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Analysis of green deal communication on twitter: environmental and political perspective

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The Green Deal and its implementation are generating discussions across society. Changes brought about by the agreement could impact sustainable development worldwide; therefore, identifying the most common Green Deal-related topics on a global scale can offer insight into the public mood around implementation of the agreement. Social networks provide the opportunity to find such topics because they contain a large amount of data produced by users worldwide: analysis of their content can therefore provide insight into the discourse on the Green Deal and identify the sentiment in discussions around this topic. In this article, we present perceptions of the Green Deal and identify the main Green Deal-related topics based on analysis of communication on the Twitter social network (currently X social network). Using the search terms "green deal," "greendeal," and "#greendeal," 192,567 tweets from 89,328 unique users were captured between 1 January 2019 and 31 March 2023. We identified the 40 most used unique hashtags that people used when communicating about the Green Deal, which included "#EU," "#eugreendeal," and "#climatechange," and the 16 most relevant topics discussed in relation to the Green Deal, which included both European ("European Green Deal") and North American ("Green New Deal") perspectives. Each topic was associated with a certain amount of negative, positive, or neutral sentiment: the most positive sentiment was associated with the "Industrial plan" and "Hydrogen" topics, and the most negative sentiment was associated with topics relating to "Joe Biden" and "Alexandria Ocasio-Cortez." Overall, our analysis of the discourse regarding the Green Deal offers organizations and decision-makers insight into how people perceive different aspects of the Green Deal and related topics. This may be beneficial in tackling disinformation across social networks and increasing public awareness, which could create a society better equipped to face the global concern of climate change.

KEYWORDS

Green Deal, climate change, environment, sustainability, social media analysis, Twitter, X

1 Introduction

Climate change and other environmental shifts present significant challenges to global economies, societies, and ecosystems; this has necessitated urgent measures to secure environmental stability and prevent socio-ecological decline (Aguiar et al., 2018; He and Silliman, 2019; Barry and Hoyne, 2021; Persson et al., 2022; Hereu-Morales et al., 2023). Specifically, over the past 50 years, there has been considerable political progress towards implementing sustainable development processes (Lenschow and Sprungk, 2010; Burns et al., 2020; Lenschow et al., 2020). Historically, one stimulus for these initiatives was the emphasis on environmental protection and sustainable development in The Stockholm Declaration of 1972 (Domorenok and Graziano, 2023), a sentiment echoed in "Limits to Growth" (Meadows and Club of Rome, 1972; Meadows et al., 2004; Best and Meyer, 2022). More recently, proposals for different policy packages and deals have been introduced, which have been fundamental in efforts to preserve ecology and fight climate change (Mastini et al., 2021; Vela Almeida et al., 2023). The most important of these deals are those formed within the European Union, Great Britain, the United States, and Canada, as well as in China, South Korea, and Latin America (Bloomfield and Steward, 2020; MacArthur et al., 2020; Chen and Li, 2021; Leonard et al., 2021; Yoon, 2021; Caggiano and Landau, 2022; Brown et al., 2023; Vela Almeida et al., 2023). The urgency of change was confirmed in the adoption of the Paris Climate Agreement by a number of countries (Falkner, 2016), which the European Union legislatively transformed into the European Green Deal (Barry and Hoyne, 2021). This is considered to be the first published state-run obligation towards climate neutrality (Vela Almeida et al., 2023).

After the signing of the Paris Agreement in December of 2015 (Nations, 2015), and the drafting of the Sustainable Development Agenda for 2030 in the same year (Osborn et al., 2015), a new growth strategy to transform the EU into a just and prosperous society was initiated. Under the leadership of Ursula Von der Leyen, the newly appointed President of the European Commission, the European Green Deal was introduced to secure climate protection, shift key economic sectors in the EU toward sustainability, and lead the transition to a climate-neutral European Union by 2050 (Knodt and Ringel, 2019; Aszódi et al., 2021; European Commission, 2021; Johnson et al., 2021; Kougias et al., 2021; The European Green Deal -). The European Green Deal prioritizes environmental protection by promoting sustainable practices across industries and agriculture (European Commision, 2021; Keenor et al., 2021; Fayet et al., 2022). With the intention of being an example to global economies, the European Green Deal aims to reduce greenhouse gas emission by 50%, reduce the release of harmful products into the environment, and review whether existing policies are climate-safe or not (Aszodi et al., 2021; Buckley et al., 2021; European Commision, 2021). Together, it is hoped that these goals will enable Europe to reach world-leading levels of environmental protection (Aszodi et al., 2021; European Commision, 2021).

One of the European Green Deal plans is to lead nations in phasing out fossil fuel subsidies, which means that all countries will need to transfer to renewable energy sources (Decision (EU) 2022/591 of the European Parliament and of the Council of 6 April 2022 on a General Union Environment Action Programme to 2030, 2022), which will require fundamental changes in economic, social, and industrial fields. However, this ambition is not without its critics: stakeholders are concerned about whether governance of the clean energy transition will be hard rather than soft (Ringel et al., 2021; Schuelke-Leech, 2021); in addition, although Green Deals worldwide have focused on technologies beneficial to people, some studies argue that there is no concern for the socio-environmental costs of these technologies (Dunlap and Laratte, 2022). Nonetheless, the European Green Deal embodies the commitment of Europe to achieve its climate and environmental objectives through green values (White et al., 2019; Tan et al., 2022), asserting that sustainable economic growth can occur without increasing resource consumption in sectors including industry, agriculture, building renovations, and biodiversity conservation (Bonfante et al., 2020; Robbins, 2020). Energy is one of the most concerning issues as the European Green Deal promotes the transition to clean energy to preserve nature and biodiversity for the future (Krämer, 2020). Specifically, the European Union power scheme is grounded in direct electrification and the development of clean energy using fuels such as hydrogen (Fleming and Mauger, 2021). Although financial security is a crucial variable influencing the success of the scheme (Siddi, 2020), the authors state that the Green Deal program is well supported financially. Indeed, they propose mechanisms that would lead to a significant redistribution of public funds into renewable energy efficiency, including subsidies, grants, and incentives (Siddi, 2020; Fleming and Mauger, 2021; Sikora, 2021).

A long-term perspective is key in mitigating climate change (Sikora, 2021), and the European Green Deal is an promising project in this respect. However, to be successful, it needs to be rooted in the constitutional structure of the European Union legal order, particularly solidarity, sustainable development, and advanced safeguarding of the environment (Sikora, 2021). The European Committee unveiled an integrated industrial policy as part of its objective in 2010, and in March 2020, it introduced an industrial strategy that aims to incentivize environmental goals, revitalize regions, and develop cutting-edge knowledge (European Commision, 2010). By lowering carbon emissions by 55% by 2030 and reaching carbon neutrality by 2050, the European Green Deal aims to accelerate the transformation of the European Union into a climate-neutral economy (Sikora, 2021), and to take the initiative in combating climate change on a worldwide scale (Rodríguez-Espinosa et al., 2021). Some of these goals focus on achieving climate neutrality within industry, fostering a green and digital economy, and decarbonizing and modernizing both food and agricultural industries (Ringel et al., 2021; Fayet et al., 2022). The European Union aims to overcome the high energy consumption and low labor force currently evident in agriculture (Robbins, 2020; Rep, 2021); this will require support for farmers, which may be challenging (Rep, 2021). Another emerging policy is focused on waste management and recycling, where the European Union plans to integrate waste registry systems within its countries (Bobba et al., 2020; Sileryte et al., 2022). In line with this, the European Union plans to discontinue outsourcing unused materials externally, and to re-examine its policies around illegal exports and waste shipping (European Commision, 2020).

As mentioned above, society faces a significant challenge in climate change. In the last 50 years, the global conversation on climate change, global warming, and sustainability has also grown (Lipschultz, 2017;

Sabherwal and Kácha, 2021), which evokes certain emotions, feelings, and reactions in individuals (Hayes et al., 2018; Stanley et al., 2021; Pihkala, 2022; Tran and Matsui, 2023). Likewise, issues related to the Green Deal and whether it will fulfil its aim of sustainable transformation are of concern to all stakeholders affected by the deal (Ossewaarde and Ossewaarde-Lowtoo, 2020; Eckert and Kovalevska, 2021; Fleming and Mauger, 2021; Ringel et al., 2021; Samper et al., 2021; Schuelke-Leech, 2021; Hereu-Morales et al., 2023). Finally, climate change itself raises moral and ethical questions for society (Antadze, 2020; Pihkala, 2022), as well as possible fears and negative emotions (Clayton and Karazsia, 2020; Pihkala, 2020; 2022; Ojala et al., 2021). Therefore, along with political and economic perspectives, societal views on climate change and mitigation strategies are key in evaluating the Green Deal.

1.1 The aim of the research and analytical framework

The aim of this research was to uncover public discourse and concerns worldwide through analysis of communication about the Green Deal on the social network Twitter, currently X (in the following text, only the original name Twitter is used, as the data for analysis was downloaded before the renaming of this network; see part 2, Material and methods). As confirmed by numerous studies, social media is broadly used to understand the degree to which people act as individuals or a group (Song et al., 2017; Adzawla et al., 2019; Etemadi et al., 2022; Prieto Santamaría et al., 2022). Social media gives the ideal space for studying this due to the large amount of data generated by millions of people sharing their opinions every day (Sahayak et al., 2015; Pearce et al., 2019): these data are available not only for industrial, but also academic, purposes (Kvasničková Stanislavská et al., 2023; Rosenberg et al., 2023). Within the past decade, since the establishment of the Twitter social network in 2006, more than 27,000 studies including the word Twitter have been published (Antonakaki et al., 2021). Twitter has become a legitimate research platform providing a large quantity of real-time data. These data provide insight into people's opinions on various issues (Gaytan Camarillo et al., 2021; Hussain et al., 2021; Prieto Santamaría et al., 2022), the possibility to analyze tweet sentiment (Ballestar et al., 2020; Vargas et al., 2021; Hassan et al., 2022; Park et al., 2022), and the ability to identify trends in communication (Tran and Matsui, 2023). According to published statistics, the Twitter social platform had 368 million active users per month worldwide, as of December 2022 (X/Twitter: number of users worldwide 2024, 2024). Particularly, Twitter offers a helpful resource for examining public discourse on climate change and the global environment (Pearce et al., 2014; Fownes et al., 2018; Pilař et al., 2019; Effrosynidis et al., 2022; Yao et al., 2022).

Current literature suggests that analyzing the public perception of climate change policies such as the Green Deal may highlight key concerns of the general public. Public opinion therefore plays an important role in influencing the implementation of measures aimed at mitigating and adapting to the effects of climate change (Taufek et al., 2021; Pueyo-Ros and Garau, 2023). Thus, the goal of this research was to obtain a deeper understanding of the Green Deal discourse on social media and to identify sentiment related to particular themes within this space using Twitter analytic techniques. To achieve this research aim, we addressed the following research questions.

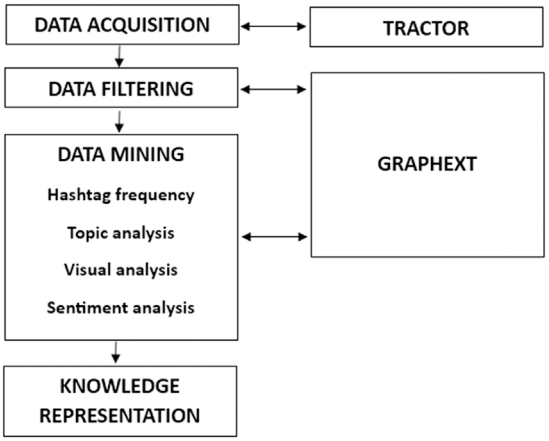

FIGURE 1
The four steps of social media analysis based on the SMAHR framework.

1) What are the most frequently used hashtags in tweets related to the Green Deal?
2) What topics resonate most in discussions (tweets) around the Green Deal?
3) What sentiments are expressed within Green Deal topics discussed on Twitter?

This article offers comprehensive insights into Green Deal communication on Twitter worldwide using social media data analysis techniques. This article contributes to the literature in several ways: it broadens existing knowledge by identifying the leading topics communicated on Twitter; it identifies the type and level of sentiment around the communicated topics; and it identifies the context in which individual topics appear and the sentiment associated with them.

In the following sections, the methodology is described, and the social media context of the Green Deal is discussed, including through content analysis and discourse monitoring.

2 Materials and methods

The data were analyzed based on the SMAHR (Social Media Analysis based on Hashtag Research) framework (Pilař et al., 2021b), which has previously been used to study various topics that resonated on social networks (Pilař et al., 2019; 2021c; 2021a; Šímová et al., 2021; Pilařová et al., 2022; Ježková Petrů et al., 2023; 2023; Kvasničková Stanislavská et al., 2023; Šálková et al., 2023). In the case of this research, the analysis consisted of four steps outlined in Figure 1 and described below.

2.1 Data acquisition

This step aimed to collect data on the Green Deal from the Twitter social network. For this purpose, all messages (tweets) containing the phrase "green deal", the word "greendeal", or the hashtag "#greendeal" were considered relevant. The Twitter API v2

(Twitter, 2015) was used for the extraction of tweets from the Twitter database. TRACTOR software (Graphext, 2023) was set to capture all tweets including ["greendeal" OR "green deal" OR "#greendeal"]. All relevant tweets from 1 January 2019 (the year of the official presentation of the European Green Deal) to 31 March 2023 were retrieved, which comprised 192,567 tweets from 89,328 unique users.

2.2 Data filtering

The data filtration phase aimed to safeguard the dataset's integrity and relevance. This was done by identifying any deceptive content or spam to preserve the dataset's accuracy and dependability. To do this, we thoroughly filtered the dataset, including manual examination, to carefully analyze the dataset. This procedure involved the following steps.

- Filtering messages not containing the keywords "greendeal" OR "green deal" OR "#greendeal", thus verifying that the relevant data had been correctly downloaded.
- Creating a list of Twitter users and the number of tweets created per year, making it possible to detect spam accounts, such as those that promote their products on various platforms. For example, the "Bouncedeals" account posted 1,113 tweets of products it called "green deals."
- Sorting messages alphabetically, making it possible to visually detect whether a certain tweet is being widely distributed among users on Twitter, which could artificially create a separate topic. No such message was found in this case.

Despite the comprehensive nature of our search, we found no misleading messages or spam in the collected tweets. This finding corroborated the high standard of the data and its compatibility for the next stages of the analytical process.

2.3 Data mining

The aim of this step was to extract relevant information from the downloaded dataset. For this purpose, the following analyses were performed.

a. Hashtag frequency. Hashtags have two primary functions on social media: 1) they serve as identifiers of certain topics with which the users associate (mark) their messages (Chang and Iyer, 2012; Pilař et al., 2017); and 2) they are used to emphasize values, experiences, attitudes, and opinions in tweets (Pilař et al., 2017; Childers et al., 2019; Zhang K. et al., 2020). Hashtags were extracted from the dataset (all tweets) by Hashtag extractor software (Pilař et al., 2021a). The calculation of the frequency of individual hashtags was performed by importing the data into Gephi 0.9.2 software (Bastian et al., 2009).

b. Topic analysis. Topic analysis is used to identify the main topics or themes being communicated within a large dataset, such as social media posts. In complex networks, such as social media networks, some nodes (i.e., hashtags or words) are more interconnected with each other than with the rest of the network. This makes it possible to identify topics based on clusters of individual hashtags and words. This part of the analysis aimed to identify the topic structure of discussions related to the Green Deal on Twitter. In comparison to frequency analysis, topic analysis was created based on whole tweets (not only on hashtags). This tool allows better understanding of the dynamics of communication by identifying links between individual hashtags. For topic analysis, Graphext software was used (Graphext, 2020). To analyze the network's community structure, Graphext utilized a modified version of the Louvain algorithm (Blondel et al., 2008). The network was created based on the interconnectedness of individual words in a tweet. The Louvain algorithm employs an iterative process of allocating nodes to clusters with the aim of optimizing a performance metric known as modularity. This metric gauges the relative density of edges within clusters compared with those between clusters. The number of distinct communities in the dataset was calculated as follows:

$$\Delta Q = \left[\frac{\sum_{in} + 2k_{i,in}}{2m} - \left(\frac{\sum_{tot} + k_i}{2m}\right)^2\right] - \left[\frac{\sum_{in}}{2m} - \left(\frac{\sum_{tot}}{2m}\right)^2\right]$$

where $\sum_{in}$ is the sum of weighted links inside the community, $\sum_{tot}$ is the total number of weighted connections inside the community, k_i is the total number of weighted links related to community hashtags, $k_{i,in}$ is the total weighted linkages from an individual to community hashtags, and m is the normalization factor, calculated as the total weighted links over the entire graph (Blondel et al., 2008).

c. Visual analysis. Network visualization techniques such as force-directed layouts can be used to highlight different aspects of a network, such as the density of connections or polarization of topics. The aim of this part of the analysis was to identify the polarity of identified topics. Visual analysis was created using Graphext software (Graphext, 2020). Based on the ForceAtlas layout technique, a two-dimensional graph was generated; specifically, an improved version of the ForceAtlas algorithm, called ForceAtlas2, which focuses on massive networks, was used. This approach uses visual representations of smaller samples to identify network communities' intercommunity connections (Jacomy et al., 2014).

d. Sentiment analysis. Sentiment analysis is used to identify the emotions expressed in tweets about a particular topic (Shamoi et al., 2022). It allows a text to be categorized into positive, negative, or neutral sentiments based on the context and tone of the language used. Sentiment analysis was used to better understand the social atmosphere related to the Green Deal. This method analyzes people's emotions, attitudes, evaluations, and opinions communicated through unfiltered social network posts (Elbagir and Yang, 2019; Eom et al., 2022). For sentiment analysis, we used VADER (Valence Aware Dictionary and Sentiment Reasoner), a Lexicon and Rule-Based Sentiment Analysis Tool (Hutto and Gilbert, 2014; Hota et al., 2021). This part of the analysis aimed to

TABLE 1 The 40 most frequently used hashtags related to the Green Deal on Twitter sorted by frequency.

No.	Hashtag	Frequency	No.	Hashtag	Frequency
1	#greendeal	52,740	21	#energytransition	778
2	#EU	5,865	22	#klimaschutz	778
3	#eugreendeal	3,450	23	#hydrogen	762
4	#climatechange	2,978	24	#co2	756
5	#covid19	1,970	25	#climateemergency	743
6	#sustainability	1,955	26	#innovation	723
7	#europe	1,753	27	#europeanunion	705
8	#climate	1,676	28	#farmtofork	635
9	#energy	1,567	29	#sustainable	623
10	#climatestrike	1,479	30	#renewables	620
11	#green	1,396	31	#energiewende	609
12	#climateaction	1,317	32	#gas	605
13	#circulareconomy	1,207	33	#renewableenergy	599
14	#greennewdeal	1,153	34	#coronavirus	595
15	#europa	976	35	#solar	587
16	#ue	966	36	#h2020	569
17	#fitfor55	950	37	#fossilfuels	535
18	#climatecrisis	905	38	#climat	529
19	#greenrecovery	877	39	#cop26	528
20	#environment	801	40	#timmermans	525

identify sentiments expressed in identified topics related to the Green Deal on Twitter.

2.4 Knowledge representation

Knowledge representation is a critical step in the data analysis process that allows the transformation of raw data and outcomes from previous analyses into intelligible and interpretable forms. This process involves the use of visualization tools and methods that facilitate the communication of complex information and findings to a broader audience. The aim is to provide a clear and concise picture of the insights gained to enable efficient dissemination of all findings and allow important findings to be highlighted (Pilař et al., 2021b).

Within our methodology for knowledge representation, we employed a combination of sentiment analysis, hashtag frequency analysis, and visual analysis of identified themes to provide a comprehensive overview of the dynamics and emotional tone of the discussion on the Green Deal on Twitter. Sentiment analysis enables identification and categorization of the emotions expressed in tweets, thus offering a deeper insight into public sentiment, whether positive, negative, or neutral, and uncovers areas of broad support or controversy. Hashtag frequency analysis reveals which key terms, hashtags, or themes dominate the conversation, aiding in the identification of the most heated topics of discussion. Visual analysis focuses on the polarity of individual themes, utilizing advanced visualization techniques for interpreting and displaying this polarity through intuitively understandable maps. This approach offers unique insight into the complex structure of conversations about the Green Deal and reveals how themes are interconnected.

3 Results and discussion

3.1 Hashtag analysis

There were 192,567 tweets from 89,328 unique users with Green Deal content as explained in the Methods section above. Table 1 shows the top 40 most frequently used hashtags associated with Green Deal Twitter conversation. The hashtag with the highest frequency was "#greendeal," one of the search conditions in the Python script used when downloading the data. The high frequency of this hashtag (52,740) confirms its utility as a marker of messages on the Green Deal.

The second most frequently used hashtag 2) was "#EU," by which many users underline that their tweets are related to the European Green Deal. This emphasis was also evident in the third-most frequent hashtag, "#eugreendeal" 3) and the synonymous "#europeanunion" (27) and "#UE" (16), which continued to appear in the analyzed tweets, including in those with language

mutations. Language mutations appeared mainly in French, Italian, or Spanish, e.g., "#europe" 7) and "#europa" (15). The worldwide debate on the Green Deal often combines all proposals under a single Green New Deal, especially in G20 countries (Lee et al., 2021; Mogos et al., 2023). Therefore, in debate specifically concerning the European policy framework, academics, professionals, and the public use "European Green Deal" (Mastini et al., 2021; Rosamond and Dupont, 2021; Vela Almeida et al., 2023).

Another group of associated hashtags were those connected with climate change because users often point to the importance of the Green Deal in solving this issue. Examples of these hashtags include "#climatechange" 4), "#climate" 8), "#climatestrike" (10), "#climateaction" (12), "#climatecrisis" (18), "#klimaschutz" (22; climate protection in German), "#climateemergency" (25), and "#climat" (38). That "#climatechange" was in fourth place suggests that climate change is strongly associated with the Green Deal and its aim to mitigate the consequences of climate change (Melidis and Russel, 2020; Barry and Hoyne, 2021; Sikora, 2021; Carter and Pearson, 2022; Cifuentes-Faura, 2022). This association is particularly pertinent given the current consequences of climate change in Europe (Clayton et al., 2015; Hrabok et al., 2020; Pihkala, 2020).

The popularity of the hashtags "#covid19" 5) and "#coronavirus" (34) suggest that the COVID-19 pandemic raised discussion about to what extent the pandemic might impact the European Green Deal or Green New Deals and their implementation (Dupont et al., 2020; Gosens and Jotzo, 2020; Crnčec, 2021; Cassetti et al., 2023). In fact, studies confirm that the reaction of the European Union to COVID-19 strengthened the need to implement the European Green Deal (Sovacool et al., 2020; Crnčec, 2021; Smol, 2022). Indeed, previous research shows that areas with higher levels of air pollution suffered the hardest after-effects of COVID-19 (Bashir et al., 2020); therefore, implementation of green environmental policies may reduce the spread of infectious diseases and their impact in the future (Bashir et al., 2020; Becchetti et al., 2021).

The hashtags "#sustainability" 6), "#green" (11), "#circulareconomy" (13), "#environment" (20), "#sustainable" (30), and "#renewables" (21) were included within discourse on sustainability. Discussion about sustainability in the environmental and social sciences does not often correlate with, and in fact often contradicts, politically motivated discourse, which widens the debate over the European Union's sustainability ambitions (Eckert and Kovalevska, 2021). Although there are industries where practitioners are reluctant to adopt circular economy practices (Bonoli et al., 2021), use of the "#circulareconomy" hashtag suggests discourse is rising around the need to transition from a linear economy, with stakeholder support increasing through sharing changes in their own social and personal behavior (Van Buren et al., 2016).

One aspect of sustainability is sustainable energy sources, which are enforced by the Green Deal. Discussion around this topic included the hashtags "#energy" 9), "#energytransition" (21), "#hydrogen" (23), "#energiewende" (31; energy transition in German), "#renewableenergy" (33), and "#solar" (35). However, some tweets also addressed the other side of this issue, including carbon dioxide production ("#co2", 24), and the burning of fossil fuels ("#gas", 32 and "#fossilfuels", 37). The majority of the debate corresponded to the energy transition, with renewable energy predicted to make up the majority of the world's energy profile by 2050 (Jianhua, 2022); however, the perception of renewable energy development differs from acceptance to refusal, depending on the country (Pellizzone et al., 2017; Oluoch et al., 2022; Spampatti et al., 2022; Tidwell and Tidwell, 2022; Panarello and Gatto, 2023).

A separate group of tweets included those that mark other policies (or political events) with which the Green Deal is related, such as "#fitfor55" (17), "#farmtofork" (28), "#H2020" (36), and "#COP26" (39). The European Union's Fit for 55 package is an unparalleled set of policies and tools that by 2030 aim to reduce greenhouse gas emissions by 55% compared with 1990, and by 2050 aim to achieve net zero emissions (European Commision, 2021; Ovaere and Proost, 2022). The farm to fork strategy is a fundamental part of the European Green Deal. It focuses on a sustainable transition in agriculture, sustainable food value chains, food security, and sustainable nutrient management (European Commission, 2021). However, stakeholders have polarized attitudes towards the farm to fork strategy, as reported in previous studies (Zhang A. et al., 2020; Alsetoohy et al., 2021; Georgescu et al., 2022; Adina et al., 2023; Aerni, 2023). The hashtag "#H2020" represents Horizon 2020, the European Union's €80 billion research and innovation funding program contained within the Innovation Union strategy, which ended in 2020 (European Commission, 2020); Horizon 2020 succeeded the European Commission for Research's previous framework (Veugelers et al., 2015). The last hashtag from this group, "#COP26," refers to the 26th climate change conference, the so-called Conference of Parties (COP) 26, which led to commitments ensuring sustainable economic progress towards the goals outlined in the Paris Agreement, as well as agreement on pledges to curtail climate change (Bai et al., 2023).

Finally, from the list of the most used hashtags, three remain that were not directly classifiable into any previously mentioned group. The hashtag "#greennewdeal" (14) refers to the topic of the Green New Deal, which is the United States equivalent of the European Green Deal (Boyle et al., 2021); the hashtag "#innovation" (26), which is related to the search for green innovations required to meet the commitments of the Green Deal, and to the Horizon 2020 funding program (Veugelers et al., 2015; Aydin et al., 2023; Otto et al., 2023); and the hashtag "#timmermans" (40), which refers to the former vice-president of the European Commission, Frans Timmermans, who was responsible for the realization of the Green Deal in the European Union.

3.2 Topic analysis with visual and sentiment analysis

Topic analysis allows a better understanding of the dynamics of Twitter communication by identifying links between individual components of tweets (hashtags, words, and phrases). The results of the topic analysis are shown in Table 2. This table includes 16 topics that contained 1,000 or more tweets. The topics are sorted according to the absolute and relative (%) frequency of tweets that fall within the given topic; together, these topics cover 89.39% (172,135) of the downloaded tweets. Further visual analysis in Figure 2 aimed to identify the interconnectedness and/or

TABLE 2 Identified topics related to "#greendeal" on Twitter.

No.	Topic	Frequency of the topic		Key terms
		%	No.	
1	European Green Deal	38.66	74,448	EU, Europe, European Green Deal, European Commission, von der Leyen, policy, climate, climate change, plan, energy, sustainability, transition, innovation, 2030, 2050
2	Green New Deal–Political perspective	18.95	36,483	New Green Deal, America, people, want, need, vote, government, democrats, socialist, Alexandria Ocasio-Cortez (AOC), Trump, money, work, job, tax, oil, bill
3	Green New Deal–Environmental perspective	8.33	16,042	New Green Deal, climate change, renewable, crisis, environment, planet, world, global, time, need, want, carbon, CO2, emission, energy, power, electric, fossil, gas, fuel, coal, wind, solar
4	War in Ukraine	4.00	7,704	EU, Ukraine, Russia, Putin, war, energy, fossil-fuel, gas, oil, coal, industry, ECT (Energy Charter Treaty), nuclear treaty, noECT, block bold climate action, dangerous treaty, stop climate-killer treaty, neutrality if the energy
5	Farm to fork	2.88	5,554	EU, European Green Deal, farm to fork, food, agriculture, strategy, policy, CAP (Common Agricultural Policy), sustainable, commission, production, biodiversity, pesticide
6	European Commission representatives	2.68	5,155	Frans Timmermans, EU, Ursula von der Leyen, cartoon
7	Transport	2.02	3,895	EU, European Green Deal, sustainable mobility, travel, electric, clean, reduce, emission, CO2, 2050, 2035, target, achieve, goal, rail, aviation, car, air, maritime
8	Alexandria Ocasio-Cortez (AOC)	1.58	3,045	New Green Deal, AOC, Cortez Alexandria-Ocasio, Kamala Harris, Tammy Bruce, Nancy Pelosi, dems promoting, socialist, work quilt, new green hoax, promoting a fraud, moronic new green deal, quilt promising a cure
9	Joe Biden	1.56	2,999	New Green Deal, American, Joe Biden, Biden's Green Deal, Trump, Harris, Bernie Sanders, want, support, people, vote, gas, oil, taxis, prices, high, job, destroy, lie, China
10	Industrial plan	1.54	2,971	Industrial plan, Green Deal Industrial plan, 2050, Europe, neutral continent, European Commission
11	Italian perspective	1.33	2,556	Italy (Italia); deal for Italy (deal per l'italia), green deal europeo (European Green Deal), continente neutro (neutral continent), project (progetto), challenge (sfida), marathon (maratona), environment (ambiente), transition (transizione), opportunity (opportunità), sustainability (sostenibilità), renewable (rinnovabile), development (sviluppo), economy (economia), business (impresa), agriculture (agricoltura), emerge from the pandemic (pandemic uscire dalla pandemia), pandemic (pandemia)
12	Dutch perspective	1.28	2,461	Green Deal, concern (zorg), sustainability (duurzaamhei), farm to fork, agriculture (landbouw), farmer (boer), education (onderwijs), nature-inclusive agriculture (natuurinclusieve landbouw)
13	COVID-19	1.13	2,170	Coronavirus, covid-19, pandemic, resilient recover, after covid-19, deal must be central, recovery after covid-19, covid-19 climate home, WeMove.eu
14	Hydrogen	0.96	1,843	Greendeal, Europe, hydrogen, energy, battery, fuelcell, green hydrogen, zero-emission, fuel, renewable energy, electrification, clean energy, lithium, storage, industry, production, company, hydrogen economy
15	Circular economy	0.94	1,818	European Green Deal, circular economy, recycling, circular economy erected, chemicals strategy, reuse, sustainability, action plan, number one priority, adopt, waste, plastic, packaging, material, raw materials, toxic
16	Renewable energy	0.82	1,576	Renewable energy, electricity, power, solar, solar panels, solar for business, wind, free solar, fee exemption, energy efficiency, energy savings, delays but keeps the climate, keeps climate target plan

polarization of individual topics. The results of the sentiment analysis are shown in Figure 3. This analysis sorts the opinions and attitudes expressed by users in tweets into three categories: positive, neutral, or negative sentiments.

GND, Green New Deal; Polit. persp., political perspective; Envi. persp., environmental perspective; EC, European Commission; AOC, Alexandria Ocasio-Cortez. The largest (first-placed) topic (38.66% of tweets) was the "European Green Deal," a set of

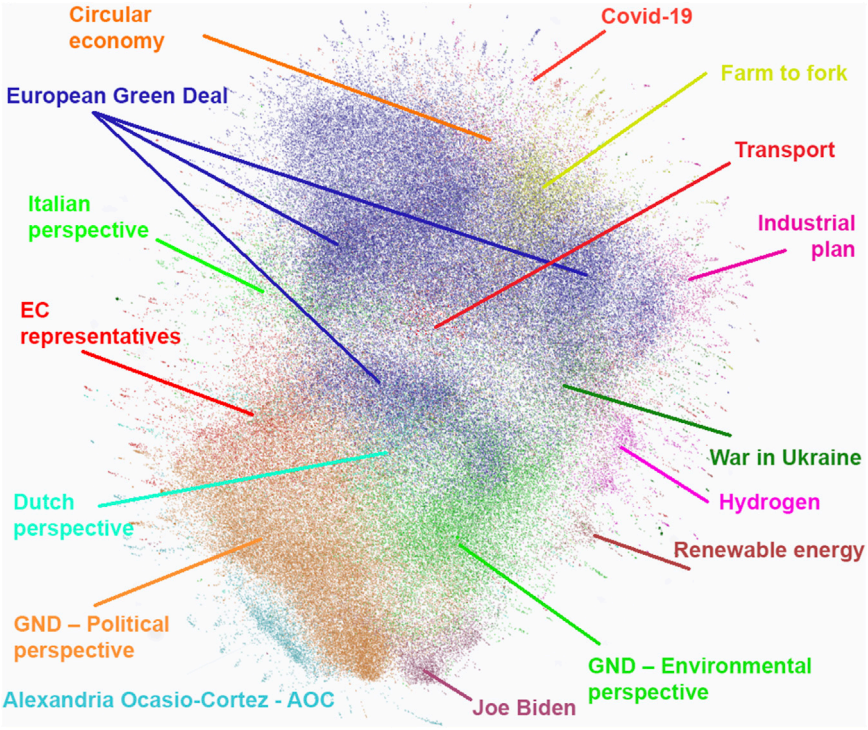

FIGURE 2
Visual analysis of the interconnectedness and polarization of discussion related to the Green Deal on Twitter.

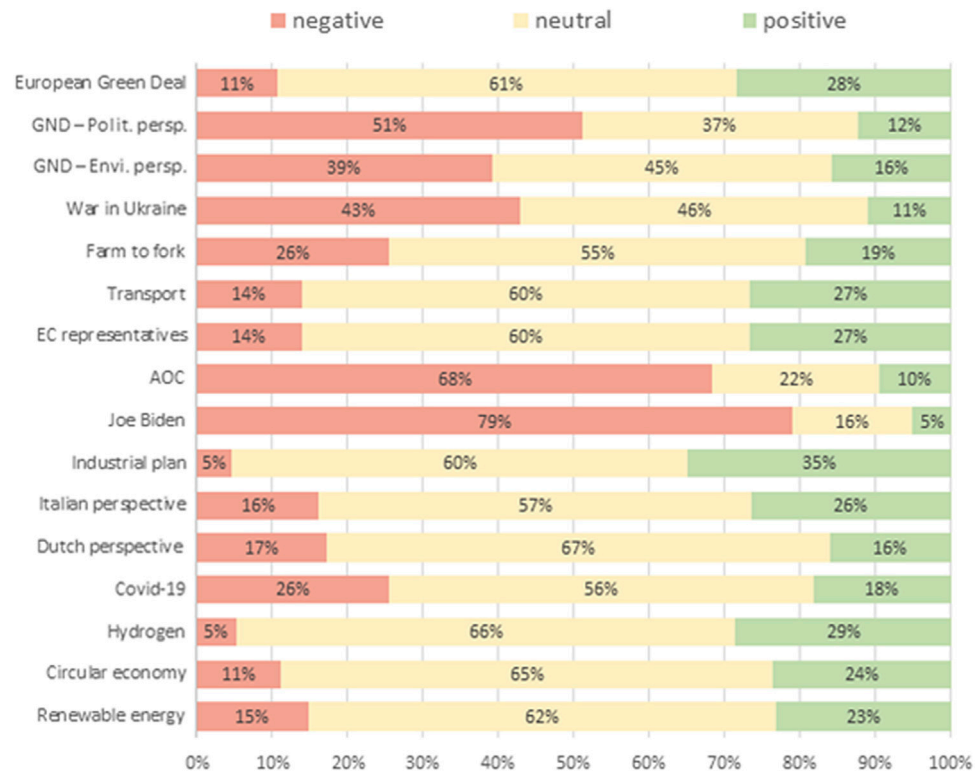

FIGURE 3
The proportion of negative, neutral, or positive sentiments associated with the identified topics.

proposals that put the European Union on track to achieve its 2030 climate goals in a fair, cost-effective, and competitive way (European Commision, 2019). The discussion was usually around climate change, sustainability issues, the necessity of an energy transition, innovations, and plans and policies. Although public perceptions of climate change are frequently incomplete, incorrect, and heavily affected by the media, it is crucial to engage the public in addressing this issue, as their behavior plays a crucial role in both creating and reacting to global climate change (Clayton et al., 2015; Rousell and Cutter-Mackenzie-Knowles, 2020). The name of the main bearer of the European Green Deal proposal was also often mentioned in the topic, for example, the "European Commission," as well as its chairwoman and proponent (Ursula) "von der Leyen" (Domorenok and Graziano, 2023; Vela Almeida et al., 2023). Figure 2 shows polarization between the "European Green Deal" topic (dark blue in Figure 2) and the four topics related to the United States Green New Deal ("GND–Political perspective," "GND–Environmental perspective," "AOC," and "Joe Biden"). By contrast, the "European Green Deal" was closely connected with discussion of other green topics within the European Union. The "European Green Deal" was the third-highest topic where positive sentiment prevailed over negative (28% positive, 61% neutral, and 11% negative). High levels of neutral and positive emotions were linked to keywords relating to the European Commission, its policies, and the content of individual European Green Trade documents (Ringel et al., 2021; Borghesi et al., 2022; Garito et al., 2023). In general, moods associated with European topics were moderate (neutral), and in some case, positive reactions even prevailed over negative ones.

A large part of the discussion was devoted to the Green New Deal (GND), particularly the Green New Deal of the United States. However, it was divided between several separate topics, which included political arguments (no. 2, "GND–Political perspective") and conversations surrounding its most significant protagonists (no. 8, "Alexandria Ocasio-Cortez" and no. 9, "Joe Biden"). In all the topics mentioned, negative sentiment significantly prevailed, mainly in the politically oriented discussions. Fifty-one percent of tweets had a negative sentiment, 37% were neutral, and 12% were positive. Expressions such as "democrats" and "socialist" appeared regarding this topic, whose differing views on the Green New Deal are discussed in other studies (Galvin and Healy, 2020; Ajl, 2021; Boyte and Throntveit, 2022). As the content of the Green New Deal is focused on changing to a sustainable economy, related discussions regarding elections, government, and taxation (Dogan et al., 2023), as well as the American society, jobs, and the workforce, were also present (Lachmann, 2022).

The environmental side of the Green New Deal (no. 3, "GND–Environmental perspective") seemed to be in the background of these topics. The environmental perspective of the Green New Deal partially overlapped with the "European Green Deal" topic, suggesting that the discussion at the core of these environmental agreements are similar. These include debates over the deployment of state power to gradually decarbonize economies, revitalize communities, and limit emissions (Green, 2022; Driesen and Mehling, 2023). Other key terms used within this topic were words like "climate change," "planet," "world," "global," and "environment," as well as terms related to energy resources like "renewable," "fossil," "energy," "power," "electric," "gas," "coal," "wind," and "solar" (Bagus and Peña-Ramos, 2023; Belaïd et al., 2023; Donaghy et al., 2023). Previous studies suggest that the transition of economies towards sustainability provokes discussion from those who see the changes on which the Green New Deal is based as necessary. The methods of change, especially renewable resources and energy acquisition, are also at the center of debates, not only among the public, but also political critics (Bloomfield and Steward, 2020; Allam et al., 2022; Lachmann, 2022) and academics (Pilař et al., 2019; Green, 2022; Chaudhuri and Huaccha, 2023; Morgan et al., 2023; Presberger and Bernauer, 2023). Although the debates were associated with criticism, there was not such a negative sentiment compared with the political perspective of the Green New Deal: the rate of negative posts was 39%, with neutral and positive posts accounting for 45% and 16%, respectively.

The fourth-most discussed topic was "War in Ukraine" and discussion of the possible consequences of this geopolitical conflict (Sandri et al., 2023; Siddi, 2023), especially in connection with the "European Green Deal," "Transport," and "Hydrogen," which is evident in the visual analysis in Figure 2. The mood of tweets was largely negative (43%) or neutral (46%), with a positive sentiment of only 11%. Previous research supports these findings and the discourse around individual topics related to the war in Ukraine, as the potential consequences on energy supplies, fossil fuels, and industry, are discussed (Farrell and Newman, 2019; Goldthau and Sitter, 2022; Ciot, 2023; Rečka et al., 2023; Romanova, 2023; Sheth and Uslay, 2023). In response to the war in Ukraine, the European Union reformulated policies to enforce interdependence on gas suppliers through diversification of fuels and clean energy, including renewable resources such as hydrogen, wind, and solar (Kalantzakos et al., 2023; Kaldor, 2023; Proedrou, 2023).

The discussion topic "Farm to Fork" was the fifth-largest topic; sentiment was neutral (55%) to negative (26%), with 19% positive tweets. This topic was polarized from other sub-policies, such as "Hydrogen" and "Renewable energy," and had the highest proportion of negative emotions out of the topics related to European Commission policies. As confirmed by previous studies, negative or questioning perceptions exist among farmers, especially regarding the increasing costs, decreasing income, and reduced profitability associated with farm-to-fork initiatives (Riccaboni et al., 2021; Cortignani et al., 2022; Adina et al., 2023). This topic was associated with the terms "EU," "European Green Deal," "food," "agriculture," "strategy," "policy," "Common Agricultural Policy," "biodiversity," and "pesticide" (Borrelli et al., 2023; Lecina-Diaz et al., 2023; Rudnicki et al., 2023). From the results, it was evident that the "Farm to Fork" topic was also discussed at the regional level, as shown by its inclusion as a key term within the 12th topic, the Dutch perspective.

Topic number six, "European Commission representatives," dealt with content in which representatives were the target of cartoon caricatures. These were aimed at both main representatives of the European Green Deal, Ursula von der Leyen and Frans Timmermans, and were also associated with the words "EU" and "cartoon." This topic was polarized from topics about Alexandria Ocasio-Cortez and United States President Joe Biden. The results show that this topic was perceived more positively (27%) or neutrally (60%) due to the humorous content included in these tweets. Caricatures are usually hand-drawn pictures or

cartoons that express ideas, themes, and situations that would be complicated to describe through text, and political cartoons and caricatures are increasingly framing europolitical topics in media (Van Hecke, 2017). These images contain overstatements and sarcasm aimed to inform and amuse, as well as to publicize information in a funny way (Marín-Arrese, 2008; Swain, 2012; Jaashan, 2019) and represent a powerful tool in communication, with research suggesting that the public more easily accepts messages from caricatures than text (Chalániová, 2011).

The subject of the seventh-most high-ranking topic was "Transport" on the old continent, the shape of which will be significantly changed by the European Green Deal (McNamara, 2023; Oberthür and von Homeyer, 2023). The key terms in this topic were "European Green Deal," "sustainable mobility," especially in terms of urban mobility (Tsavachidis and Petit, 2022), "electric," "emissions," "CO_2," "rail," "aviation," "car," "air," and "maritime" (Benga et al., 2023; Modarress Fathi et al., 2023), as well as the years significant to the policy, "2035" and "2050" (Fleming and Mauger, 2021). Transport was discussed with a largely neutral (60%) or positive mood (27%), rather than a negative mood (14%). The position was closely related to the "European Green Deal" topic and overlapped with the "War in Ukraine" and "Industrial plan" topics. The discussion surrounding transportation issues during the war, including disruptions to rail and road networks, underscores the importance of achieving resource independence from external providers (Kalantzakos et al., 2023; Sheth and Uslay, 2023).

The leading negative tweets were related to the names of United States political representatives (no. 8, "Alexandria Ocasio-Cortez" and no. 9, "Joe Biden"). Both were discussed with high degrees of negativity (68% and 79%, respectively) with visible polarization from most topics, but high interconnectivity with "GND–Political perspective" (topic no. 2). Since 2019, Ocasio-Cortez has been a member of the United States House of Representatives. She is the youngest woman ever to serve in the United States Congress (Andersson et al., 2019) and became known mainly for her pre-election speech, her activist involvement in 2016, and her significant activity on social networks. The last point has previously been discussed in studies focusing on political fandom: Ocasio-Cortez shows the ability to successfully leverage social networks, especially Twitter, to create a fan base (Rasulo, 2020; Santamaria, 2021; Rubio and Conesa, 2022). However, her high levels of activity draw both supportive and negative comments, the latter including satire, ridicule, and sexism and racism (Rodriguez and Goretti, 2022), as well as those from political and publicist opponents including Nancy Pelosi and Tammy Bruce. Discussion of climate change brings criticism from activists promoting fraud and green hoaxes (Strong, 2022); for example, after Joe Biden's administration introduced the Green New Deal, the volume of discussions and criticism rose sharply (Rowe, 2020; Cha et al., 2022), with former president Donald Trump's defenders leading this rhetoric (Kou, 2023). However, this criticism is not necessarily a negative: the Green New Deal aims to tackle fundamental and currently unsolvable environmental problems, and it would be remiss not to consider the issues and the trade-offs that will be required (Olsson and Janssens, 2021; Butterfield and Bullen, 2022).

The greatest degree of positive sentiment was associated with the 10th topic, the "Industrial plan" (35% positive, 60% neutral, and 5% negative). According to research, before the launch of the European Green Deal Industrial Plan (European Commission, 2023), shortcomings were identified in the political package addressing climate change (Pianta and Lucchese, 2020). In relation to this topic, comments appeared clarifying this as part of European Green Deal policy. The visual analysis shows the polarization of this topic from most other topics; however, discussions were interconnected with the "European Green Deal" topic with common terms including "Europe," "European Commission," "neutral continent," and "2050" (Holz et al., 2021; Huo et al., 2023).

According to the titles of topics no. 11 ("Italian Perspective") and no. 12 ("Dutch Perspective"), it is evident that the Green Deal is discussed in the local language in some countries. However, the discussion in Italy was rather varied, and the topic included terms such as "neutral continent," "transition," "sustainability," and "renewable" (Marelli, 2021; Prontera, 2021; Di Pirro et al., 2022). The Green Deal offers targeted incentives for integrated, community-related projects in rural areas (Rangone and Ali, 2021). The sentiment being more neutral (57%) or positive (26%) suggests that Italians see the positive opportunities in the European Green Deal. In the Netherlands, the main subject of the discussion was "agriculture," "Farm to Fork," "farmers," and "nature-inclusive agriculture" (Anderson et al., 2021; Friedmann, 2021; Wesseler, 2022; Wilts Jansen, 2023), with the mood more neutral (67%) and negative (17%). Based on the visual analysis of topics (Figure 2), the "Dutch perspective" appears to draw a border between the discussions in Europe and the United States; indeed, the Dutch sustainable approach has been presented as a global example (Friedmann, 2021).

The smallest topics at the end of Table 2 deal with the topics "COVID-19" (no. 13); energy sources, which are divided between "Hydrogen" (no. 14) and "Renewable energy" (no. 16); and the "Circular economy" (no. 15). The positions of these topics in the visual analysis in Figure 2 suggest that "COVID-19" and "Circular economy" are almost exclusively communicated within European discussions, while "Hydrogen" and "Renewable energy" seem to be related to a similar extent to the "GND–Environmental perspective" topic. The "COVID-19" topic is mostly related to discussion of economic and social recovery after covid and building resilience for the future (Smol, 2022; Cassetti et al., 2023; Ryner, 2023); perceptions around this topic were neutral (56%) and negative (26%). Topic 14, "Hydrogen," had the second-most positive sentiment (29%), although the majority of tweets were neutral (66%). Terms associated with this topic were "fuel," "electrification," "batteries," "energy," "clean energy," "industry," "production," and "hydrogen economy" (Fleming and Mauger, 2021; Kakoulaki et al., 2021; Igliński et al., 2022; Włodarczyk and Kaleja, 2023). "Circular economy" (no. 15) was mostly discussed in neutral (65%) or positive (24%) tones with 11% of tweets having negative sentiments. Connected with this topic were terms such as "circular economy," "recycling," "reuse," "packaging," "waste," "raw materials," "plastic" and "toxic" (Bonoli et al., 2021; Krajnc et al., 2022; Mihai and Ulman, 2023). The smallest topic, "Renewable energy" (no. 16), discussed "renewables," "energy resources," "savings," "efficiency," "solar," and "wind" (Hainsch et al., 2022; Panarello and Gatto, 2023). In this topic, there was a mostly neutral tone (62%), followed by positive (23%) and negative (15%) tones.

Previous studies show that discussion on the topic of climate change is mainly accompanied by negative sentiment and steps

leading to its elimination are generally perceived positively (Cody et al., 2015; Dahal et al., 2019; Taufek et al., 2021), especially when it comes to the necessity of carbon neutrality (Xiang et al., 2021), the transition to renewable energy sources (Loureiro and Alló, 2020), and the idea of a circular economy (Maulida, 2023). Analysis of public opinion is key to understand how people take measures to mitigate the effects of climate change (Taufek et al., 2021; Pueyo-Ros and Garau, 2023). Our results show that positive sentiment slightly prevailed around the "Industrial Plan" (35%), "Hydrogen" (29%), the "European Green Deal" itself (28%), "Transport" (27%), and the "Circular Economy" (24%). This suggests that public acceptance of these policies (or changes in these areas) can be considered somewhat more successful than, for example, "Farm to Fork", where a negative sentiment prevailed (26%).

None of the above topics, however, had such a clear preponderance of negative sentiment as American topics. Above all, negative sentiments were obvious in politically oriented topics: "GND–Political perspective" (51%), "AOC" (58%), and "Joe Biden" (79%). This only confirms previous findings that in the United States, the discussion surrounding solutions to climate change are heavily politicized and much more aggressive (Cody et al., 2015; Dahal et al., 2019). Within European topics, the discussion was much more moderate, as evidenced by the discussions at the local level, particularly the "Italian perspective" and the "Dutch perspective" (positive 26% and 16%, respectively; negative 16% and 17%, respectively). Although more moderate than sentiment in the United States, the differences between these countries indicate that sentiments surrounding climate change and the ways to tackle it may differ between individual European states, findings similar to previous studies (Loureiro and Alló, 2020).

4 Conclusion

In general, the perception of climate change is a controversial topic that has been heavily influenced by media coverage for over 30 years (Clayton et al., 2015; Rousell and Cutter-Mackenzie-Knowles, 2020; 2020; Saari et al., 2021; Hereu-Morales et al., 2023). The topic is often discussed on social media, which nowadays plays a significant role in disseminating information. As there are no borders on social media, it is possible to follow the views of discussants globally. In addition, discussions on social networks provide a certain anonymity, so it can be assumed that participants are expressing genuine opinions in real time. Public discourse on climate change has risen in response to a number of political deals and agreements, such as the Green Deal. Based on our results, we answered predetermined research questions and filled the knowledge gap regarding the public perception of the Green Deal and concerns associated with this policy.

Hashtag analysis results answered the first research question, by revealing the most frequently used hashtags and their level of frequency 1). Analysis of hashtags on Twitter found that "#greendeal" (52,740) was the most frequently used hashtag in the analyzed discussions, followed by "#EU" (3,450) and "#eugreendeal" (3,450). We also found that almost two-fifths of tweets discussed the European Green Deal as a set of proposals to steer the EU towards its 2030 climate goals. Further results answered the two following research questions through identification of the most discussed topics 2) and the sentiment expressed within these topics 3) within Green Deal discussions on Twitter. In total, 16 related topics were identified, each of which contained at least 1,000 tweets; the presence of positive, neutral, or negative sentiments within these tweets varied by topic and location. Negative sentiment prevailed in US-related topics, especially the politically oriented ones, for example, "GND–Political perspective," "AOC," and "Joe Biden." The most significant optimism (positive sentiment) prevailed around the "Industrial Plan," "Hydrogen," the "European Green Deal" itself, "Transport," and "EC representatives." However, in the case of the latter topic, positive sentiment can likely be attributed to the satirical nature of the content. By contrast, a greater negative sentiment was found in two topics, "War in Ukraine" and "COVID-19." Among other European-focused topics, more negative tweets were related to "Farm to Fork". Within the EU, it became apparent that countries had a different opinion of the Green Deal, as demonstrated by the "Italian perspective" and "Dutch perspective": analysis within these topics suggested that Italians perceived Green Deal issues more positively than the Dutch. Our research shows that discussion of the Green Deal elicits both positive and negative public reactions; this suggests careful analysis and understanding of the public's voice is required as society engages with and shapes global environmental efforts.

Given the seriousness of this global challenge, approaches to tackle climate change must be comprehensive, long-term, and global. The thorough analysis of Twitter data related to Green Deal conversations highlights public perceptions and the interconnectedness of different aspects of the Green Deal. We observed a diverse debate marked by different attitudes to different topics and intersectionality revolving around the European Green Deal and its resonance on both a regional and global scale. Policymakers, decision-makers and stakeholders may utilize these insights to interact more effectively with the public on social media platforms and enhance communication strategies. Governments and decision-makers can utilize the findings of this research to assess public support for different policies in theory and action. Identifying emotional responses and opinions influenced by disinformation across social networks could help design tailored interventions to counteract false narratives while promoting public confidence through awareness campaigns.

However, it is critical to recognize certain inherent limitations in our research that should be accounted for in future research. Despite the large amount of data reviewed, we still may not have captured the entire spectrum of opinions and sentiments related to the Green Deal on Twitter. The views of those discussing the issue are diverse and may be influenced by many factors such as geographical location, government policies and actions, the quality and objectivity of the media, generational differences and personal experiences, and knowledge and scientific awareness of the issue. One of the main limitations of our research is that it only analyzed posts on Twitter, which is a specific social network, and users' opinions on other social networks or forums might differ. Another limitation is the use of machine text processing, which, despite high technological sophistication, may not always understand the nuances in tweet sentiment (for example, irony may be misunderstood in sentiment analysis).

Regardless of these limitations, our research offers several future research directions. Conducting comparative analysis across different areas and countries may provide insight into disparities in perspectives and sentiments regarding the Green Deal, providing insights into how global opinions toward environmental policies differ. Longitudinal studies may reveal shifting public sentiment and concerns as the Green Deal conversation evolves in response to policy changes and major events. Future research should delve deeper into the sentiments expressed within the Green Deal discourse, which would entail going beyond automated sentiment analysis and using qualitative research methods to gain a better understanding of the motivations and justifications for positive and negative opinions. Furthermore, user profiling may assist in identifying key stakeholders and influential voices within the conversation, allowing for a more granular understanding of the dynamics at work, while integrating further social network analysis with the data collected from Twitter may reveal significant opinion leaders and information circulation trends within the Green Deal conversation. Such an approach could shed light on how opinions spread and key nodes in the conversation's network structure. Including a broader range of social media platforms, reports, and media outlets in the analysis would also provide a broader perspective on public discourse and coverage through the media. Finally, future research could look into the actual impact of the Green Deal and similar policies on environmental and economic outcomes, allowing assessment of the efficacy of such policy initiatives; this would help to bridge the gap between policy intent and real-world consequences, providing valuable insights into the effectiveness of environmental policies.

In conclusion, our research contributes to a greater understanding of the Green Deal discourse on Twitter; however, it also emphasizes the need for further scientific investigation. In future, research should build on these findings by gaining a better understanding of public sentiment, policy implications, and the complex factors influencing environmental debates in the digital era.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by CULS Ethics Committee - This grant is funded via FEM grant, where is the purpose of the research is also assessed from an ethical point of view.

Author contributions

TB: Conceptualization, Formal Analysis, Writing–original draft, Project administration. LuP: Formal Analysis, Resources, Writing–original draft. MP: Data curation, Investigation, Validation, Visualization, Writing–original draft. MJ: Resources, Writing–original draft. LS: Formal Analysis, Resources, Writing–original draft. LaP: Conceptualization, Formal Analysis, Funding acquisition, Methodology, Supervision, Writing–original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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