

Capturing Climate Change Online Discourse to Support agriculture Research

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Abstract. This study investigates the changing conversation around climate change on social media in Indonesia, specifically analysing the time frame from January to May 2024. Given the ongoing and substantial risks that climate change presents to countries, communities, and people, it is crucial to comprehend how the public perceives and discusses this pressing matter. We collect data from social media platforms and the Scopus research database. Then employing a deliberate scraping method to gather 2,300 tweets that had hashtags and keyword linked to “PerubahanKlim” or “climate change”. After the first dataset was obtained, the preparation step progressed to the preprocessing phase. This comprehensive methodology enables a detailed comprehension of the progression of climate change discourse on social media in Indonesia. The research also emphasises the fluidity of climate change discourse, illustrating the transformation of public opinion and involvement with the subject during the five-month study period. This study adds to the expanding corpus of research on climate change communication in social media settings, specifically focusing on developing countries. Through a comprehensive examination of online conversations in Indonesia, we present significant observations for politicians, environmental organisations, and researchers aiming to comprehend and tackle climate change issues in the area.

1 Introduction

One of the main problems in the world today is climate change. And assessing public perception and awareness of this topic is essential to formulate policies that successfully reduce its consequences [1]. Climate change has far-reaching consequences, ranging from serious impacts on physical and mental health to negative effects on the global economy [2]. To understand the development of collective content produced in public discussions about climate change, especially in the context of online climate change action, we used social media platforms such as Twitter, TikTok, and Facebook as the main data sources [3]. The use of social media is increasingly widespread in everyday life. Especially after the COVID-19 pandemic which has changed daily routines significantly and brought major changes in various sectors [4].

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There is a clear and growing connection between climate change and the occurrence of extreme weather events. These events are becoming more often and intense, which is affecting emergency response efforts and influencing how the public views climate change. Social media channels are essential for distributing up-to-date information and urgent notifications following storms, floods, and wildfires [1]. Nevertheless, they can function as fertile environments for the dissemination of false or inaccurate information, which can result in bewilderment, alarm, and suboptimal decision-making in critical situations [1]. Dissemination of inaccurate information regarding climate change through social media platforms has the potential to skew the public's comprehension, manipulate their actions, and impact their long-term endorsement of climate initiatives [1]. Research indicates that when individuals are exposed to severe weather occurrences such as fires, their views on climate change may be temporarily influenced. However, these effects fade rapidly, underscoring the intricate relationship between experiences with extreme weather and attitudes towards climate change [5–7].

Climate change presents a significant threat to global food security, especially impacting developing nations like Indonesia, known for its vulnerability to climate-related challenges [8,9]. Indonesia's agricultural sector faces unique obstacles due to its extensive coastline and island geography, exposing it to rising sea levels, extreme weather events, and altered rainfall patterns that can disrupt crop production and water availability [10,11]. Research on climate change and sustainable agriculture in Indonesia highlights the importance of exploring online platforms to analyze keywords and hashtags, shedding light on public awareness, policy dialogues, and grassroots efforts related to climate change and agriculture [12]. By examining these digital markers, valuable insights can be gained into public perceptions and strategies for addressing climate change, aiding policymakers, researchers, and practitioners in developing effective communication strategies and interventions to bolster Indonesia's agricultural resilience and sustainability in the face of climate challenges [8,12].

Table 1. Setting Word's margins.

Margin	mm
Top	24
Bottom	16
Left	20
Right	20

2 Literature review

Conducting online research on discussions about climate change and sustainable agriculture is essential for several reasons. Firstly, it facilitates a more profound comprehension of public opinions regarding the effects of climate change on agriculture, hence assisting in the creation of customized communication strategies [13]. Furthermore, the examination of online debates enables stakeholders to remain informed about new concerns and trends, hence promoting the implementation of novel solutions [14]. Moreover, analyzing online conversations allows us to gain a deeper understanding of how climate policies and advocacy initiatives are perceived. This knowledge may help us improve our present strategies and identify areas that need improvement [15]. This research provides support to grassroots movements by identifying successful local efforts and obstacles, facilitating the expansion of beneficial solutions [16]. Furthermore, it aids policymakers in formulating more efficient

policies that are in line with public opinion and evidence-based communication endeavors [17].

Ultimately, comprehending internet discussions about sustainable agriculture assists in recognizing effective methodologies and obstacles, providing useful perspectives for constructing a more robust agricultural industry in light of climate change difficulties. Recent studies examining research growth and trends have demonstrated a substantial increase in the publication trend of climate change communication and sustainable agriculture. The increase in publications indicates a rising acknowledgment of the significance of skilled communication in dealing with the intricate problems linked to climate change [18,19]. Researchers have progressively directed their attention towards keywords such as "social media," "science communication," "environmental communication," and "climate action," signifying a transition towards more current and pertinent subjects in the discipline [20]. Furthermore, the conversation around climate change in the online media arena has emphasized the importance of employing effective communication strategies and messaging to improve civil discourse and public involvement regarding this matter [20]. Through the examination of these changing patterns and methods of communication, your analysis of content can offer significant perspectives on the progress, difficulties, and possibilities for promoting sustainable agriculture in the context of climate change.

Kaplan and Haenlein's thinking about effective social media analysis tools continues to evolve in line with scientific advances in big data analysis. Many industries, such as marketing, use giant data for monitoring social media such as LinkedIn, Facebook, and Twitter for market growth and brand management [21]. Organizations can monitor, assess, and analyze data from social media to improve their online presence and expand exposure of their services, products, and activities [22]. This is achieved by implementing a social media analysis strategy. Even social media analysis drives changes in marketing approaches, organizational structures, and culture [23]. In the political field, sentiment analysis can be used to predict regional head and presidential candidates [24]. From an academic perspective, Social Media Analytics (ASM) includes the development and evaluation of informatics tools to measure user activity on social media platforms.

Big data has a variety of applications to retrieve significant information and knowledge to assist organizations in planning and making decisions [25]. Conversations, post interactions, emotions, influence, and other variables can be collected, monitored, analyzed, and represented as social data. Kaplan and Haenlein's thinking about efficient social media analysis tools is increasingly evolving along with scientific advances in big data analysis. Organizations can monitor, evaluate and analyze social media data to increase their online presence as well as exposure to their services, products and activities [22]. Furthermore, the search restriction with A social media monitoring tool is a software application that employs sentiment analysis to examine and quantify sentiments and conversations around a company, its goods, or any subject on social media sites [26].

Social media analytics refers to the process of collecting data from various social media platforms and analyzing it using advanced analytical tools to support informed business decision making. Social media analysis can be defined as the systematic extraction of valuable patterns and insights through the development and assessment of informatics tools and frameworks. This process involves the collection, monitoring, analysis, summarization, and visualization of social media data, usually in response to the specific needs of a particular application [27]. Currently, most of the data comes from hashtags that users use to promote their accounts, businesses, and so on. Social media users express their opinions and feelings using hashtags or hashtags. These hashtags need to be analyzed to organize the data. Hashtag analysis on social media is an effective marketing strategy. It indicates how your product is received by customers and suggests hashtag modifications that can improve their business [28].

3 Material and methodology

In this research, data collection was carried out in three stages. First, it was done using an application called Brand24 to see on which social platforms conversations about climate change were taking place. Brand24 is a tool for monitoring what other people are discussing about a particular brand or keyword on social media. Brand24 monitors brands on social media, news portals, forums and blogs. This software allows researchers to track brand, keyword or product mentions and interactions across multiple channels. Additionally, one can also monitor whether the products mentioned on the platform receive positive responses or not (sentiment analysis).

Brand24 can be accessed via the site <https://brand24.com/>. This research uses the free version of Brand24. This research uses the keyword or hashtag "climate change". The data period taken is 3 months from the time of data withdrawal. The time for data collection is 29 May 2024, while Brand24 can only access a maximum of three months of posting a particular hashtag, so the data that can be collected is within the time period 29 February 2024 to 29 May 2024. Second, data collection is carried out by taking secondary data from conversation on the Twitter platform. The data collection phase employs the Python programming language in conjunction with the tweet-harvest library. Python is an interpreted, high-level computer language that is widely used for web development, data analysis, scientific computing, and programs that use artificial intelligence [29,30].

This combination allows for efficient and targeted extraction of Twitter data based on specific keywords or hashtags related to "climate change". The data collection period spans from January to May 2024, ensuring the dataset's recency and relevance to current climate change discussions. Third, data collection was carried out by taking data from the Scopus database. Scopus data was taken in order to see the development of academic conversations in online media based on research results. Data from the Scopus database will be processed using vos-viewer.

4 Findings and discussion

4.1 Data from social media

Analyze climate change hashtags to measure how much public awareness there is about this issue. The number and frequency of hashtag use can indicate the extent of people's attention to environmental issues. Research conducted over 90 days in the period 29 Feb 2024 - 29 May 2024 analyzed the number of mentions and reach contained in the media monitoring analysis tools, Brand24 had the results as below:

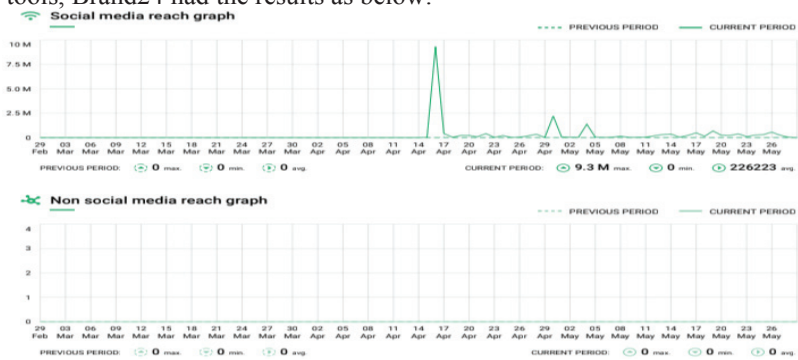


Fig.1. Social media and non-social media reach graph

The number of mentions and reach regarding climate change received 20586325 reach and 1864 mentions on social media. Meanwhile, on non-social media, climate change only received 0 mentions and 0 reach in three months.

Most influential sites

SITE	VISITS	INFLUENCE SCORE
1 facebook.com	16 B	10 /10
2 twitter.com	6.3 B	10 /10
3 tiktok.com	2.4 B	10 /10

Fig.2. The most influential site

According to research results using Brand24 tools, the facebook.com site has the highest number of visits with 16M visits with an influence score of 10/10, followed by the twitter.com site with 6.3M visits with an influence score of 10/10, then followed by the tiktok.com site with the highest number of visits. 2.4M visits with an influence score of 10/10.

Most active sites

SITE	MENTIONS
1 twitter.com	1003
2 tiktok.com	483
3 facebook.com	378

Fig. 3. The most active site

Based on the image above, the site that is most active in discussing climate change is the twitter.com site which received a total of 1003 mentions, followed by tiktok.com with 483 mentions, and the facebook.com site with 378 mentions. With the context of the discussion as can be seen in Figure 4 below:

hayati ragam bu/tuh data bumi dukung indonesia menteri adaptasi tantang cuaca potensi dampak rumah akibat berkontribusi
 sumber pangan bangun kembang transformasi isu pln manusia water banjir krisis energi disebabkan tani suhu ubah akses
 upaya kuat mitigasi hadap jenderal hutan salah kurang daya kelola masyarakat sebab polusi alam air utama peran
 program hasil naik lanjut ekosistem sosial aspek hidup dunia iklim perintah digital kolaborasi baca world wwf cepat aksi baru
 teknologi milik listrik lingkung inovasi karbon atas tangan forum kait tata ekonomi kerja fokus wilayah kementerian global
 laut kendali 2024 panas lingkungan tingkat negara ancam bali bencana tahan jaga emisi komitmen

Fig.4. The Discussion Context

Trending hashtags

HASHTAG	MENTIONS
1 #perubahaniklim	506
2 #plnecorangers	241
3 #greenlifestyle	160
4 #waterforsharedprosperity	138
5 #fyp	137
6 #10thworldwaterforum	134
7 #climatechange	115
8 #krisisiklim	94
9 #genz	92
10 #gayahiduphijau	76
11 #ekonomi	76
12 #gayahidupterbarukan	74
13 #bencanaalam	74
14 #haribumi	70
15 #lingkungan	66
16 #haribumi2024	65
17 #fypシ	62
18 #kesehatan	61
19 #pakaimolismakinasyik	60
20 #plnmobileproliga2024	60

Fig.5. The most Trending hashtag

Based on the data above, the most frequently mentioned hashtag is #perubahaniklim with 506 mentions, #plnecorangers with 241 mentions, #greenlifestyle with 160 mentions, #waterforsharedprosperity with 138 mentions, #fyp 137 mentions, #10thworldwaterforum with 134 mentions, # climatechange with mentions, #krisisiklim with 94 mentions, #genz with 92 mentions, #gayahiduphijau with 76 mentions, #ekonomi with 76 mentions, #gayahidupterbarukan with 74 mentions, #bencanaalam 74 mentions, #haribumi with 70 mentions, #lingkungan with 66 mentions, #haribumi2024 with 70 mentions, #fypシ with 62 mentions, #kesehatan with 61 mentions, #pakaimolismakinasyik with 60 mentions, dan #plnmobileproliga2024 with 60 mentions.

+ Most active public profiles

PROFILE	SOURCE	FOLLOWERS	MENTIONS
1 @mediahijaucom	X	1116	131
2 mai_aquaponics_farm	♪	13 000	44
3 infoppkk	X	10 421	32
4 @mediahijaucom	♪	5	29
5 sekatojambi.dot.com	♪	2091	15
6 TitikMusti96209	X	70	13
7 kitadanbumi	X	4606	9
8 IESR	X	4766	9
9 kita_dan_bumi	♪	265	8
10 DPRRI	👥	680 119	8
11 KOMPAScom	👥	10 M	8
12 bmkgminangkabau	X	1575	8
13 Kemendag	X	436 615	8
14 gprrtv.id	♪	1602	7
15 lilaapple	X	1	7
16 petani_pakis	♪	135	6
17 pembagianyar	♪	42	6
18 kompascom	X	8.6 M	6
19 esg_indonesia	X	17	6
20 rinaamelia255	♪	3	5

Fig 6. The active public profile

The public profile of climate change is dominated by organizational accounts and most of them come from social media @mediahijaucom with 131 mentions,

@mai_aquaponics_farm with 44 mentions, @infoppkk with 32 mentions, @mediahijaucom with 29 mentions, and @sekatojambi.dot.com with 15 mentions.

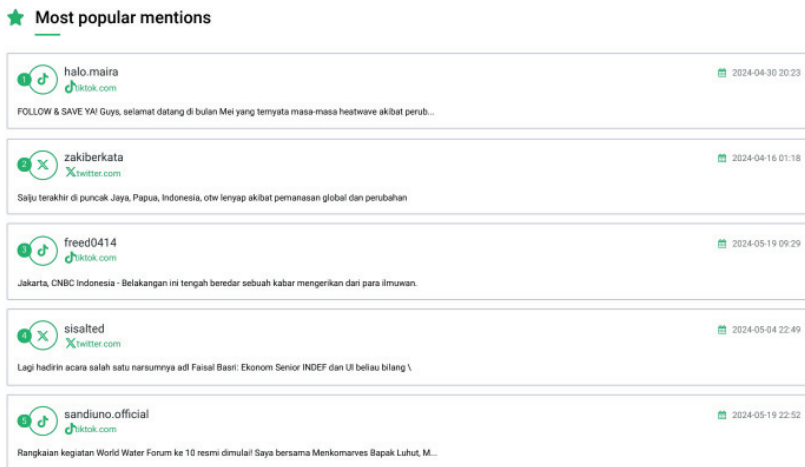


Fig 7. The most popular mentions

The image above shows the most popular and newest mentions regarding climate change on TikTok social media for three months starting from 29 Feb 2024 - 29 May 2024. The most popular mentions came from the account @halo.maira with said "FOLLOW & SAVE YA! Guys, welcome to the month of May which turns out to be a time of heatwave due to climate change ☹️ #heatwave #asia # mei #gemini #globalwarming" has been watched more than 6.7 million times, 226 thousand likes, 13.3 thousand comments and 17.4 thousand shares. This post expresses negative sentiment. This can be seen from the use of sad emoticons (☹️) and the use of words such as "heatwave" and "globalwarming", which refer to the negative impacts of climate change. Then the second popular mention was posted by the account @zakiberkata on social media X (twitter) that has been seen by 1.1 million times with 24 thousand likes, 746 quotes, and reposted 6,246 times.

This account states "The last snow on the peak of Jaya, Papua, Indonesia, has disappeared due to global warming and climate change." The sentence expresses negative sentiment. This can be seen from the use of words such as "disappearing due to global warming and climate change", which indicates that this phenomenon is caused by the negative impacts of climate change. The third popular mentions by the account @freed0414 which has been viewed more than 737 thousand times contains content regarding a re-post from CNBC Indonesia media with the title "Doomsday Schedule Revealed, 15,000 Scientists Become Witnesses", this post contains negative sentiment as seen from the content which discusses life in The earth is currently facing serious threats due to climate change caused by human activities, especially in terms of the release of greenhouse gases from the fossil fuel industry.

Based on this data (fig. 8), it can be seen that of the total 1864 mentions about climate change, there were 123 mentions with negative sentiment, while only 77 mentions received positive sentiment. This reflects that discussions about climate change tend to more often lead to negative aspects or problems that arise as a result. The high number of negative sentiments may reflect that issues such as the negative impacts of climate change, future uncertainty, or failures in handling policies often receive greater attention in public discussions.

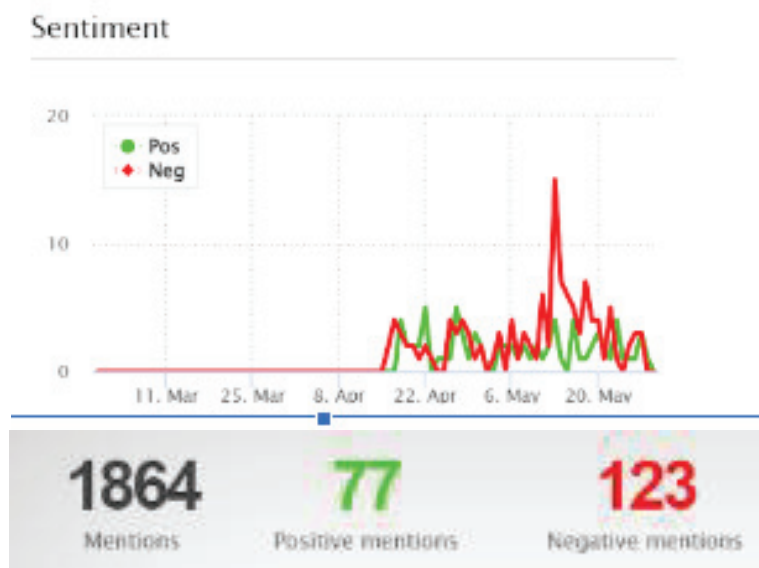


Fig 8. Sentiment analysis

This can lead to concerns and the need for more effective solutions. While negative sentiment is important to bring awareness to existing problems, it is also important to explore and promote positive sentiment about climate change. This could include green technology innovation, efforts to increase awareness, better education, effective communication, global collaboration, the success of local initiatives in reducing carbon footprints, and providing examples of success that can be used as inspiration.

4.2 Data Twitter

The capability of tweet-harvest allows for the systematic retrieval of tweets, which are then stored in CSV (Comma-Separated Values) format. The Twitter data from the spreadsheet were converted into CSV files. These files were subsequently imported into the Gephi tool. to analyse the data and visualise the communication network. This choice of format is particularly advantageous as it offers a structured, tabular representation of the data that is easily readable by both humans and various software tools, facilitating subsequent analysis steps. After the initial dataset was generated, the preparation stage commenced into preprocessing phase.

The preprocessing stage leverages Google Collab, a cloud-based integrated development environment (IDE) that supports collaborative work and provides access to a wide array of Python libraries. This platform choice is significant as it allows for scalable processing power and eliminates the need for local computational resources, which can be particularly beneficial when dealing with large datasets. The pre-processing steps are: Tokenization, Tokenization breaks the sentence into words. In this phase, the word before “#” is likewise identified as different. We categorise Twitter tweets by hashtag. Stop removing words Stop words are words that add little or no meaning during analysis. So we must eliminate it. A, am, also, but, etc. are stop words. Stemming/Lemmatizing Stemming and lemmatizing are comparable. Stemming removes prefixes and suffixes, while lemmatizing uses a lexicon to find the underlying word. The following table (considering “#”-preceded terms). The cleaned

The presence of clusters centered on "technology," "transition," and "energy efficiency" indicates a rising fascination with inventive solutions and environmentally-friendly activities. The rise in this trend might be attributed to the growing need for climate-smart agriculture and the emergence of new technology. Moreover, the incorporation of terminology such as "awareness," "knowledge," "farmer," and "perception" indicates a transition towards comprehending the human aspects of climate change and the significance of modifying behavior. This tendency is likely a result of the acknowledgment that effective climate change adaptation and mitigation necessitate the involvement and active participation of farmers and other relevant parties.

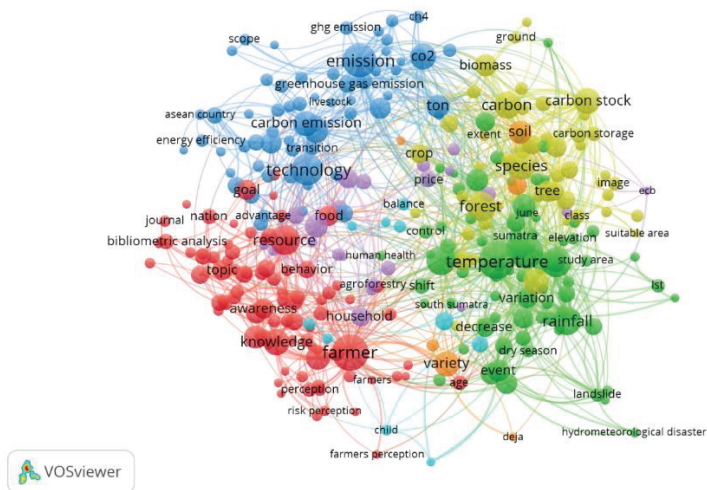


Fig. 15. Network Visualisation

The VOSviewer map demonstrates a fluid and developing research environment in the field of climate change and agriculture. The primary emphasis is on addressing the effects of climate change by sequestering carbon and decreasing emissions of greenhouse gases, as indicated by the prominent grouping of terms such as "emission," "greenhouse gas," "carbon," and "soil." The significance of "agriculture," "crop," "biomass," and "livestock" underscores the sector's crucial role in both contributing to and alleviating climate change. The appearance of clusters associated with "technology," "transition," and "energy efficiency" signifies an increasing fascination with technical remedies and sustainable methodologies. Moreover, the incorporation of terminology such as "awareness," "knowledge," "farmer," and "perception" implies a transition towards comprehending the human aspects of climate change and the significance of modifying behavior. This tendency is probably a result of the growing acknowledgment of the necessity for multidisciplinary research that combines scientific and social sciences in order to tackle the intricate challenges posed by climate change in agriculture.

Fig. 17. Network visualization of climate change

The VOSviewer map given here provides a detailed and nuanced overview of the climate change and agriculture research landscape. The center cluster "climate change impact" emphasizes the primary focus on understanding the effects of climate change on agricultural systems. The use of the terms "farmer," "adaptation," and "variety" emphasizes farmers' vital role in reacting to these problems, as well as the importance of generating climate-resilient crop varieties. The inclusion of "woman," "awareness," and "knowledge" indicates a rising acknowledgment of the importance of addressing gender inequities and empowering women in agriculture to improve climate adaptation efforts. Furthermore, the formation of clusters centered on "technology," "ecosystem service," and "policy" implies a growing interest in developing new solutions and supportive policy frameworks for sustainable agriculture. This rise is largely due to the growing importance of addressing climate change and the need for integrated methods that include scientific research, technology innovation, and policy initiatives.

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