutralisation techniques operate at the micro-level of everyday online interaction between individual users. By applying neutralisation techniques to posts by Reddit users, this study addresses a theoretical gap.

Studying neutralisation techniques is societally relevant, because these techniques have been shown to undermine moral obligation and reduce support for climate policies (Pilgreen et al., 2025). Pilgreen et al. (2025) investigated how neutralisation techniques influence norm activation and support for climate action. In their study, respondents were asked to indicate how much they agreed with neutralizing beliefs, such as economic priorities outweigh climate action, that climate change is too costly to address, or that it is merely a political issue. Those that agreed to neutralizing beliefs reported feeling a weaker personal moral obligation regarding climate change, which in turn reduced activation of personal norms that typically drive pro-environmental behaviour. Additionally, they found that people holding neutralising beliefs report less awareness of climate change consequences and will be less likely to support collective action and governance addressing climate change.

By identifying which neutralisation strategies are most prevalent in an online public forum, like Reddit, communicators can better anticipate justifications for inaction, enabling policymakers, educators, and climate advocates to tailor counter-messages that directly address specific forms of moral disengagement. The relevance of such an approach is illustrated by Zhong et al. (2025), who investigated interventions to climate change denial and conspiracy ideology in Reddit communities. Labelled bot accounts responded to denialist content with pro-social, evidence-based messages created using insider language familiar to these communities. This intervention stimulated a more open discussion among users expressing climate sceptics, and reinforced evidence-based discussions among climate-supportive users. This demonstrates that interventions engaging with denialist narratives, instead of ignoring them, can be more effective than information provision. Thus, understanding which neutralisation techniques are used by Reddit users could provide a basis for designing targeted, science-based counter-messages.

The present study advances prior research by analysing the prevalence of neutralisation techniques in Reddit climate discussions at the micro-level of posts. Based on prior work on CCCM discourse, we hypothesise that condemnation of the condemner will be most frequently used by Reddit users (*H1*) and that policy-oriented neutralisation techniques will appear more frequently than science-denial techniques (*H2*).

The outline of the paper is as follows. First, a justification is provided for applying neutralisation techniques as a framework for analysing climate change denial narratives, together with relevant prior literature. Second, the methodology section outlines the primary reasons for using structural topic modelling and critical discourse analysis, as well as the ethical considerations regarding the use of Reddit data. Third, the results section presents the main findings. Lastly, the discussion and conclusion address the strengths and limitations of the study and offer recommendations for future research.

Theoretical framework

Neutralisation techniques

In an attempt to understand why juvenile delinquency occurs different theoretical viewpoints have emerged. Juvenile delinquency is a form of behaviour based on values and norms of a deviant sub-culture and assumes that those that are delinquent are socialized into an alternative way set of values that lead people to delinquency. In opposition to socialization theory, Sykes and Matza (1957) propose that 'a juvenile delinquent is at least partially committed to the same dominant social order, as they exhibit guilt or shame when they violate shared behavioural norms, accord approval to certain conforming figures, and differentiate between appropriate and inappropriate targets for his deviance' (p.666). They explain normative systems that guide behaviour is characterized by flexibility, where rules are not held to be binding under all conditions. For example, causing someone harm or injury may be legally less criminalized when it was in an act of self-defence. Compulsion, drunkenness can be used as defence to a crime in order to avoid self-blame and sanctions of society. Delinquency is an unrecognized extension of defences to crimes, in the form of justifications for deviance that are seen as valid by the delinquent but not by the legal system or society at large.

Justifications help escape feelings of self-blame after committing a crime but can also precede deviant behaviour by making this behaviour possible. Social control mechanisms that serve to prevent and stop deviant behaviour are neutralised or rendered inoperative. By neutralizing or deflecting, disapproval (a form of social control) of non-confirmative behaviours vocalized by peers, colleagues, parents and authoritative figures, an individual will feel free to engage in deviant behaviours, including delinquency. In rationalizing deviant behaviour individuals remain committed to the dominant normative system yet qualifies the norms of the dominant system in such a way that violations of norms become acceptable, if not justified. Rationalizations of deviant behaviour are known as neutralisation techniques. By learning these techniques, a juvenile becomes delinquent, rather than through adopting values or attitudes that contrast with those of the dominant society. The original five techniques are:

Denial of responsibility: the deviant negates personal responsibility by arguing that the act was accidental or beyond their control (e.g. unloving parents, slum neighbourhood).

Denial of Injury: the deviant argues his behaviour does not really cause any harm by qualifying this behaviour as an extension of a common practice. According to McKie (2018) the deviant may also assert their behaviour has a positive impact.

Denial of the victim: the deviant positions himself as an avenger, whereas the victim is changed into a wrong doer. Injury is a form of rightful retaliation or punishment, which means the deviant does not see a victim or sees the victim as deserving.

Condemnation of the condemner: the deviant shifts attention away from the norm violation by attacking the legitimacy, motives, or integrity of those making the claim.

Appeal to higher loyalties: the deviant justifies the act as a necessary trade-off in resolving a dilemma. The violation of the law is framed as unfortunate but acceptable as it serves a greater obligation

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Neutralisation techniques applied to climate change

Neutralisation theory extends beyond juvenile delinquency and is useful for understanding harmful behaviours that are not legally defined as criminal. In the context of climate change, neutralisation has been identified as a pervasive feature of climate change countermovement discourse, scepticism and denial (McKie, 2018). Whyte (2016) applies neutralisation theory to wrongdoing in the automobile industry, showing how industry actors use neutralisation techniques to shape the public debate around socially harmful practices, such as pollution, health and safety violations. Similarly, Fooks et al. (2013) demonstrate how British American Tobacco uses neutralisation techniques in corporate social responsibility reports to deflect criticism and legitimize unethical practices. These studies show that neutralisation techniques are suited to analyse discursive strategies that normalise harm and deflect accountability in context where the deviant behaviour is not overtly criminal.

Lörcher and Taddicken's study (2017) on online climate change communication further supports the relevance of applying neutralisation techniques to Reddit discussions. They distinguish between different online public arenas, including mass-media-induced discussion arenas, expert arenas, and activist-oriented or civil society arenas. The mass-media-induced discussion arena starts with journalistic input, where users react to online news articles and subsequently exchange views and opinions regarding the news content or preceding comments (Lörcher & Taddicken, 2017). Their findings show that questioning the credibility of climate science is especially common in mass-media-induced discussion arenas, whereas uncertainty about climate science appears more broadly across arenas. In these mass-media-induced contexts, climate scientists are frequently accused of being politically or economically motivated. This serves to undermine their legitimacy as credible sources of knowledge. From the perspective of neutralisation theory (Sykes & Matza, 1957), such credibility attacks align closely with the technique of *condemning the condemner*, because they delegitimize those who stress the scientific and moral urgency of taking action against climate change. Given that Reddit often functions as a mass-media-induced discussion platform, (where users respond to journalistic content and engage in layperson debate), neutralisation techniques are suitable for analysing how climate-related norms are contested and neutralised.

Similarly, Mckie (2018) identifies *condemnation of the condemner* as the most frequently used neutralisation technique within climate change countermovement discourse across time. Mckie (2018) explored whether arguments by counter climate change movements (CCCM) contain neutralisation techniques and whether the adoption of these techniques track change in organizational messaging over time. By drawing on a list of CCCM organisations (e.g. including conservative foundations, conservative Think Tanks and fossil fuel industries) from prior research and identifying affiliated partners, the study analysed messaging from 53 organisations. Their content analysis demonstrated that a message used on average two to three neutralisation techniques, suggesting that organizations attempt to appeal to different groups by combining techniques. By monitoring two time frames from 1957 to 2014 and from 2015 until the organisation's latest operation, McKie (2018) found that organisations increasingly use the

condemnation of the condemner technique by assigning deviant labels to scientists, environmentalists and policy actors. For instance, organisations portray scientists as misrepresenting facts to condemn these actors and cast doubt on climate research. *Condemnation of the condemner* was the most popular as it appeared in 64% of all organisational messaging. Over time, the technique was increasingly being used in organizational messaging.

One of the few studies conducted on frames adopted by different subreddits found 'remarkable similarities in discourse strategy and ideology between /r/climateskeptics and think tanks that promote climate skepticism', even though the subreddit has no financial links to think thanks (Gadanidis, 2020). A common discourse strategy, users attempt to discredit those advocating for climate action by assigning them deviant labels or political motives. Rather than engaging directly with the scientific claims, the focus shifts to portraying scientists, environmentalists, or "green" groups as ideologically driven, corrupt, or self-interested (Gadanidis, 2020). By framing climate advocacy as a partisan agenda, the credibility of the condemners is undermined. This suggests that neutralisation techniques are not confined to organisations. The similarity in discursive strategies used by counter climate change movements and reddit users may be generalizable across other subreddits, because Reddit encourages users to join in multiple subreddits based on topics of interest (Medvedev, Lambiotte & Delvenne, 2019). This means that reddit users could post similar rhetorical arguments regarding climate change. Therefore it is hypothesized that among the neutralisation techniques, *condemnation of the condemner* is the most frequently used by Reddit users in discussions on climate change (*H1*).

Prevalence of different neutralisation techniques

McKie's (2018) content analysis of CCCM organisational messaging shows that while denial-based techniques are present, organisations increasingly rely on policy-oriented justifications that challenge the legitimacy of climate action rather than the existence of climate change itself. In her findings, *appeal to higher loyalties* emerged as the second most frequently used technique, framing climate mitigation as subordinate to economic growth, national interest, or global development. *Denial of responsibility* is the third most frequently used technique, where organisations acknowledge that climate change is happening, but argue that it is caused by natural factors. The use of the denial of injury that there is no considerable harm caused by human action - such as human emissions constitute only a minor part of the global greenhouse emissions - has declined over time. Because there is widespread evidence of wildfires, floods and other extreme weather impacting communities, denying injury has likely lost its power. The *denial of the victim*, which justifies that affected groups by climate change are not truly harmed or that the harm is blown out of proportion, was the least frequently used technique. This finding is likely attributed to organizations knowing that contrasting victim and offer in a narrative may backlash in stimulating resistance to climate action. The pattern that emerged from these findings is that *condemnation of the condemner* and *appealing to higher loyalties* are the most frequently used techniques.

McKie (2018) argues that *condemnation of the condemner* and *appealing to higher loyalties* do not outright deny climate change and therefore are distinct from *denial of injury*, *denial of the victim* and

denial of responsibility. The former are policy-oriented techniques, whereas the latter are science denial techniques.

Additional evidence that supports the strategic shift away from science denial to policy-oriented techniques comes from Boussalis and Coan (2016). Using unsupervised computational modelling, they analysed 16,000 documents produced by North American climate Think Tanks between 1998 and 2013. They found that denial arguments cluster primarily around policy, regulation, political economy, and energy rather than climate science. The production of denial content was found to respond strategically to political contexts, particularly pending climate legislation, which indicates that messaging is oriented toward contesting climate governance. In general, despite claims by a couple commentators that anthropogenic global warming doubt was declining. The levels of doubt about climate science and policy remained strong throughout the years. Additionally, the scientific integrity cluster was as proximate to both the science cluster and the domestic and international politics cluster - indicating the political nature of questioning the integrity and benevolence of scientists and scientific institutions that publish on climate change. As Boussalis and Coan note, "... scientists are presumed to wield 'junk science' to achieve political aims" (pp. 94–95). This framing corresponds with the neutralisation technique of *condemning the condemner*, in which responsibility for inaction is deflected by portraying scientists as self-interested actors.

Farell's (2016) large-scale analysis of over 40,000 texts produced by climate countermovement organizations further substantiates the expectation that policy-oriented neutralisation techniques are more prevalent than science-denial strategies. Farell's structural topic modelling shows that countermovement discourse is organised around economic and political costs of implementing policies to address global warming. This theme aligns with *appeal to higher loyalties*, whereby climate inaction is justified by prioritising economic progress over environmental responsibilities. A key theme identified across the topics was suspicion toward scientific authorities and the IPCC. This is representative of the newer emphasis on scientific integrity. Scientific integrity is typically questioned in documents by counter climate organisations, which aligns with the *condemnation of the condemner*. Because there is a lack of literature on applying neutralisation techniques to climate change comments on Reddit, these findings from CCCM literature guide our hypothesis. Together, these findings support the hypothesis that *condemning the condemner* and *appealing to higher loyalties* will appear more frequently in Reddit climate discussions than science-denial techniques such as *denial of responsibility*, *denial of injury*, and *denial of the victim* (*H2*).

Methodology

Research design

To answer the research question, this study will adopt a deductive mixed-method-approach. Combining topic modelling and critical discourse analysis facilitates answering how neutralization techniques are used in Reddit posts posted in the subreddits r/environment, r/climate, and r/climatechange. Structural topic modelling is used, which is a quantitative method that looks at the co-

occurrence of words in various documents and determines topics out of large textual data (Roberts et al., 2019). These topics give insight into the discussions in the posts.

Additionally, critical discourse analysis is applied. This is a qualitative approach for understanding how languages can be used to influence others and how these patterns appear across different texts and discussions (Wodak & Meyer, 2016). Critical discourse analysis is well suited, because it enables an analysis of how Reddit users use language to justify certain behaviour with neutralization techniques within the context of climate change.

Data collection

For this study, posts were collected from the subreddits r/environment, r/climate, and r/climatechange. These subreddits function as online forums where users can discuss and share information about climate change. The subreddit r/environment presents itself as a place for "current news, information and issues related to the environment" (Reddit, n.d.). R/climate describes their subreddit as a space for "truthful and accurate information about the world's climate" (Reddit, n.d.). Lastly, the subreddit r/climatechange described their subreddit as "a place for the rational discussion of the science of climate change" (Reddit, n.d.). Posts uploaded on these subreddits will show insights on what is being discussed related to climate change.

For data collection, the download tool of Arctic Shift (https://arctic-shift.photon-reddit.com/download-tool/) was used. The posts from the relevant subreddits were collected, with the time window of January 1st 2020 to November 30th 2025. This time window was chosen to ensure manageable computational demands, while still having sufficient data for analysis. Solely posts were collected for this study, as including comments would considerably complicate the analysis. Furthermore, due to a limited timeframe of this study, it wasn't feasible to include the comments to the analysis. Moreover, comments often provide limited textual information, making annotating techniques challenging.

The datasets consisted of 158,769 posts, after downloading it. Figure 1 in Appendix B shows the distribution of posts between the subreddits and the process of preparation of the data set for the analysis. Further, the posts only containing "[deleted]", "[removed]", or containing only a title were removed from the data set. 13,670 posts remained in the data set. These posts were used for the analyses. The title and the added text of posts were combined and made into a new variable, to have as much textual information at once. All the preprocessing and the analyses were completed in the statistical program and language R (R 4.5.1), and the script can be found in Appendix A.

Analysis

Topic modelling

As mentioned earlier, structural topic modelling (STM) was used for gaining insight on the topics that are discussed in the posts. STM was performed with the stm R package (v1.3.8; Roberts et al., 2019). The process of this analysis was first to preprocess the data, then estimate the topics with STM, and lastly to interpret the topics given from the model.

Firstly, the preprocessing of the data. Textual information needs to be processed before the model can work with it. The R package stm consists of two functions that can be used to process the texts. Firstly, the function *textProcessor* was used, which removes extra white spaces and stop words, and stems words with the snowball stemmer (Roberts et al., 2019). After this, the function *prepDocuments* was used to remove infrequently occurring words, update word IDs, and discard posts that contained no remaining text after preprocessing. Five posts were removed as they contained no remaining characters after the preprocessing step.

Secondly, the number of topics need to be estimated for the STM. A model was generated containing different amounts of topics, from ten to sixty topics with steps of ten topics in between. Figure 2 in Appendix B shows a visualization of the coherence and exclusivity of the models. Coherence is about how often terms with a high probability of belonging to one topic, also co-occur in the relevant posts (Roberts et al., 2019). Exclusivity determines how exclusive terms are in a certain topic (Roberts et al., 2019). For both concepts, the higher the value is, the better. To balance these two concepts, the best model would probably be in between thirty and forty topics. Within this range, exclusivity still improves greatly, as after forty topics the line stagnates. However, there is a substantial drop in coherence when it goes from thirty to forty topics. For this reason, it is chosen that the final model should have 35 topics, to ensure that exclusivity is high, without it being at the expense of coherence.

Lastly, it is important to interpret the topics. This interpretation is done by examining the top twenty most prominent posts for each topic, along with the top 15 words for each topic. In Table 1 in Appendix C are the labels of each topic shown, along with the top 10 words of each topic. After interpreting the 35 topics, the topics were clustered to overarching topics, which is shown in Figure 3 in Appendix C.

Critical discourse analysis

Alongside structural topic modelling, critical discourse analysis was used to answer the research question. The discourse analysis will give insight into how much and in what way neutralization techniques are used in Reddit posts about climate change. The process of the discourse analysis was to firstly select the posts to dive further into, secondly to annotate the sample, after that look into the inter-annotator agreement of the annotations and lastly to interpret the results.

First, a sample needed to be selected from the data. The selection was chosen at random and contains 342 posts. This number of posts was chosen, due to the limited time frame only being able to dive into around 2,5% of the data. A random selection was selected to have a representable sample from the whole data set.

Secondly, after collecting a sample of posts, it is important to annotate these posts. Annotations were done using the annotinder R package (v0.1.0; Welbers, 2022). This package made it possible to annotate within RStudio and directly import the annotations to the data set. Beforehand, an annotation guideline was made, which can be found in Appendix E**.** This guideline was followed during annotations done by two annotators. The annotator had to choose between seven different labels to annotate a post. A post had to be annotated as one of the neutralization techniques, as not containing a technique, or as

"Other". The label "Other" was added to the annotations to capture neutralization techniques used in posts that were not predefined. Further information of the annotation rules used during annotating can be found in the annotation guidelines in Appendix E.

Third, determining the inter-annotator agreement is important for the quality of the annotations. Cohen's kappa was therefore calculated, resulting in a value of 0.1207. This indicates a very weak inter-annotator agreement. The results suggest that there were a lot of disagreements between the two annotators. The confusion matrix in Table 4 in Appendix D indeed shows these differences. Solely focussing on the posts identified with a neutralization technique, only five posts were marked similarly. Table 5 presents a selection of posts with different annotations, which were analysed to identify recurring themes of the disagreements. Three overarching themes emerged: misinterpretation of a certain technique, (not) considering the references or reproduced statements of other people, and different interpretation of the most prominent technique within a post. In addition, Figure 6 in Appendix D shows annotator 1 coded *denial of responsibility* and *other* more frequently, whereas annotator 2 coded more posts as *none*. These differences highlight the complexity and interpretative challenges involved in extracting neutralization techniques within Reddit posts. Despite these limitations, the analysis still holds informative insights. Nevertheless, the results should be interpreted with caution given the low inter-annotator agreement.

Ethical considerations and transparency

Using data which is user-generated from Reddit raises some ethical questions and challenges (Gliniecka, 2023). Therefore, the framework made by Gliniecka (2023) is used for the ethical considerations in this study. This framework presents various questions to think about when working with Reddit data. The questions are related to the digital context, users' views, and project specificity. The digital context regards the size and structure of the data, availability, anonymity, and the terms and conditions of use (Gliniecka, 2023). The users' views are about what the users know of the data usage and how they view this usage. Last of all, project specificity is about the specifics of the data and group.

This study uses three large subreddits, with posts uploaded from a time range of around five years. Reddit does not block the use of data scraping software and makes their data publicly available (Gliniecka, 2023). Nevertheless, the data do show information about the users, such as the username. Even though usernames on Reddit are mostly pseudonyms (Gliniecka, 2023), some users choose to use their own name. This can give away their identity, which is why it is chosen to remove this information from the data set. Furthermore, is it impossible to ask for informed consent of the users to use their data given the scale of the data. Additionally, Gliniecka (2023) describes in their framework that asking for informed consent can harm the group, as this could discourage them from participating in the subreddit (p.8). Therefore, there was no informed consent given for this data. Nonetheless, this study tries to de-identify the data as much as possible to bridge the gap between ethical limitation and the ability of conducting research.

Furthermore, transparency and replicability are important within research. Therefore, a GitHub repository has been created for this study. The repository contains all scripts, data, and detailed documentation of the study's procedures

(https://github.com/marleen101/BDSD_final_assignment/tree/main). A README.md file in the repository provides an overview of the contents and guidance on where to find specific information.

Results

Topic modelling

Topic modelling enabled creating a broad overview into the discussion taking place among Reddit users within the selected subreddit. The model generated 35 topics, however due to space constraints, only the ten most prominent topics will be discussed. All the topics and their ten most representative words are shown in Table 1 in Appendix C. Additionally, to provide a broad overview of the topics extracted from the data, clusters that were made manually, will be discussed. To ensure as much anonymity as possible, posts are not quoted directly. Relevant posts are paraphrased and shown in Table 2 in Appendix C.

Ten most prominent topics

The prominent topic is about *Hopelessness* (T4). As shown in Figure 4 and 5 in Appendix C this topic accounts for the largest proportion of the data. Posts associated with *Hopelessness* are about the pessimistic view about the future, because of climate change. Posts can be about knowing that species will go extinct or that the sea levels will rise, which makes certain regions inhabitable. Most of these posts do ask for reassurance that it all will be okay.

Furthermore, the second and third most prominent topics are about *Recommendations to learn* (T33) and *Wanting to learn more* (T19). Posts within these topics typically involve users seeking information about specific aspects of climate change. The difference between these two topics lies in the nature of the request. T33 is more about asking for books and studies they can read about a certain topic and T19 is more about not knowing something and asking others about their opinion and knowledge.

Additionally, users discussed *Future outlooks* (T32). These posts discussed the impact of, for example, the rising temperatures or the rising sea levels on the future. Some users asked for illustrations on how the future will probably look like, while others predicted the future.

Users expressed interest in *Businesses investing in sustainability* (T8). Some users were interested in which businesses or organizations to support that invest in sustainability. Moreover, others discussed greenwashing done by certain organizations, referring to the method companies use to present themselves as investing in sustainability, while lacking the commitment or action to do so.

An interesting topic that came forward was *Respondents requitement* (T16). These posts were requesting other users to participate in their projects about climate change. Some users needed respondents for a school project, and others were asking to participate in their master thesis.

Climate scepticism discussions (T29) is about users who express their scepticism towards climate change, looking for information to understand the scientific evidence. Furthermore, posts within this topic were discussing how to convince others to believe in climate change and encourage them to take action.

The topic *Change of season patterns* (T30) is self-explanatory, as it is about users talking about the changes of seasonal patterns. Such as, posting about not having snow in the region they live in, even

though it should be covered in snow. It is sharing about the experiences of feeling the patterns of the seasons changing.

Further, some posts discussed *Alternative energy* (T18). Users talked about the use of alternative energy which can help with climate change, and which kind is better compared to others. Such as the energy generated by wind or solar.

Lastly, a selection of posts also discussed *Carbon* (T22). These discussions can range from different perspectives on the topic, including carbon emissions, the role of carbon dioxide in oceanic processes, and carbon uptake by plants. Additionally, some posts reflect on the perceived decline in public discourse surrounding carbon, as illustrated by the example presented in Table 2 in Appendix C.

Clusters

The clusters provide a concise overview of the main themes discussed in the Reddit posts. Figure 3 in Appendix C shows a network plot of the relationship between the topics and clusters. There are six clusters made: Changing *weather and atmospheric processes, Ecosystems, Emotions, Information seeking and professional engagement, Society and governance* and *Technological and mitigation innovations.*

Changing weather and atmospheric processes shows that people talked about the change of weather and seasons, in relation to the rising temperature, earth heating up to 1,5 °C, and temperature records made globally. This cluster further contains topics about the consequences of the changing weather and seasons, such as the increase of natural disasters and the rising sea level. *Ecosystems* is a small cluster of topics. These topics are about certain ecosystems, like talking about trees, oceans and the extinction of mostly animals globally. *Emotions* relate to users expressing their emotions related to climate change, such as the hopelessness people deal with when thinking about climate change and how the future of life looks like. Furthermore, it is about users reflecting on their behaviour in relation to climate change, such as minimizing their carbon footprint. *Information seeking and professional engagement* has various topics. It is related to users wanting to learn more and ask for recommendations or others' opinions. Furthermore, it is about users asking others which careers or studies can help combat climate change. Last of all, it is about recruiting respondents for projects. *Society and governance* relate to the impact of certain events on climate change. This can be coronavirus, but also the American elections. Lastly, *Technological and mitigation innovations* is about users talking about certain innovations which can help solve climate change and how certain innovations contribute to worsening climate change, such as airplanes and vehicles.

Interestingly, *Society and governance* and *Technological and mitigation innovations* are somewhat overlapping, as can be seen in Figure 3. Especially, *Vehicles* (T2), *Projects and studies for moderating climate change* (T6), *Innovations for managing climate change (T24),* and *Climate change information of countries* (T28) are overlapping topics. This can be due to the reason that users talk about the topics of *Technological and mitigation innovations* at country level, which relates to *Society and governance.* For T28, the information about the countries can relate to certain countries being behind on innovations to combat climate change, which relates to the *Technological and mitigation innovations* cluster.

Neutralization techniques

Condemnation of the condemner and appeal to higher loyalties

Based on neutralisation theory by Sykes and Matza (1957) this study hypothesized that *condemnation of the condemner* would be the most frequently used neutralisation technique by Reddit users (*H1*) and that policy-oriented techniques would appear more often than science denial techniques in climate discussions (*H2*). These hypotheses were tested on a random sample of 342 posts in total. The authors annotated the same posts individually using the coding scheme. Even though there are notable differences in how posts were coded, as seen in Table 4 in Appendix D, most of the posts were coded as *none* by both annotators ($N = 266$). From the distribution of the labels, in Table 4, it can be seen that a considerable number of posts did not include a single neutralisation technique.

Table 4 demonstrates that *condemnation of the condemner* as one of the more appearing techniques (Annotator 1; $N = 11$, Annotator 2; $N = 8$). However, annotations for *condemnation of the condemner* were not about the same post. Reasons for potential differences in annotating are explained in the error analyses in Table 5. One overlapping post was identified by both annotators as an instance of *condemnation of the condemner*, a technique in which a person attacks the legitimacy or integrity of those making a moral or factual claim (Sykes & Matza, 1957). In this post, the user questions whether there is scientific evidence demonstrating that human activities have caused changes in the Earth's climate and environment since the Industrial Revolution due to greenhouse gases. Given that anthropogenic climate change is supported by decades of climate research and is grounded in a well-established scientific consensus, the request for clarification dismisses the publicly available scientific knowledge as 'unscientific'. By doing so, the user indirectly casts doubt on the integrity of climate scientists as producers of valid evidence. Similarly, another user commented that climate change cannot be caused by humans, by arguing that the air had high levels of greenhouse gases during the pre-industrial period and providing overwhelming amounts of information that seem factual.

Another post questioned the credibility of climate scientists by contrasting climate research with scientific practices observed during a recent public health crisis. The user suggested that, unlike pandemic-related science, climate research appears unresponsive to new information and does not sufficiently revise or challenge its underlying assumptions. By portraying climate researchers as rigid and unwilling to update their conclusions, the post implied a lack of scientific integrity. Likewise, several posts were made about failure in climate change forecasting. They claim climate models are unable to make accurate predictions because of a lack of information on future scenarios. This argument was framed in a way that depicts climate scientists as unreliable because they rely on such models. This harms their legitimacy in producing scientific knowledge. Another post contained a reference that argued against climate change being real, and framed scientists as instilling a false sense of fear into people. Annotators differed in their coding, likely because the other comments were not as straightforward in *condemning the condemner*. A clear conclusion regarding hypothesis 1 cannot be drawn from the results in Table 4.

By contrast, *appeals to higher loyalties* were identified less often by the coders (Annotator 1; *N*

= 2, Annotator 2; *N* = 7). The technique was characterised by prioritizing economic progress, societal stability or other collective goals over efforts to mitigate the harmful consequences of climate change. The user speculates that meaningful climate mitigation would require a fundamental reordering of political and economic systems, with environmental protection placed above all other global concerns. By presenting such a transformation as unrealistic or unattainable under current conditions, the post implicitly suggests that existing economic stability, political feasibility, and societal continuity take precedence over immediate climate action. In another post, a user scrutinized an environmental activist group for directing their attention to a foreign conflict rather than focusing on climate change. They argued that the activist group had abandoned what was framed as their higher responsibility creating awareness of climate change. *Appeal to higher loyalties* operated by invoking responsibility as superior moral obligation, against which other forms of activism are seen as inappropriate. Additionally, a user described reasons for being self-sufficient and creating environmentally friendly products while noting that current companies choose to make people dependent on non-environmentally friendly disposable consumer goods simply for profits. Although these illustrations show that *appeal to higher loyalties* was used in a critical evaluation of the current system or activist groups, the data did not show emerging patterns that prove that *appeal to higher loyalties* and condemnation of the condemner were used more often than denial of responsibility, denial of the victim and denial of injury. *Denial of a victim* was absent in the data potentially because arguing for victim and offender roles may not be effective in stimulating resistance to climate action.

Other usages of neutralization techniques

Besides the results related to the hypotheses, additional patterns emerged from the data. Such as users using futility as a justification mechanism for inaction, users wishing to use neutralization techniques themselves, or users seeing others using neutralization techniques and wanting to stop this. The appeal to futility and the self-referential use of neutralization techniques primarily emerged within posts annotated as *other*. While this category is intentionally ambiguous and resulted in limited overlap between annotators, it enabled the identification of these findings valuable for this study.

Firstly, an appeal to futility emerged in a subset of posts. In these posts, users framed climate change as too complex, or big, to solve. This frame justifies inaction within climate change, while not denying responsibility, injury, or victimhood. Furthermore, it does not *condemn the condemners* and does not *appeal to higher loyalties*. Thereby, these posts were not labelled as the predefined neutralization techniques. For example, a post addressed the difficulty of effectively dealing with climate change, emphasizing that its lengthy and complex nature may have a discouraging effect on climate action. They argue that, given the scale of the global population and patterns of human consumption, it is challenging to implement change. This framing justifies inaction, because of the emphasis on the complexity, where actions taken are seen as useless.

Secondly, a substantial number of posts displayed users explicitly wanting to apply neutralization techniques to cope with climate change anxiety. As already indicated during topic modelling, feelings of hopelessness or a doom perspective towards the future is a considerable part of the discussions on the

subreddits. In these posts, users often asked others for reassurance that the climate situation is not as bad as they see and that it will be okay. This pattern shows that users are inclined to use the technique *denial of injury* to cope with their climate change anxiety. An example is a post where a user talks about the rising temperature, especially exceeding the 1.5 °C threshold, and the catastrophic consequences this trajectory can have. They state that, due to this, they feel lost and want reassurance as potentially their fears are exaggerated. In this way, users could have a desire to apply *denial of injury* by seeking reassurance.

Finally, consistent with the topic *Climate scepticism discussions (T29)*, a considerable portion of posts are users describing the use of neutralization techniques by people in their immediate surroundings. In these posts, users are asking for advice to stop the use of these techniques by others. For example, a user recounted a discussion with coworkers about climate change, during which the coworkers used *denial of injury* to dismiss the potential harms raised by the user. The users ask in the post for ways to stop this. The users acknowledge the others using the technique and want to do something about it.

Conclusion and Discussion

This study set out to explore which neutralisation techniques are commonly used in climate discussion debates on Reddit. Drawing from literature that analysed neutralisation techniques used by climate change countermovement (McKie, 2018; Dunlap & Jacques, 2013; Boussalis & Coan, 2016), this study hypothesized that *condemnation of the condemner* would appear most frequently in posts and that policy-oriented techniques would appear more often than science denial techniques. Although our findings do not allow us to give straightforward answers to both hypotheses, they provide relevant insights for research. The present study found that climate science is frequently framed as an enterprise incapable of producing reliable knowledge. Posts questioned the validity of climate change forecasting by portraying climate models as inherently inaccurate because they run on proxies for future scenarios. By extension, climate scientists were framed as unreliable for using these models. This framing corresponds with climate change countermovement strategies that question the validity of climate models and criticize the statistical techniques used by climatologist, to demonstrate that evidence of climate change is uncertain at best (McCright & Dunlap, 2015). Similarly, some Reddit users would attribute climate change to natural factors, such as thermal dynamics, instead of human activity. This neutralisation technique is also adopted by Nongovernmental International Panel on Climate Change (NIPICC), with the goal of making claims appear uncertain and the subject of scientific controversy (Plehwe, 2014).

Additionally, the study expected that policy-oriented techniques (e.g. *condemnation of the condemner* and *appeal to higher loyalties*) would occur more frequently than other neutralisation techniques. The findings regarding appeal to higher loyalties correspond with earlier research showing that climate inaction is often justified through moral trade-offs and competing collective goals (McKie, 2018). Reddit users argued that the current economic system is not set up to prioritize environmental protection, implying that other factors such as economic progress, political developments are more important than climate action. This framing aligns with an appeal to higher loyalties because climate

action is positioned as morally desirable but subordinate to other priorities.

Critical discourse analyses revealed other ways neutralising techniques were used beyond those mentioned by McKie (2018). In some posts climate change was depicted as an overwhelmingly complex issue, justifying climate inaction. Prior research indicates that individuals refrain from acting when they believe that their efforts are insignificant in relation to the magnitude of the issue and when they doubt their ability to influence outcomes (Gifford, 2018; Ajzen, 2002). Alongside complexity, feelings of hopelessness towards the future were present in multiple posts. Topic modelling supported this, by showing that approximately 17% of the documents contained topics related to *Hopelessness and doom perspectives* and *Climate scepticism discussions* emerged in the posts. Feelings of hopelessness manifested in asking reassurance that the predicted negative effects of global warming will not come true. These feelings of distress linked to the climate crisis, can be understood as climate anxiety and includes both mild and intense experiences of anxiety (Sangervo et al., 2022). Climate anxiety can motivate proactive behaviour in response to a threat but also contribute to passivity and inaction (Kurth, 2018). The latter could contribute to justifying climate inaction. In this context, users may have sought reassurance to cope with climate-related worries.

Limitations and recommendations for future research

A strength of topic modelling is that it provides a foundation of key concepts for the critical discourse analysis and enables the inductive identification of prominent topics within large textual datasets (Arande et al.,2021). Nevertheless, this method also faces limitations. Due to time constraints, topic interpretation and labelling were conducted by a one author, which may reduce the reliability of the interpretations. Moreover, it was not feasible to manually verify if every post was correctly assigned to the topic. As a result, some posts may have been misclassified.

Another limitation is that it was not possible to code for multiple techniques being used in one post. The coding scheme developed by McKie (2018) was followed. She notes that these techniques are not mutually exclusive. Due to time constraints, the current study did not allow for coding at the sentence level, meaning that only a single technique could be assigned to each post.

Future research could address this limitation by developing automated classification models capable of annotating entire datasets. Automated approaches, such as the method proposed by Bhatia et al. (2023) enable large-scale analyses of neutralisation techniques and may reveal additional patterns. Reddit's submission-based structure facilitates real-time reactions to societal and political developments. McKie (2018) emphasizes the value of longitudinal analysis in understanding how climate countermovement messaging shifts over time.

Finally, our analyses indicate that Reddit users draw on strategies beyond classical neutralisation techniques, including references to perceived behavioural control and self-efficacy. This framework identifies seven structural barriers to pro-environmental behaviour (Gifford, 2011). Future research could explore how these psychological barriers intersect with neutralization techniques in online discussions, to get a better understanding of the factors that sustain climate inaction among social media users.

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Appendix A: R script

---

title: "Final assignment"

format: pdf

editor: visual

Final assignment BDSD

This is the Quarto file with the code for all the analysis done in the final assignment of Big Data, Small Data. The Github page "BDSD_final_assignment" contains all the files and information needed to follow this analysis. In the README.md file, which can be seen when you open the Github page, is all the information of where everything can be found and further information about the results of the project.

A link to the Github page: https://github.com/marleen101/BDSD_final_assignment/tree/main

In this file, the packages will firstly be installed and activated. Then the data set is imported and processed to work with during the analysis. The analysis will first be topic modelling. After the code for the visualizations for topic modelling, the code will be for collecting a small sample of the whole data set the further dive in to the data for the qualitative part of the study. There will be part to annotate the data and with this annotated data, a machine will be trained and used to annotate the whole data set, which will help us interpret information of the whole data set.

Loading packages

```{r Loading packages, message=FALSE, warning=FALSE}

#install.packages(c("tidyverse", "curl", "stm", "reshape2","stringr", "caret", "stopwords", "tidytext", "textstem", stringi","remotes", "summarytools", "igraph", "ggraph","ggforce","ggwordcloud", "psych"))
```

```
library(remotes)

#remotes::install_github("ccs-amsterdam/annotinder-r")

library(tidyverse)

library(readr)

library(curl)

library(stm)

library(reshape2)

library(stringr)

library(caret)

library(stopwords)

library(tidytext)

library(textstem)

library(stringi)

library(annotinder)

library(summarytools)

library(igraph)

library(ggraph)

library(ggforce)

library(ggwordcloud)

library(psych)
```

Importing data from Github

```{r from github, message=FALSE}
```

data_climatechange <-
read_csv("https://raw.githubusercontent.com/marleen101/BDSD_final_assignment/refs/heads/main/Data/Data%20Climate%20Change/data_climatechange.csv")

```

This code will import data via the Github page made for this project. However, it is also possible to download the data from the Github page and import it manually by yourself. Look at the README.md file for further information on where the data set is stored on the page. The data from the individual subreddits can also be found in the same place.

### **Prepare the data set**

```{r preparing the dataset}
#Combining the title and the self text of each post in one variable
data_climatechange$text_all <- paste(data_climatechange$title,
                                     data_climatechange$selftext,
                                     sep = "\n")

#date variable, UTC time zone
data_climatechange <- data_climatechange %>%
  mutate(date = format(
    as.POSIXct(created_utc, origin = "1970-01-01", tz = "UTC"),

```
  "%Y-%m-%d %H:%M:%S"
 ))

#process for topic modelling
processed <- textProcessor(data_climatechange$text_all, metadata = data_climatechange)
out <- prepDocuments(processed$documents, processed$vocab, processed$meta)
```

For the pre-processing of the data set, the title and text of the post is combined in to one variable. Furthermore, is there a data variable made. Lastly, for topic modelling, the texts are processed (removing, for example, pronunciations, stop words, and numbers) and made in to a data frame which can be used for the analysis. This code showed that after processing five documents were removed from the analysis as there were no characters there anymore after stemming, removing stop words, punctuation, numbers.

Analysis

Topic modelling

```{r amounts of topics for topic modelling}
set.seed(159)

# Criteria amount of topics with Coherence and Exclusivity

K_climate <- seq(10,60,by = 10) # for calculating the exclusivity and coherence with 10 till 60 topics, with the increment of the sequence of 10.
```

#code underneath is for creating different models with different amount of topics. It is possible to download the R Data file via the github page to save some time. The file is placed under the map Data and Topic model (file "fit_climate.rds").

```
####fit_climate <- searchK(processed$documents, processed$vocab, K= K_climate)
fit_climate <- readRDS("fit_climate.rds")

# Making the scores of Coherence and Exclusivity for each amount of topic
plot_climate <- data.frame("K" = K_climate,
                           "Coherence" = unlist(fit_climate$results$semcoh),
                           "Exclusivity" = unlist(fit_climate$results$exclus))

plot_climate <- melt(plot_climate, id=c("K"))
plot_climate
climate_wider <- pivot_wider(plot_climate, names_from = variable, values_from = value)

#Plot results of the Coherence and Exclusivity
# Axis ranges
ylim_prim <- range(climate_wider$Coherence)
ylim_sec  <- range(climate_wider$Exclusivity)

# Scaling parameters
b <- diff(ylim_prim) / diff(ylim_sec)
a <- ylim_prim[1] - b * ylim_sec[1]
```

```
ggplot(climate_wider, aes(x = K)) +
  geom_line(aes(y = Coherence, color = "Coherence"), linewidth = 1) +
  geom_point(aes(y = Coherence, color = "Coherence"), size = 2) +
  geom_line(aes(y = Exclusivity * b + a, color = "Exclusivity"), linewidth = 1) +
  geom_point(aes(y = Exclusivity * b + a, color = "Exclusivity"), size = 2) +
  scale_y_continuous(
    name = "Coherence",
    sec.axis = sec_axis(~ (. - a)/b, name = "Exclusivity")
  ) +
  scale_color_manual(values = c("Coherence" = "coral2", "Exclusivity" = "seagreen3")) +
  labs(
    title = "Topic Model Diagnostics",
    x = "Number of Topics (K)",
    color = ""
  ) +
  theme(legend.position = "bottom")
```

A model was made to look at the exclusivity and coherence of different model. The different models where models where there are 10, 20, 30, 40, 50, or 60 topics. Looking at the visualization of the exclusivity and coherence of these models, it is decided to choose a model with 35 topics. The visualizations show that between 30 en 40 the exclusivity still increases, but coherence decreases. After 40 the exclusivity is stagnating, which shows that a max of 40 topics is good to have with this model. However, to limit the decrease of coherence, we chose to pick 35 topics. This model ensure that exclusivity is high and that it is not at the expense of the coherence of the model.

```{r topic modelling}

set.seed(159)

##to save time, it is also possible to download the rds file of topic_model on the github page and import it with the code underneath the topic modelling code.

#topic_model <- stm(documents = out$documents,

#         vocab = out$vocab,

#         K = 35,

#        verbose = TRUE)

topic_model <- readRDS("topic_model.rds")

theta <- make.dt(topic_model)

data_climatechange$Topic <- NA

#there will be an error at the end for this code. No worries, this is caused, because 5 documents were not in the topic modelling as they didn't contain any characters anymore.

for (i in 1:nrow(data_climatechange)){

  column <- theta[i,-1]

  maintopic <- colnames(column)[which(column==max(column))]

  data_climatechange$Topic[i] <- maintopic

}

freq(data_climatechange$Topic)

#mean, standard deviation and median of the amount of words per posts per topic
```

```
data_climatechange %>%
  group_by(Topic)%>%
  summarise(mean = round(mean(str_count(text_all ,"\\W+")),2),
            sd = round(sd(str_count(text_all ,"\\W+")),2),
            median = round(median(str_count(text_all, "\\W+")),2))



#the 15 top words of the topics
labels <- labelTopics(topic_model, n=15)
topwords <- data.frame("features"= t(labels$frex))
colnames(topwords)<- paste("Topic", c(1:35))

#see which documents were deleted from the process.
out[["docs.removed"]]
data_climatechange$text_all[c(1288,7407,7725,8252,8891)]
```

After examining the 20 most prominent posts for each topic and the corresponding top words, each topic was assigned a descriptive label. The labels and top words can be seen in Table 1.

| Topic | Content | Top words |

|----------:|----------|----------|

| 1 | Places | Citi, town, Washington, san, london, York, local, rural, nyc |

| 2 | Vehicles | Car, bike, child, petrol, idl, drive, parent, walk, truck, great, road |

| 3 | Extinction (animals) | Nanoparticle, smuggle, ozon, ozone-deplet, livestock, feed, cattl, beef, pig, moor |

| 4 | Hopeless / doom perspectives | Thing, feel, dont, don’t, think, anyth, doom, els, realli, bad |

| 5 | Harm of certain kinds of electricity | Mongabay, bio-energi, palm, smil, Vaclav, euro, wri, miner, lithium, iea |

| 6 | Projects and studies for moderating climate change | Contruct, build, concret, paint, visibl, nich, network, homeown, recurs |

| 7 | Rising sea levels (melting ice/glaciers) | Glacier, ice, melt, sea, permafrost, sheer, antarctica, meter, arctic, antarct |

| 8 | Business investing in sustainability | Busi, money, company, fight, non-profit, chariti, sustain, credit, volunt, organ |

| 9 | Warming of 1.5 / 2 degrees Celsius | Ipcc, tip, report, warm, global, celsius, decad, degree, point, trajectori |

| 10 | Aviation (celebrities) | Cruis, elon, travel, plane, flight, fli, aviat, train, musk, richest |

| 11 | Coronavirus | Que, cambio, covid--, mundo, pandem, virus, covid, coronavirus, esto, breath |

| 12 | American politics | Elect, court, senat, voter, vote, trump, republican, presidenti, biden, administr |

| 13 | Oceans | Coral, invas, reef, speci, habitat, extinct, ecosystem, whale, ending, fish |

| 14 | Moral and ethical reflection | Society, moral, solv, cultur, politician, existenti, acknowledge, modern, greed |

| 15 | Critique of fossil fuels | Cop, fossil, fuel, confer, militari, oil, summit, leader, minist, host |

| 16 | Respondent recruitment | Survey, app, quastionnair, particip, interview, user, email, share, server, minut |

| 17 | Change in weather | Amok, atlant, stream, northern, gulf, rainfall, hemisphere, southern, circul, merdion |

| 18 | Alternative energy | Nuclear, reactor, hydrogen, power, uranium, solar, energi, kwh, renew, panel |

| 19 | Wanting to learn more | Chang, climat, combat, effect, affect, impact, posit, mitig, discuss, issu |

| 20 | Data | Model, data, graph, accur, rcp, observ, confid, predict, map, correl |

| 21 | Careers and degrees | Career, podcast, book, recommend, advic, college, fiction, episode, skill, master |

| 22 | Carbon | Dac, carbon, captur, offset, footprint, gwp, neutral, methan, ghg, dioxid |

| 23 | Natural disasters | Hurricane, wilfir, fire, flood, strom, drought, tornado, helen, disast, valley |

| 24 | Innovations for managing climate change | Strategi, challang, innov, ensur, secur, develop, sector, integr, crucial, econom |

| 25 | Trees | Tree, Ecosia, amazon, rainforest, forest, soil, deforest, harvest, fertile, plant |

| 26 | Cooling devices | Hot, heat, wave, hotter, humid, outisd, summer, pump, cold, cooler |

| 27 | Temperature records | Mayhem, warmest, abrupt, record, februari, niño, video, hottest |

| 28 | Country-level climate information | Country, capita, india, china, price, per, trillion, tonn, total, billion |

| 29 | Climate scepticism discussion | Argument, denier, claim, debat, convinc, denial, deni, debunk, skeptic, alarmist |

| 30 | Seasonal change patterns | Snow, ago, week, last spring, rememb, year, lake, normal, coupl |

| 31 | Sustainable alternative products | Reusable, groceri, bag, package, landfill, plastic, trash, wast, reus, item |

| 32 | Future outlooks | Will, future, happen, worst, realist, term, soon, becom, eventu, live |

| 33 | Recommendations to learn more | Anyon, guy, look, question, read, wonder, find, thought, topic, ask |

| 34 | Atmospheric composition | Radiat, cloud, geoengin, aerosol, ppm, concentr, vapor, erupt, volcano |

| 35 | Solutions for climate change | World, crisi, save, face, moment, bring, need, biggest, cricl, globe |

: Table 1: Thematic content of the topics

Visualizations topic modelling

```{r visualizations}
```

```
#Plot topics
plot(topic_model)

#Bar plot
ggplot(data_climatechange, aes(x=as.factor(Topic), fill = as.factor(subreddit)))+
  geom_bar()+
  theme(axis.text.x = element_text(angle = 35, hjust = 1))+
  labs(title= "Barplot of the distribution of Reddit posts between the topics and subreddits",
       x= "Topics",
       y= "Frequency",
       fill =  "Subreddit")


#Correlation plot
cor <- topicCorr(topic_model)
#simple network
plot(cor)

#Network analysis with clusters
network_pos <- cor$cor
network_pos[network_pos < 0] <- 0

for_network_plot <- graph_from_adjacency_matrix(
  network_pos,
  mode = "undirected",
  weighted = TRUE,
```

```
  diag = FALSE)


cluster_manual <- c(
  "1" = "Society and governance",
  "2" = "Technological and mitigation innovations",
  "3" = "Ecosystems",
  "4" = "Emotions",
  "5" = "Technological and mitigation innovations",
  "6" = "Technological and mitigation innovations",
  "7" = "Changing weather and atmospheric processes",
  "8" = "Society and governance",
  "9" = "Changing weather and atmospheric processes",
  "10"= "Technological and mitigation innovations",
  "11"= "Society and governance",
  "12"= "Society and governance",
  "13"= "Ecosystems",
  "14"= "Emotions",
  "15"= "Technological and mitigation innovations",
  "16"= "Information seeking and professional engagement",
  "17"= "Changing weather and atmospheric processes",
  "18"= "Technological and mitigation innovations",
  "19"= "Information seeking and professional engagement",
  "20"= "Information seeking and professional engagement",
  "21"= "Information seeking and professional engagement",
  "22"= "Technological and mitigation innovations",
  "23"= "Changing weather and atmospheric processes",
```

```
  "24"= "Technological and mitigation innovations",
  "25"= "Ecosystems",
  "26"= "Changing weather and atmospheric processes",
  "27"= "Changing weather and atmospheric processes",
  "28"= "Society and governance",
  "29"= "Information seeking and professional engagement",
  "30"= "Changing weather and atmospheric processes",
  "31"= "Technological and mitigation innovations",
  "32"= "Emotions",
  "33"= "Information seeking and professional engagement",
  "34"= "Changing weather and atmospheric processes",
  "35"= "Emotions")

V(for_network_plot)$name <- as.character(1:vcount(for_network_plot))
V(for_network_plot)$Cluster <- cluster_manual[V(for_network_plot)$name]
V(for_network_plot)$name <- paste0("Topic ", V(for_network_plot)$name)

cluster_colors <- c(
  "Emotions" = "darkorange",
  "Society and governance" = "steelblue1",
  "Information seeking and professional engagement" = "khaki",
  "Changing weather and atmospheric processes" = "firebrick",
  "Ecosystems" = "chartreuse2",
  "Technological and mitigation innovations" = "dodgerblue4")
```

```
ggraph(for_network_plot, layout = "fr") +
  geom_edge_link(aes(width = weight),
                 alpha = 0.3,
                 colour = "grey30") +
  geom_node_point(aes(color = Cluster),
                  size = 5) +
  geom_node_text(aes(label = name),
                 repel = TRUE,
                 size = 3) +
  geom_mark_hull(aes(x = x, y = y, group = Cluster, fill = Cluster),
                 alpha = 0.3,
                 concavity = 1,
                 expand =0.03,
                 color = NA) +
  scale_color_manual(values = cluster_colors) +
  scale_fill_manual(values = cluster_colors) +
  labs(title = "Network of the relationship between the topics shown in six clusters")



#Wordclouds


labels_wordcloud <- labelTopics(topic_model, n=15)$frex
topword_wordcloud <- data.frame(labels_wordcloud)
colnames(topword_wordcloud) <- paste0("Topic_", 1:ncol(topword_wordcloud))


topwords_long <- topwords %>%
```

```
  pivot_longer(
    cols = everything(),
    names_to = "Topic",
    values_to = "term") %>%
  group_by(Topic) %>%
  mutate(word_id = row_number(),
         size = 16 - word_id,
         topic_num = as.numeric(gsub("Topic ", "", Topic)),
         group = ceiling(topic_num / 9)) %>%
  ungroup()



# Group 1: Topics 1-9
topwords_long %>%subset(group == 1)%>%
  ggplot(aes(label = term, size = size)) +
  geom_text_wordcloud(area_corr = TRUE) +
  facet_wrap(~Topic, scales = "free") +
  scale_size_area(max_size = 12) +
  labs(title = "Word Clouds for Topics 1-9")


# Group 2: Topics 10-18
topwords_long %>% subset(group == 2)%>%
  ggplot(aes(label = term, size = size)) +
  geom_text_wordcloud(area_corr = TRUE) +
  facet_wrap(~Topic, scales = "free") +
  scale_size_area(max_size = 12) +
```

```
  labs(title = "Word Clouds for Topics 10-18")

# Group 3: Topics 19-27
topwords_long %>% subset(group == 3)%>%
  ggplot(aes(label = term, size = size)) +
  geom_text_wordcloud(area_corr = TRUE) +
  facet_wrap(~Topic, scales = "free") +
  scale_size_area(max_size = 12) +
  labs(title = "Word Clouds for Topics 19-27")

# Group 4: Topics 28-35
topwords_long %>% subset(group == 4)%>%
  ggplot(aes(label = term, size = size)) +
  geom_text_wordcloud(area_corr = TRUE) +
  facet_wrap(~Topic, scales = "free") +
  scale_size_area(max_size = 12) +
  labs(title = "Word Clouds for Topics 28-35")
```

Content analysis

```{r selection for qualitative analysis}
set.seed(159)
```

```
#sample of 342 posts, the file of the sample can be downloaded from github
#sample_annotate <- data_climatechange[sample(nrow(data_climatechange), size =342),]
sample_annotate <- readRDS("sample_annotate.rds")



#for doing a coding job
units <- create_units(sample_annotate,
                      id = "id",
                      set_text("text", text_all))



technique <- question("Neutralization technique",
                      "Which neutralization technique is present in the post?",
                      codes = c(crimson = "None",
                                lightgreen = "Denial resp.",
                                dodgerblue = "Denial injury",
                                salmon = "Denial victim",
                                plum = "Condemnation",
                                darkorange = "Higher loyalties",
                                grey = "Other"
                                ))


codebook <- create_codebook(technique)


job <- create_job("codejob_technique", units, codebook)
job_db <- create_job_db(job)
```

start_annotator(job_db)

```

```{r compare annotations}

#Gather the annotations

#from Github

Annotator_1 <- readRDS("Annotator_1.rds")

Annotator_1<- Annotator_1[,-c(2,3)]

Annotator_2 <- readRDS("Annotator_2")

Annotator_2 <- Annotator_2[,-c(2,3)]

#When done with annotinder package

#Annotator_1 <- gimme_annotations(job_db)

confusionMatrix(as.factor(Annotator_1$value), as.factor(Annotator_2$value))

Annotated_combined <- Annotator_1 %>%

  left_join(Annotator_2, by = "id")

Not_overlapping <- Annotated_combined[which(Annotated_combined$value.x !=
Annotated_combined$value.y),]

```
Id_error_analysis <- c("l6e673", "1ihsr2h", "1avueog", "volodh", "n36t2i", "myfqge", "u9odal",
"1jnd905", "y9hrsi", "q2uk3i", "kvcmek", "1je1dck", "1g0mr94", "u0o4mt", "izj39e", "1cq8ph5")

#Posts for error analysis

data_climatechange$text_all[data_climatechange$id %in% Id_error_analysis]

Overlapping <- Annotated_combined[which(Annotated_combined$value.x ==
Annotated_combined$value.y),]

Id<- c("mlgn0d","o80ltk","fg76pe","1ggtxr6","1etur0g")

#The posts with the same annotated technique

data_climatechange$text_all[data_climatechange$id %in% Id]

#Adding the results in the data set

coding <- data.frame(

  id = sapply(units, `[[`, "id"),

  text = sapply(units, function(x) x$unit$text_fields[[1]]$value),

  stringsAsFactors = FALSE

)

Annotated_data_with_text <- Annotated_combined%>%

  left_join(data_climatechange, by = "id")
```

#Visualizations of annotations

```
ggplot(Annotated_data_with_text)+
  geom_bar(aes(x=value.y, fill = "Annotator 2"), alpha=.6)+
  geom_bar(aes(x=value.x, fill = "Annotator 1"), alpha=.6)+
  scale_fill_manual(values = c("Annotator 1" = "coral1",
                               "Annotator 2" = "seagreen"))+
  labs(title = "Annotated labels by the two annotators",
       fill =  "Annotator",
       x= "Label",
       y="Frequency")
```

```

#### Code for classification

Unfortunately due to time limitations this part of code was not added to the final study. The code here underneath is for classification of neutralization techniques used within posts. After annotating, the data can be used within a model which will classify the rest of the posts if it contains some sort of neutralization technique or not.

> Note!

>
```

> Your annotated data needs to be big, or contain enough data on which the model can predict. If the distribution between containing a technique and not is out of balance, the model will look at the data and see that classifying posts as not containing a technique has a higher probability. This results in the model not predicting any posts containing a technique.

```{r training for classification}
set.seed(159)

#Changing variable to a binary one. So it will be a variable stating if is does contain
Annotation_binary  <- annotated_sample
Annotation_binary <- Annotation_binary %>%
  mutate(binary = case_when(value %in% c(
                          "Denial resp.",
                          "Denial injury",
                          "Denial victim",
                          "Condemnation",
                          "Higher loyalties",
                          "Other"
                        ) ~ "Yes",
                        value == "None" ~ "No"))

#Deviding the data in to testing (30%) and training (70%)
divide_test_train <- createDataPartition(Annotation_binary$binary, p = 0.70, list = FALSE)
train <- Annotation_binary[divide_test_train,]
test <- Annotation_binary[-divide_test_train,]
```

```
#The distribution between the two sets
ggplot() +
  geom_bar(data = train, aes(x = binary), fill = "blue", alpha = .5) +
  geom_bar(data = test, aes(x = binary),fill = "red", alpha = .5) +
  labs(color = "Density", title = "Random Sampling Distribution")



#Prepping for training and testing
#cleaning
tokens_train <- train %>%
  mutate(text = str_remove_all(text_all.y, "https?://\\S+")) %>%
  unnest_tokens(word, text) %>%
  mutate(
    word = str_remove_all(word, "@\\S+"),
    word = str_remove_all(word, "[[:punct:]]"),
    word = str_remove_all(word, "[[:digit:]]"),
    word = str_to_lower(word),
    word = stri_trans_general(word, "Latin-ASCII"),
    word = str_replace_all(word, "[^a-zA-Z0-9]", "")
  ) %>%
  filter(str_detect(word, "\\S")) %>%
  filter(!word %in% stopwords("en")) %>%
  mutate(word = lemmatize_words(word))



tokens_test <- test %>%
```

```
  mutate(text = str_remove_all(text_all.y, "https?://\\S+")) %>%
  unnest_tokens(word, text) %>%
  mutate(
    word = str_remove_all(word, "@\\S+"),
    word = str_remove_all(word, "[[:punct:]]"),
    word = str_remove_all(word, "[[:digit:]]"),
    word = str_to_lower(word),
    word = stri_trans_general(word, "Latin-ASCII"),
    word = str_replace_all(word, "[^a-zA-Z0-9]", "")
  ) %>%
  filter(str_detect(word, "\\S")) %>%
  filter(!word %in% stopwords("en")) %>%
  mutate(word = lemmatize_words(word))

#tokens to dtm
dtm_train <- tokens_train %>%
  rename(doc_id = id) %>%
  count(doc_id, word) %>%
  bind_tf_idf(word, doc_id, n) %>%
  select(doc_id, word, tf_idf) %>%
  pivot_wider(
    names_from = word,
    values_from = tf_idf,
    values_fill = 0
  )
```

```
dtm_test <- tokens_test %>%
  rename(doc_id = id) %>%
  count(doc_id, word) %>%
  bind_tf_idf(word, doc_id, n) %>%
  select(doc_id, word, tf_idf) %>%
  pivot_wider(
    names_from = word,
    values_from = tf_idf,
    values_fill = 0
  )



missing_cols <- setdiff(colnames(dtm_train), colnames(dtm_test))

for (col in missing_cols) {
  dtm_test[[col]] <- 0
}



#adding the labels
train <- rename(train, doc_id = id)
train_ml <- dtm_train %>%
  left_join(train %>% select(doc_id, binary), by = "doc_id")

test <- rename(test, doc_id = id)
```

```
test_ml <- dtm_test %>%
  left_join(test %>% select(doc_id, binary), by = "doc_id")

train_ml$binary <- as.factor(train_ml$binary)
test_ml$binary  <- as.factor(test_ml$binary)



control <- trainControl(
  method = "cv",
  number = 5,
  classProbs = TRUE,
  summaryFunction = twoClassSummary,
  sampling = "smote"
)



#Training
train_model <- train(
  binary ~ .,
  data = train_ml %>% select(-doc_id),
  method = "glmnet",
  trControl = control,
  metric = "ROC"
)
```

```
#Predict and evaluate

prediction_model <- predict(train_model, test_ml)

confusionMatrix(prediction_model, test_ml$binary)

freq(test$binary)#this shows how the distribution of the techniques of golden standard (binary)
```

Appendix B: Methodology

Figure 1: Flow chart data

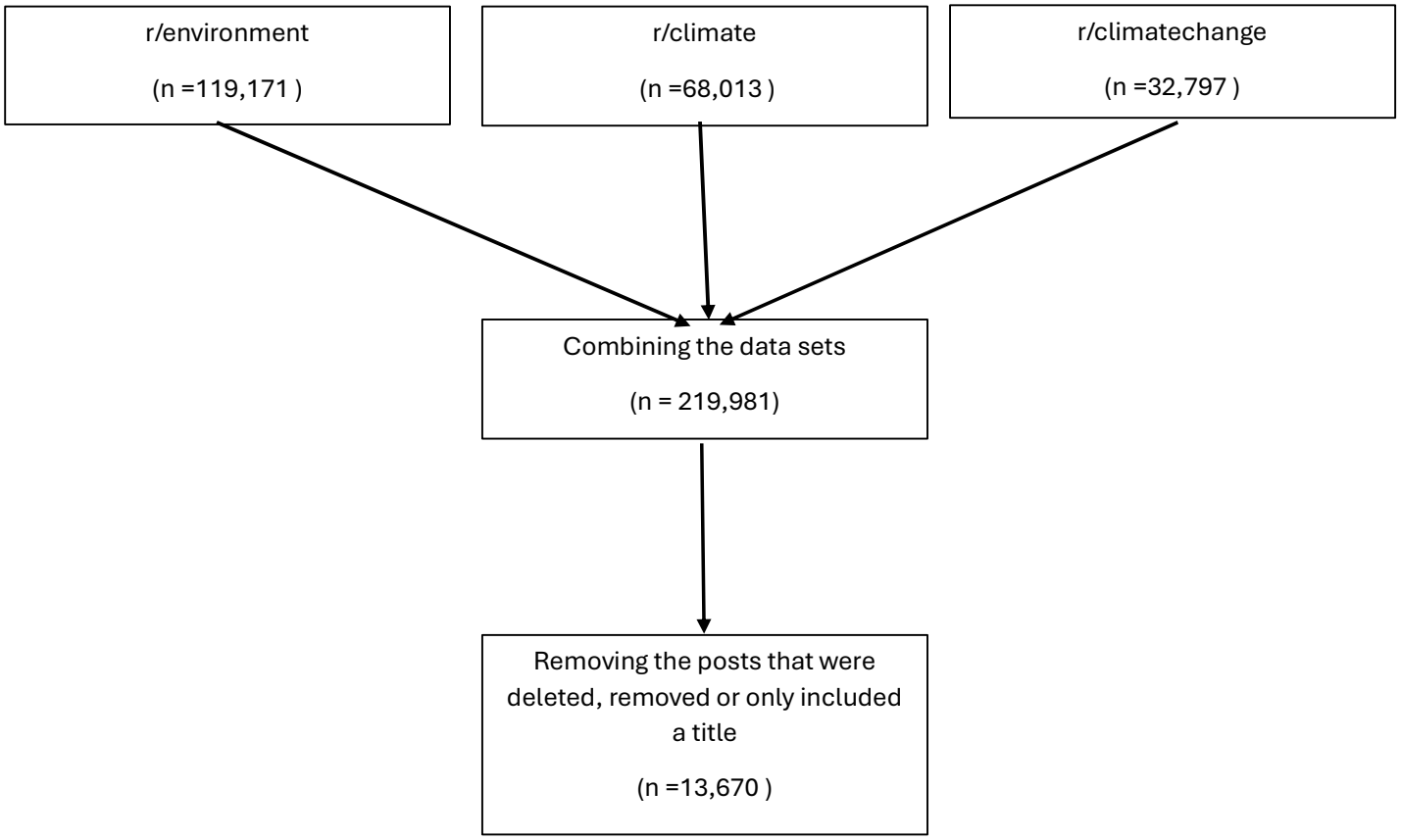
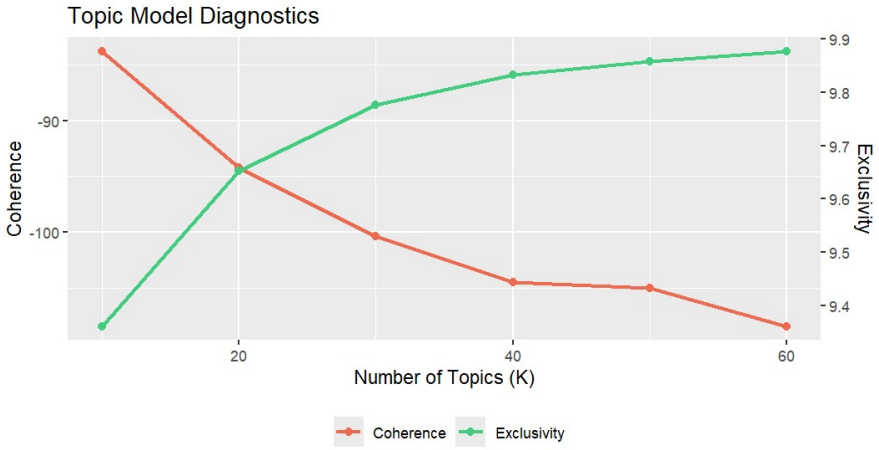


Figure 2: Coherence and exclusivity of the different model



Appendix C: Topic modelling

Figure 3: Network plot of the topics and clusters.

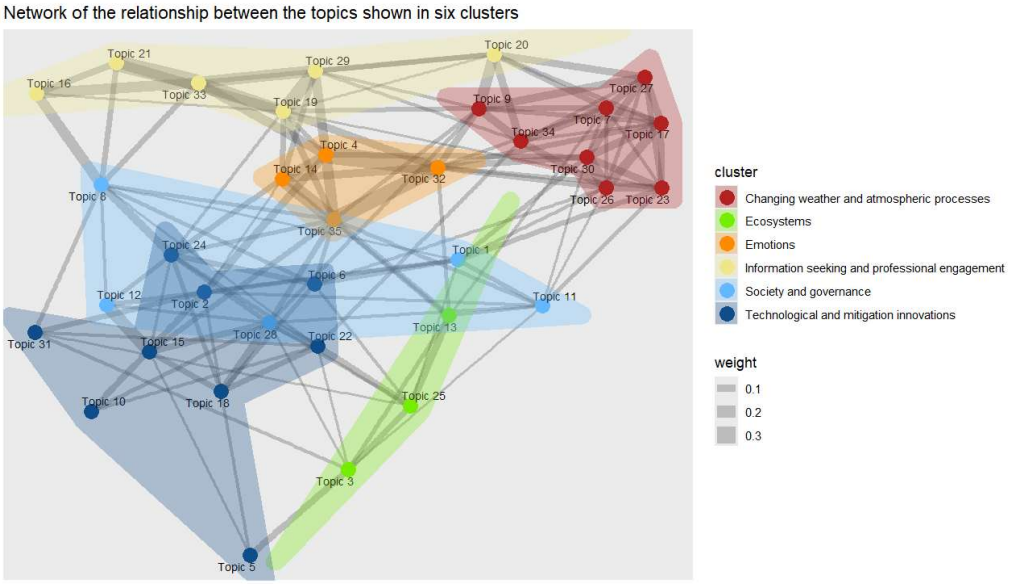


Figure 4: Distribution of topics

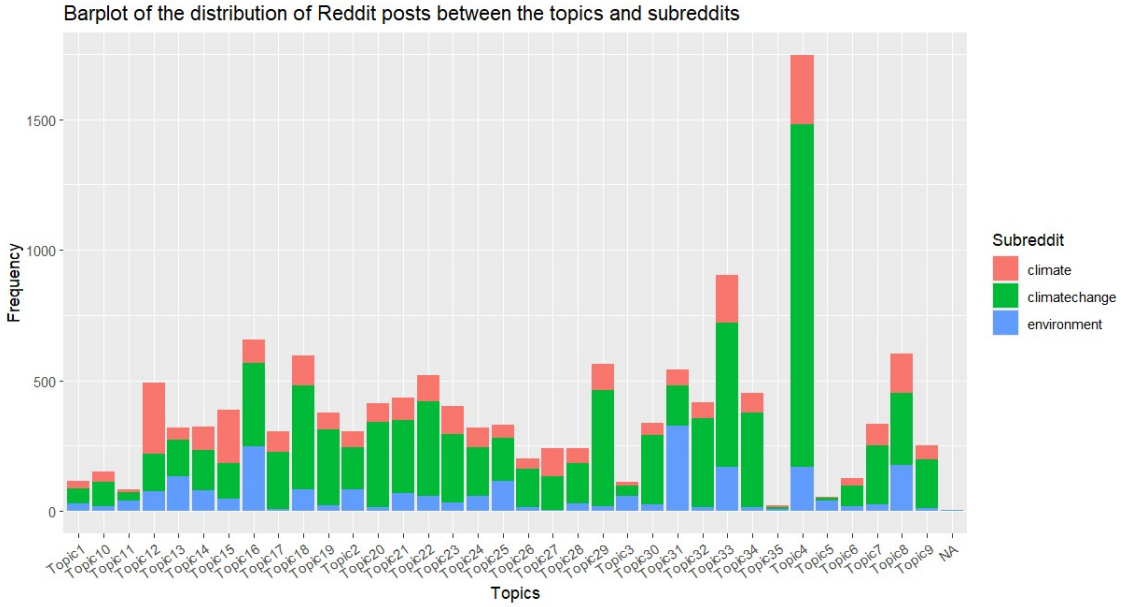


Figure 5: Topic proportion

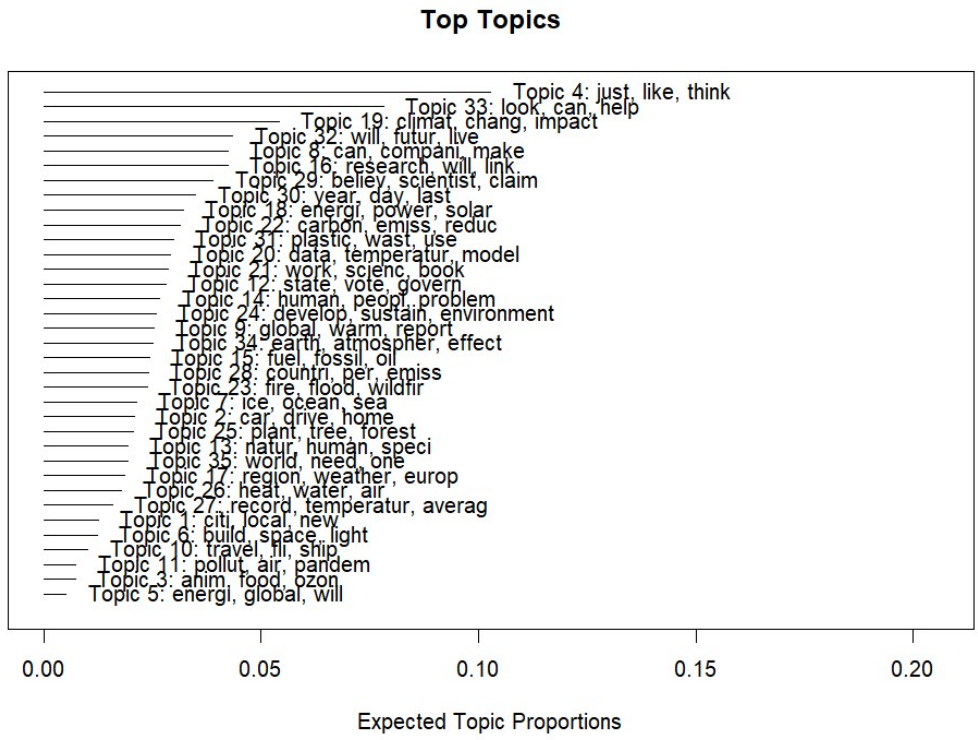


Table 1: Thematic content of the topics		
Topic	**Content**	**Top words**
1	*Places*	Citi, town, Washington, san, london, York, local, rural, nyc
2	*Vehicles*	Car, bike, child, petrol, idl, drive, parent, walk, truck, great, road
3	*Extinction (animals)*	Nanoparticle, smuggle, ozon, ozone-deplet, livestock, feed, cattl, beef, pig, moor
4	*Hopelessness / doom perspectives*	Thing, feel, dont, don't, think, anyth, doom, els, realli, bad
5	*Harm of certain kinds of electricity*	Mongabay, bio-energi, palm, smil, Vaclav, euro, wri, miner, lithium, iea
6	*Projects and studies for moderating climate change*	Contruct, build, concret, paint, visibl, nich, network, homeown, recurs
7	*Rising sea levels (related to the melting of ice/glaciers)*	Glacier, ice, melt, sea, permafrost, sheer, antarctica, meter, arctic, antarct
8	*Business investing in sustainability*	Busi, money, company, fight, non-profit, chariti, sustain, credit, volunt, organ
9	*Warming of 1,5/ 2 degrees of Celsius*	Ipcc, tip, report, warm, global, celsius, decad, degree, point, trajectori
10	*Aviation (of celebrities)*	Cruis, elon, travel, plane, flight, fli, aviat, train, musk, richest
11	*Coronavirus (A lot of Spanish posts)*	Que, cambio, covid--, mundo, pandem, virus, covid, coronavirus, esto, breath
12	*American politics*	Elect, court, senat, voter, vote, trump, republican, presidenti, biden, administr
13	*Oceans*	Coral, invas, reef, speci, habitat, extinct, ecosystem, whale, ending, fish
14	*Moral and ethical reflection*	Society, moral, solv, cultur, politician, existenti, acknowledge, modern, greed
15	*Critique about fossil fuel*	Cop, fossil, fuel, confer, militari, oil, summit, leader, minist, host
16	*Respondent recruitment*	Survey, app, quastionnair, particip, interview, user, email, share, server, minut
17	*Change in weather*	Amok, atlant, stream, northern, gulf, rainfall, hemisphere, southern, circul, merdion
18	*Alternative energy*	Nuclear, reactor, hydrogen, power, uranium, solar, energi, kwh, renew, panel
19	*Wanting to learn more*	Chang, climat, combat, effect, affect, impact, posit, mitig, discuss, issu
20	*Data*	Model, data, graph, accur, rcp, observ, confid, predict, map, correl
21	*Careers and degrees in climate change*	Career, podcast, book, recommend, advic, college, fiction, episode, skill, master
22	*Carbon*	Dac, carbon, captur, offset, footprint, gwp, neutral, methan, ghg, dioxid
23	*Natural disasters*	Hurricane, wilfir, fire, flood, strom, drought, tornado, helen, disast, valley
24	*Innovations for managing climate change*	Strategi, challang, innov, ensur, secur, develop, sector, integr, crucial, econom
25	*Trees*	Tree, Ecosia, amazon, rainforest, forest, soil, deforest, harvest, fertile, plant
26	*Cooling devices with the rising temperatures*	Hot, heat, wave, hotter, humid, outisd, summer, pump, cold, cooler

27	*Temperature records*	Mayhem, warmest, httppaulbeckwithnet, abrupt, dot, record, februari, niño, video.., hottest
28	*Climate change information of countries*	Country, capita, india, china, price, per, trillion, tonn, total, billion
29	*Climate scepticism discussion*	Argument, denier, claim, debat, convinc, denial, deni, debunk, skeptic, alarmist
30	*Change of season patterns*	Snow, ago, week, last spring, rememb, year, lake, normal, coupl
31	*Sustainable alternative products*	Reusable, groceri, bag, package, alndfil, plastic, trash, wast, reus, item
32	*Future outlooks*	Will, future, happen, worst, realist, term, soon, becom, eventu, live
33	*Recommendation to learn more about climate change*	Anyon, guy, look, question, read, wonder, find, thought, topic, ask
34	*Atmospheric composition*	Radiat, cloud, geoengin, aerosol, ppm, concentr, vapor, erupt, volcano, loop
35	*Solutions for climate change*	World, crisi, save, face, moment, bring, need, biggest, cricl, globe

Table 2: Example of posts of the ten most prominent topics

Topic	**Example post (paraphrased)**
Hopelessness	The user expresses concern about climate change impacts, including species extinction, rising sea levels, and extreme weather, and asks if there is any reason for optimism about the future. They mention feeling anxious about living through these changes.
Recommendations to learn and *Wanting to learn more*	The user requests recommendations for books about climate change and later expresses gratitude for the suggestions. The user asks about approaches to reduce atmospheric CO_2 without creating other resource imbalances, noting that solutions like reforestation may have trade-offs. They reference an article on converting CO_2 into solid carbon and ask whether it could help address excess carbon, why such technologies are not widely supported or researched, and whether light-duty devices using graphene capacitors might be a viable alternative to batteries for small electronics.
Future outlook	The user discusses anticipated impacts of climate change, including rising temperatures, sea levels, and extreme weather, and reflects on how these changes may shape the future, expressing curiosity or concern about what to expect in the coming years.
Business investing in sustainability	The user suggests that companies could improve sustainability by making products and services more environmentally friendly, avoiding partnerships with polluters, and advocating for stronger climate policies. They also highlight the potential role of consumers in encouraging corporate climate action and ask for opinions on how to motivate companies to do more.
Respondent recruitment	The post invites young people in the UK to participate in a short, anonymous survey for a thesis study exploring climate change anxiety. The survey link and support resources for climate anxiety were provided. The post also includes information about researcher contact details, data confidentiality, consent procedures, and participants' right to withdraw.
Climate scepticism discussion	The user expresses that they previously paid little attention to the issue. They note having encountered conflicting opinions ranging from climate change being insignificant to catastrophic warnings about human extinction. They ask for accurate information about

	the current situation and future projections, emphasizing a desire for honest, unfiltered scientific perspectives. Additionally, they request recommendations for reliable resources to better understand the topic.
Change of season patterns	The user expresses nostalgia for snowy winters and describes feeling depressed due to the lack of snow in recent years, noting a contrast with their childhood experiences of frequent heavy snowstorms in New York.
Alternative energy	The user reflects on solutions to the climate crisis, particularly regarding energy production. While acknowledging the benefits of solar panels and wind turbines, they raise concerns about the environmental and social impacts of mining required for these technologies, including worker exploitation, child labour, and threats to Indigenous lands and culturally significant sites. They also extend these concerns to other technologies such as electric vehicles and infrastructure. The user asks whether it is possible to produce electricity and electronics without mining and questions the feasibility of maintaining current technological practices sustainably.
Carbon	The user critiques the prioritization of commercial real estate profits over reducing carbon emissions, noting that long commutes contribute significantly to individual carbon footprints. They argue that remote work or use of local co-working spaces could reduce emissions and question outdated commuting practices. The user also suggests repurposing commercial buildings to address social issues, such as housing displacement resulting from technological changes like AI.

Appendix D: Critical discourse analysis

Figure 6: Distribution of annotations.

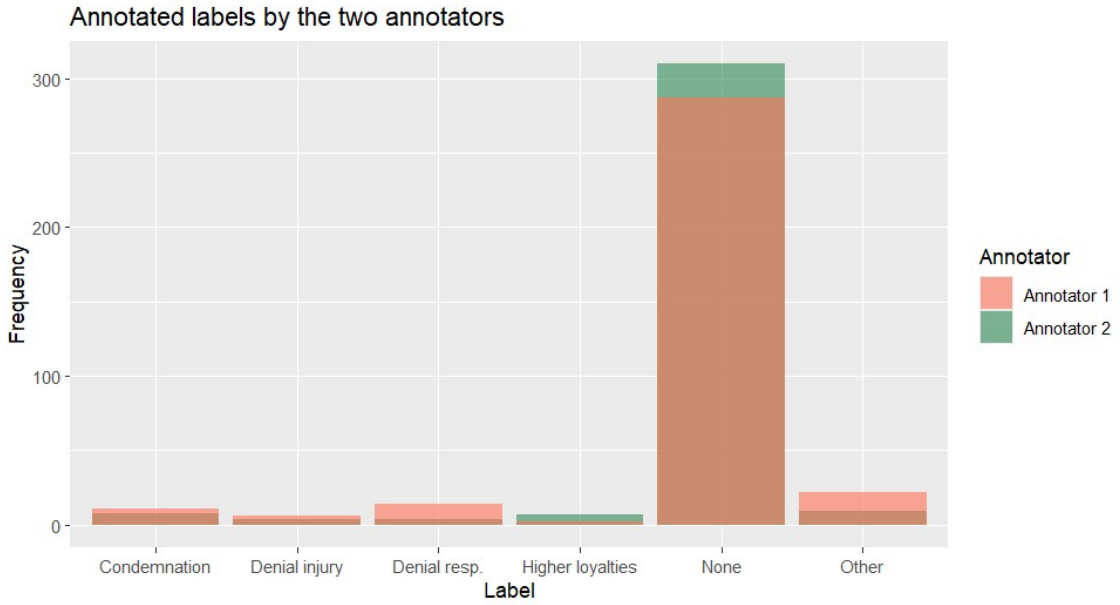


Table 3: Overlapping annotation neutralization techniques	
Label	*Posts (paraphrased)*
Condemnation of the condemner	The user asks whether there is scientific evidence demonstrating that human activities have caused changes in the Earth's climate and environment since the Industrial Revolution due to greenhouse gases.
Denial of responsibility	The user questions why climate change science does not appear to update or challenge assumptions in the same way that scientific guidance evolved during the COVID-19 pandemic. They note that effective science, as observed during the pandemic, involves continuously revising forecasts and recommendations as new evidence emerges. The user cites a quote from Richard Feynman emphasizing scientific integrity and transparency, and expresses the view that such approaches seem less visible in discussions and media coverage of climate change.
Denial of responsibility	The user expresses support for taking action on climate change but is uncertain about the extent to which it is caused by human activity. They seek information on the evidence for anthropogenic climate change in order to engage effectively with sceptics.
Other	The post describes a young student expressing profound feelings of hopelessness related to climate change and broader societal issues. Despite having taken personal actions to reduce their environmental impact, the user reports continued despair when confronted with ongoing negative news. The post reflects emotional distress, feelings of social exclusion, and concerns about humanity's ability to change, raising questions about whether meaningful collective action and a more harmonious relationship with nature are achievable.
Other	The post is written by a teenager who expresses fear and anxiety about the future in relation to climate change. They describe distress over environmental changes and a perception that meaningful action is not being taken by those in power. Although they acknowledge engaging in individual pro-environmental behaviours, they feel these efforts are insufficient. The post reflects longstanding mental health struggles and a sense of grief over the possibility that anticipated future experiences and life milestones may not occur due to climate change.

Table 4: confusion matrix annotations

		Annotator 1							
		None	Denial of responsibility	Denial of injury	Denial of the victim	Condemnation of the condemner	Appeal to higher loyalties	Other	Total
Annotator 2	None	**266**	1	2	0	5	7	6	287
	Denial of responsibility	11	**2**	0	0	0	0	1	14
	Denial of injury	5	0	**0**	0	1	0	0	6
	Denial of the victim	0	0	0	**0**	0	0	0	0
	Condemnation of the condemner	8	1	1	0	**1**	0	0	11
	Appeal to higher loyalties	2	0	0	0	0	**0**	0	2
	Other	18	0	1	0	1	0	**2**	22
	Total	310	4	4	0	8	7	9	**342**

Cohen's Kappa= .1207

Table 5: Selection for error analysis

	Post (paraphrased)	Annotator 1	Annotator 2	Theme error
1	This post critiques planned obsolescence as a core driver of environmental degradation, arguing that a linear "take–make–waste" economic model prioritizes consumption over durability. It emphasizes the environmental and social harms of excessive production, particularly mining-related emissions, pollution, biodiversity loss, and resource depletion, and calls for systemic economic reform rather than placing responsibility solely on individual consumers.	*Condemnation of the condemner*	*None*	Misinterpretation of *Condemnation of the condemner*
2	The author describes feeling caught between catastrophic and optimistic interpretations of climate science and expresses uncertainty about what the evidence actually supports. They seek guidance on how to evaluate conflicting claims from scientists and commentators, as well as advice for managing climate-related anxiety.	*Condemnation of the condemner*	*Denial of injury*	Misinterpretation of *Condemnation of the condemner*
3	This post argues that the fossil fuel industry has a history of misleading the public, first regarding leaded fuel and later concerning carbon dioxide emissions. The author claims these actions have caused widespread harm and calls for accountability.	*Condemnation of the condemner*	*Denial of responsibility*	Misinterpretation of *Condemnation of the condemner*
4	The post discusses a U.S. Supreme Court ruling affecting the EPA's authority to regulate carbon emissions. While acknowledging the decision as a setback, the author argues that its impact is more limited than some media portrayals suggest, noting that key regulatory powers remain intact.	*Denial of injury*	*None*	Overfocussing on specific sentence
5	This post challenges claims that the IPCC endorses large-scale direct air carbon capture as a primary solution. The author argues that such technologies are often misrepresented, remain underdeveloped, and risk being used to justify continued emissions rather than systemic change.	*Denial of injury*	*Condemnation of the condemner*	Different interpretation of most prominent technique
6	The author presents a sceptical argument encountered online claiming that atmospheric CO_2 cannot meaningfully warm oceans due to thermodynamic constraints. The post seeks clarification and scientific rebuttal to this claim, particularly in light of evidence on ocean acidification and historical mass extinctions.	*Denial of responsibility*	*None*	Reference/reproduces of a person's statement.

7	Using humour, the author asks experts for updated assessments of how quickly climate impacts are expected to unfold, expressing concern about long-term planning such as retirement in the context of accelerating environmental change.	*Denial of responsibility*	*Other*	Different interpretation of most prominent technique
8	This post requests help responding to claims that climate change cannot be linked to increased hurricane intensity. It summarizes common sceptical arguments related to limited historical data, natural climate variability, CO_2 levels in Earth's past, and alternative explanations for warming.	*Appeal to higher loyalties*	*None*	Reference/reproduces of a person's statement.
9	The author seeks advice on how to respond to dismissive attitudes toward climate data in workplace discussions. They express frustration at claims that temperature records are "cherry-picked" and ask how to effectively explain the robustness of global temperature measurements.	*None*	*Appeal to higher loyalties*	Reference/reproduces of a person's statement.
10	This post asks for additional scientific studies comparing urban and rural temperature trends globally, in response to claims that observed warming is primarily caused by urban heat island effects rather than global climate change.	*None*	*Condemnation of the condemner*	Overlooked technique
11	The author explores whether coordinated global action, such as widespread renewable energy deployment, nuclear power, and carbon capture, could realistically mitigate climate change and restore ecosystems, expressing cautious optimism about human ingenuity.	*None*	*Other*	Overlooked technique
12	This post shares criticism from scientists who argue that governmental climate commitments lack credibility due to continued fossil fuel subsidies, deforestation, and contradictory policies, framing this as a form of "climate hypocrisy."	*None*	*Denial of injury*	Overlooked technique
13	The author asks for recommendations for genuinely environmentally friendly products, noting confusion caused by greenwashing and the difficulty of making informed consumer choices	*None*	*Denial of responsibility*	Misinterpretation of the *Denial of responsibility*
14	This post reflects on reading the IPCC Summary for Policymakers and notes that it appeared less catastrophic than expected. The author discusses perceptions of bias in climate reporting and emphasizes the importance of	*Other*	*None*	Misinterpretation of *Other*

	building resilient communities regardless of uncertainty.			
15	The author questions claims made in an online advertisement suggesting beef production is environmentally beneficial. They ask whether such claims contradict established science and whether the content should be considered misinformation.	*Other*	*Condemnation of the condemner*	Different interpretation of most prominent technique
16	This post endorses a response video countering claims that reducing meat consumption has little environmental benefit. The author criticizes the spread of misleading narratives that downplay individual and systemic responsibility, particularly when linked to industry influence.	*Other*	*Denial of injury*	Misinterpretation of *Other*

Appendix E: Annotation guidelines

Annotation guidelines

Introduction

Climate change is a broadly discussed topic (Pilgreen et al., 2025). Within this discussion, there is a divide between individuals who are sceptical about climate change and those who express a growing concern and take action (Pilgreen et al., 2025). This study explores the use of neutralization techniques within Reddit posts from the subreddit r/environment, r/climatechange and r/climate. The framework of neutralization techniques, developed by Sykes and Matza (1957), identify five different techniques. This framework is aimed to explain how individuals, who committed a crime, justify their behaviour (Sykes & Matza, 1957). Even tough this framework was developed with a criminological context, it can be applied to other contexts, too. A study conducted by McKie (2019) applied this framework to the Climate Change Counter Movement (CCCM). Another study done by Pilgreen et al. (2025) examined the use of these techniques with the justification of climate inaction and how the techniques influence the support of climate action.

Building on prior research, this study adopts the framework and the applications of it to climate chang to examine the use of neutralization techniques by Reddit users. The annotation guidelines will support the identification and annotation of these techniques within the Reddit posts.

Specification of the annotation guidelines

Annotation rules

The annotation is to be conducted at the level of the entire Reddit posts. During the annotation, annotators must firstly identify the presence of any neutralization technique within a Reddit post. A neutralization technique is considered present when the poster themselves uses a technique within their own statement. Additionally, a technique is also considered present when the poster references or reproduces another person's statement that contains a neutralization technique.

When a neutralization technique is identified in a post, the annotator must identify which neutralization technique is used. In the situation where multiple techniques appear in a post, the annotator has to select the most prominent technique in the post. If the annotator is uncertain whether a technique is present, the post should be annotated as an absence of a technique. This approach ensures that only posts with clear presence of a technique can be examined. Lastly, if the annotator determines a presence of a technique in a post, but it does not fit within any of the five predefined neutralization techniques, the post should be annotated as "Other". The aim of this category is to capture neutralization techniques that are not defined within the existing framework.

Labels

The techniques which can be annotated include *Denial of responsibility, Denial of Injury, Denial of the Victim, Condemnation of the Condemners,* and *Appeal to Higher Loyalties*. To ensure the capture of neutralization techniques that are not predefined, but may be relevant in our data, an additional label, *Other* is included. The definition of these labels is drawn from Sykes and Matza (1957) and McKie (2019).

Denial of responsibility

This technique is defined as the individual denies responsibility of their behaviour, as other factors forced them to behave this way. Related to climate change, it can be seen as denying responsibility of causing climate change. As McKie describes it as "climate change is happening, but humans are not the cause" (2019, p. 295).

Denial of injury

Denial of injury is a technique where the individual does take responsibility, however the consequences of the harm or injury are not as bad as it is claimed to be. The harmful consequences can sometimes even be seen as beneficial. For climate change, it means that individuals say that their behaviour doesn't cause significant harm to climate change or may even be beneficial in a way.

Denial of victim

This technique will frame the situation as something with an absence of a victim. If the individual does accept that there is a victim, they will likely frame it in a way that they were deserving to be a victim. Individuals can claim that there are no climate change victims, and if there are climate change victims, they are deserving to be victimized.

Condemnation of the condemner

Condemnation of the condemner is about shifting the negative and critical reactions about the individual to those who react in this way. This will reject the higher status of the condemners. For climate change, McKie (2019) interprets it as "climate change research is misrepresented by scientists, and manipulated by media, politicians, and environmentalists" (p. 295).

Appeal to higher loyalties

With this technique, the individual will state that the behaviour, even though it breaks social norms, is necessary to support a group or a higher cause. In relation to climate change, can this technique be defined as possibly something that other developments, such as economic or residential construction is more important compared to preventing climate change.

Other

This category is used, when there is a neutralization technique present, however it does not fit the techniques above.

Examples

These are examples of when a technique is present in a post. Some of these examples were extracted from McKie (2019) and the rest of the examples were made with the help of GPT-5.2.

Denial of responsibility

- *"There is no such thing as climate change, the changes in global temperatures are natural".*
- *"I really care about our climate, but I need to fly for my work".*
- *"People living near the coast choose to live there, so why would my tax dollars go to the protection of them?"*
- *"I drive a car, because public transport is awful here".*
- *"Someone said that recycling doesn't help, because big companies are really causing climate change".*

Denial of injury

- *"Sometimes eating meat isn't that bad. It barely impacts climate change".*

- *"CO2 does not control the climate. It is an essential plant food, and more CO2 will produce more plant growth and a greener globe".*
- *"Plastic bags don't hurt the environment much; they're convenient".*
- *"I take flights for vacations; one trip isn't going to harm anyone".*
- *"Another Redditor said that buying one fast fashion item won't worsen climate change".*

Denial of victim

- *"A post said that hurricanes only affect careless people who didn't prepare".*
- *"The rising temperatures aren't affecting anyone; it just gets a little hotter".*
- *"I don't really feel the consequences of climate change".*
- *"A friand said that extinction of animals is just nature taking its course, not climate change".*
- *"I care about polar bears, but humans aren't directly harmed by this".*

Condemnation of the condemner

- *"I reduce my emissions, but environmental activists are too extreme".*
- *"I try to bike, but climate activists judge anyone who can't go zero-emission".*
- *"A comment claimed that scientists manipulate climate data for funding".*
- *"Someone said environmentalists exaggerate problems to push ideology".*
- *"Our main purpose is to bring reason, integrity, and balance to a debate that has become seriously unbalanced, irrationally alarmist, and all too often depressingly intolerant".*

Appeal to higher loyalties

- *"It is important to invest more in the economy, instead of preventing climate change".*
- *"This article states that it is important to be prepared for war in these times, instead of focussing on climate change".*
- *"I care about climate change, but my family's needs come first".*
- *"I avoid single-use plastics when I can but helping my business stay afloat is more important right now".*
- *"Someone wrote that ensuring access to healthcare is more critical than acting on climate change immediately".*

Other

- *"There is so much information on climate change, I don't know where to start, so I don't even begin."*
- *"I'm worried about the planet, please tell me that it is all not so bad".*
- *"Climate change is scary, and I get anxious thinking about it, so I avoid reading more."*
- *"I care about climate change, but I get so stressed that I just ignore it sometimes."*
- *"I read somewhere that the problem is so big, is this correct? Please say it isn't".*

References

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