



Ecological Modelling: Applying Computational Analysis to the UN Secretary-General's Speeches on Climate Change (2018–2022)

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The present study analyzes the UN Secretary-General's speeches on climate change to investigate latent topics. The study aimed to sum up the challenges and strategies proposed by the UN. The addresses, delivered from 2018 to 2022, were retrieved from the official website of the UN. A computational technique named Latent Dirichlet Allocations (LDA) was applied to uncover the hidden topics from the corpus. The present study underpinned Computational Grounded Theory (CGT) as the theoretical framework for the analysis. The results revealed multiple topics such as renewable energy, the effects of climate change, proposed action plan, climate change disasters, mitigation strategies, and global food insecurity. The study is significant in the sense that it provides insightful directions to overcome the threat of climate change.

La présente étude analyse les discours du Secrétaire général des Nations unies sur le changement climatique afin d'étudier les sujets latents. L'étude vise à résumer les défis et les stratégies proposés par l'ONU. Les discours, prononcés entre 2018 et 2022, ont été récupérés sur le site officiel de l'ONU. Une technique informatique appelée Allocation de Dirichlet Latent (en anglais Latent Dirichlet Allocations ou LDA) a été appliquée pour découvrir les sujets cachés du corpus. La présente étude s'appuie sur la théorie computationnelle ancrée (Computational Grounded Theory ou CGT) en tant que cadre théorique pour l'analyse. Les résultats ont révélé de nombreux sujets tels que les énergies renouvelables, les effets du changement climatique, le plan d'action proposé, les catastrophes liées au changement climatique, les stratégies d'atténuation et l'insécurité alimentaire mondiale. L'étude est significative dans le sens où elle fournit des orientations perspicaces pour surmonter la menace du changement climatique.



Introduction

Sustainable development includes social, economic, and environmental perspectives (Moldan, Janoušková, and Hák 2012). It is an umbrella term used to describe policies, projects, and investments for a better present without sacrificing environmental, social, and personal health in the future (Bircher and Kuruvilla 2014). It aims to promote development that reduces problems associated with nature and helps meet the needs of the existing generation without compromising the quality of the environment for future generations (Robert, Parris, and Leiserowitz 2005). Climate change is a challenge for sustainable development because it can drag millions of people into poverty (Kyte 2014).

Climate change is a universal issue that has affected people across the globe. The climate of Earth is changing due to human activities, releasing greenhouse gases that are hazardous to human health (Jain 1993; Yue and Gao 2018). Hence, climate change is a global challenge. United Nations (UN) is a worldwide organization that transcends national boundaries and addresses the issues of the whole world (Rasche and Kell 2010). Being a reliable forum, the UN highlights concerns and provides strategies to overcome climate change. It is essential to observe how UN Secretary-General speeches reflect concerns and propose strategies to deal with the issue. Therefore, the present study focuses on the climate change speeches delivered by the UN Secretary-General from 2018 to 2022. These speeches highlight the hurdles and disasters caused by climate change and possible solutions to mitigate its effect. The last five years experienced extreme weather conditions and are responsible for global greenhouse gas emissions due to melting glaciers (Nema, Nema, and Roy 2012). **Figure 1** shows the rise in carbon dioxide concentration from 408 to 420 ppm (Global Monitoring Laboratory 2021).

The Intergovernmental Panel on Climate Change (IPCC) concludes that to prevent millions of climate change-related deaths, the world must limit temperature rise to 1.5°C (Hoegh-Guldberg et al. 2019). Hence, it is essential to investigate the concerns raised by the UN and to find out the possible areas of focus where a combined strategy is to be adopted.

The present research is significant in the sense that it provides linguistic insight for examining the prospects and concerns of climate change. The previous studies on climate are context-specific (Conway and Schipper 2011; Dash et al. 2007; Farooqi, Khan, and Mir 2005; Adedoyin et al. 2011), whereas others deal with different aspects such as forestry (Kirilenko and Sedjo 2007), Global Food Security (Wheeler and Von Braun 2013), and adaptation (Eisenack et al. 2014). However, a linguistics perspective, giving a detailed view of the phenomenon, is yet to be explored. For this purpose, the speeches explicitly delivered on climate change by the UN General Secretary have been focused

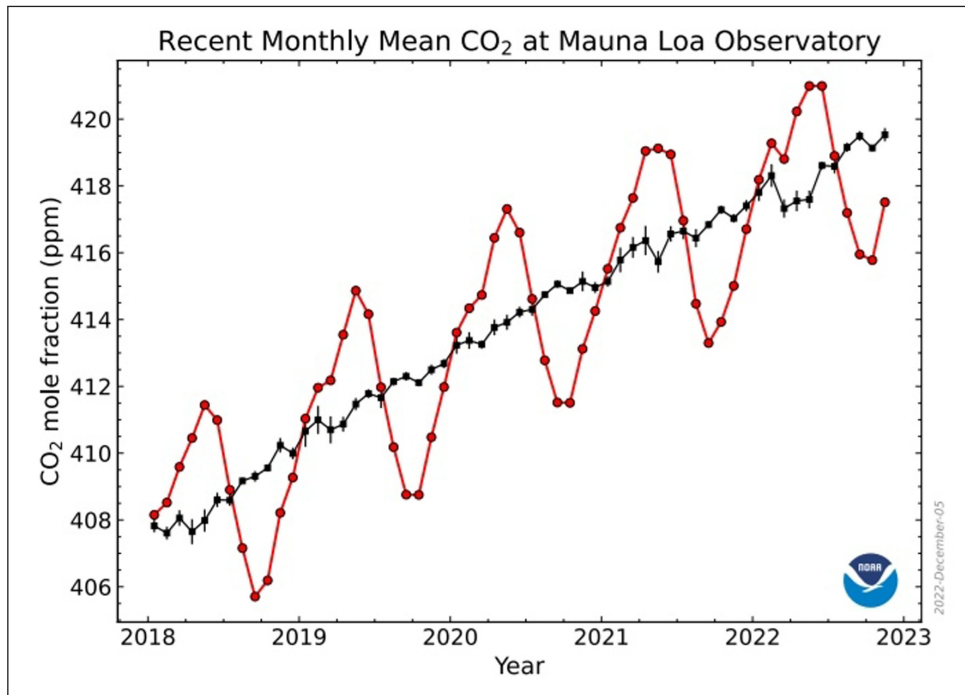


Figure 1: Monthly mean of CO₂ at Mauna Loa Observatory (2018–2022)

on examining the prevailing factors relevant to climate change issues. In addition, the topic modelling technique has been applied to extract latent topics that inform about climate change prospects. Topic modelling is a robust method of generating the topics from a large corpus compared to manual research, which is time-consuming (Blei, Ng, and Jordan 2003).

Literature review

Climate change refers to global warming, which may result in variations in temperature, precipitation, pressure, and humidity in the atmosphere where humans are regarded as drivers of this change (Hussain et al. 2019; IPCC Core Writing Team, Pachauri, and Reisinger 2008). Climate change mitigation measures vary from high- to low-income countries (Berrang-Ford, Ford, and Paterson 2011). Moreover, the negative impacts of climate change affect growth rate and global economy and may trap more people in poverty (Tol 2018). In addition, Wheeler and Von Braun's research on impacts of climate change reveals that it may have an impact on crop productivity that could have consequences for food availability (Wheeler and Von Braun 2013). Hence, climate change adaptation and mitigation awareness are important both at national and international level.

Discourse analysis mainly serves for researching and evaluating texts, whether they are written or spoken, and goes beyond the sentence level because the focus is on the meaning of the sentences rather than the structure and syntax of the text (Fairclough 1993). Texts should provide information about both personal and social processes (Wells 1993). In this regard, the analysis of speeches, news, environmental problems, and even simple conversations, along with many other domains, comes under the umbrella term of discourse analysis. Many researchers have conducted the discourse analysis of UN speeches because the United Nations is a global organization that addresses the issues of the whole world (Baturo, Dasandi, and Mikhaylov 2017; Khan, Ahmed, and Mubeen 2022). Primarily, these analyses focus on state preferences and priorities where the member states' concerns and strategies are echoed.

In media studies and sociology, the impacts of climate change on life and the economy are widely addressed. Previous researchers in social sciences have focused on the local context prevailing in a country. Therefore, researchers like Fam and colleagues, Dobes and colleagues, Wheeler and Von Braun, Heshmati, Farooqi and colleagues, and Ziervogel and colleagues have discussed climate change from the perspective of economics, in addition to impacts on forestry, impacts on Nigeria, impacts on Global Food Security, impacts and adaptation in South Africa, impacts on Pakistan and its effect on life (Dobes, Jotzo, and Stern 2014; Fam et al. 2017; Farooqi, Khan, and Mir 2005; Heshmati 2021; Wheeler and Von Braun 2013; Ziervogel et al. 2014). Reviews, reports, and articles are also present on *United Nations Speeches*.

Discourse analysis is a helpful technique not just in the field of linguistics but also in social sciences, environmental studies, psychology, and anthropology. Hence, by studying ecological discourse analysis, the relationship between language and environmental issues is understood to protect Mother Nature (Ahmed, Ain, and Ghilzai 2021; Ain, Ahmed, and Nawaz 2021). This incorporates sustainable development (SD) discourse because it perceives human progress as an amalgam of local and global policies related to environmental, economic, and social issues. The sustainability discourse normally encompasses social implications and the interaction between economic and ecological criteria. The social, economic, and environmental aspects of sustainability are interdependent (Burton 1987). Research on policy decision-making proposes when making policy decisions, equal attention should be given to the financial, environmental, and social dimensions (Ain et al. 2023; Elkington 1997). Therefore, scholars have debated and proposed methods to lessen or eliminate the effects of organizations' and communities' actions on the environment to address these environmental concerns.

Topic modelling is a text-mining approach for studying large corpus by using unsupervised machine learning where a corpus of thousands of documents can be

condensed by topic modelling into a concise summary that captures the most important topics found in the corpus (Kherwa and Bansal 2019). A topic model is used when the summary is presented as themes or groups of related words (Ahmed, Mubeen, and Nawaz 2022; Sia, Dalmia, and Mielke 2020). There are several methods for topic modelling, but Latent Dirichlet Allocation (LDA) is one of the most popular ones (Ahmed and Khan 2022; Jelodar et al. 2019). Research has been conducted through topic modelling employing LDA, such as “Discursive Landscapes and Unsupervised Topic Modelling in IR: A Validation of Text-as-Data Approaches through a New Corpus of UN Security Council Speeches on Afghanistan” (Schönfeld et al., 2018) and “Theory-Driven Analysis of Large Corpora: Semisupervised Topic Classification of the UN Speeches” (Watanabe and Zhou 2022; see also Khan, Ahmed, and Mubeen 2022). Similarly, in forensic linguistics and economics, this approach is used to examine financial statement fraud and financial fraud cases and economic challenges (Ahmed, Nawaz, and Jadoon 2022; Dong, Liao, and Liang 2016; Zaki and Theodoulidis 2013). Furthermore, it has been explored from the perspective of social media covering Facebook and Twitter platforms.

However, in linguistics, research related to UN Secretary-General Speeches on Climate Change from 2018 to 2022 is yet to be explored. The present study aims to investigate the issue of climate change from the broader perspective of linguistics. For this purpose, the speeches on climate change by the UN Secretary-General have been delimited to examine the prevailing factors related to climate change.

Research methodology

Topic modelling and LDA

Topic modelling is an unsupervised machine-learning technique that detects neighbouring words and phrase patterns within a set of documents (Blei, Ng, and Jordan 2003; Isoaho, Gritsenko, and Mäkelä 2021). It analyzes data to detect cluster words and similar expressions that describe a corpus (Gerlach, Peixoto, and Altmann 2018). Latent Dirichlet Allocation (LDA), an algorithm, is used for topic modelling. LDA tries to determine a set of topics that are generated through the collection of words and topics. Although a topic is composed of words, the distribution of those words is not equal; therefore, LDA consists of two parts. Firstly, it includes words within a document and, secondly, the probability of words belonging to a topic (Maier et al. 2018; Wei and Croft 2006). The algorithm determines the likelihood of words belonging to a specific topic for the set of given documents. The present study applied LDA topic modelling to extract topics from the corpus based on UN Secretary-General speeches regarding climate change from 2018 to 2022.

Data filtration

This study explores the issues associated with climate change at the global level. For this purpose, the data were retrieved from the United Nations website. It consists of speeches taken from 5 Sep. 2018 to 14 Nov. 2022. The first process in filtering the data is to smooth out the noisy data, which consists of noisy information that contributes less to the meaning-making process (García, De Carvalho, and Lorena 2013). Hence, it is removed in preprocessing.

Preprocessing in the case of the present study was conducted in the following various steps. Firstly, the corpus of speeches was divided into different paragraphs consisting of separate topics. Paragraph and topic detection was conducted by the researchers and later on validated by the language expert. The rationale for separating the paragraph is that one paragraph consists of one focused topic or a discussion about a specific aspect of the topic (Kaplan 1966). This was followed by sentence segmentation, the process of determining longer processing units consisting of one or more words (Palmer 2000). It means that the paragraphs are divided into sentences for further processing. Secondly, tokenization was carried out, which involved breaking sentences into words termed tokens. Tokens are the building blocks upon which analysis is conducted (Palmer 2000). Thirdly, all text was converted to lowercase or uppercase to normalize the data (Vijayarani, Ilamathi, and Nithya 2015). Fourthly, spell correction was the step where an extra space or repetition of words was corrected. Likewise, the next part involves the removal of stop-words. The words frequently used or commonly occurring in the English language are termed stop-words (Silva and Ribeiro 2003). These consist of little or no meaning and only help in forming a sentence. Furthermore, stemming was carried out to remove any trouble in the process of smooth analysis. Stemming refers to the base or root form of a word and involves the conversion of all words to their root forms (Vijayarani, Ilamathi, and Nithya 2015). For example, *learn* is a base word for its variants such as *learns*, *learning* and *learned*. In the end, text normalization cleans the text and replaces all words with their standard forms for the best results.

Theoretical framework

The present study underpinned Computational Grounded Theory (CGT) as its theoretical understanding. The theory combines “expert human knowledge and hermeneutic skills with the processing power of computer” (Berente and Seidel 2014; Nelson 2020). It is the extended form of Grounded Theory and consists of three main steps. Firstly, it relies on pattern recognition, which makes use of inductive computational exploration of the text. It reduces complicated messy text into simple and interpretable list of words. Secondly, it involves a confirmation step, which is regarded as the qualitative

part of the study where the researcher is supposed to visit the original text multiple time to confirm whether the computationally recognized patterns are plausible, add interpretation to the analysis, and potentially modify the identified patterns to better fit the holistic reading of the data. Lastly, the third step involves whether the patterns identified in the first two steps are generalizable to the entire corpus. During the application of CGT, special care was taken into account; the analysis should be computer assisted, not computer guided (Baumer et al. 2017; Carlsen and Ralund 2022).

The present research followed the CGT in that the initial pattern recognition step involved data filtration and LDA topic modelling. In the pattern confirmation step, the original refined data were visited time and again to check the plausibility of the LDA extracted topics. Lastly, the generalizability of the results has been evaluated. The complete details have been explained through data validation process.

Data validation

The validation process was carried out at three levels, as proposed by DiMaggio and colleagues (DiMaggio, Nag, and Blei 2013). Statistical validation involved the analysis of a model's ability to predict the set of documents (DiMaggio, Nag, and Blei 2013). It explores the limits of topic modelling concerning the number of documents and their lengths (DiMaggio, Nag, and Blei, 2013). It works better when the words associated with different topics are clearly separated. This is done in the preprocessing, where certain stop-words are removed from the data to avoid any hurdles.

At first, the researcher ran ten topics in the software, but the results were unclear. Then, the model was run according to eight topics, and these fitted the criteria. The process of narrowing or selecting the appropriate number of topics plays a role in the interpretation of the topics. So, eight topics were finalized, keeping in view their relevance to the corpus. For this purpose, the researcher had to continuously visit the original text or data to look for the validity of the keywords suggested by the model. Furthermore, semantic validation was carried out to compare the results of the LDA method with expert reasoning to make semantic sense of the topics (Isoaho, Gritsenko, and Mäkelä 2021). The word cloud was generated as a result of eight topics consisting of specific keywords. These keywords depicted semantic meanings according to themes being discussed in the topics. The researcher then explored these themes to make sense of the hidden information. Moreover, in predictive validation, external events predict the outcome of the model (Isoaho, Gritsenko, and Mäkelä 2021). Therefore, the researcher, in the end, reached the sense of the extracted topics and predicted solutions or measures to overcome the discussed problem.

Analysis

Table 1 contains the LDA result and suggested topic headings for the extracted keywords. It consists of eight topics, which are inferred from word clouds and their corresponding word probabilities. **Figure 4** shows the visualization of the topics extracted through LDA.

Topic Keywords	Themes
[(0, '0.048**energy" + 0.043**support" + 0.032**people" + 0.027**access" + ' '0.027**deliver" + 0.027**international" + 0.022**system" + ' '0.021**renewable" + 0.018**already" + 0.017**public"),	Renewable Energy
(1, '0.100**climate" + 0.045**crisis" + 0.041**vulnerable" + 0.040**impact" + ' '0.037**gap" + 0.033**support" + 0.033**livelihood" + 0.023**increase" + ' '0.021**protect" + 0.020**community"),	Effects of Climate Change
(2, '0.052**country" + 0.036**world" + 0.033**climate" + 0.024**make" + ' '0.016**today" + 0.016**action" + 0.016**government" + 0.015**work" + ' '0.014**crisis" + 0.014**year"),	Climate Action Plan
(3, '0.061**loss" + 0.055**disaster" + 0.036**progress" + 0.034**happen" + ' '0.018**region" + 0.018**low" + 0.017**flood" + 0.016**record" + 0.014**hit" + ' ' + 0.013**yet"),	Climate Change Disasters
(4, '0.046**life" + 0.045**food" + 0.023**become" + 0.021**humanity" + ' '0.020**ukraine" + 0.019**conflict" + 0.018**situation" + 0.016**people" + ' '0.016**give" + 0.015**ocean"),	Global Food Insecurity
(5, '0.042**global" + 0.031**emission" + 0.019**need" + 0.016**climate" + ' '0.016**way" + 0.015**clear" + 0.015**price" + 0.015**action" + ' '0.015**damage" + 0.014**time"),	Mitigation of Greenhouse Gases
(6, '0.054**country" + 0.035**investment" + 0.028**transition" + ' '0.022**fossil_fuel" + 0.022**use" + 0.019**market" + 0.019**ensure" + ' '0.019**fund" + 0.018**coal" + 0.017**grow"),	Sustainable Development Goals
(7, '0.053**develop" + 0.042**need" + 0.035**adaptation" + 0.030**finance" + ' '0.019**provide" + 0.017**pact" + 0.017**climate" + 0.015**financial" + ' '0.013**debt" + 0.013**hope"]]	Climate Change Adaptation

Table 1: LDA topics extracted from the corpus of climate change speeches

The table depicts the *topic word proportions* and the *document topic proportions*. Topic word proportions represent keywords associated with each topic, whereas document topic proportions display topics connected to keywords along with their proportions or weights in the document (Vijayarani, Ilamathi, and Nithya 2015). Initially, ten LDA was run with a limitation to ten topics. However, by observing the redundancy of keywords across multiple topics, the total number of topics was limited to 8. It consists of the most co-occurring words in the document ranging from 0 to 7. Each group consists of ten keywords and are written with their corresponding weight or probabilities in the document. **Table 1** consists of keywords and the proposed themes.

The first set of keywords relates to the generation of green energy (0.048). It suggests that people (0.032) should have access (0.027) to renewable (0.021) energy sources. As renewable energy is already (0.018) cheaper than fossil fuels, it can help deliver (0.027) alternate energy. This can be done with the support (0.043) of the international (0.027) system (0.022) and public (0.017) action to increase the ambition in support of climate change plans.

The second group of words highlights the effects of climate change on our lives. It suggests that the climate (0.100) crisis (0.045) has increased due to the gap (0.037) between national commitments and what people actually need to do to reduce the emission of harmful gases. The impact (0.040) of the climate crisis is devastating, and as a result, vulnerable (0.041) nations and groups suffer the most. That is why developed countries should support (0.033) the efforts of developing countries with an increase (0.023) in finance. Likewise, protecting (0.021) livelihoods (0.033) should be considered a priority to save the community (0.020).

The third set of keywords relates to the work (0.014) on the part of government (0.016) to make (0.024) our world (0.036) a clean place. Today (0.016), technology and the economy are under the control of human beings, but no country (0.052) is safe from the effects of climate change. Every year (0.014), climate crises (0.014) are experienced by people; therefore, climate (0.33) action (0.016) plans should be made effective by each country (0.052).

The fourth set of keywords across topic reflects upon the loss (0.061) caused by natural disasters (0.055). Climate-related disasters (0.055) have hit (0.014) a record (0.016) in the past five years. In several regions (0.018) of the world, coal power plants are still built in large numbers. The Pacific region (0.018) is on the frontline of climate change. Storms and floods (0.017) have caused innumerable deaths in many countries of the world. Ocean heat is at a record (0.016) level. Arctic sea ice is melting, and now

re-freezing is the slowest on record (0.016). Yet (0.013), despite ample awareness, the world is not making progress (0.036) fast enough. The focus must be on low (0.018) carbon emissions and a climate-resilient future. We are not yet (0.013) winning the battle in relation to climate change, but this can happen (0.034) through the mutual effort of people coming together.

The fifth set of keywords in **Table 1** relates to global food (0.045) and life (0.046) crises caused by climate change. Climate change has now become (0.023) a threat to all humanity (0.021). There is a clear connection between climate change and the situation (0.018) in the oceans (0.015). Climate change is forcing people (0.016) to move from their houses as a result of floods and other natural calamities. The conflict (0.019) among the countries (0.020), which has resulted in wars, has caused food (0.045) and energy crises. Ukraine's (0.020) production of food was not accessible to the international markets in the past year because Russia banned the exports of food and fertilizers. All of this gives (0.016) us a glimpse of what lies ahead; prolonged droughts, extreme weather conditions and horrific flooding. Therefore, limiting global temperature rise must be the priority.

The sixth set of keywords relates to mitigating the effects of greenhouse gases. Our world has crossed the threshold of a safe temperature level. Hence, all countries need (0.019) a clear climate (0.016) action (0.015) plan to reduce and cut global (0.042) emissions (0.031). We are really out of time (0.014), so the governments must act now to prevent further irreversible damage (0.015). The solutions are very clear (0.015). All nations need (0.019) to join the net zero emissions coalition, as the only way (0.016) to prevent exceeding this threshold is to step up our efforts to reduce the temperature to 1.5°C. Otherwise, the world may pay a tragic price (0.015).

The seventh set of keywords highlights sustainable development goals. It urges an end to the use (0.022) of coal (0.018) with the help of international support. The UN Secretary-General stresses closing carbon markets (0.019) and adopting plans for transitioning to net zero emissions by 2050. He suggests the transition (0.028) of energy systems from fossil fuels (0.022) to renewables, as renewable energy is the only energy source expected to grow (0.017) in the future. Therefore, financial institutions are now shifting their investments (0.035) toward a decarbonized, sustainable, and resilient economy. Hence, investment funds (0.019) and companies that have the technological knowledge provide financial and technical support for every country (0.054) that needs assistance.

The last set of keywords relates to climate change adaptation. It stresses the need (0.042) to develop (0.053) adaptation (0.035), which requires strong international support as climate (0.017) change is rapidly increasing. This topic also focuses on finance (0.030) to provide (0.019) money for adaptation (0.035) and resilience in developing countries as they face debt (0.013) crises. For this purpose, the UN Forum requests all financial (0.015) institutions and banks to align their investments with the Paris Agreement Pact (0.017) to help vulnerable countries re-launch their economies in a sustainable and inclusive way. In this way, we can hope (0.013) to secure the breakthrough in adaptation and resilience that is needed to overcome the issue of climate change.

For further validation of the proposed keywords and themes explained in **Table 1**, all the topics were visualized through word clouds. LDA topics using word clouds separate a text corpus into *different* topics, assigning each document in the corpus a topic weight (Nastiti, Hidayatullah, and Pratama 2021). Each topic, in turn, is represented by a set of term weights. The word with the highest weight appears bigger than the other ones. Likewise, the words with less weight appear in a smaller size. This helps the researcher to generate topics according to the keywords and their probabilities as shown in **Figure 2**.

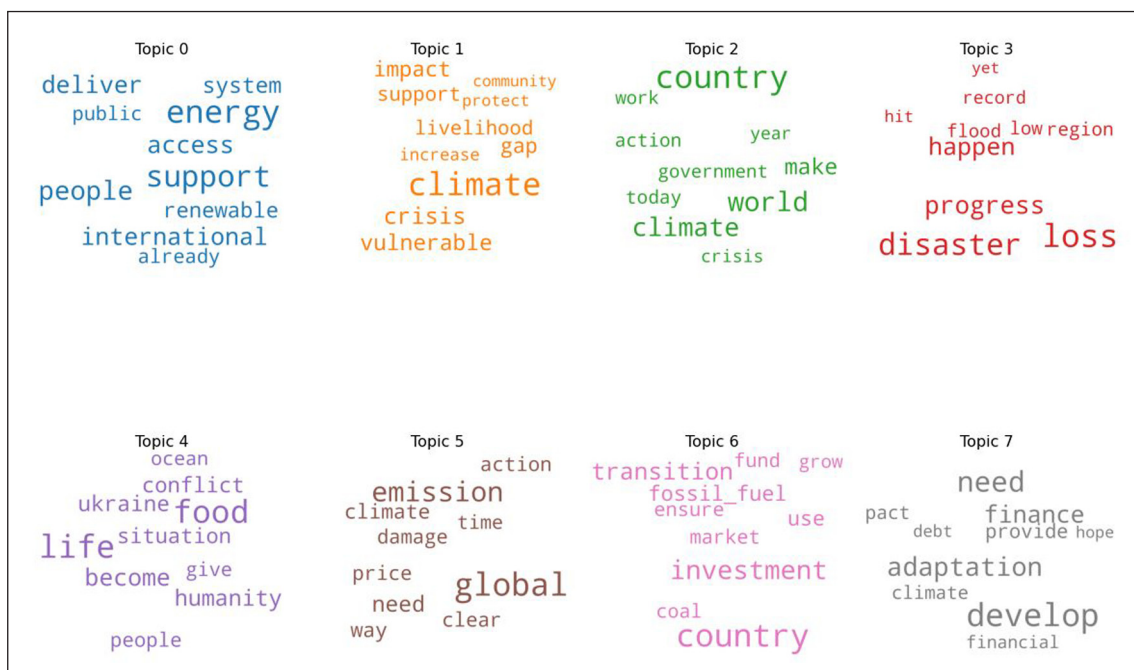


Figure 2: Word cloud based on extracted LDA topics from the corpus

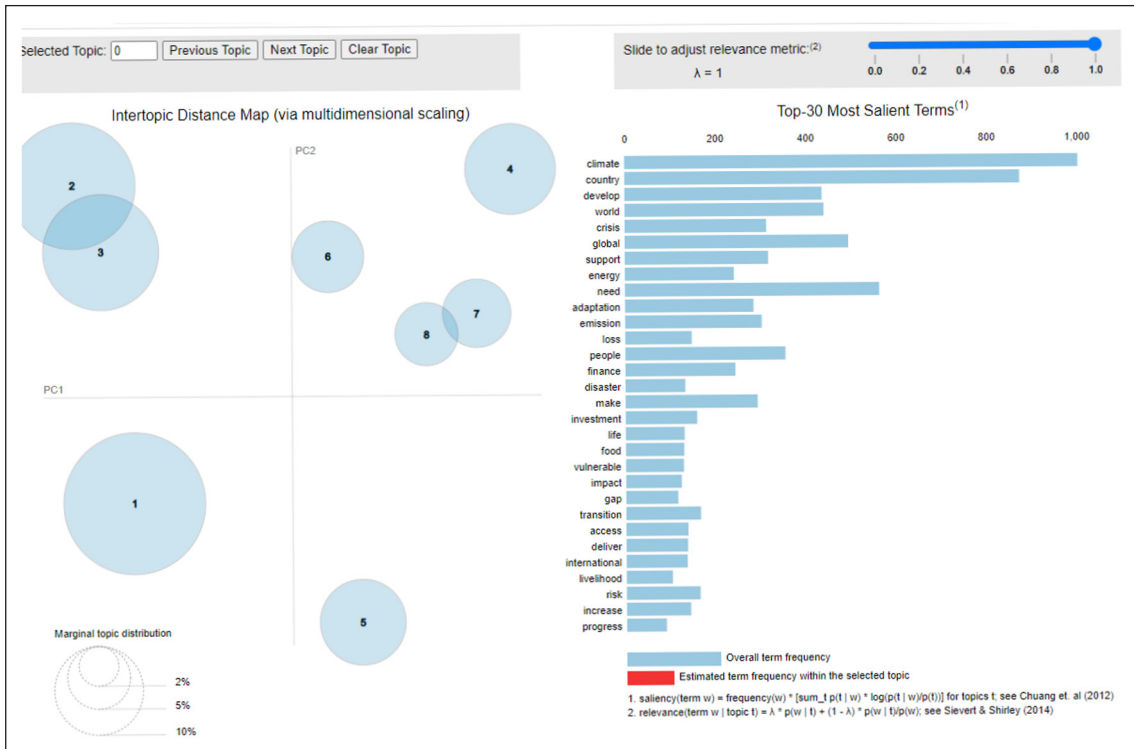


Figure 3: LDA topic visualization

Figure 3 shows a t-Distributed Stochastic Neighbor Embedding (t-SNE) chart, which is a visualization technique that can help to explain the structure of a large corpus of data. The plot is two-dimensional and shows clusters of similar documents based on their content (Yi, Xue, and Compare 2013). Each topic in the plot represents a document, and the location of the topic reflects the content and relationship between documents (Yi, Xue, and Compare 2013). In order to highlight how one topic differs from others in terms of distribution, each topic has been given a different colour. This is useful for exploring and understanding the similarities and differences between different topics.

Figure 4 demonstrates the topic distribution derived by t-SNE through the LDA procedure. The distribution suggests that the themes are distinct from one another, and the topics have meanings of their own, contributing to the whole corpus.

Discussion

The study investigated the issue of climate change at a global level. The data was extracted from the UN Secretary-General’s speeches from the website. This research used LDA to extract topics from the speeches. The main purpose of LDA analysis

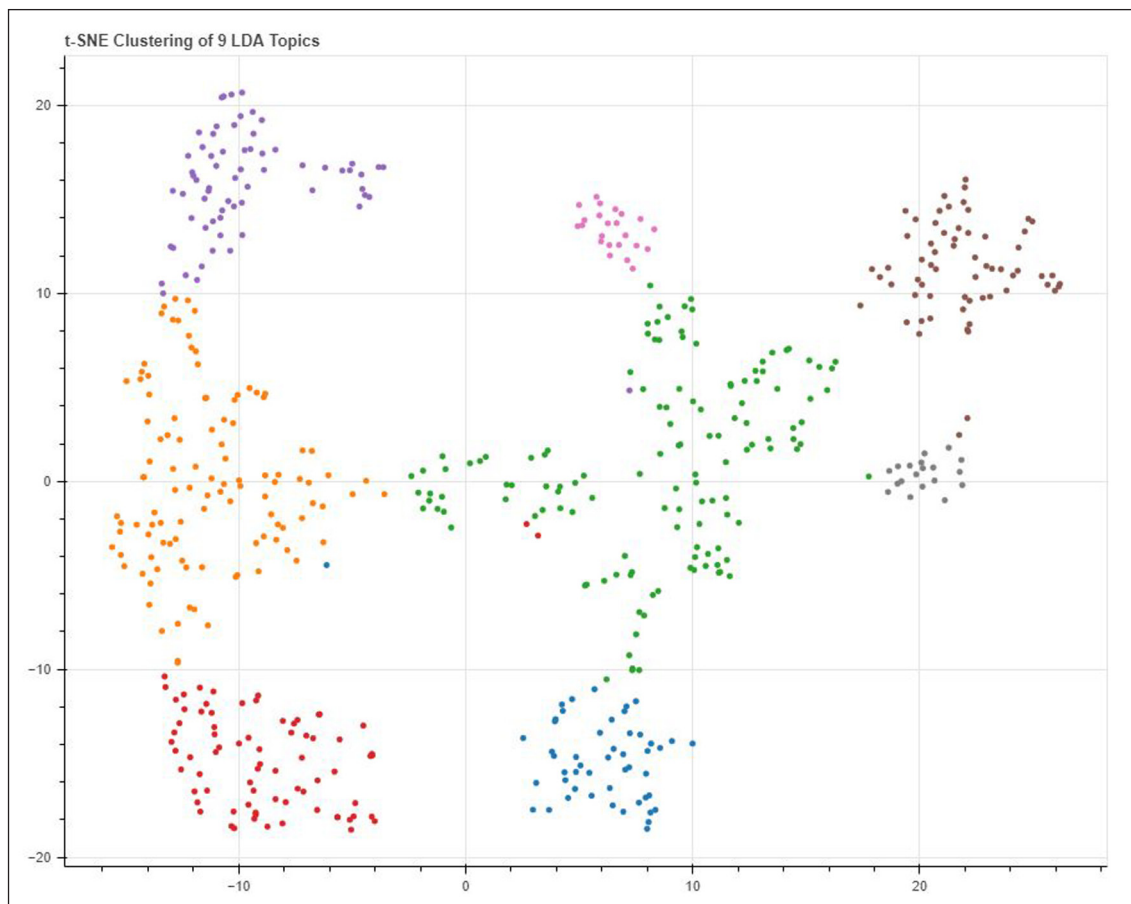


Figure 4: A t-SNE distribution of topics extracted through LDA

was to highlight the issues and solutions associated with climate change. The study followed Computational Grounded Theory, as a result of which, eight topics emerged. The themes revolve around renewable energy, the effects of climate change, climate action plans, global food insecurity, mitigation of greenhouse gases, climate change disasters, sustainable development goals, and climate change adaptation.

The topics being discussed above can be divided into two main layers. Out of the eight suggested topics in **Table 1**, the first category combines topics 1, 3, and 4 because they refer to the damages caused by climate change in the whole world. The damages caused by natural disasters have increased over the past decade (Ritchie and Rosado 2022). The United Nations Intergovernmental Panel on Climate Change (IPCC) reports that since the 1950s, the world has warmed up by approximately 0.6°C (IPCC Core Writing Team, Pachauri, and Reisinger 2008). Economic development has been fostered by the use of fossil fuels, but the accumulation of greenhouse gases, particularly carbon dioxide and methane, has implications for the world's climate

(Haines and Patz 2004). The impact of climate change is devastating due to heat waves, storms, droughts, and floods (Haines and Patz 2004). Storms and floods have caused innumerable deaths in Kerala, India (James et al. 2020). Glaciers have started melting because of global warming and greenhouse gas emissions (Bajracharya, Mool, and Shrestha 2008). Climate change has forced people to migrate from their homes and lands as a result of natural disasters (Perch-Nielsen, Bättig, and Imboden 2008). It has also led to food and energy crises owing to droughts, extreme weather conditions, and horrific flooding (Manyeruke, Hamauswa, and Mhandara 2013). Climate change has now become a threat to all of humanity. Therefore, its effects should be mitigated.

The second category of suggested topics comes under the umbrella term of sustainability. It encourages the generation of green energy and suggests that people around the whole world should have access to renewable energy sources. Temperatures have been rising in the past decade; hence, the mitigation of greenhouse gases is important. For this reason, all countries need a clear climate action plan to reduce the temperature of Earth to 1.5°C (Rhodes 2019). In addition to this, the Sustainable Development Goals (SDGs) urge an end to the use of coal with the help of international support (Elavarasan et al. 2021). The main objective is to adopt plans for transitioning to net zero emissions by 2050 (Caetano, Winkler, and Depledge 2020). It can be achieved by the transition of energy systems from fossil fuels to renewable energy sources. Therefore, financial institutions are now shifting their investments toward a decarbonized, sustainable, and resilient economy (Eschalier, Cochran, and Deheza 2015). For this purpose, all financial institutions are requested to provide funds for adaptation and resilience in developing countries as they face debt crises.

The present study underpinned Computational Grounded Theory, which guided in reaching from messy to simpler interpretable text in the form of results and verifying the results through validating process and lastly evaluating generalizability of the results (Nelson 2020). The extracted topics and themes reflect the understanding of the phenomenon (i.e., climate change) (DiMaggio, Nag, and Blei 2013; Macanovic 2022).

Conclusion

The research concludes that the topics revealed through the use of LDA revolve around renewable energy, effects of climate change, climate action plans, global food insecurity, mitigation of greenhouse gases, climate change disasters, sustainable development goals, and climate change adaptation. These are the issues and solutions

concerning climate change reflected in the speeches of the UN Secretary-General delivered from 2018 to 2022. These depict damages done by climate change and focus on the implementation of sustainable development goals.

The natural language processing with topic modelling and LDA helps determine the challenges and issues faced by the whole world as a result of climate change. Topic modelling and word clustering assisted in determining damages caused by climate change; therefore, its effects should be mitigated with the help of sustainable development goals and strategies. Hence, finding hazards and solutions related to climate change can be done effectively and practically by using the LDA method.

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Data Curation: FA

Formal Analysis: AA, FA

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Software: FA

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