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Social network platforms and climate change in China: Evidence from TikTok

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ABSTRACT

The actions and policies enacted by today's youth hold profound implications for future generations, underscoring their pivotal role in advocating for climate issues. Younger cohorts exhibit heightened concern regarding climate change and are highly visible on social media platforms. Hence, this study aims to delineate the portrayal of climate-related news and disasters on TikTok. The research draws upon fifty TikTok accounts focused on climate-related content. Employing social network analysis, PageRank, and Superedge Rank methodologies, this investigation evaluates how TikTok users—called TikTokers—address climate change and its impact on social media. The assessment scrutinizes climate-related news, disasters, and the resultant networks to gauge the influence wielded by social influencers in disseminating messages. Results reveal that among the four key entities—internet influencers, government, scientists, and producers—internet influencers exert the most substantial influence on climate change news dissemination on TikTok, while the government plays an influential role in climate disasters. Like other social media platforms, TikTok is a valuable arena for gauging public sentiment on critical health concerns like global warming. Nonetheless, ensuring the reliability and depth of messages shared on TikTok necessitates the presence of credible experts who can deliver comprehensive and scientifically sound information within the platform's time constraints.

1. Introduction

While public interest in climate has always been prevalent, the recent surge in scientific evidence regarding climate change has elevated it to a significant societal concern (Corbett and Savarimuthu, 2022; Wei et al., 2021). This heightened attention is reflected in various indicators, such as its prominence in Gallup's rankings, online search trends, and the prevalence of climate discussions across social media platforms, all underscoring a growing apprehension about the adverse effects of climate change (Rosenthal, 2022). To construct a discourse on climate change, society values reliable information sources. The literature shows that "prestige newspapers," news aggregators or organizations, and opinion leaders, which can include celebrities, are the most trusted sources of information regarding environmental topics (Lee and Theokary, 2021). Nevertheless, social networks serve as a platform for exchanging and disseminating opinions, ideas, and dialogues, transforming the 21st-century agora (Ballestar and Sainz, 2020; Martin-Llaguno et al., 2022). Transnational decision-making and worldwide discussion are essential for climate change management. As a result, social media platforms like Facebook, TikTok, and Instagram have emerged as a necessary avenue for citizens to engage with researchers and policymakers (Cody et al., 2015; Nisbet et al., 2009).

More than 88 % of Chinese use at least one social media site compared to 70 % of Americans (Pew Research Centre, 2021), demonstrating a tremendous increase in popularity over the previous 15 years. These tools are accessible to people of all ages, although some demographics tend to use them more frequently than others. Therefore, many social media sites appeal to a wide range of demographics. Five hundred ninety-seven million people in China are using social media. Most young adults (19–30) in China use at least one kind of social media. It includes popular sites like TikTok, YouTube, and Instagram. Because the choices and policies of today will have enduring effects on the climate and sustainability, today's kids play a vital part in climate advocacy. Having safe places to voice discontent might prevent young

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people from isolating themselves, becoming passive, or lashing out at other marginalized groups, including economic migrants (O'Brien et al., 2018). Accessible climate change information available to youth from numerous sources, including social media, may increase future activism and change (Han and Ahn, 2020). Other successful youth-led campaigns, such as the "March for Our Lives," have shown the power of social media's unrestricted reach for gathering information, raising awareness, and collecting support for causes (Bandura and Cherry, 2020).

TikTok is a rapidly growing platform, with over 2 billion app downloads worldwide. Research into using new social media sites like TikTok for distributing public health information has recently begun (Basch et al., 2021). Certain public health agencies and groups have turned to social media and social media influencers to raise public awareness of crucial health issues. For instance, when asked what problem the world faces most, those aged 18 to 25 from 22 nations named climate change (Barbiroglio, 2019). Young people are starting to worry more and more about climate change. Therefore, this research aims to characterize climate-change-related news and climate-change disasters due to TikTokers in China.

The rapid development of computing has resulted in the emergence of the network as the fourth type of media, joining print, radio, and television. The Network Age has arrived. The Internet is becoming an essential medium for the propagation of public opinion. Internet users can share their thoughts and ideas freely, leading to rapid social change thanks to the Internet's transmission technology. It is inescapable that certain undesired things found online will harm society and the environment. Still, online public opinions are closely related to the various paradoxes and sensitive themes throughout China's Social Transformation Period. The environmental and climatic crises have made TikTok a vital platform for spreading awareness (Cody et al., 2015). Few studies, however, have attempted to characterize and assess the influence of environmental leaders in these systems. There has been no insinuation that the tools and techniques used to measure influencer impact (such as the amount of reels or follows).

Existing research has mostly ignored intangibles like followers' perceptions of an influencer's credibility and the quality of the information they provide. However, the literature gives "environmental influencers" (a subset of "digital activists") very little attention in terms of analyzing their function, traits, and techniques in comparison to other types of influencers. The stability and security of society are at imminent risk if proper oversight and guidance are not in place. Any Internet user who can operate a computer, communicate their opinions in a specific style, and participate in the issue addressed in a particular method may become the online opinion leader in the process of public opinion transmission online. Lazarsfeld et al. (1944) developed the term "opinion leaders" in the 1940s. Opinion leaders have much sway over others and use their voices to help the general public grasp complex societal issues. Opinion leaders quickly stir strong reactions and considerable attention when significant events occur at home and abroad. Identifying online opinion leaders is vital since doing so is a necessary first step towards influencing public opinion online.

Networks help conceptualize many physical, biological, social, and information science systems. Therefore, the scientific study of networks is an important topic that may inform nearly every other scientific and technological discipline (Newman, 2018). To depict a system in the actual world, mathematicians often use the term "network," which is synonymous with "graph." Centrality measures are among the most popular and extensively used metrics for understanding and evaluating networks because of their ability to pinpoint the most pivotal nodes in the structure. Several centrality measures, including degree, eigenvector, Katz, PageRank, betweenness, and proximity, have been proposed since numerous ways exist to characterize significance. Conventional centrality measurements typically consider either the local or global network topology. There has been rising interest in expanding traditional centrality metrics to encompass node-specific information (Agryzkov et al., 2012; Giustolisi et al., 2020; Wiedermann et al., 2013), as network nodes can demonstrate importance (such as based on intrinsic relevance or external information) that is independent of network topology.

The ten-year-old Adapted PageRank Algorithm (APA) model (Agryzkov et al., 2012) is gaining popularity as a centrality measure. It modifies the PageRank centrality model by ranking the intersections (nodes) of a city's street network (Brin and Page, 1998). The primary goal of the APA model is to score the meetings based on the presence or absence of nodes (such as stores, restaurants, or tourist attractions) and the structure of the underlying nodes of the network. Like the PageRank model, the APA model can be understood as a random walker who systematically traverses the node grid; the longer the walker spends at a particular intersection, the greater its value. One major flaw in the APA model is that the random walker has an equal chance of teleporting to every corner in the street network, regardless of how far away it is. It comes from the PageRank model. To reconcile this seeming inconsistency, Agryzkov et al. (2016) tweaked the APA model to make the random walker more likely to hop to a nearby intersection. While their method is an improvement, more work is required to make the APA model user-friendly for networks and a complete solution to the teleportation problem. As a result, we suggest a centrality model that refines the APA model by making the random walker more likely to hop to an adjacent intersection rather than a distant one. To achieve this goal, we take advantage of recent developments in non-local random walks, which allow a random walker to hop to any node in the network (not just adjacent nodes) with probabilities that depend on the distance separating the nodes (Estrada et al., 2018; Riascos & Mateos, 2012 and 2021).

Sheffi introduced the term "supernetwork" in 1985 (Sheffi, 1985). University of Massachusetts professor Nagurney defined supernetworks in 2002 as networks that exist on top of and beyond existing networks (Nagurney, 2005). These networks have many characteristics, including layers, levels, attributes, and erratic degrees of coordination and congestion. An example of a supernetwork would be how its constituent networks interact and influence one another. Its framework has made studying how different networks affect one another easier. Utilizing a supernetwork's many features and benefits can bring it on par with the average internet user's knowledge, psychology, and viewpoint. It allows for a more accurate depiction of the growth and development of online public opinion. It builds a 4-layer supernetwork of internet users, information, psychology, and viewpoint to classify the online public opinion leader, and investigate the function mechanism. At the same time, it may explore the environmental information that has the most significant impact on internet users and the underlying psychological drive that shapes public opinion.

Here is how the rest of the paper is structured. In the second piece, we'll talk about how researchers in the past have tried to pinpoint key opinion formers. In the third section, we'll review the fundamentals of the centrality measures, page rank, and supernetwork model for analyzing online public opinion. We also propose an algorithm based on the model and call it Superedge-Rank. We then introduce the factors that influence the algorithm, such as the amount of information shared, the likelihood of change between personality types, and the similarity of keywords representing different points of view. Ultimately, we will propose a system for locating influential people in the digital sphere by employing the SuperedgeRank algorithm in a supernetwork. In the final piece, we'll examine how this algorithm was used at a recent show in China and the US.

2. Literature review

At least 150,000 people die yearly because of climate change (World Health Organization, 2021). Most climate scientists agree that increasing levels of greenhouse gases are raising global temperatures. Climate experts warn that climate change and its health hazards will

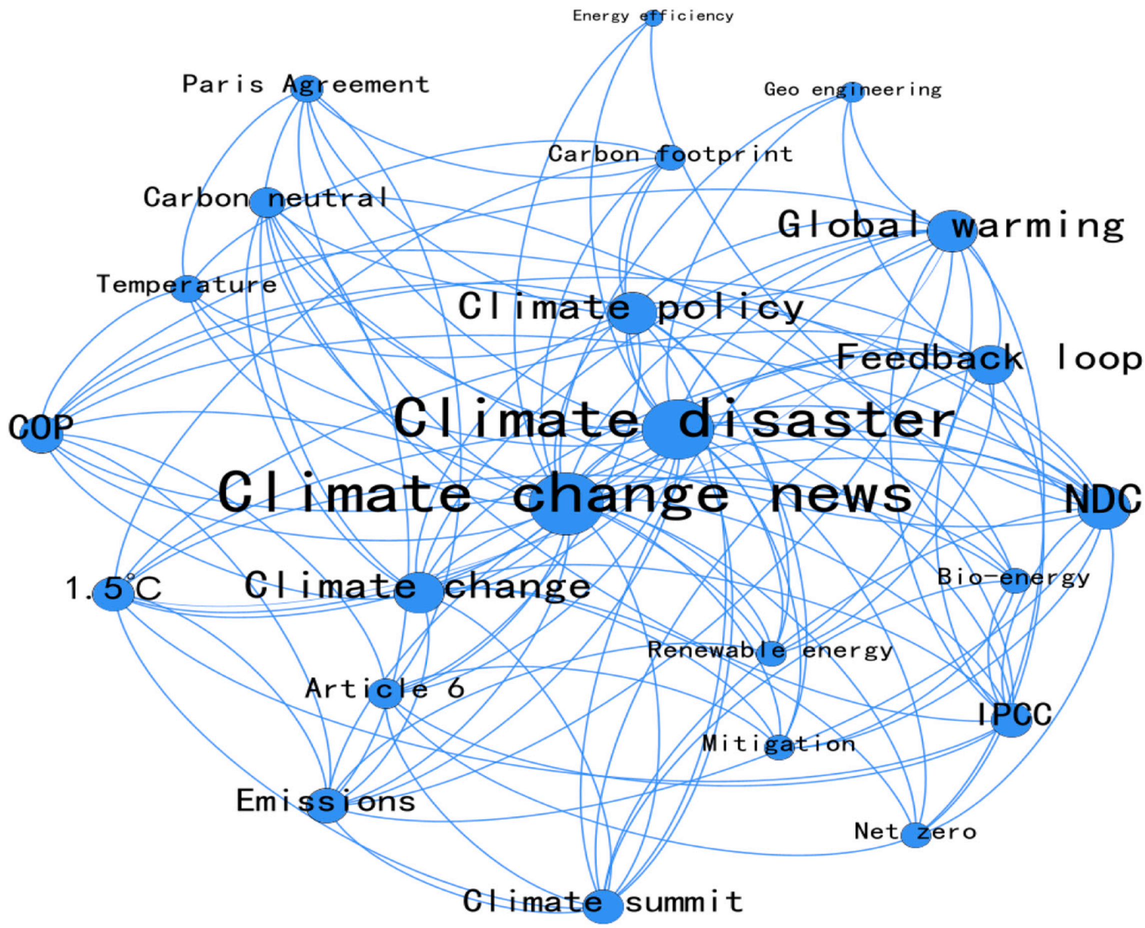

Fig. 1. Chinese climate change news and climate disaster from 1st October 2022 to 31st December 2022.

worsen without action (NASA, 2019). The effects of human activities such as industrialization and urbanization, which have contributed significantly to global temperatures, may be permanent. More enormous wildfires, more prolonged droughts, different weather patterns, rising sea levels, higher flood risks, and melting ice caps are only some of the climate disruptions that have increased due to climate change (NASA, 2019). Wildfires destroyed an average of seven million acres annually between 2000 and 2020. The annual acreage burned during this time was 3.3 million (Congressional Research Service, 2021). The ice in the Arctic is decreasing by 13.1 % every decade. Because of this, sea levels have increased by an average of 3.3 mm annually since 1993 (NASA, 2019).

The effects of rising global temperatures vary from region to region. One study looking at the impact of global warming on the Great Lakes region found that longer growing seasons for crops also meant longer pollen and allergy seasons. Constant human influences disrupt the natural state of things, including the health hazards associated with climate change (Butler, 2018; Walter et al., 2022). A healthy earth is crucial to health, peace, equality, and prosperity (Pew Research Centre, 2021), and pollution of the air, groundwater, and soil, as well as catastrophic climate disturbances, harm local communities and businesses, including agriculture and infrastructure (Ebi et al., 2006; Patz et al., 2008). The dissemination of knowledge about climate change to educate the public is of the utmost importance.

Basch et al. (2022) proposes that the actions and policies of today's youth can have far-reaching effects on future generations, making them crucial to climate advocacy. Younger people are increasingly worried about the impacts of climate change. One hundred climate-related TikTok videos in English were analyzed for the study. At the time of the research, the topic of climate change received the most mentions on Twitter; therefore, it was picked as the hashtag to analyze. Every video's total views, comments, and favorites were logged. The presence of certain standardized features in the videos was also tracked. Basch et al. (2022) concluded that popular opinion on public health issues like global climate change could be better understood with the help of social media platforms like TikTok.

Many members of today's internet culture get their news not from the mainstream media but from influential voices (their followers) in the field. The ability of opinion leaders to influence their followers because of their superior position, leadership, and social prestige is crucial to developing communities and improving group performance (Li et al., 2019). Identifying opinion leaders is a topic of study in several academic disciplines, including those about the stock market, politics, public opinion on the Internet, and online reputation management.

Context-specificity is a crucial finding from catastrophe research on ICT and social media. As mentioned above, research findings on social media trust and government use are often contradictory (Takahashi et al., 2015; White and Fu, 2012). In the Philippines, the local government did not use social media (ibid). Still, Hurricane Sandy case studies show that local government authorities and traditional media were the most critical nodes in social networks. China's top-down crisis management approach renders social media's function in information dissemination unclear.

China's environmental risk management, including disaster planning, is top-down. China's top-down, reactive, Integrated Coastal Management policy for natural catastrophes lacks public engagement, policy integration, and resources. Therefore, China's disasters involve social media. After the 2010 Yushu earthquake, citizens utilized Sino-Weibo, a Chinese Twitter-like microblog, to express sentiments and criticize official answers (He et al., 2016).

China has been seeking to increase public participation in environmental policy decisions. The 2002 Environmental Impact Assessment (EIA) Law demands public engagement. The 2015 Environmental Protection Law has an extensive chapter on environmental information transparency and participation (He et al., 2017; Zhang et al., 2016). The Chinese government has invested in online government services; however, online environmental data is still biased and inaccurate (Brombal, 2017; Mol, 2008). More Chinese residents, especially in cities, use WeChat, Sina Blogs, and Sino Weibo to protest and report environmental risks and pollution (Hsu et al., 2020). Sometimes with government agencies. The Chinese government's "Urban Black and Odorous Water Information Platform" uses WeChat to monitor water pollution (Hsu et al., 2020). It tracks and pressures local government implementation. Social media protests against government-supported industrial projects, such as the Xiamen paraxylene (PX) factory protest, occurred in 2007 (Chin-Fu, 2013). Social media has fueled demonstrations against the Liulitin trash incinerator. Thus, China is "a society in transition, in which public (environmental) activism is emerging and the relationship among various public and private stakeholders is increasingly tense" in environmental policy-making (He et al., 2017).

Distributing knowledge via social media and fostering citizen participation has not inevitably opened ICT. Social media and the data society are surveillance tools. The Chinese government monitors and controls social behaviors through digital data. Google and Facebook are censored (Feng and Guo, 2013), while Chinese social media platforms have active censorship (Zeng et al., 2017). Chinese internet users know that the government censors and filters material for public control. Rural and urban environments may differ. In a recent survey, Beijingers valued ICT gears (including social media) to increase public involvement in environmental sustainability. Still, they recognized that its impact on decision-making had been limited. White and Fu (2012) found that rural Sichuan residents, after the 2008 earthquake, distrusted social media as a source of rumors (e.g., kidnappings) and trusted official information from TV news stations.

From our research of the relevant literature, we know that many different hypotheses have been formulated to explain how to locate thought leaders by employing PageRank-based methods. Still, there hasn't been much study into the effectiveness of using supernetwork analysis to track down influential people in the digital space. For instance, Social Network Analysis zeroes focused on the online community leaders (the people who participate and talk online) in forming a consensus. It hasn't considered how internet users react to new information, how people's motivations and emotions shape what they write online, etc. To effectively identify the online opinion leaders of public events and study their involvement in the occurrence and evolution of events, it is not sufficient to focus attention just on the reacting behaviors of the internet users. We must also clarify the six elements of when, where, who, what, why, and how. Additionally, we found limited evidence that analyzed the association between opinions and climatic conditions using Page Rank and Superedge Rank methods. Considering the above, we coupled both these methods in our study to better understand how to identify influential voices in the digital sphere.

3. Materials, methods, and results

Fig. 1 shows two essential topics in this period: Climate change news and disasters. The selected account is the top 50th TikTok search account in this period. The details are shown in the table in the appendix. There are four attributes: 15 Internet Influencers, 14 Government, 12 Scientists, and 9 Producers.

The predominant focus on "Climate change news" and "disasters" in Fig. 1 indicates the shifting dynamics of climate discussions on TikTok, where these subjects have gained significant attention due to many factors. The phrase "Climate change news" signifies the increasing need for access to information and updates on climate change developments. There is a growing trend among TikTok users, particularly younger individuals, to actively look for reliable and authoritative sources of information on contemporary climate trends, scientific research, and policy developments. Consequently, individuals responsible for creating and producing content are taking advantage of this heightened interest by providing educational and up-to-date climate-related news information to keep their viewers or readers adequately informed.

Simultaneously, "disasters" serve as a comprehensive representation of the tangible outcomes of climate change in the world. In a period characterized by a notable increase in occurrences of severe weather phenomena such as wildfires, hurricanes, and floods, these observable consequences need urgent consideration and evoke a profound response from observers. Disasters offer an unmediated perspective on the destructive impact that climate change may have on societies, compelling observers to actively participate, demonstrate empathy, and mobilize efforts towards transformative action. By employing personal tales and on-the-ground reporting, the disaster-related videos on TikTok can establish a connection between abstract deliberations concerning climate matters and the pressing imperative for prompt action. The combination of "Climate change news" and "disasters" functions as effective mechanisms for cultivating climate consciousness, stimulating active participation, and driving constructive transformation on this prominent social media platform. Social network analysis is given in appendix (see Appendix B.2).

3.1. The algorithm of page rank

The PageRank algorithm was developed in the 1970s by Pinski and Narin (1976) and popularized in the 1990s to rank web pages by their 'popularity.' It was reorganized as a search–engine ranking algorithm that prioritized pages with many incoming web hyperlinks or a small number of incoming associations from highly graded pages. Notably, the algorithm gives a more excellent score to highly connected pages and pages that are allied by prominent websites. The model underlying the algorithm's web application assumes a web surfer who follows links between web pages, becomes bored after a series of movements and lands on a random page. Therefore, the PageRank of a given page is proportional to the likelihood that a random surfer will arrive on that page. Thus, the model can be viewed as a Markov process in which the states are web pages, and the connections between web pages determine the transition probabilities. The similarity between the PageRank calculation and the derivation of the Markov stationary distribution is, therefore, not remarkable. Specifically, the PageRank-fixing equation reads π as:

$$\pi = \frac{1-d}{N} 1 + d\widetilde{\omega}\pi \tag{1}$$

where 1 is the unitary N-dimensional vector and where the elements $\widetilde{\omega}_{ij}$ of the matrix $\widetilde{\omega}$ are given by $\omega = \{\omega_{ij}\}_{i,j=1}^{N}$, the weight matrix of the network observed above. The quantity d is the 'damping factor'. It is connected to the probability of exiting a page and touching an arbitrary website. The damping factor, along with the first term on the RHS of Eq. (1), is incorporated to certify an evolution when landing on a page without out-going links to reserve the lack of any point of the process and to guarantee the convergence of π to a unique stationary density (Masuda et al., 2017). The PageRank is typically figured iteratively, with an initial guess $\pi^{(1)}$ that gets rationalized by applying Eq. (4) above as:

$$\pi^{(n+1)} = \frac{1-d}{N} 1 + d\widetilde{\omega}\pi^{(n)}, \pi_{\rightarrow}^{(n)n\rightarrow\infty}\pi \tag{2}$$

The N-dimensional vector resulting from this algorithm represents the likelihood of viewing any TikTok account $i = 1,......$ N, or the 'popularity' of that account. Our work focuses on metrics like audience growth, video plays, profile visits, likes, comments, and shares of climate change-related content. In this context, we may infer the network's collective interest in every piece of climate-related news. Unlike

Table 1
The Fifty Subjects PageRank Ranking.

Account	Type	Pagerank (after 50 iterations)
LW	Internet influencers	0.050082
Wind Aid	Internet influencers	0.048026
Mr. Xiaobo	Internet influencers	0.047796
HN	Internet influencers	0.042466
CWE	Internet influencers	0.039695
WE	Internet influencers	0.033571
CSP	Internet influencers	0.033107
JSW	Government	0.03129
SDL	Internet influencers	0.02846
MV	Government	0.028445
DISR	Internet influencers	0.026531
Miss Guo	Internet influencers	0.025482
CW	Government	0.025178
NWI	Government	0.023283
CGN	Government	0.021151
BJW	Government	0.020968
Gao Han	Internet influencers	0.020866
CPN	Government	0.020819
SBJ	Government	0.019338
TTN	Internet influencers	0.019164
UNEP	Internet influencers	0.018707
HNE	Government	0.017383
CMA	Government	0.017363
BB	Internet influencers	0.016964
LH	Internet influencers	0.016352
CCTV News	Government	0.015974
WTSF	Scientist	0.015959
TK	Scientist	0.015875
UNCF	Producer	0.015453
CMB	Producer	0.014655
BJR	Government	0.013887
MEE	Government	0.013844
ENF	Producer	0.013063
CT	Producer	0.012928
PS	Scientist	0.012904
CBCDF	Producer	0.012435
BJPSD	Producer	0.012428
WWF	Producer	0.012125
CAAS	Scientist	0.012108
AHE	Government	0.011549
CS	Scientist	0.011549
STM	Scientist	0.011503
SSS	Scientist	0.011395
GP	Producer	0.011157
SRR	Scientist	0.010609
ICS	Scientist	0.01036
CSC	Scientist	0.009677
HN	Producer	0.009336
CME	Scientist	0.008412
ST	Scientist	0.008329

other methods (for example, Pinski and Narin (1976)), the PageRank algorithm we employ here does not consider the total number of posts each TikToker generates. We went this route since the academic fields we study are pretty small. The size distribution of the accounts under consideration is quite close to the mean, except for a handful of small TikTok accounts that (we checked) would be over-rewarded by a normalized version of the Page Rank algorithm. We opted to use an unweighted variant of the PageRank algorithm because of this problem.

The PageRank results dated 31st December 2022 are, once again, interesting. In the top position, we find in Table 1 that seven internet influencers have higher page rank values. Fig. 2 shows that pink nodes represent internet influencers against the government, scientists, and producers. We have used 50 TikTok accounts of internet influencers, government, scientists, and producers to check their impact on climate change disasters and news. Internet influencers have a significant impact on climatic information.

Influencers may make a big difference regarding online coverage of climate change. They can change people's minds because of the large number of people they reach and the interest they generate. Influencers often utilize stories from their lives to make the topic more approachable and advocate for sustainable behaviors. Working with other groups and initiatives helps spread the word and raises the profile. However, influencers must be responsible and knowledgeable enough to distribute only the facts. Influencers can inform and motivate their audiences to combat climate change.

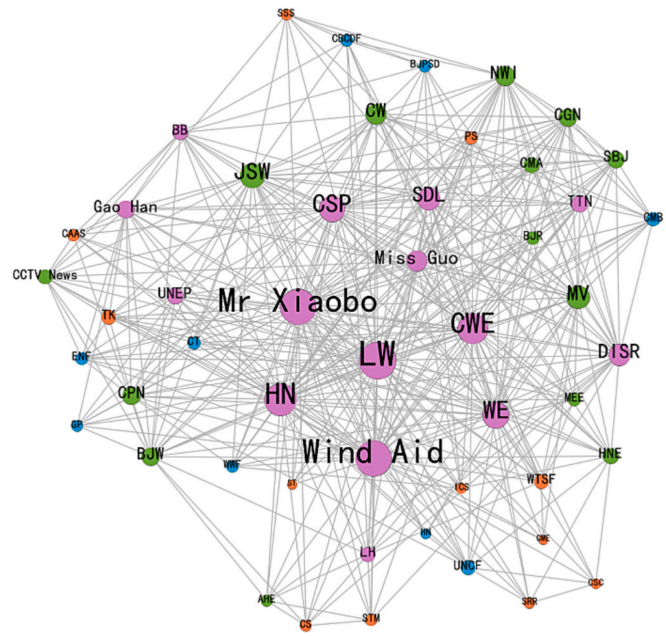

Fig. 2. The Network of Fifty Subjects PageRank.

Online influencers may help spread different stories and points of view about climate change. They have the potential to elevate the voices of underrepresented groups and draw attention to the disproportionate effect of climate change on the most disadvantaged people and communities. By sharing these personal accounts, influencers may draw attention to climate change-related social justice and equality concerns. In addition, influencers may motivate their audience to act by increasing engagement and participation. They may mobilize their audience to support environmental activities by promoting climate-related campaigns, encouraging people to engage in climate strikes, and striking themselves. By working together, we can raise consciousness about climate change and generate a feeling of urgency about finding solutions.

Opinion leaders must check the integrity of the data they present and assess the credibility of their sources. Inaccurate information or "greenwashing" can hurt our ability to combat climate change successfully. Influencers who care about their reputation should verify the accuracy of their material and work with reputable sources in the scientific community. In conclusion, online influencers significantly impact the dissemination of information about climate change because of the awareness they spread, the sustainable habits they promote, the variety of narratives they provide, and the mobilization of their followers. Their influence may help people learn more about climate change and motivate them to act on an individual and societal level.

4. Case study: the COP 27 conference

COP is an annual international climate conference hosted by the United Nations. COP is an abbreviation for "Conference of the Parties," which refers to the international treaty known as the United Nations Framework Convention on Climate Change (UNFCCC). The parties to the treaty have agreed to adopt voluntary measures to prevent "dangerous anthropogenic [human-caused] interference with the climate system." Countries take turns hosting an annual meeting where

Table 2
Environmental view, psychological view, and main opinions of the COP 27 conference.

		Example	
Environmental subnetwork under the news theme	3	E1	The impact of climate change has been becoming important
		E2	COP 27 claims that climate change has turned into a massive crisis
		E3	COP 27 agrees to establish a climate compensation fund
Psychological View	8	Psychological subnetwork: The psychological tendency can be divided into optimistic, neutral, and adverse, and the psychological intensity is determined by the number of keywords with opinion tendency published by the corresponding subject.	
Opinion subnetwork under the news theme	20	Positive view	**K1:** People warmly celebrate the opening of COP 27. **K2:** COP27 is an important conference. **K3:** COP 27 can be beneficial to climate change. **K4:** The conference shows the equality between men and women in climate change action. **K5:** All humanity should work together to protect the earth. **K6:** Governments should make a good preparation for climate change.
		Neutral view	**K7:** The effects of COP27 need to be deeply observed. **K8:** The UN is an integral part of climate change.
		Negative view	**K9:** Women do not affect climate change. **K10:** The COP27 Conference does not have effects on climate change. **K11**: Climate change is not essential for people. **K12:** People can do nothing about climate change. **K13:** Climate change has no relationship with humanity.

government representatives report on progress, establish intermediate objectives, reach agreements to share scientific and technological advancements of global benefit and negotiate policy. The meeting last year took place in Glasgow, Scotland. This year's conference, the 27th since the UNFCCC treaty was negotiated in 1992, is being convened in Sharm El-Sheikh, Egypt.

What constitutes a dangerous level of global warming is partially a scientific issue (what impacts are likely to occur with a given class) and partly a value judgment (how intolerable those impacts would be). In this regard, social media users participate via social media. In this paper, we are also collecting feedback via TikTok. We tracked the incident from beginning to end, cataloguing not just the several TikTok accounts involved but also the underlying environmental subnetwork, psychological types, and opinion network that formed the basis of the climate change news story. Based on this data, we created a supernetwork model of the public's sentiments in cyberspace. Throughout the event, agents made 20 evaluations, comprising three pieces of environmental data and eight psychological categories. After COP 27 in Scotland, there were two peaks in public posting. We identified all agents throughout the event and the corresponding environmental data, psychological categories, and keywords. From these data, an online public opinion supernetwork model was developed (Table 2).

4.1. Superedges of the COP 27 conference

Table 3 displays several examples of this model's superedges, where each line signifies a superedge SE_i generated by a particular agent a_i. Next, the columns characterize the ecological information type e_m and the psychological type p_j. The columns indicate the agent's opinion type k_n. Only an agent, some information about the surrounding environment, a psychological type, and several keywords are included in each superedge.

4.2. Superedge degree (LSE)

In a supernetwork, it may be said that two superedges connected by the same node are considered supersedes. According to Wang et al. (2010), Superedge Degree is the total number of other Superedges connected to a certain Superedge through its nodes. For instance, in the abovementioned straightforward online public opinion supernetwork model, LSE1 = 49 (Table 4).

4.3. The attribute of influential degree of information dissemination

The climate change subnetwork contains all the information that was made public about a particular climate change news event during its inception and growth (let's assume there are N pieces). Each piece of information corresponds to one information node, e_i ($1 \leq i \leq n$). The influential degree of information distribution, or $I(e_i)$, is defined as the degree to which certain types of information are effective. Two indices—the breadth of information dissemination $R(e_i)$ and the depth of information dissemination $D(e_i)$—are used to quantify the influence of information dissemination.

The breadth of information dissemination: The scope of information dissemination is determined by the total frequency of information occurring in the public online opinion supernetwork model and the total number of superedges, or, more specifically, by the ratio of connected superedges of ei to the total number of superedges in the model is.

$$R(e_i) = \frac{F(e_i)}{N} \tag{3}$$

where 'N' is the total number of superedges in this climate change news supernetwork model, and $F(e_i)$ is the number of linked superedges of information e_i.

Depth of information dissemination $D(e_i)$: This refers to the extent to which TikTok influencers distribute information and is determined by the overall frequency of the information piece/blogs/posts/reels in superedges and the number of followers in the social subnetwork that is influenced by it.

$$D(e_i) = \frac{F(e_i)/A(e_i)}{N/N_a} \tag{4}$$

where $F(e_i)$ denotes the quantity of information e_i's related superedges; In this climate change news supernetwork model, $A(e_i)$ stands for the number of followers jointly building superedges with knowledge in social subnetworks, N for the total number of superedges, and Na for the total number of followers in social subnetworks.

According to those mentioned above, the depth and breadth of information dissemination work together to determine the influential degree of information dissemination $I(e_i)$. The equation is as follows:

$$I(e_i) = R(e_i) \times D(e_i) = \frac{F(e_i)^2 \times N_a}{(N)^2 \times A(e_i)} \tag{5}$$

The climate change subnetwork of this well-established, essential climate change news model entirely consists of three information nodes. Table 5 displays the computation results for the degree of information diffusion influence.

4.4. Transformation relations among psychological types

The netizens that publish material or blogs to engage in the

Table 3
Superedges oef the COP 27 conference.

Climate change news																
				Positive						Neutral		Negative				
Sei	Ai	ei	pi	k1	k2	k3	k4	k5	k6	k7	k8	k9	k10	k11	k12	k13
Se1	LW	e1	1	1	0	1	1	1	0	0	0	1	1	0	1	0
Se2	Wind Aid	e2	2	0	1	1	0	1	0	1	0	0	0	1	0	0
Se3	Mr Xiaobo	e3	3	1	1	1	1	1	0	0	1	0	0	1	1	0
Se4	HN	e1	1	0	1	0	1	1	0	1	1	0	1	0	1	0
Se5	CWE	e3	0	0	0	1	1	1	0	1	0	0	0	1	1	1
Se6	WE	e2	1	0	1	1	1	0	1	0	1	0	1	1	0	1
Se7	CSP	e3	−1	1	0	1	0	0	1	0	1	1	1	1	0	1
Se8	JSW	e2	1	0	1	1	0	1	0	1	1	1	0	0	1	0
Se9	SDL	e1	3	1	1	1	0	1	0	0	1	0	0	1	0	0
Se10	MV	e1	1	1	1	1	0	0	1	1	1	1	1	0	0	1
Se11	DISR	e2	2	1	0	0	1	1	1	1	0	0	1	0	0	1
Se12	Miss Guo	e3	−3	1	0	0	0	0	0	1	1	1	0	1	1	1
Se13	CW	e3	0	0	1	1	1	0	1	0	0	1	1	0	1	1
Se14	NWI	e1	−1	1	0	1	0	0	1	1	1	1	1	0	1	1
Se15	CGN	e2	2	1	1	1	0	0	1	0	0	0	1	0	1	0
Se16	BJW	e3	0	0	1	0	1	0	1	0	0	0	1	0	1	1
Se17	Gao Han	e1	0	1	1	0	0	1	1	0	0	1	1	0	1	1
Se18	CPN	e2	1	0	0	0	1	0	1	1	1	0	0	0	0	1
Se19	SBJ	e3	−3	0	0	0	1	1	0	0	1	1	1	1	1	1
Se20	TTN	e2	0	0	1	1	0	0	1	0	0	0	1	0	1	1
Se21	UNEP	e1	1	1	0	0	0	1	0	0	1	0	0	0	0	1
Se22	HNE	e1	0	0	0	1	0	1	1	1	1	1	1	0	1	0
Se23	CMA	e3	−1	0	0	0	0	1	1	0	0	1	1	0	0	1
Se24	BB	e2	1	0	1	0	1	0	1	1	0	0	0	0	1	1
Se25	LH	e1	−3	0	0	0	0	0	0	0	1	0	1	0	1	1
Se26	CCTV News	e2	2	0	1	1	1	1	1	1	0	1	1	0	1	0
Se27	WTSF	e1	−1	0	0	1	0	1	1	0	0	1	0	1	1	1
Se28	TK	e3	−3	0	0	0	0	0	0	1	1	0	0	1	1	1
Se29	UNCF	e2	2	1	0	0	1	1	1	0	0	0	0	0	1	1
Se30	CMB	e3	−3	1	0	0	0	0	0	1	0	1	1	0	1	1
Se31	BJR	e2	−1	1	1	0	1	0	0	1	0	1	0	1	1	1
Se32	MEE	e1	−3	0	1	0	0	0	0	0	0	1	1	0	1	1
Se33	ENF	e2	1	1	0	1	0	0	1	0	1	0	1	0	1	0
Se34	CT	e2	−1	1	0	0	1	0	1	0	0	1	0	1	1	1
Se35	PS	e3	1	1	1	0	1	1	1	0	0	1	1	1	1	0
Se36	CBCDF	e3	0	1	1	1	0	1	0	1	1	1	1	1	0	1
Se37	BJPSD	e1	3	1	0	1	0	1	1	0	0	0	1	0	0	0
Se38	WWF	e3	1	0	1	0	1	0	1	1	1	0	0	1	1	0
Se39	CAAS	e2	0	1	1	0	1	0	1	1	0	1	1	1	0	1
Se40	CS	e1	3	0	1	0	1	1	1	0	1	0	1	0	0	0
Se41	AHE	e1	2	0	1	0	1	1	1	1	0	0	1	0	1	0
Se42	STM	e2	3	0	1	1	1	0	1	1	0	0	0	0	0	1
Se43	SSS	e1	2	1	1	1	1	1	1	1	0	0	1	1	1	1
Se44	GP	e3	4	1	1	1	1	0	1	0	0	0	0	0	1	0
Se45	SRR	e1	0	1	1	1	0	0	0	1	1	0	1	0	1	1
Se46	ICS	e1	−1	1	1	0	1	1	0	1	0	1	1	1	1	1
Se47	CSC	e3	1	1	1	1	0	1	0	1	0	1	0	1	1	0
Se48	HN	e2	0	1	0	1	0	1	1	0	0	1	1	1	0	1
Se49	CME	e2	4	1	1	1	1	0	1	1	1	1	0	0	0	0
Se50	ST	e1	0	1	0	1	0	0	1	1	1	0	1	0	1	1

conversation at the start and during the event's evolution are of various psychological kinds. The psychological nodes of the online public opinion supernetwork model have variable inclination and strength because different psychological types have distinct psychological tendencies. The psychological profiles of the agents can be determined by reading their internet posts or blogs. The definition of psychological type pi is an integer with a range of +1 to _1. Pi's positive and negative directions define psychological propensity, while Pi's absolute value determines psychological strength.

_ the negative psychological propensity, represented by pi <0, and psychological strength, represented by|pi|;

_ the positive psychological propensity, represented by pi >0, and psychological strength, represented by |pi|;

_ the neutral psychological propensity, represented by pi = 0, and psychological strength represented by |pi|.

After classifying each node in the psychological subnetwork, we quantify the transformation relations between node types across superedges. Taking any two superedges at random, if their psychological nodes have the same tendency and psychological strength, then these two superedges may be related. A relationship between two superedges is unlikely if their psychological preferences are opposed, and the disparity between their psychological strengths is significant. The formula p_{ij} describes the relationship between two personality types, p_i, and p_j. Here is the formula for calculating it:

$$p_{ij}\begin{cases} sign\left(p_i \times p_j\right)/|p_i - p_j|, & p_i \neq p_j \\ 1, & p_i = p_j \end{cases} \tag{6}$$

wherein $sign\left(p_i \times p_j\right)$ is a sign function. When $x \geq 0, sign(x) = 1$; when x < 0, sign(x) = −1.

Among the above-established simple online public opinion supernetwork model, there are a total of 6 psychological types. Let $p_1 = -3$, $p_2 = -2, p_3 = -1, p_4 = 1, p_5 = 2, p_6 = 3$. The calculated correlations among the 6 psychological types of this simple model are shown in

Table 4
Calculation of superedge degree.

Se1	LW	–	L(Se1) = 49
	e1	Se4,Se9,Se10,Se14,SE17,Se21,Se22,Se25,Se27,Se32, Se37,SE40,Se41,Se43,Se45,Se46,Se50	
	k1	Se3,Se7,Se9~Se12,Se14,Se15,Se17,Se21,Se29~Se31, Se33~Se37,Se39,Se43~Se50	
	k3	Se2,Se3,Se6~Se10,Se13~Se15,Se20,Se22,Se26,Se27, Se33,Se35~Se37,Se42~Se45,Se47~Se50	
	k4	Se3~Se6,Se11,Se13,Se16,Se18,Se19,Se24,Se26,Se29, Se31,Se34,Se35,Se38~Se44,Se46,Se49	
	k5	Se2~Se5,Se8,Se9,Se11,Se17,Se19,Se21~Se23,Se26, Se27,Se29,Se35~Se37,Se40,Se41,Se43,Se46~Se48	
	k9	Se7,Se8,Se10,Se12~Se14,Se17,Se19,Se22,Se23, Se26~Se27,Se30~Se32,Se34~Se36,Se39,Se46~Se49	
	k10	Se4,Se6,Se7,Se10,Se11,Se13~17,Se19,Se20,Se22,Se23, Se25,Se26,Se30,Se32,Se33,Se35~Se37,Se39~Se41, Se43,Se45,Se46,Se48,Se50	
	k12	Se3~Se5,Se8,Se12~Se17,Se19,Se20,Se22,Se24~Se35, Se38,Se41,Se43~Se47,Se50	

Table 5
Influential Degree of Information Dissemination.

ei	F(ei)	A(ei)	N	R(ei)	D(ei)	I(ei)
e1	18	18	50	0.36	0.24	0.0864
e2	17	17	50	0.34	0.16	0.0544
e3	15	15	50	0.3	0.36	0.108

Table 6
Transformation Relations among Psychological Types.

pij	P1	P2	P3	P4	P5	P6
P1	0.00	1.00	0.50	0.33	0.25	0.2
P2	1.00	0.00	1.00	0.50	0.33	0.25
P3	0.50	1.00	0.00	1.00	0.50	0.33
P4	0.33	0.50	1.00	0.00	1.00	0.5
p5	0.25	0.33	0.50	1.00	0.00	1.00
P6	0.2	0.25	0.33	0.5	1.00	0.00

Table 6.

4.5. The similarity of keywords in different superedegs

The vector space model (VSM) is frequently employed to determine object correlation coefficients. The TF-IDF method is based on the vector space model (VSM), which considers the frequency of distinct words in all texts and the higher resolution of this word across texts. This method is extensively employed for calculating text similarity. In this paper, we calculated the similarity of keywords from two distinct supersedes using the TF-IDF method. Following is the formula for the similarity between SE1 and SE2:

$$Sim(SE_1, SE_2) = Sim_{1,2} = COS\,\theta = \frac{\sum_{j=1}^{m} w_{1j} \times w_{2j}}{\sqrt{\left(\sum_{j=1}^{m} w^2{}_{1j}\right)\left(\sum_{j=1}^{m} w^2{}_{2j}\right)}} \tag{7}$$

wherein $w_{1j}$and w_{2j} represent the keyword j's weight in superedge SE_1 and superedge SE_2, respectively. Using the preceding formula, the calculated similarity of keywords in all superedges in a simple online opinion supernetwork model is shown in Table 7.

4.6. Online opinion leader identification

4.6.1. Ranking result of SuperedgeRank

In the basic online public opinion supernetwork model described previously, the attributes of superedges are calculated using the MATLAB programming tool and SuperedgeRank algorithm. The ranking of 17 superedges is displayed in Table 8.

4.6.2. Robustness

4.6.2.1. Mechanism of opinion leader identification. A single Internet user might show up in multiple superedges. The overall score of the superedges associated with an agent in a social subnetwork is found after all the superedges are ranked and calculated. The average score is then computed by adding each agent's node superdegree index. The leading agent is the one with the highest score.

We utilized the SuperedgeRank technique to rank all the superedges. Then, we identified opinion leaders using the online public opinion supernetwork model of the COP 27 Conference using the MATLAB programming tool. Table 9 shows the robust of identifying 10 leaders among the 50 respondents.

Table 9 displays a comprehensive hierarchy of influential individuals participating in The COP 27 meeting, specifically highlighting their categorization and related scores of influence. The table contains a wide range of significant entities, which have been grouped into four distinct groups: Internet influencers, Government officials, Scientists, and Producers. It is worth mentioning that the top 10 opinion leaders demonstrate comparatively higher influence ratings, which range from 0.758 to 0.629. These scores indicate their substantial influence in shaping conversations and spreading information within the framework of The COP 27 conference. These individuals, frequently portrayed as influential figures on the Internet, have significant roles in moulding public dialogue and help transmit messages, potentially serve as essential components of the communication methods employed by The COP 27

Table 7
Similarity of keywords in different superedegs.

Column1	Se1	Se2	Se3	Se4	Se5	Se6	Se7	Se8	Se9	Se10	Se11	Se12	Se13	Se14	Se15
Se1	1.00	0.34	0.67	0.57	0.57	0.40	0.53	0.57	0.46	0.50	0.57	0.43	0.67	0.63	0.62
Se2	0.34	1.00	0.63	0.51	0.68	0.47	0.32	0.68	0.73	0.45	0.34	0.34	0.32	0.30	0.37
Se3	0.67	0.63	1.00	0.67	0.67	0.63	0.50	0.67	0.87	0.47	0.40	0.53	0.50	0.47	0.58
Se4	0.57	0.51	0.67	1.00	0.57	0.53	0.27	0.71	0.46	0.50	0.57	0.43	0.53	0.50	0.46
Se5	0.57	0.68	0.67	0.57	1.00	0.53	0.40	0.57	0.46	0.38	0.57	0.57	0.53	0.50	0.31
Se6	0.40	0.47	0.63	0.53	0.53	1.00	0.75	0.40	0.58	0.71	0.53	0.40	0.75	0.59	0.58
Se7	0.53	0.32	0.50	0.27	0.40	0.75	1.00	0.40	0.58	0.82	0.53	0.67	0.63	0.82	0.58
Se8	0.57	0.68	0.67	0.71	0.57	0.40	0.40	1.00	0.62	0.63	0.29	0.57	0.53	0.63	0.46
Se9	0.46	0.73	0.87	0.46	0.46	0.58	0.58	0.62	1.00	0.54	0.31	0.46	0.29	0.41	0.50
Se10	0.50	0.45	0.47	0.50	0.38	0.71	0.82	0.63	0.54	1.00	0.63	0.63	0.71	0.89	0.68
Se11	0.57	0.34	0.40	0.57	0.57	0.53	0.53	0.29	0.31	0.63	1.00	0.43	0.53	0.63	0.46
Se12	0.43	0.34	0.53	0.43	0.57	0.40	0.67	0.57	0.46	0.63	0.43	1.00	0.40	0.76	0.31
Se13	0.67	0.32	0.50	0.53	0.53	0.75	0.63	0.53	0.29	0.71	0.53	0.40	1.00	0.71	0.72
Se14	0.63	0.30	0.47	0.50	0.50	0.59	0.82	0.63	0.41	0.89	0.63	0.76	0.71	1.00	0.68
Se15	0.62	0.37	0.58	0.46	0.31	0.58	0.58	0.46	0.50	0.68	0.46	0.31	0.72	0.68	1.00

Table 8
Superedge ranks.

Rank	SuperedgeRank value	Superedge number
1	0.758	3
2	0.749	7
3	0.723	1
4	0.712	4
5	0.708	9
6	0.699	5
7	0.693	10
8	0.691	6
9	0.685	2
10	0.677	14
11	0.669	17
12	0.653	8
13	0.649	15
14	0.633	12
15	0.626	11
16	0.611	19
17	0.608	18
18	0.597	22
19	0.59	13
20	0.581	20
21	0.563	23
22	0.55	30
23	0.541	16
24	0.529	26
25	0.511	24
26	0.498	21
27	0.481	28
28	0.459	31
29	0.437	25
30	0.412	33
31	0.385	29
32	0.366	35
33	0.337	27
34	0.319	37
35	0.297	34
36	0.276	32
37	0.264	40
38	0.239	38
39	0.225	42
40	0.212	36
41	0.186	45
42	0.166	41
43	0.14	46
44	0.125	39
45	0.107	49
46	0.095	43
47	0.083	50
48	0.054	47
49	0.038	44
50	0.029	48

Table 9
Opinion leaders of The COP 27 conference.

Rank	Account	Type	Score
1	LW	Internet influencers	0.758
2	Wind Aid	Internet influencers	0.744
3	Mr. Xiaobo	Internet influencers	0.719
4	HN	Internet influencers	0.697
5	CWE	Internet influencers	0.684
6	WE	Internet influencers	0.665
7	JSW	Government	0.655
8	SDL	Internet influencers	0.648
9	MV	Government	0.638
10	DISR	Internet influencers	0.629
11	Miss Guo	Internet influencers	0.609
12	CSP	Internet influencers	0.587
13	Gao Han	Internet influencers	0.557
14	CPN	Government	0.549
15	SBJ	Government	0.528
16	TTN	Internet influencers	0.509
17	UNEP	Internet influencers	0.497
18	HNE	Government	0.476
19	CMA	Government	0.455
20	BB	Internet influencers	0.438
21	LH	Internet influencers	0.419
22	CW	Government	0.398
23	NWI	Government	0.385
24	CGN	Government	0.364
25	BJW	Government	0.348
26	CCTV News	Government	0.329
27	WTSF	Scientist	0.318
28	TK	Scientist	0.298
29	AHE	Government	0.287
30	CMB	Producer	0.276
31	BJR	Government	0.265
32	MEE	Government	0.248
33	ENF	Producer	0.229
34	CT	Producer	0.211
35	PS	Scientist	0.197
36	CBCDF	Producer	0.184
37	BJPSD	Producer	0.165
38	WWF	Producer	0.154
39	CAAS	Scientist	0.148
40	UNCF	Producer	0.134
41	CS	Scientist	0.122
42	STM	Scientist	0.109
43	SSS	Scientist	0.964
44	GP	Producer	0.837
45	SRR	Scientist	0.639
46	ICS	Scientist	0.432
47	CSC	Scientist	0.293
48	HN	Producer	0.197
49	CME	Scientist	0.138
50	ST	Scientist	0.093

meeting.

The subsequent section of the table expands its scope to embrace a wider range of opinion leaders, so indicating the active involvement of individuals from various backgrounds, including government officials, scientists, and producers. Although the impact ratings may exhibit variability, they add to the intricate discourse around The COP 27 summit. This ranking offers a comprehensive viewpoint on the various stakeholders engaged in the event, emphasizing the presence of renowned institutions such as the United Nations Environment Programme (UNEP) alongside relatively unfamiliar online influencers. Each stakeholder assumes a unique role within the information ecosystem about climate-related deliberations at The COP 27 conference.

4.7. Networks of four attributes

4.7.1. Government network under the theme of climate disaster

Fig. 3 shows the government network under the theme of climate disaster from 1st October 2022 to 31st December 2022 using the Netdraw visualization tool in UCINET software (UCINET v6.0, Analytic Technologies, Lexington, KY, USA). The spatial correlation link of the government network for climate disasters was evaluated, and the association matrix was developed. It can be seen that there is a meaningful spatial network link between government news networks in China, and it can be detected that the network shape is consistent with typical network structure characteristics. It is displayed that CMA, CW, NWI, CCTV News, GSW, and BJR networks are closely related to others shown in Fig. 3.

Table 10 displays the primary analysis of the Government network in China concerning the catastrophic disaster theme of climate change. CMA, CW, NWI, CCTV News, GSW, and BJR are the most central of the six networks since they are the most established and have the most ties to other networks dealing with disasters. The SBJ, BJW, CGN, MEE, AHE, and MV nodes are centrally situated in disaster-related networks.

There would then be less of an impact from those disaster-themed ideas spreading to other areas. This study examines 14 government networks, including receiving and transmitting nodes, by counting each network's associations. In the aftermath of climate-related and natural disasters, social media has emerged as the primary means of information

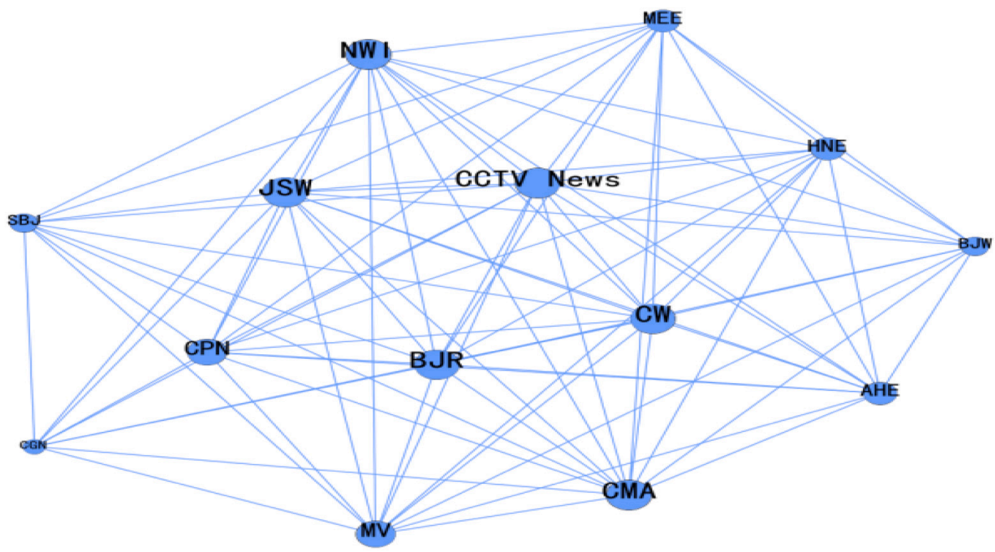

Fig. 3. Government network under the theme of climate disaster from 1st October 2022 to 31st December 2022.

Table 10
Centrality Analysis of Government Network under the Climate Disaster Theme.

Account	Degree	Closeness centrality	Betweenness centrality
CMA	13	1	1.055988
CW	13	1	1.055988
CGN	9	0.764706	0
NWI	13	1	1.055988
CCTV News	13	1	1.055988
JSW	13	1	1.055988
MEE	11	0.866667	0.447222
AHE	11	0.866667	0.190909
HNE	11	0.866667	0.190909
MV	12	0.928571	0.840079
CPN	12	0.928571	0.688131
BJR	13	1	1.055988
BJW	10	0.8125	0.090909
SBJ	10	0.8125	0.215909

dissemination. It allows for disseminating information from various sources, providing mutual help through information exchange and emotional support, and maintaining contact if more conventional means of communication become unavailable. Despite this, some wonder if the added value of social media is worth the effort. Numerous case studies demonstrate how social media's role and importance in emergencies differ across contexts. Many sources provide contradictory results, such as comparing people's trust in social media to their trust in more established, government-led sources and venues. More broadly, in environmental policy, the Chinese government has attempted to strengthen the role of public engagement in decision-making. The Environmental Impact Assessment (EIA) Law has required enhanced public participation since 2002. The 2015 Environmental Protection Law includes a lengthy chapter on increasing participation and transparency in environmental information (He et al., 2017; Zhang et al., 2016).

4.7.2. *The internet influencers network under the climate disaster theme*

The correlation between internet influencers and climate disaster news themes from 1 October 2022 to 31 December 2022 using the Netdraw visualization tool in UCINET software (UCINET v6.0, Analytic Technologies, Lexington, KY, USA). The spatial correlation link of internet influencers on climate disasters was evaluated, and the association matrix was developed. It can be seen that there is a significant spatial network correlation among internet influencers' networks in

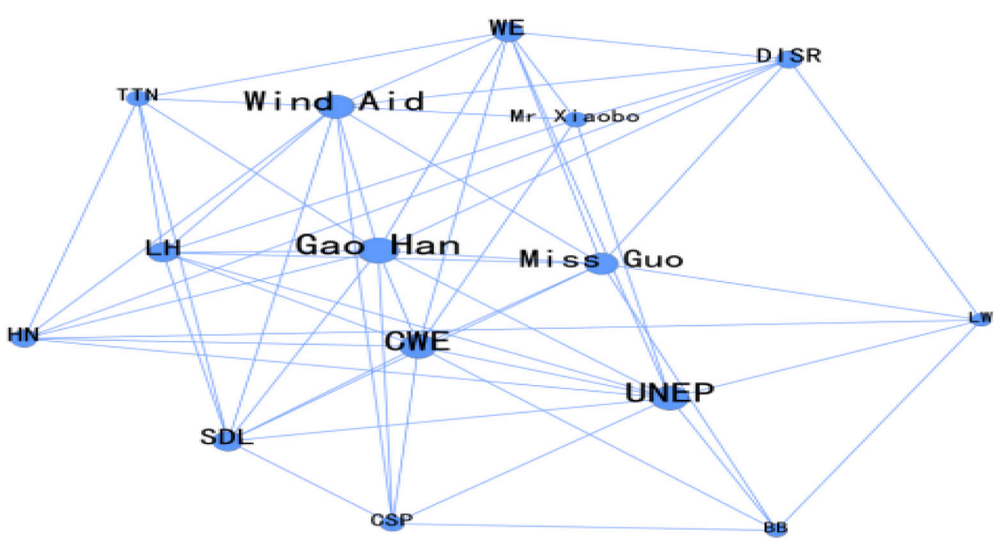

Fig. 4. Internet influencers network climate disaster from 1st October 2022 to 31st December 2022.

Table 11
Centrality analysis of internet influencers network under the climate disaster theme.

Account	Degree	Closeness centrality	Betweenness centrality
UNEP	10	0.777778	7.672682
CWE	10	0.777778	5.582206
Mr Xiaobo	6	0.636364	1.060714
HN	7	0.666667	3.309085
WE	8	0.7	2.518609
Gao Han	11	0.823529	5.264098
LW	5	0.608696	1.428822
CSP	6	0.636364	1.425752
LH	8	0.7	2.118609
SDL	8	0.7	1.954574
BB	5	0.583333	1.092857
Miss Guo	9	0.736842	5.814348
Wind Aid	10	0.777778	5.481454
DISR	7	0.666667	2.4
TTN	6	0.608696	0.87619

Table 12
Centrality analysis of scientists' network under the climate disaster theme.

Account	Degree	Closeness centrality	Betweenness centrality
PS	3	0.6	2
CS	2	0.428571	0
ICS	3	0.6	2
STM	4	0.75	9
WTSF	3	0.8	1
SSS	2	0.666667	0.333333
CAAS	3	0.8	0.333333
CSC	3	0.8	0.333333
CME	3	0.8	1
TK	3	0.6	2
SRR	2	0.428571	0
ST	3	0.6	2

Table 13
Centrality analysis of producers' network under the disaster theme.

Account	Degree	Closeness centrality	Betweenness centrality
HN	4	0.571429	19
WWF	2	0.533333	15
UNCF	3	0.444444	7
GP	2	0.421053	0
CT	1	0.380952	0
ENF	3	0.444444	13
BJPSD	1	0.32	0
CMB	1	0.32	0
CBCDF	1	0.32	0

China, and it can be observed that the network shape is stable with typical network structure characteristics. It is shown that Wind Aid, Gao Han, CWE, and UNEP have extensive networks and are closely related to each other against other influencers, as shown in Fig. 4.

The centrality analysis of internet influencers' networks under the climate disaster theme in China is shown in Table 11. It proves that the four internet influencers' networks have the highest centrality. The influencers' network with those themes is developed and has more connections with each other. These networks centre all influencers' networks, such as TTN, DISR, BB, LW, etc. In such instances, the disaster themes are more advantageous and less self-sufficient, resulting in less spillover. The number of associations in each network is analyzed, including the number of relationships sent and received, and 15 internet influencers' networks with the receiving and sending connections are explored.

Eco-influencers at the "forefront" of the environmental movement now hoard media attention, creating a positive feedback loop of greater engagement and more followers. The structure of social media promotes one's involvement with an issue to be focused solely on awareness. It is intended to entice consumers to spend hours reading through automated feeds. Users can like a single post from an eco-influencer and feel good about themselves for taking a position against climate disaster before moving on to watch cat videos.

Unlike influencers, grassroots organizers advocate directly inside communities, building bonds with citizens and their needs. They take accurate measures to divest institutions from fossil fuels, block the establishment of toxic industrial facilities in Black and brown neighborhoods, influence local legislators on environmental laws, and so much more. After raising awareness, they take the critical next step: to effect actual change (Bjorn, 2020). The focus on individual branding and personality in influencer culture is opposed to grassroots organizing. It establishes a hierarchy inside the climate movement, giving those with the most platforms more weight. The media encourages this endeavor by continuously spotlighting a few individuals as the "face of the movement," even though it is a group effort. Furthermore, these "faces" are rarely drawn from frontline communities, whose voices should be most heard.

4.7.3. Scientists' network under the climate disaster theme

The correlation between scientists and climate disaster themes from 1 October 2022 to 31 December 2022 using the Netdraw visualization tool in UCINET software (UCINET v6.0, Analytic Technologies, Lexington, KY, USA). The association matrix was created after analyzing the scientists' spatial correlation relationship with climate disasters. It can be seen that there is insignificant spatial network association among scientists' networks in China, and it can be viewed that the network shape is less consistent than typical network structure characteristics. It is shown that only STM have extensive networks.

Table 12 displays the centrality outcomes of the network of scientists in China for the climate issue. It demonstrates the most significant degree of centrality is in one scientist network only in the light of the fact that the scientists' network surrounding certain news subjects has grown slowly and has fewer links. These networks are essential to all scientists' networks, including CSC, ICS, WTSF, and others. There is less spillover in this case since the disaster topics are more beneficial and less self-sufficient. An analysis of 12 scientists' networks with receiving and sending relationships considers that each network's affiliations comprise the number of connections sent and received.

Scientists can affect climate change via popular media platforms like TikTok. These technologies let them visually explain complicated scientific concepts. Scientists may explain climate disasters, exchange research, and show their effects on society and the environment in short videos. They may dispel climate disaster myths by offering accurate and trustworthy facts. Scientists can also use TikTok to persuade viewers to embrace sustainable practices and make eco-friendly decisions (Rosa et al., 2022). They help people minimize their carbon footprints and fight climate disasters by giving practical solutions. These actions can be daily or lifestyle changes. TikTok users must also collaborate. Scientists can collaborate with peers, organizations, and influencers to develop content, compete, and expand their reach. Together, they can reach more people, boost engagement, and build a climate change community. Scientists on TikTok need audience involvement. They can answer climate change topics and communicate with viewers through comments, duets, and live sessions. It builds trust, credibility, and communication.

4.7.4. Producer networks under the climate disaster theme

Using the Netdraw visualization tool in the UCINET programme (UCINET v6.0, Analytic Technologies, Lexington, KY, USA), Fig. 6 depicts the relationship between producers and the climate disaster subject from October 1, 2022, to December 31, 2022. The association matrix was developed after examining the producers' correlation with climate disasters. The network form is less stable with typical network structure features, and it is evident that there is not a sizeable geographical

Table 14
The fifty subjects Pagerank ranking.

Account	Type	Pagerank (after 50 iterations)
CW	Government	0.032278
NWI	Government	0.032278
CCTV News	Government	0.032278
CMA	Government	0.030999
BJR	Government	0.028451
MV	Government	0.02835
JSW	Government	0.027737
Gao Han	Internet influencers	0.027646
Wind Aid	Internet influencers	0.02514
AHE	Government	0.02472
LH	Internet influencers	0.023894
MEE	Government	0.023269
UNEP	Internet influencers	0.022013
SBJ	Government	0.021904
CPN	Government	0.021848
Miss Guo	Internet influencers	0.021833
HNE	Government	0.020174
SDL	Internet influencers	0.01994
HN	Internet influencers	0.019906
LW	Internet influencers	0.019703
WE	Internet influencers	0.019583
BJW	Government	0.019567
CGN	Government	0.019361
DISR	Internet influencers	0.019348
CWE	Internet influencers	0.019342
ENF	Producer	0.019287
HN	Producer	0.018939
TTN	Internet influencers	0.018822
SSS	Scientist	0.018742
WTSF	Scientist	0.018696
CS	Scientist	0.018647
STM	Scientist	0.018372
ST	Scientist	0.018176
WWF	Producer	0.018044
PS	Scientist	0.017958
TK	Scientist	0.01631
CSP	Internet influencers	0.01616
UNCF	Producer	0.016132
SRR	Scientist	0.016012
Mr Xiaobo	Internet influencers	0.015744
CT	Producer	0.015729
CAAS	Scientist	0.015729
CMB	Producer	0.015398
ICS	Scientist	0.014845
CSC	Scientist	0.01379
BB	Internet influencers	0.01368
GP	Producer	0.012612
BJPSD	Producer	0.011691
CME	Scientist	0.010742
CBCDF	Producer	0.008181

network association among Chinese producers. Compared to other producers, it has been demonstrated that only HN, UNCF, and ENF have substantial networks and are strongly connected to others.

Table 13 displays the centrality investigation of the network of producers in China for the climate change news issue. It demonstrates that the most remarkable centrality is only among the two producers' networks. Producers in China have considerable sway over climate change reporting thanks to their ability to shape coverage through editorial decisions, story structuring, source selection, the introduction of possible biases or sensationalism, and collaboration with advertisers (Manish et al., 2022). What the general population thinks and knows about climate change largely depends on their decisions. However, ethical producers may raise awareness and develop educated dialogues by encouraging accurate and fair reporting. Producers with a sense of responsibility will see the significance of delivering thorough and truthful coverage of climate change. They try to underline the issue's urgency, provide several viewpoints, and underscore the scientific agreement. They help educate the public, stimulate thoughtful debate, and propel China's climate change response.

Producers as content creators on social media platforms such as TikTok can influence consumer behavior and indirectly affect climate disasters. They can encourage their audience to make more climate-conscious decisions by creating and promoting content emphasizing sustainable practices, eco-friendly products, and responsible consumption (Jiang et al., 2021). Producers can set trends, influence purchasing decisions, and nurture climate change conversations, increasing followers' awareness and inspiring action. Collaborations with environmental organizations and activists can magnify their impact even further. However, producers must also consider their ecological footprint and implement sustainable production methods. Overall, TikTok producers have the potential to influence public attitudes and actions regarding climate change mitigation significantly.

4.7.5. *The algorithm of page rank*

The PageRank results dated 31st December 2022 are, once again, somewhat interesting. In the top position, we find in Fig. 7 that seven internet influencers have higher page rank values. Fig. 7 shows that pink nodes represent internet influencers against the government, scientists, and producers. We have used 50 TikTok accounts of internet influencers, government, scientists, and producers to check their impact on climate disasters. The government has a significant impact on climatic disasters.

Influencers may impact climate disaster reportage online. They can alter their views due to their big audience and curiosity. Influencers use personal tales to make the issue more approachable and promote sustainable behaviors. Working with others raises awareness. Influencers must be accountable and know the truth. Influencers may inspire climate action.

Online influencers may also disseminate climate disaster narratives. They can highlight the disproportionate impact of climate disasters on the poor and marginalized. These personal narratives may help influencers raise awareness of climate change-related social justice and equity issues. Influencers can also encourage audience involvement and action. They may mobilize their audience by endorsing climate-related causes, encouraging climate strikes, and striking themselves. Together, we can raise awareness of climate disasters and urgency about finding answers.

Opinion leaders must verify their data and sources. "Greenwashing" can hinder climate disaster efforts. Influencers who care about their reputation should check their heads and cooperate with recognized scientists. Finally, internet influencers disseminate climate disasters, encourage sustainable practices, offer a range of narratives, and mobilize their followers. Their impact may help people understand climate disasters and act individually and collectively (Table 14).

5. Case study (disaster: super cold wave in the United States, December 23rd-28th, 2022)

The winter storm dubbed Elliott by forecasters intensified into a bomb cyclone near the Great Lakes on Friday, bringing high winds and blizzard conditions from the Northern Plains to western and upstate New York, along with life-threatening flooding, flash-freezing, and travel pandemonium as it moved. With an estimated width of 2000 miles, the storm has produced blizzard-like conditions and plunging temperatures, taking out power from Texas to Maine. Forecasters in the United States have warned of "potentially crippling impacts across the central and eastern United States."

It is estimated that >1.5 million households were without electricity due to the advent of the Arctic blast. After Joe Biden was briefed on Elliott at the White House, the president stated, "This is not like a snow day when you were a child. It is imperative." National Weather Service (NWS) forecaster Bob Oravec estimated that approximately 200 million individuals in the 48 contiguous states were under severe weather alerts. An advisory warned that a powerful cold front would engulf the eastern United States tonight, with pervasive, dangerous cold expected to persist across most of the eastern two-thirds of the country through the holiday

Table 15
Environmental view, psychological view, and main opinions of super cold wave (23rd-28th December 2022).

		Example	
Environmental subnetwork under the disaster theme	3	E1	It is the largest cold alert ever.
		E2	The main flights have been cancelled.
		E3	Gas production plummeted.
		E4	The price of food has increased many times.
Psychological subnetwork under the theme of disaster	8	The psychological tendency can be divided into positive, neutral, and negative, and the psychological intensity is determined by the number of keywords with opinion tendency published by the corresponding subject.	
View the subnetwork under the disaster theme	20	Positive view	K1: The United States should actively respond to climate disasters.
			K2: The consequences of climate disasters should be taken seriously.
			K3: The government can do an excellent job in post-disaster reconstruction.
		Neutral view	K4: Mankind should discuss how to prevent climate disasters.
			K5: Mankind does not understand the consequences of climate disasters.
		Negative view	K6: Climate disasters do not affect humanity.
			K7: Climate disasters are inevitable.
			K8: Mankind is powerless against climate disasters.
			K9: Mankind should not exploit nature.
			K10: The consequences of climate disasters are severe.
			K11: Mankind should not develop the economy.
			K12: Climate disasters are rumors.

Table 16
Calculation of superedge degree of super cold wave.

Se1	LW	–	L
	e1	Se4,Se9,Se10,Se14,SE17,Se21,Se22,Se25,Se27,Se32, Se37,SE40,Se41,Se43,Se45,Se46,Se50	(Se1) = 49
	k1	Se3,Se7,Se9~Se12,Se14,Se15,Se17,Se21,Se29~Se31, Se33~Se37,Se39,Se43~Se50	
	k3	Se2,Se3,Se6~Se10,Se13~Se15,Se20,Se22,Se26,Se27, Se33,Se35~Se37,Se42~Se45,Se47~Se50	
	k4	Se3~Se6,Se11,Se13,Se16,Se18,Se19,Se24,Se26,Se29, Se31,Se34,Se35,Se38~Se44,Se46,Se49	
	k5	Se2~Se5,Se8,Se9,Se11,Se17,Se19,Se21~Se23,Se26, Se27,Se29,Se35~Se37,Se40,Se41,Se43,Se46~Se48	
	k9	Se7,Se8,Se10,Se12~Se14,Se17,Se19,Se22,Se23, Se26~Se27,Se30~Se32,Se34~Se36,Se39,Se46~Se49	
	k10	Se4,Se6,Se7,Se10,Se11,Se13~17,Se19,Se20,Se22,Se23, Se25,Se26,Se30,Se32,Se33,Se35~Se37,Se39~Se41, Se43,Se45,Se46,Se48,Se50	
	k12	Se3~Se5,Se8,Se12~Se17,Se19,Se20,Se22,Se24~Se35, Se38,Se41,Se43~Se47,Se50	

Table 17
Influential Degree of Information Dissemination.

ei	F(ei)	A(ei)	N	R(ei)	D(ei)	I(ei)
e1	18	18	50	0.36	0.24	0.0864
e2	17	17	50	0.34	0.16	0.0544
e3	15	15	50	0.3	0.36	0.108

weekend. "Rapid temperature drops, sometimes 50 degrees or colder than the previous day," Oravec told the Associated Press. "It's a fairly effective system." This event attracted the attention of many social media users as well. We identified all agents throughout the event and the corresponding environmental data, psychological categories, and keywords. From these data, an online public opinion supernetwork model was developed (see Table 15).

5.1. Superedge degree (LSE)

In a supernetwork, it may be said that two superedges connected by the same node are considered supersedes. According to Wang et al. (2010), Superedge Degree is the total number of other Superedges connected to a certain Superedge through its nodes. For instance, in the abovementioned straightforward online public opinion supernetwork model, LSE1 = 49 (Table 16).

5.2. The attribute of influential degree of information dissemination

The climate change subnetwork contains all the information that was made public about a particular climate change news event during its inception and growth (let's assume there are N pieces). Each piece of information corresponds to one information node, e_i ($1 \leq i \leq n$). The influential degree of information distribution, or $I(e_i)$, is defined as the degree to which certain types of information are effective. Two indices—the breadth of information dissemination $R(e_i)$ and the depth of information dissemination $D(e_i)$—are used to quantify the influence of information dissemination.

This climate disaster subnetwork is well-established; the basic climate disaster model consists entirely of three information nodes. Table 21 displays the computation results for the degree of information diffusion influence.

Table 17 provides a complete assessment of the level of influence in disseminating information among three organizations referred to as e1, e2, and e3. These entities function as repositories of knowledge, and the table utilizes many important parameters to evaluate their influence inside their respective networks. The table provides an analysis of the count of persons who have been recipients of information from various entities (F(ei)), the count of individuals who have actively accepted or interacted with this material (A(ei)), and the overall size of the audience (N). The metrics R(ei) and D(ei) are used to assess each entity's level of information reach and engagement, respectively. Finally, the impact factor (I(ei)) is computed to offer a comprehensive viewpoint that considers both the reach and engagement elements. The table provides a quantitative analysis of the information dissemination strategies employed by these entities, as well as the extent of their audience reach and level of active involvement achieved.

Based on the analysis of these measures, it is apparent that the entities e1, e2, and e3 possess differing levels of impact. As an illustration, e1 achieves a 36 % reach among its audience, but e3, albeit attaining a smaller proportion of its audience (30 %), effectively engages a noteworthy 36 % of the reached individuals. These observations demonstrate the mechanisms of information propagation inside these organizations, providing a deeper understanding of the intricacies involved in the distribution and reception of information. The present research offers significant academic perspectives on the intricacies of information dissemination and its many ramifications inside networks.

5.3. Transformation relations among psychological types

The netizens that publish material or blogs to engage in the conversation at the start and during the event's evolution are of various psychological kinds. The psychological nodes of the online public opinion supernetwork model have variable inclination and strength because different psychological types have distinct psychological tendencies. The psychological profiles of the agents can be determined by

Table 18
Transformation Relations among Psychological Types.

pij	P1	P2	P3	P4	P5	P6
P1	0.00	1.00	0.50	0.33	0.25	0.2
P2	1.00	0.00	1.00	0.50	0.33	0.25
P3	0.50	1.00	0.00	1.00	0.50	0.33
P4	0.33	0.50	1.00	0.00	1.00	0.5
p5	0.25	0.33	0.50	1.00	0.00	1.00
P6	0.2	0.25	0.33	0.5	1.00	0.00

reading their internet posts or blogs. The definition of psychological type pi is an integer with a range of +1 to _1. P_i's positive and negative directions define psychological propensity, while p_i's absolute value determines psychological strength.

Among the above-established simple online public opinion supernetwork model, there are a total of 6 psychological types. Let $p_1 = -3$, $p_2 = -2$, $p_3 = -1$, $p_4 = 1$, $p_5 = 2$, $p_6 = 3$. The calculated correlations among the 6 psychological types of this simple model are shown in Table 18.

5.4. The similarity of keywords in different superedges

The vector space model (VSM) is frequently employed to determine object correlation coefficients. The TF-IDF method is based on the VSM, which considers the frequency of distinct words in all texts and the higher resolution of these words across texts. This method is extensively employed for calculating text similarity. In this paper, we calculated the similarity of keywords from two distinct superedges using the TF-IDF method. Using the preceding formula, the computed similarity of keywords in all superedges in a simple online opinion supernetwork model is shown in Table 19.

5.5. Online opinion leader identification

5.5.1. Ranking result of SuperedgeRank

In the basic online public opinion supernetwork model described previously, the attributes of superedges are calculated using the MATLAB programming tool and SuperedgeRank algorithm. The ranking of 17 superedges is displayed in Table 20.

5.5.2. Robustness

5.5.2.1. Mechanism of opinion leader identification. A single Internet user might show up in multiple superedges. The overall score of the superedges associated with an agent in a social subnetwork is found after all the superedges are ranked and calculated. The average score is then computed by adding each agent's node super degree index. The leading agent is the one with the highest score.

We utilized the SuperedgeRank technique to rank all the superedges. Then, we identified opinion leaders using the online public opinion supernetwork model of the COP 27 Conference using the MATLAB programming tool. Table 21 shows the robust of identifying ten leaders among the 50 respondents.

Table 21 presents an exhaustive compilation of thought leaders throughout the timeframe linked with the “Super Cold Wave.” The classification of these influential individuals is determined by their account names, account kinds, and ratings, which measure their impact or prominence in engaging with subjects about the Super Cold Wave. The various sorts of accounts may be broadly classified into four main categories: Internet influencers, Government officials, Scientists, and Producers.

The ranks allocated to each opinion leader are determined based on their respective scores, which serve as indicators of their relevance within the debate around the Super Cold Wave. It is worth mentioning that individuals who have gained prominence on the Internet referred to as “Internet influencers” in the “Type” column, occupy the highest ranks, with LW, Wind Aid, and Mr. Xiaobo securing the first three spots. The numerical scores allocated to each leader serve as quantitative indicators of their respective levels of influence, with higher scores denoting a greater impact in shaping debates and spreading information of the Super Cold Wave phenomenon. The chart shown above serves as a great tool for identifying prominent individuals who have made significant contributions in addressing and disseminating information about the Super Cold Wave phenomenon, notably through diverse internet platforms and channels.

The findings of this study illustrate the broad range of opinion leaders engaged in conversations on the Super Cold Wave. Internet influencers distinguish themselves by their exceptional influence ratings, underscoring their substantial impact on moulding the prevailing discourse. Government officials, scientists, and producers contribute significantly to the discourse, each providing distinct viewpoints and valuable knowledge.

It is crucial to acknowledge that the determination of impact scores relies on the SuperedgeRank algorithm, which considers the intensity of connections and interactions within the online public opinion supernetwork. The presented table offers useful insights into the key persons and institutions that have exerted the most substantial influence on the discourse around the Super Cold Wave.

6. Discussion and policy implications

6.1. Discussions

We analyze that the phenomena of “climate change news” and “disasters” encompass separate yet interconnected dimensions under the overarching subject of climate change as observed on the social media

Table 19
Similarity of keywords in different superedges.

Column1	Se1	Se2	Se3	Se4	Se5	Se6	Se7	Se8	Se9	Se10	Se11	Se12	Se13	Se14	Se15
Se1	1.00	0.37	0.40	0.47	0.17	0.55	0.47	0.37	0.47	0.47	0.85	0.63	0.45	0.40	0.45
Se2	0.37	1.00	0.18	0.43	0.62	0.67	0.43	0.50	0.58	0.43	0.46	0.43	0.82	0.55	0.41
Se3	0.40	0.18	1.00	0.63	0.51	0.37	0.47	0.55	0.63	0.47	0.68	0.47	0.45	0.20	0.75
Se4	0.47	0.43	0.63	1.00	0.67	0.72	0.75	0.58	0.63	0.75	0.67	0.75	0.71	0.47	0.82
Se5	0.17	0.62	0.51	0.67	1.00	0.46	0.53	0.62	0.80	0.53	0.29	0.40	0.63	0.51	0.76
Se6	0.55	0.67	0.37	0.72	0.46	1.00	0.58	0.50	0.58	0.58	0.62	0.72	0.82	0.37	0.54
Se7	0.47	0.43	0.47	0.75	0.53	0.58	1.00	0.43	0.50	0.88	0.53	0.88	0.71	0.63	0.82
Se8	0.37	0.50	0.55	0.58	0.62	0.50	0.43	1.00	0.72	0.58	0.46	0.58	0.68	0.37	0.54
Se9	0.47	0.58	0.63	0.63	0.80	0.58	0.50	0.72	1.00	0.63	0.53	0.63	0.59	0.63	0.71
Se10	0.47	0.43	0.47	0.75	0.53	0.58	0.88	0.58	0.63	1.00	0.53	0.88	0.71	0.79	0.71
Se11	0.85	0.46	0.68	0.67	0.29	0.62	0.53	0.46	0.53	0.53	1.00	0.67	0.63	0.34	0.63
Se12	0.63	0.43	0.47	0.75	0.40	0.72	0.88	0.58	0.63	0.88	0.67	1.00	0.71	0.63	0.71
Se13	0.45	0.82	0.45	0.71	0.63	0.82	0.71	0.68	0.59	0.71	0.63	0.71	1.00	0.45	0.67
Se14	0.40	0.55	0.20	0.47	0.51	0.37	0.63	0.37	0.63	0.79	0.34	0.63	0.45	1.00	0.45
Se15	0.45	0.41	0.75	0.82	0.76	0.54	0.82	0.54	0.71	0.71	0.63	0.71	0.67	0.45	1.00

Table 20
Ranking of superedge rank.

Rank	SuperedgeRank value	Superedge number
1	0.758	3
2	0.749	7
3	0.723	1
4	0.712	4
5	0.708	9
6	0.699	5
7	0.693	10
8	0.691	6
9	0.685	2
10	0.677	14
11	0.669	17
12	0.653	8
13	0.649	15
14	0.633	12
15	0.626	11
16	0.611	19
17	0.608	18
18	0.597	22
19	0.59	13
20	0.581	20
21	0.563	23
22	0.55	30
23	0.541	16
24	0.529	26
25	0.511	24
26	0.498	21
27	0.481	28
28	0.459	31
29	0.437	25
30	0.412	33
31	0.385	29
32	0.366	35
33	0.337	27
34	0.319	37
35	0.297	34
36	0.276	32
37	0.264	40
38	0.239	38
39	0.225	42
40	0.212	36
41	0.186	45
42	0.166	41
43	0.14	46
44	0.125	39
45	0.107	49
46	0.095	43
47	0.083	50
48	0.054	47
49	0.038	44
50	0.029	48

Table 21
Opinion leaders of the super cold wave.

Rank	Account	Type	Score
1	LW	Internet influencers	0.758
2	Wind Aid	Internet influencers	0.744
3	Mr. Xiaobo	Internet influencers	0.719
4	HN	Internet influencers	0.697
5	CWE	Internet influencers	0.684
6	WE	Internet influencers	0.665
7	JSW	Government	0.655
8	SDL	Internet influencers	0.648
9	MV	Government	0.638
10	DISR	Internet influencers	0.629
11	Miss Guo	Internet influencers	0.609
12	CSP	Internet influencers	0.587
13	Gao Han	Internet influencers	0.557
14	CPN	Government	0.549
15	SBJ	Government	0.528
16	TTN	Internet influencers	0.509
17	UNEP	Internet influencers	0.497
18	HNE	Government	0.476
19	CMA	Government	0.455
20	BB	Internet influencers	0.438
21	LH	Internet influencers	0.419
22	CW	Government	0.398
23	NWI	Government	0.385
24	CGN	Government	0.364
25	BJW	Government	0.348
26	CCTV News	Government	0.329
27	WTSF	Scientist	0.318
28	TK	Scientist	0.298
29	AHE	Government	0.287
30	CMB	Producer	0.276
31	BJR	Government	0.265
32	MEE	Government	0.248
33	ENF	Producer	0.229
34	CT	Producer	0.211
35	PS	Scientist	0.197
36	CBCDF	Producer	0.184
37	BJPSD	Producer	0.165
38	WWF	Producer	0.154
39	CAAS	Scientist	0.148
40	UNCF	Producer	0.134
41	CS	Scientist	0.122
42	STM	Scientist	0.109
43	SSS	Scientist	0.964
44	GP	Producer	0.837
45	SRR	Scientist	0.639
46	ICS	Scientist	0.432
47	CSC	Scientist	0.293
48	HN	Producer	0.197
49	CME	Scientist	0.138
50	ST	Scientist	0.093

platform TikTok. Within the "climate change news domain," TikTok functions as a medium for engaging in well-informed dialogues and disseminating educational material. Creators and outlets serve as platforms for disseminating up-to-date information on climate change policy, international agreements, and scientific research. Additionally, they provide movies that elucidate the underlying scientific principles of climate change, encompassing its origins, ramifications, and prospective remedies. The main objective of this information is to augment public comprehension, cultivate consciousness, and promote dialogue around climate change. The platform provides users with the necessary information to actively participate in well-informed discussions regarding significant global concerns, fostering collaborative efforts towards adopting sustainable behaviors and policies. The expansive reach of TikTok enables it to serve as an inclusive platform that caters to a diverse audience, facilitating their ability to remain educated and up-to-date on advancements in the field of climate change.

In contrast, the content on "disasters" on TikTok tends to prioritize highlighting the concrete and urgent consequences associated with climate change. This category frequently showcases live recordings and individual accounts of severe weather phenomena, such as extreme weather occurrences and natural catastrophes, as well as the subsequent consequences. Creators aim to increase public consciousness regarding the pressing nature of climate change by presenting the catastrophic consequences of wildfires, hurricanes, floods, and other calamities on societies, ecosystems, and physical structures. The videos effectively establish a connection with viewers by presenting a personal perspective on the hardships endured by those impacted by environmental catastrophes. These phenomena highlight the need of prompt action, the importance of being prepared for disasters, and the necessity of implementing steps to enhance resilience to climate change. Consequently, they stimulate discussions and inspire activism in response to catastrophes associated with climate change. The dissemination of climate change-related information and the portrayal of climate change-induced disasters on TikTok both serve significant purposes in teaching the general public about the phenomenon. While one approach focuses on providing factual knowledge, the other aims to convey the harsh reality and repercussions associated with climate change.

The role of governments as opinion leaders is crucial in tackling

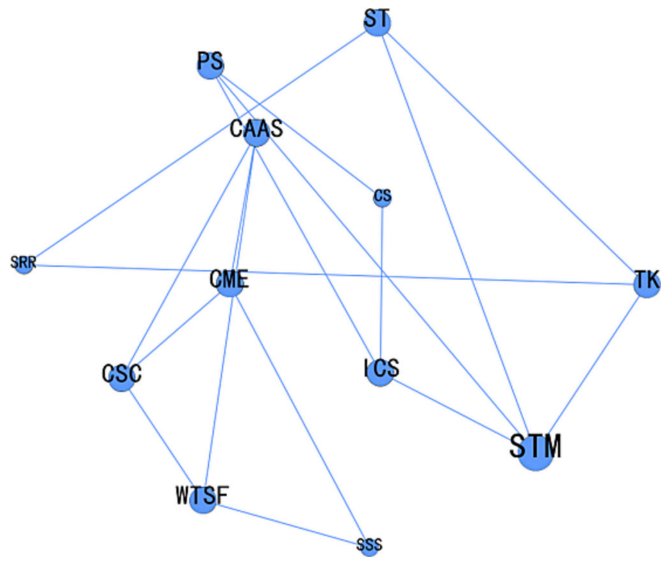

Fig. 5. Scientists' network under climate disaster theme from 1st October 2022 to 31st December 2022.

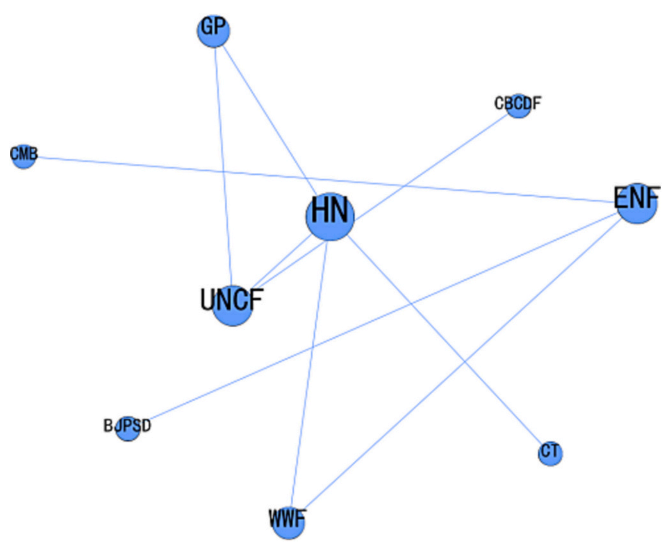

Fig. 6. Producers' network under climate disaster theme from 1st October 2022 to 31st December 2022.

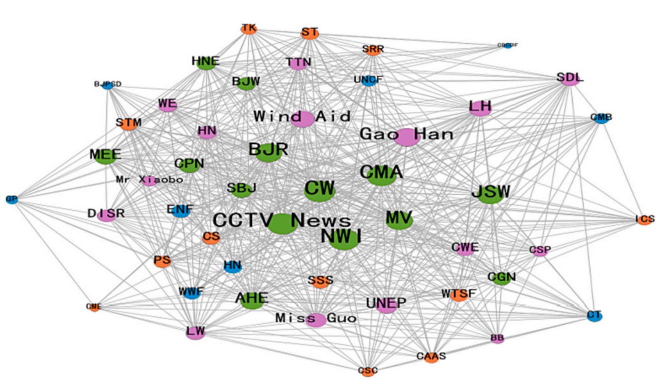

Fig. 7. The network of fifty subjects PageRank.

climate change and mitigating climate-related calamities. Policies, legislation, and international agreements are established to reduce climate change and enhance preparedness for climate-related calamities. The aforementioned components encompass emissions reduction objectives, renewable energy incentives, and disaster management strategies. Governments also allocate financial resources towards the support of climate research initiatives, as well as the provision of assistance and recovery measures in response to climate-related incidents. It is imperative for them to assume leadership roles in addressing climate change, both inside their own country and on an international scale, therefore serving as a model for the general populace and other relevant parties.

As opinion leaders, scientists also play a crucial role in leading climate change research. The provision of crucial data and analysis serves as the foundation for our comprehension of climate change and its associated consequences. The scope of their activity includes the surveillance of climatic patterns, the execution of environmental evaluations, and the anticipation of prospective calamities (Geels and Ayoub, 2023). In addition to disseminating their research within the scientific community, scientists also disseminate their results to various external audiences, including the general public, policymakers, and other relevant stakeholders. This serves the purpose of increasing public knowledge and understanding and offering evidence-based recommendations and guidance. They engage in partnerships with governmental entities and various groups to formulate and implement plans to reduce the impacts of climate change and effectively address its consequences.

Producers, encompassing both enterprises and industries, have a substantial role in the realm of climate change and catastrophe mitigation. Organizations can implement sustainable and ecologically conscious strategies, therefore mitigating emissions and minimizing their overall carbon footprint. Producers have the potential to make significant contributions towards fostering a more environmentally sustainable economy and mitigating the impacts of climate change via the development and implementation of eco-friendly goods and the use of green technology. Responsible manufacturing and efficient supply chain management practices can effectively mitigate the environmental consequences associated with the production and distribution of products and services. Producers can set a precedent and influence customers, encouraging them to adopt more sustainable behaviors.

The impact of internet influencers on the awareness of climate change is steadily increasing. They possess a distinctive capacity to effectively connect with and captivate a broad range of individuals via various social media channels. Internet influencers can utilize their widespread appeal to effectively promote public consciousness regarding climate change and its associated impacts. They could encourage environmentally conscious behaviors, endorse sustainable practices, and advocate for measures addressing climate change. Through leveraging their digital presence, individuals are able to impart knowledge and motivate their audience, so assuming a pivotal function in galvanizing public opinion and fostering collaborative efforts towards addressing climate change.

Internet Influencers have emerged as powerful agents of change in the context of climate news and awareness. Their influence can be attributed to a combination of key strategies, enabling them to shape public opinion and attitudes towards climate change effectively (Knupfer et al., 2023). Firstly, Internet Influencers wield the power of large and highly engaged audiences. With millions of followers across platforms like YouTube, Instagram, and TikTok, these influencers can reach a vast and diverse demographic (Roshandel et al., 2023). These audiences are more likely to interact with and share climate-related content, creating a ripple effect of awareness and engagement (Brüggemann et al., 2020).

Secondly, what sets Internet Influencers apart is their ability to convey complex climate-related topics in a relatable and accessible manner. They are skilled at translating scientific jargon and intricate environmental concepts into everyday language. This demystification of climate science makes it easier for the general public to grasp the urgency of environmental issues (Robinson et al., 2022). Additionally, influencers often employ storytelling and personal anecdotes to connect with their audiences connect with their audiences emotionally. This emotional appeal can be a powerful motivator, encouraging individuals to take climate action. Internet Influencers are adept at using visual and interactive content to capture and maintain audience attention. Videos, infographics, live streams, and interactive elements like polls and Q&A sessions make climate news informative and engaging (Luttrell, 2018). The interactive nature of these platforms fosters active participation and discussion, which are instrumental in sustaining climate conversations. Consistency and frequency in content creation also play a vital role. Influencers maintain a regular schedule of climate-related content, keeping the topic consistently in the public eye (Jin et al., 2013). This sustained focus serves to reinforce the importance of climate change in the minds of their followers.

Collaborations and partnerships are another key driver of their impact. Many influencers to collaborate with climate organizations, experts, and fellow influencers to broaden their reach and credibility. These collaborations introduce their audiences to diverse perspectives, ensuring a more holistic understanding of climate-related issues (Dupar et al., 2019). An essential component of their approach is direct engagement. Influencers actively interact with their followers by responding to comments and questions. This two-way dialogue creates a sense of community and fosters discussions about climate change, further fueling awareness and action (Martin and MacDonald, 2020). Leveraging trends and challenges is yet another influencer strategy. They often align their climate-related content with trending topics and popular challenges on social media platforms. This strategy capitalizes on the broader public interest in such trends and ensures that climate change remains relevant and visible in the online space (Leung et al., 2022). Finally, Internet influencers go beyond raising awareness. They actively advocate for concrete actions, motivating their audiences to participate in climate initiatives, projects, and environmental conservation efforts. Their calls to action empower individuals to contribute to addressing climate change at a personal level. In conclusion, Internet influencers have harnessed a combination of strategies and elements to convey climate news effectively and inspire their audiences to engage with the pressing issue of climate change. Their large and engaged audiences, relatable messaging, emotional appeal, visual and interactive content, consistency, partnerships, direct engagement, trend utilization, and advocacy collectively make them influential drivers of environmental awareness and action on a global scale.

6.2. Policy implications

To effectively address climate change challenges, fostering collaboration among diverse stakeholders is imperative. Government authorities, scientists, producers, and internet influencers should engage in joint efforts to formulate comprehensive climate communication strategies. This collaboration should extend to sharing accurate, up-to-date information and aligning their messaging to provide a unified front against climate change. This synergistic approach enables each group to leverage its strengths and reach, ultimately leading to more impactful climate change communication and intervention.

Internet influencers have emerged as influential opinion leaders in climate change news. Recognizing their reach and impact, governments and environmental organizations should proactively engage with these influencers. Collaborative campaigns and partnerships can be forged to harness their extensive reach and the trust they have built with their audiences. By aligning internet influencers with environmental causes and providing them with credible information and resources, it becomes possible to channel their influence towards raising climate awareness, changing behaviors, and inspiring collective action.

Given the pivotal role of government authorities as opinion leaders in addressing climate change disasters, there is a critical need to enhance disaster response mechanisms. Governments should invest in robust early warning systems, well-coordinated disaster relief efforts, and efficient communication strategies during climate-related emergencies. Being well-prepared for climate-induced disasters minimises their impact and fosters public trust in government leadership.

A cornerstone of effective climate change communication is public awareness initiatives. These initiatives should encompass both climate change news and disaster-related information. In collaboration with relevant stakeholders, governments should invest in campaigns that offer accurate, accessible, and engaging content to the public. These campaigns can cover climate change impacts, adaptation strategies, and eco-friendly behaviors. We can drive positive change and promote sustainable practices by providing the public with knowledge and actionable steps.

Understanding the psychological dynamics that underlie climate communication is crucial. It is possible to develop tailored intervention tactics by conducting in-depth research within psychological subnetworks. This may involve addressing climate misinformation, countering climate apathy, and promoting positive behavioral changes. Psychological insights are instrumental in designing messages that resonate with diverse audiences and inspire meaningful actions.

The proliferation of misinformation and rumors related to climate change necessitates swift and accurate responses. Governments and media organizations should establish robust fact-checking mechanisms to verify information and promptly clarify misconceptions or false narratives. Rapid responses to misinformation are essential to prevent the spread of misleading content and to ensure that the public receives accurate and reliable information.

The SuperedgeRank algorithm has proven to be a valuable tool for identifying influential voices and emerging trends in climate communication. Utilizing data-driven approaches can enable a deeper understanding of the evolving discourse on climate change. Analyzing the data makes it possible to identify shifting opinion leaders, evolving narratives, and emerging challenges. This data-driven approach informs more effective interventions and keeps climate communication strategies relevant.

It is vital to incorporate environmental education within the educational system to empower future generations with the knowledge and awareness to address climate change. Environmental topics, climate change impacts, and sustainable practices should be integrated into curricula at all levels. This educational approach equips students with the information and skills to become informed, responsible, and proactive participants in the fight against climate change.

In conclusion, a comprehensive strategy to address climate change requires a concerted effort from all stakeholders. By collaborating, engaging with internet influencers, enhancing disaster response, promoting public awareness, conducting psychological research, fact-checking, utilizing data-driven approaches, and emphasizing education, we can collectively tackle climate change and work towards a more sustainable future. When implemented effectively, these policies contribute to building a more resilient and informed society in the face of climate change and disaster challenges.

7. Conclusion

The effects of anthropogenic climate change are widely discussed in scientific publications, newspaper articles, and blogs. Newspaper articles may be inaccurate, while the gravity of scientific results may be too complex for the general people to comprehend. On the other hand, social media is a venue where people from all walks of life may communicate their thoughts and opinions. TikTok has become a significant resource for analyzing current events and breaking news as consumption switches from old to new media.

This study employs the supernetwork analysis method in identifying online public opinion leaders. It offers a Pagerank and SuperedgeRank algorithm based on the superedge ranking algorithm. First, this study briefly discusses climate change news and disasters, followed by an explanation of the development of an online public opinion supernetwork model, which primarily includes three subnetworks: environmental, psychological, and viewpoint subnetworks. Then, correlations among superedges of an established online public opinion supernetwork model are calculated, which consists of the influential degree of information dissemination, the likelihood of psychological transformation between different psychological types, and keyword similarity between different viewpoints. Based on these calculations, a new SuperedgeRank method is designed to compute and rank all of the superedges of the online public opinion supernetwork and the opinion leaders in the public event. 50 Chinese TikTok accounts were used, based on internet influencers, government, scientists, and producers. Finally, the COP 27th meeting on climate change" and the "United States super cold wave" are examples to demonstrate the reliability of Pagerank, the supernetwork analysis method, and the SuperedgeRank algorithm. We conclude that for climate change news, internet influencers play a significant role. Internet influencers are the prominent opinion leaders in Climate change news, and they have more superedges than the other three attributes. Internet influencer has more different viewpoints than the other three attributes. Meanwhile, in climate disasters, the government has the edge. The government is the prominent opinion leader in Climate change disasters. Government has more superedges than the other three attributes and has more different viewpoints than the other three attributes.

Following identifying opinion leaders in an online public opinion supernetwork, research can focus on deploying related guiding and interference techniques. These interference techniques do not function effectively and have occasionally sparked public outrage. We can find several types of critical nodes in the four layers using the SuperedgeRank algorithm. Subnetworks are a type of network. Then, various guidance and interference tactics can be devised. Opposing opinion leaders, for example, could be segregated in the social subnetwork, while positive opinion leaders should be safeguarded. After finding the crucial information in the climate change subnetwork, we may examine its time, language, and linguistic forms to determine why it is so influential. The dominant psychological type can be identified in the psychological subnetwork. Then, we can use psychological theories to analyze it, which may lead to improved intervention tactics. The mainstream viewpoint can be determined from the perspective of subnetworks from massive online posts. If this is a rumor, a prompt clarification would be immensely appreciated. As a result, we can perform numerous research with varying priorities in the supernetwork using the SuperedgeRank algorithm.

CRediT authorship contribution statement

Yunpeng Sun: Conceptualization, Data curation, Formal analysis, Methodology. **Ruoya Jia:** Investigation, Validation, Visualization, Writing – review & editing. **Asif Razzaq:** Conceptualization, Writing – review & editing. **Qun Bao:** Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft.

Data availability

The authors do not have permission to share data.

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Appendix A. Abbreviations, full form, and opinion leaders

Abbreviations	Full Form	Opinion Leaders
LW	Little Weather	Internet influencers
Wind Aid	Wild Aid	Internet influencers
Mr. Xiaobo	Xiaobo Weather	Internet influencers
HN	Headlines	Internet influencers
CWE	Chinese weather enthusiasts	Internet influencers
WE	Weather everyday	Internet influencers
CSP	Cold science	Internet influencers
JSW	Jiangsu weather	Government
SDL	Science Daily	Internet influencers
MV	Military vision	Government
DISR	Director of the Institute for the Paranormal Studies	Internet influencers
Miss Guo	Teacher Xiao Guo	Internet influencers
CW	China Weather	Government
NWI	National Warning Issued	Government
CGN	Chinese Government Network	Government
BJW	Beijing Weather	Government
Gao Han	Gao Han	Internet influencers
CPN	China Police Network	Government
SBJ	Safe Beijing	Government
TTN	TikTok natural	Internet influencers
UNEP	United Nations Environment Programme	Internet influencers
HNE	Henan environment	Government
CMA	China Meteorological Administration	Government
BB	Big Bang	Internet influencers
LH	Life Help	Internet influencers
CCTV News	CCTV News	Government
WTSF	Forum of the world's top scientists	Scientist
TK	True Knowledge	Scientist
UNCF	UNICEF	Producer
CMB	China Merchants Bank	Producer
BJR	Beijing Release	Government
MEE	Ministry of Ecology and Environment	Government
ENF	Earth Foundation	Producer
CT	Carbon Technology	Producer
PS	Panorama Scientist	Scientist
CBCDF	China Biodiversity Conservation and Green Development Foundation	Producer

(*continued on next page*)

(*continued*)

Abbreviations	Full Form	Opinion Leaders
BJPSD	Beijing Public Service Development	Producer
WWF	WWF	Producer
CAAS	China Academy of Aerospace Science	Scientist
AHE	Anhui Environment	Government
CS	Chinese Scientist	Scientist
STM	Scientific Time Machine	Scientist
SSS	Suyu Science Popularization	Scientist
GP	Greenpeace	Producer
SRR	Science Refutes Rumors	Scientist
ICS	Interviews with Chinese scientists	Scientist
CSC	Chinese Space Culture	Scientist
HN	Hello Nature	Producer
CME	Chinese Meteorological Expert	Scientist
ST	Science Travel	Scientist

Appendix B

B.1. Network matrices and properties

Degree Centrality: A node's degree of centrality in a complex network sequence can be defined as the fraction of the network's edges that go to the node (Wang et al., 2010). As a result, the degree centrality criteria may correspond to the links between nodes. The degree of centrality distribution highlights important nodes and may show topological elements of government news networks. De indicates the importance of a node in the network by counting the number of edges connecting it to other nodes. Calculating a node's degree centrality helps pinpoint its position across the web. If a node has the highest degree and has the most influence on the other nodes in the network, we call it the hub of the network. In a directed graph, the degree of each node is either a point-in degree or a point-out degree, with the former being more prevalent. The formula (1) below shows how to calculate the node's degree centrality De(i):

$$D_e = n/N - 1 \tag{1}$$

where 'n' represents the number of intermediate nodes between the target node and the whole network, and 'N' signifies the number of nodes in the network.

Betweenness Centrality: A node's betweenness centrality indicates how much power it has relative to other nodes in a network. Higher values are associated with more confidence in a node's ability to communicate and control its interactions with other nodes in the network. The value of 'Be' primarily represents the extent to which a node exerts control over the connections between different nodes. The bigger the 'Be' value, the more control the node has over the government networks' other nodes and how they communicate. Eq. (2) illustrates how to compute the betweenness centrality 'Be(i)' of a given node:

$$B_e = \sum_{j}^{n} \sum_{k}^{n} \frac{g_{jk}(i)}{g_{jk}}, j \neq k \neq ij < k \tag{2}$$

where g_{jk} stands for the number of the shortest paths between nodes j and k and $g_{jk}(i)$ stands for the number of paths that connect nodes j and k through node 'i', respectively.

Closeness Centrality: One may use closeness centrality to roughly calculate how far apart a particular node is from the rest of the nodes in each network. A node's centrality coefficient (Cl) is the inverse of the average shortest distance between that node and every other node in the network. The clustering coefficient quantifies the degree of proximity between nodes in a network. In a network, a node's centrality coefficient increases, and its connectivity to other nodes improves as the distance between that node and its neighbors decreases. It is the total distance of a node from every other node in the network, quantifying the degree to which that node is independent of the other nodes in the network. A higher score indicates that the node has more connections with other nodes, making it more difficult to control. A node's Cl value reflects its independence from neighboring nodes and ability to act. An increased Cl relative to other nodes suggests that the node is less likely to affect other nodes during government network formation. Calculating the closeness centrality "Cl(i)" of a given node 'i', as shown in Eq. (3), is a straightforward matter.

$$C_l = \sum_{j=1}^{n} d_{ij} \tag{3}$$

where 'dij' is the undeviating distance between the two nodes, 'i' and 'j,' here (i ≠j).

B.2. Networks of four attributes

B.2.1. Government network under the news theme

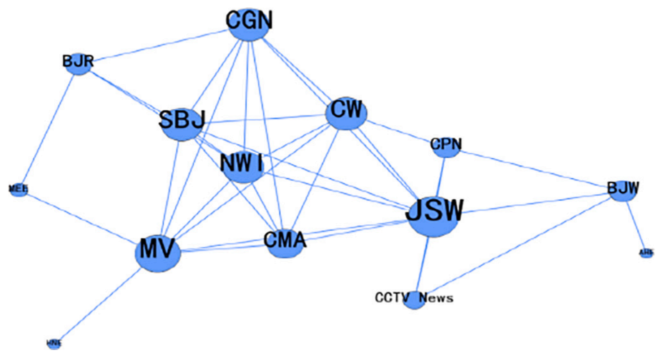

Fig. B1. Chinese government network climate change news from 1st October, 2022 to 31st December, 2022

Fig. B1 shows the Chinese government network climate change news from 1st October 2022 to 31st December 2022, employing the Netdraw visualization tool in UCINET software (UCINET v6.0, Analytic Technologies, Lexington, KY, USA). The spatial correlation link of government network news was evaluated, and the association matrix was developed. There is a significant spatial network connection between government news networks in China, and it can be seen that the network shape is persistent with typical network structure characteristics. It is shown that JSW, SBJ, NWI, CMA, and MV news networks are closely related to others shown in Fig. B1.

Table B1
Centrality analysis of government network under the news theme.

Account	Degree	Closeness centrality	Betweenness centrality
JSW	9	0.764706	29.5
MV	8	0.684211	20.5
CPN	4	0.52	1.5
SBJ	7	0.65	2.833333
BJW	4	0.52	12
NWI	7	0.65	2.833333
CGN	7	0.65	2.833333
CMA	6	0.619048	0
CW	7	0.65	4
CCTV News	3	0.5	0
MEE	2	0.448276	0.5
HNE	1	0.419355	0
BJR	4	0.464286	1.5
AHE	1	0.351351	0

The central analysis of the Government network under the new theme of climate change in China is depicted in Table B1. It verifies that the seven news networks have the maximum centrality in all associations: JSW, MV, NW1, CMA, SBJ, CGN, and CW. They considered that the network with those news themes is developed and has more connections with other news networks. These networks are central to news-related networks such as CPR, BW, CPN, etc.

There is less spillover in such instances since those news themes have an immense advantage and a lesser capacity for self-sufficiency. Fourteen government networks with receiving and sending dealings are examined, with the number of affiliations in each network considering the number of relationships transmitted and received. People between 18 and 24 are most likely to access alternative news sources. This age group uses social media three times more frequently than those over 55 to seek non-traditional sources of climate change information (Du et al., 2017). There is much conflicting information on climate change in the media since it is a divisive subject. The effect of factual knowledge on global climate change obtained from media sources relies on a person's media literacy, capacity to distinguish fact from fiction, and evaluation of political claims and judgments. Views and contributions on social media platforms may reflect broader attitudes and behaviors (Li et al., 2019). It is probably because social media networks are cost-free, easily accessible, and have few content limitations (Du et al., 2017).

B.2.2. The internet influencers network under the news theme

Fig. B2 shows the correlation between Chinese internet influencers on climate change news themes from 1st October 2022 to 31st December 2022 using the Netdraw visualization tool in UCINET software (UCINET v6.0, Analytic Technologies, Lexington, KY, USA). The spatial link of internet influencers on climate news was evaluated, and the association matrix was developed. There is an essential spatial network connection among internet influencers' networks in China, and it can be detected that the network shape is firm with typical network structure characteristics. It was revealed that Mr. Xiaobo, HN, CSP, CWE, Wind Aid, LW, and SDL have large networks closely related to other influencers, as demonstrated in Fig. 3.

The centrality analysis of internet influencers' networks under the climate change news theme in China is shown in Table B2. It proves that the seven internet influencer networks have the highest centrality. They are considering that the influencers' network with those news themes is developed and has more connections with each other. These networks are central to all influencers' networks, such as TTN, DISR, BB, UNFP, etc. In such instances, the news themes are more advantageous and less self-sufficient, resulting in less spillover. It analyzes that the number of connotations in each network contains the number of associations sent and received. Fifteen internet influencers' networks with the receiving and sending associations are analyzed.

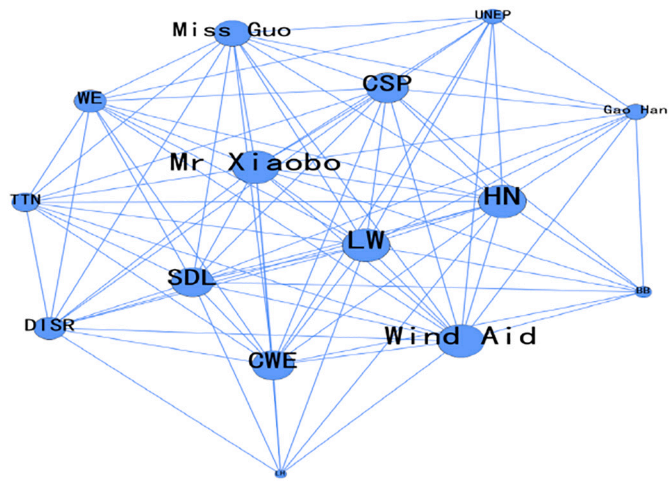

Fig. B2. Chinese internet influencers network climate change news from 1st October, 2022 to 31st December, 2022.

Table B2
Centrality Analysis of Internet Influencers Network under the News Theme

Account	Degree	Closeness centrality	Betweenness centrality
LW	14	1	2.71746
Wind Aid	14	1	2.71746
HN	14	1	2.71746
Mr Xiaobo	14	1	2.71746
CSP	13	0.933333	1.579365
CWE	13	0.933333	1.995635
WE	11	0.823529	0.361111
SDL	13	0.933333	2.013492
DISR	11	0.823529	0.571429
Gao Han	9	0.736842	0.378968
Miss Guo	12	0.875	0.882937
TTN	10	0.777778	0
LH	7	0.666667	0
UNEP	9	0.736842	0.236111
BB	8	0.7	0.111111

Regarding governing the world's climate, China is a major player since it is the largest producer of greenhouse gases (Larsen et al., 2021). Slowly but surely, China is becoming a leader alongside the United States in the fight against global climate change. Through their massive followings, ability to personalize and convey stories, social media activism, education and knowledge, partnerships with NGOs and companies, and even questioning official government narratives, Chinese internet influencers have a tremendous impact on how the public perceives climate change news. Influencers may rapidly share information and increase awareness about climate change due to their large audiences. They make the subject more accessible and exciting to their audience by relating personal anecdotes about their experiences.

Additionally, they use numerous social media sites to disseminate data, spark debate, and rally support for their causes. Some opinion leaders can help dispel myths and provide accurate information about the climate because of their knowledge and experience in the field. By combining their resources and audience, NGOs and companies may have a more significant effect through collaboration. Even though influencers periodically question official stories, they must work within the parameters established by the state. In sum, their work helps raise consciousness, inspires people to act, and shifts public opinion on climate change in China.

B.2.3. Scientists' network under the news theme

Fig. B3 shows the correlation between scientists and climate change news themes from 1 October 2022 to 31 December 2022 using the Netdraw visualization tool in UCINET software (UCINET v6.0, Analytic Technologies, Lexington, KY, USA). The association matrix was created after analyzing the scientists' spatial correlation relationship with climate news. It can be seen that there is a noteworthy spatial network connection among scientists' networks in China, and it can be analyzed that the network shape is less stable than typical network structure characteristics. It is publicized that only PS and CME have extensive networks and are closely related to each other against other scientists.

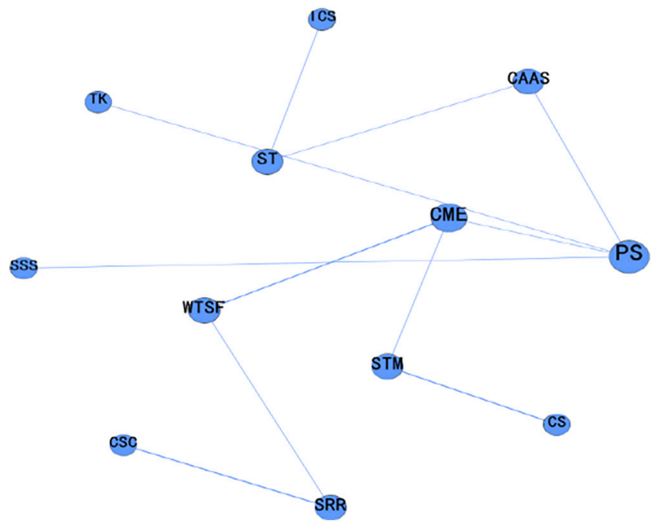

Fig. B3. Chinese Scientists' network climate change news from 1st October 2022 to 31st December, 2022

Table B3 displays the centrality investigation of the network of scientists in China for the climate change news issue. It demonstrates that the most extraordinary centrality is among the two scientists' networks only because the scientists' network surrounding certain news subjects has grown slowly and has fewer links. These networks are essential to all scientists' networks, including CSC, STM, CS, SRR, etc. There is less spillover in this case since the news topics are more beneficial and less self-sufficient. An analysis of 12 scientists' networks with receiving and sending relationships considers that each network's affiliations comprise the number of connections sent and received.

Chinese scientists have a significant effect on the media coverage of climate change. They contribute to our understanding of climate change by studying, producing scientific data, and suggesting policy changes. Their research adds to the sum of human knowledge and shapes media portrayals of the world. Scientists are working to inform the public and simplify the complexities of climate change through their public outreach activities. They work together globally and participate in assessments that help build agreement in the scientific community. The knowledge and work of Chinese scientists have impacted how the public views climate change, which has influenced policy and media coverage of the issue.

Table B3
Centrality analysis of scientists' network under the news theme.

Account	Degree	Closeness centrality	Betweenness centrality
WTSF	2	0.37931	18
CME	3	0.478261	36
CS	1	0.268293	0
STM	2	0.354839	10
CSC	1	0.234043	0
SRR	2	0.297297	10
TK	1	0.333333	0
PS	4	0.478261	37
ICS	1	0.234043	0
SSS	1	0.333333	0
CAAS	2	0.37931	18
ST	2	0.297297	10

B.2.4. Producer networks under the news theme

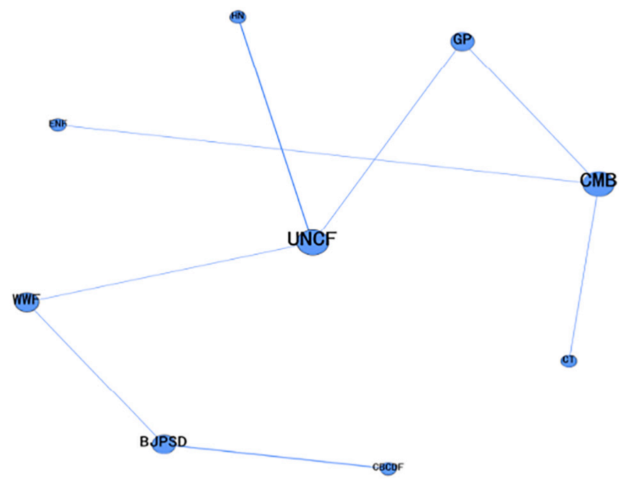

Fig. B4. Chinese producers' network climate change news from 1st October, 2022 to 31st December, 2022.

Using the Netdraw visualization tool in the UCINET program (UCINET v6.0, Analytic Technologies, Lexington, KY, USA), Fig. 5 depicts the relationship between producers and the climate change news subject from October 1, 2022, to December 31, 2022. The association matrix was developed after examining the producers' correlation with climate news. The network form is less consistent with typical network structure features, and it is evident that there is not a sizeable geographical network association among Chinese producers. Compared to other producers, it has been demonstrated that only UNCF and CMB have substantial networks and are strongly connected to others.

Table B4
Centrality analysis of producers' network under the news theme.

Account	Degree	Closeness centrality	Betweenness centrality
UNCF	3	0.5	19
HN	1	0.347826	0
CBCDF	1	0.258065	0
BJPSD	2	0.333333	7
WWF	2	0.421053	12
ENF	1	0.296296	0
GP	2	0.470588	15
CMB	3	0.4	13
CT	1	0.296296	0

Table B4 displays the centrality outcomes of the network of producers in China for the climate change news issue. It demonstrates that the most significant centrality is only among the two producers' networks. Producers in China have considerable sway over climate change reporting thanks to their ability to shape coverage through editorial decisions, story structuring, source selection, the introduction of possible biases or sensationalism, and collaboration with advertisers. What the general population thinks and knows about climate change largely depends on their decisions. However, ethical producers may raise awareness and develop educated dialogues by encouraging accurate and fair reporting. Producers with a sense of responsibility will see the significance of delivering thorough and truthful coverage of climate change. They try to underline the issue's urgency, provide several viewpoints, and underscore the scientific agreement. They help educate the public, stimulate thoughtful debate, and propel China's climate change response.

Also, producers may help increase the visibility of underrepresented groups in climate change coverage. Communities such as indigenous peoples and vulnerable populations disproportionately impacted by climate change can share their tales and viewpoints. This all-encompassing approach enables people from all walks of life to learn about climate change and its effects. It is also vital for scientists, journalists, and producers to work together. By working together, they may verify information, put it in perspective, and assure correct reporting. The coordinated effort improves the reliability of climate change reporting. It helps the public get a deeper comprehension of the subject. In conclusion, responsible Chinese producers emphasize truth, balance, and inclusion despite their ability to impact climate change news through editorial decisions, framing, and source selection. Their dedication to honest reporting and their willingness to work with scientists help spread information, stimulate thoughtful debate, and motivate people to take action in the face of climate change.

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