Crowding Out the Crowd：The Transformation of Network Disaster Communication Patterns on Weibo

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ABSTRACT

There is a surge in people turning to social media in disasters in China. In the 2010 Yushu earthquake, 5,979 Weibos were posted. Almost 10 years on, in the 2019 Yibin earthquake it was 17,495. This study presents a Social Network Analysis of the dynamics of this growth, taking the six major Chinese earthquakes of this decade as a case study. By constructing relationship matrices, the research reveals a transformation of networked crisis communication patterns on Weibo. We show how communication relationships between verified organisational users, government agencies, verified individual users (such as celebrities) and unverified ordinary users have changed, and we observe that government agencies are 'crowding out the crowd' of other users. We consider key aspects and the ethical complexities of this phenomenon.

Keywords:

Weibo, transformation, crowding out, crisis communication, mobilities.

INTRODUCTION

The term 'natural disaster' generally refers to natural calamities. However, there is no such thing as a purely 'natural' disaster, because the causes and effects of disasters are deeply entangled with human decisions (Davis 1998, Hartman and Squires 2006). Building on floodplains or in areas prone to earthquakes, lack of investment in risk analysis or preparedness, are human factors that shape vulnerabilities, and the very 'nature' of such disasters. Chroust and Aumayr (2017) argue that human factors contribute to the number and severity of 'natural' disasters. In addition, Davis (1998) and Ramalingam (2010) show that the politics of emergency response, class, race, ethnicity and gender often have a major impact on the outcomes and consequences of disasters.

The surge of social media communications moves more of these human factors into the limelight of public scrutiny. While new forms of networked crisis communication can enable deeper public understanding of the challenges that emergency agencies face, and net-centric public engagement, a more common outcome is public criticism of the formal agencies' response, a disruption of crisis management models, and a struggle for control (Boersma, Wolbers, Wagenaar 2010, Büscher, Kerasidou, Petersen, Oliphant 2017). In China these struggles take on a particularly interesting form. In this paper, we present an analysis of a new phenomenon of 'crowding out the crowd' in online communications in earthquake crises on Weibo in China between 2010 and 2019.

BACKGROUND

China is the country with the most continental earthquakes in the world (State Council Information Office, 2009),

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and improving the speed and quality of disaster response is a core challenge to China's emergency response agencies. With the advent of Web 2.0, the practices and platforms of China's natural disaster response have been transformed. In 2009, the Chinese government blocked Facebook, Twitter and other overseas social media, and instead encouraged domestic versions of social media. Weibo -- launched by Sina corporation in 2009, is similar to Twitter in that it includes posts, comments, retweets and browse functions. A notable difference is the user verification system for confirming the identity of various user groups by appending a coloured V to the username and adding verification information. Generally, verified individuals (celebrities, stars, politicians…) receive a yellow V, while a blue V marks organisations (NGOs, government departments enterprises, college...). Ordinary individual users are unverified (but still identified on the system).

In the past decade, Weibo has developed into a significant communication platform in crisis communication. During the 2013 Ya'an earthquake, for example, Weibo provided important "lifelines" for crisis communication (Zuo and Tian, 2014). Leykin et al (2018) discuss how Weibo can facilitate coordination between emergency services and disaster victims. Social media have changed crisis communication from one-way communication where the government releases disaster information through traditional media channels towards multi-way interactions and communications on social media platforms between the government, responder agencies, and members of the public. In terms of coordination, Chinese crisis communication has started to involve interactive public participation, with people providing situation awareness information, commenting on the response, and engaging in dialogue with each other. This is fueled by the overall growth of social media use and a pervasive and robust infrastructure. For example, 93.1% of Weibo users access Weibo through mobile devices (Sina, 2018) and 4G coverage in China has reached 95%. In the 2010 Yushu earthquake, 5,979 messages were posted on Weibo, and 10 years later, in the Yibin earthquake it was 17,495. Weibo has become widely regarded as a crisis communication platform.

However, China is known as a society in which the government strictly regulates news media and often censors public information. Widespread concern exists that the strict regulations on social media can have a chilling effect. Visible censorship can anger people and emboldened them to oppose the government's censorship policy (Roberts 2014), but it has also stopped some users from writing about social and political subjects (Hong and Wang, 2011) and it can stop protest and viral bursts of online-only activity (King et al. 2014). Social media users may also self-censor and suppress their communications (Zeng et al., 2017). Against the backdrop of these insights, we hypothesized that the government's participation in online communities may suppress the participation of other types of users. It is important to understand whether this phenomenon exists, and how it unfolds, because the phenomenon will impact on the cooperation between the government and other social groups in crises in China.

This study takes the six major Chinese earthquakes between 2010 and 2019 as a case study for a Social Network Analysis (SNA) to study the transformation of network crisis communication patterns (NCCP) on the Weibo platform. We discuss key changes in the communication relationships between the four main participating groups:

- Verified Governmental Users (VG)

- Unverified Individual Users (UI)

- Verified Individual users (VI)

- Verified Organisational users (VO)

Preliminary analysis revealed that the relationships between these actors changed significantly. For example, VG participation in Weibo overall has grown from 312 in 2010 to 138,253 in 2019 (Sina, 2019), including various departments such as the Public Security Department, Publicity Department and the Health Commission (People's Daily, 2017, Fig 1).
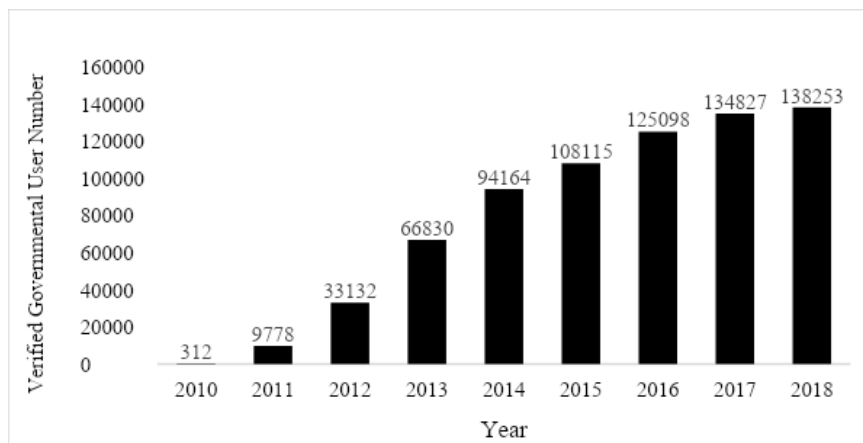
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Figure 1. The Rise Number of Verified Governmental Weibo User

As we will discuss, our data from the six earthquakes, suggests that the increase in VG, is linked to denser clusters forming around them as 'transmission subjects' and the directions of attention becoming more streamlined. Government agencies seem to be 'crowding out the crowd'.

This raises complex ethical issues, ranging from questions about power to transformations of crisis management models, and the need for 'social capital', or cultural competence and social networking capabilities, and trust to enact positive change. Most importantly for us, crowding out the crowd seems to foreclose important opportunities for positive change. If the crowd is crowded out, net-centric approaches to coordinating collaboration between multiple actors are thwarted.

ANALYTICAL FRAMEWORK

Social media drives disruptive innovation (Christensen 1997). They 'disorder old systems, create new players and serve new groups, or the same groups with new products, while marginalizing old ones, and deliver[ing] value to stakeholders who successfully implement and adapt to the innovation … [requiring] a new professional culture to develop' (EU Commission 2015). This brings both opportunities and risks. We leverage insights from sociology, media studies and informatics to highlight three key ethical and social issues.

Public perceptions and crisis governance

Governments are concerned about public perceptions of governance. Establishment of a good government image can not only enhance the influence of the government but also fundamentally help governments to meet the expectations and desires of the people. After Web 2.0, the Chinese government began to use new media to establish an information and communication network to strengthen interaction with the public.

Jha et al. (2018) argue that the Chinese government quickly realised the important role of social media in building public communication during normal times and disasters. But the fast development of social media provides a broad platform for people to make their voices heard and it makes it more difficult for the government to maintain a good image. Online 'sousveillance' can help improve government services, but it has also led to people becoming more critical and demanding of the government. Thus, the advantages of social media to the government are reduced, and disadvantages can expand.

In crises, this effect is amplified. According to Zhu et al., (2006), in a crisis, every action of the government could bring extraordinary impact. The government may obtain an unprecedentedly good social evaluation through its performance in crisis; but governments can also be criticised for responding inadequately in a crisis. Information control thus becomes important. Censorship is a powerful approach, but it has limitations. Our data shows that if VG users are sufficiently active and effective in network crisis communication, it contributes to a reduction in participation from other types of users. But the considerations above prompt us to ask: what is the effect of such 'crowding out the crowd'?

'Hunkering down' in Network Communities

Arguably, social media has engendered a democratization and diversification of public communication spaces. This seems to lie at the heart of many governments' difficulties to maintain a positive image. Our data exhibits a phenomenon that, following the social theorists below, we consider a form of 'hunkering down'.

Diverse user groups online may rapidly build complex distributed relationships and respond to crises in an

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organised manner, as a crowd. For effective cooperation, 'social capital', or capacities to engage with others with different views and from different backgrounds, and trust are essential within the crowd and in its interactions with authorities. To understand this dynamic better, we can transpose insights from studies of real world communities. In debates on the role of ethnic diversity for social capital and trust, Putnam (2007) observes a negative impact.

Putnam sees social capital as "the connections between individuals -- social networks and the resulting norms of reciprocity and trustworthiness" (2000:19). Normally, high social capital benefits members of networks and bystanders (Putnam, 2000: 20; 2007:137-138). However, in his studies of diverse neighbourhoods, Putnam finds that high ethnic heterogeneity is accompanied by lower levels of trust and a decline in solidarity: people living in multi-ethnic communities are more likely to stay indoors, a phenomenon he describes as 'hunkering down'.

Putnam's hypothesis has been highly controversial. Critics point out that linking hunkering down to ethnic diversity in a neighbourhood ignores other factors. Sturgis et al. (2010) show that, in fact, the relationship between diversity and trust is weak, and stronger reasons for hunkering down include poverty, inequality, and power imbalances. This has inspired us to examine the dynamic of crowding out the crowd that we observe in our data as a form of hunkering down. Cheong et al (2007) can help us understand the communicative power involved in more depth. They show that "policy initiatives seem to be based on the belief that community cohesion can be built by imposing a 'majority' agenda on 'minority' communities" (2007:42). This often implies the creation of government policies to shape the cohesion of communities. However, such imposed forms of cohesion are brittle. In a review of different forms of community cohesion, Portes and Vickstrom establish that "a higher form of cohesion [is] associated with a complex division of labour and the strength of institutions" (2011:476). We therefore ask, whether, by dealing with diversity in ways that enable exchange between strong formal and informal actors and institutions, hunkering down could be counteracted to enable better public-government collaboration.

Netizen's public responsibility in a digital world in crisis

This brings us to a complex third key issue. According to Sun (2015), public responsibility means that citizens have to consider various interests beyond their private status to solve problems. Social responsibilities need to be assumed for the sake of public interests, and not only focus on and personal rights and interests. Since the growth of Web 2.0, the world has also become a riskier place. Scientists have labelled the 21st Century the century of disasters and recent recognition of the severity of the climate and environmental crisis, as well as the outbreak of COVID-19 seem to confirm this. Yet citizens often still expect government agencies to protect them from disasters, reluctant to carry more responsibility for their own vulnerabilities and risks (Büscher et al., 2017). This is not to deny systemic causes or government responsibilities, or condone censorship, or to call for individualisation and responsibilisation of citizens' responsibilities. Instead it is a recognition that criticism - be it criticism of inadequate government preparedness or response, of heavy-handed information control, or rumour-mongering on the side of citizens - is not enough. What is needed is a deeper understanding of the dynamics of networked crisis communication patterns and ethically circumspect innovation for public responsibility that enables all parties to shoulder the responsibility for living in an increasingly precarious world.

Hypotheses

Based on our ongoing research and the discussion above, we developed three hypotheses:

Hypothesis 1: the size of the NCCP is directly proportional to the frequency of posting activities.

H1 posits that when posting increases in the NCCP, the size of the NCCP grows. This also indicates the strength of public opinion.

Hypothesis 2: VG are displacing (crowding out) active other users in four different ways on Weibo.

    Hypothesis 2a: VG is crowding out others by increasing the number of posting activities.

    Hypothesis 2b: VG is crowding out others by assuming a privileged information source position.

    Hypothesis 2c: VG is crowding out others by being the first to post.

    Hypothesis 2d: VG is crowding out others by becoming information transmission subjects on Weibo.

H2 posits that VG are actively and strategically conducting online crisis management to control public opinion and shape the image of the government. By examining aspects of this strategy of VG in terms of numbers, positioning as an information source, time of intervention, and actions of information transmission, we can show how NCCP dynamics have changed over the past decade.

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METHODOLOGY

Social Network Analysis(SNA)

According to Steketee et al. (2015), SNA can be used to analyse complex relationships between social groups. Every social network includes nodes and ties. Nodes represent actors in the social network (which can be individuals or groups), and ties represent connections between two nodes. The term 'transmission subject' describes actors who gather a dense cluster of relationships in the NCCP. SNA allows insight into social phenomena such as collaboration, cooperation, or trust between groups in social networks by introducing matrix algebra and visualising the data to measure density, collaboration and cohesion, and by showing patterns on network maps from micro to macro levels (Klavans and Boyack, 2006).

The Sample

On the seismic Richter scale, level 6 marks a threshold of destructive damage over a limited area, with higher levels indicating more severe and widely spread destruction (Richter 1935). The 2010 Yushu earthquake, magnitude 7.1, was recorded as the first case of Weibo being applied for crisis communication, and it furnishes the starting point for our analysis. The Changning or Yibin earthquake in 2019 was the only earthquake of magnitude 6 or higher in the year of writing this paper. Although the most intuitive changes can be obtained by comparing the earliest and the most recent event, the process of change cannot be observed in this way. Hence, all six earthquakes with a magnitude of 6 or over that occured during this period in China are taken as case studies (Table 1).

The first step in collecting posts was to extract valid posts that were not deleted on the Weibo platform and where the account of the publisher was not blocked. To clearly and specifically observe the changes of NCCP in the past decade, we extract the forwarded or original posts with a keyword extraction formula in the text part as the second step, instead of simply forwarding the posts without text part. In the forwarding mechanism of Weibo, if no text comments are added, Weibo platform will automatically add '*forwarded post*' as the forwarding content to the post and such posts will not contribute to the construction of NCCP since the forwarded content does not contain any information related to the disaster. A total of 133,440 posts were identified.

Table 1. Basic Information of Six Earthquake

E	Event	Time	Year	Location	Magnitude	Population	Death	Injured
E1	Yushu Earthquake	7:49	2010	Qinghai	7.1	401,700	2,698	12,135
E2	Yaan Earthquake	8:02	2013	Sichuan	7.0	1,537,800	193	1,211
E3	Ludian Earthquake	16:30	2014	Yunan	6.5	429,800	617	3,143
E4	Pishan Earthquake	9:07	2015	Xinjiang	6.5	249,000	3	214
E5[2]	Jiuzhaigou Earrthquake	21:19	2017	Sichuan	7.0	815001	29	543
E6	Yibin Earthquake	22:55	2019	Sichuan	6.0	467,200	13	229

In the digital age, the 'golden hour' where emergency search and rescue and response can save lives and significantly shape outcomes away from public scrutiny is transformed. Public attention and participation nowadays occurs immediately, forming a powerful storm of public opinion. The peak of public opinion related to crises usually gathers quickly, within the first 24 hours, and interest typically lasts over two weeks (Civiw, 2019). To evaluate changes in the development of public opinion, we have set the data collection period as 30 days.

All original and forwarded Weibo posts within 30 days of each earthquake were obtained from an original information source node via Python programming. Posts were collected from the Weibo website with the search formula "geographical name + earthquake" on retweets or original posts, e.g. "Yushu earthquake" (E1). Corresponding data, including nickname, release time, release tool and user type were also collected.

Core Variables

Posts are microblogs published by different types of users during disasters. They are the most intuitive variables to observe changes in NCCP scale. Variation in the total number of posts provides evidence for the transformation of frequency in Weibo users participating in NCCP. Meanwhile, observing peaks of posting behaviour in a fixed period will help to observe changes in the duration of public opinion. We tested Hypothesis 1 by comparing the daily posting volume across 6 earthquakes for 30 days each.

Actors are Weibo users, including VO, VG, VI and UI. The four types of users capture different types of social

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groups and represent their respective public responsibilities and functions. As the core variable influencing NCCP, the number of actors defines the size of the NCCP, while the degree of influence is indicated by actors' role as transmission subjects in the NCCP. Therefore, we will measure changes in participant numbers and roles across the four actor types to test the Hypothesis 2a-c.

Dyads of posts. This variable describes relations between posts and between users. The generation of posts from the NCCP involves the function of sending and forwarding, which promotes information flow within online communities. This kind of flow indicates the transmitter's affirmation and trust for the source of posts. Therefore, we need to clarify post directions in the NCCP along with the direction of information transmission. This shall enable us to observe the relationship between users to address Hypothesis 2d.

Measurement

This is a quantitative study, augmented by some analysis of qualitative case study observations from media reports and post content. The main instruments are statistical data and SNA analysis tools. Having collected a set of Weibo posts, we classified and organised all the data per individual earthquake, including total post number (post count), number of different types of users (source deduplication), and relationship between actors (relationship matrices).

According to Weibo verification mechanisms, users are divided into three main types: VI, VO and UI. The data shows that all three types are involved in constructing the NCCP, with verified government users having a significant involvement. As is the case for VO, VG users are shown with a 'Blue V' on their authentication profile. For clarity we have made a further distinction between the two. The classification of Weibo posts based on the six earthquakes is shown in Table 2.

Table 2. Weibo Posts

E	Total Posts	Total Actors	Verified Organisational Users		Verified Governmental Users		Verified Individual Users		Unverified Individual Users	
			Actors Number	Posts proportion %	Actors Number	Posts proportion%	Actors Number	Posts proportion%	Actors Number	Posts proportion%
E1	5979	5963	366	5	36	4	94	1.60	5467	89.40
E2	37420	30998	6534	14.20	1028	13.70	515	1.60	22921	70.50
E3	41333	15582	3474	14.10	1364	25.10	653	3.90	10091	56.90
E4	2087	1333	311	24.40	366	25.50	2	0.20	654	52.90
E5	29126	17654	1236	11.30	2802	23	902	4.80	12714	60.90
E6	17495	14134	2436	14.20	4131	40.50	706	4.40	6861	40.90

To analyse relationships between actors, we constructed relational matrices for each of the six earthquakes and visualised them through the SNA tool (Figures 5a-f). The construction of user relationships extracts the nodes with relationships, filters out the nodes with single participants, and makes the actor relationships more intelligible.

The definition of a relationship (a_{ij}) in the matrices is that if two specific users (i and j) appear in the same NCCP and are engaged in publish and forward activities, then a relationship exists. In this definition, Weibo users who post or forward as nodes, i and j, refer to the node serial number:

$$a_{ij} = \begin{bmatrix} 1: \text{relationship and weight between i and j} \\ 0: \text{no relationship exists between i and j} \end{bmatrix}$$

Centrality is another important concept in SNA. How central a node is in a social network can be measured in degrees of centrality. It represents the sum of direct connections between a node and other nodes to show the ability of the node to interact and connect with other nodes. Its measurement formula is:

$$C_D(N_i) = \sum_{j=1}^{g} x_{ij} \ (i \neq j)$$

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When X_{ij} is >0 or 1, it indicates that there is a relationship between node i and node j, and g is the node number in NCCP. We assume that the higher the degree centrality, the greater the influence in NCCP.

Common SNA software includes Ucinet, Pajek and Gephi. Gephi was used because it has powerful visualisation functions and strong dynamic analysis ability. ForceAtlas2 was used for forming dense clusters, and statistical tools were used for collaborative analysis.

Analytical Strategy

A single statistical analysis cannot capture the interaction or relationship between all variables, or how the whole process changes. But the combination of SNA and case studies can deliver in-depth insight into key nodes of communication and dynamics of change, driven by users, posts, and the interactions and connections between them. Moreover, those interactions and connections shape the NCCP.

The analysis of the data was divided into two steps. Firstly, the total posts in each earthquake were processed separately. Meanwhile, the daily posting volume of the six events was examined with a line chart to visualise changes in overall public opinion (Figure 2). This also enabled an evaluation of how internet public opinion developed over time. We compared the scale of the NCPP to the intensity of public opinion and posting activities to test Hypothesis 1. Secondly, we compared the multi-angle variations of different user types in the NCCP to test hypothesis 2a-c. Data analysis further focused on detecting the relationship between users to test Hypothesis 2d.

RESULTS

Rising Participation in Earthquake Communications on Weibo

To explore the transformation of NCCP and observe the motivations behind peak post activities during a fixed time period on Weibo, daily posts within 30 days after earthquakes were counted (Figure 2).
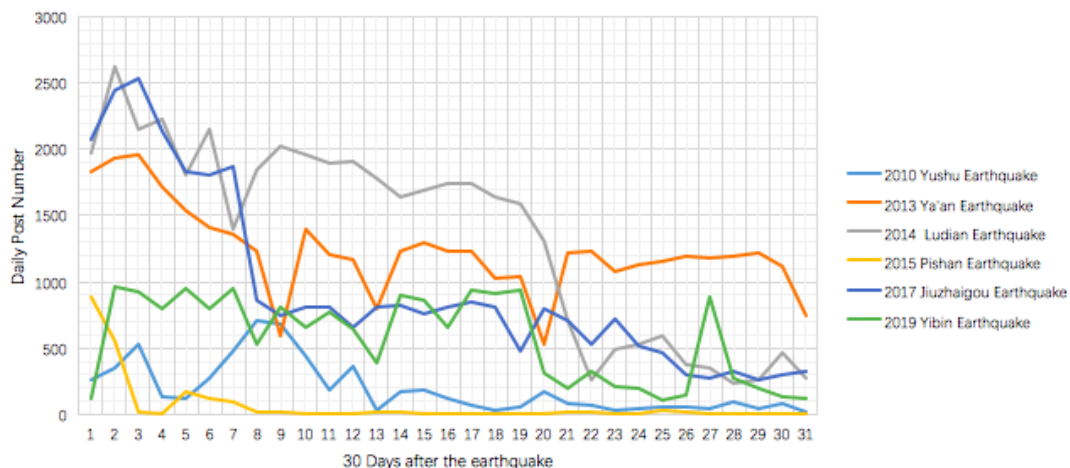

Figure 2. Trend Lines of Daily Posts

In Figure 2, it is clear that the number of Weibo posts in the 2013-2019 earthquakes E2, E3, E5, E6 increased significantly, compared with the 2010 Yushu earthquake (E1). The highest total post numbers reached 41333 in E3 (Table 2), which, as Figure 2 shows, also had the highest peak of posts in a day at over 2500. Unlike the smoothing trend seen after the initial peak in E1, multiple peaks are shown over 30 days for all of the post 2010 earthquakes (including the Pishan earthquake (E4)). Comparing the graphs shows that posting opinions publicly lasted longer for all subsequent earthquakes after E1. We can infer from this that the Weibo platform plays an increasingly significant role in the formation of public opinion and provides chances for various user types to participate in crisis communication. A substantial number of users now gather on Weibo to form NCCP by providing a huge and long-term public debate in earthquakes. Hypothesis 1 is therefore supported.

Impact of Location on Post Volume

However, a piece of evidence against Hypothesis 1 is the Pishan earthquake (E4), and therefore we further discuss the context of communications informed by our case study analysis. We found that although all six earthquakes occurred in the southwest of China, the location of E4 was significantly different to the other five earthquakes. As Figure 3 shows, E4 occurred in Pishan county, Xinjiang province, near China's inland border with Pakistan.

E4 had a magnitude of 6.5, but the deaths and injuries in this 'natural' disaster were fewer than in any of the other

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five events, in part due to the fact that Pishan is a large but sparsely populated county with a population of 249,000. The population density in the other five earthquake-stricken areas was much greater than that of E4 (Table 1). Pishan is also far from any inland cities, likely to account for the lack of public interest.

In contrast, amplifying the importance of human factors in the experience of natural disasters, the local population of the Jiuzhaigou earthquake (E5) was the lowest of the six earthquakes, but despite this it attracted significant attention, because it is located in a nationally famous scenic area in China with up to 5 million visitors a year.
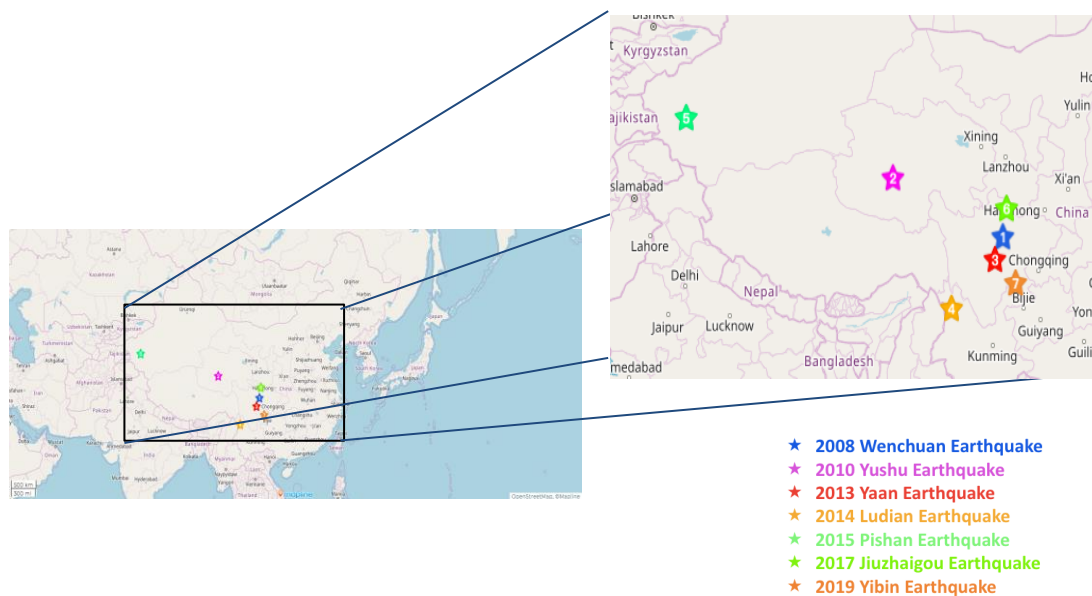

★ **2008 Wenchuan Earthquake**
★ **2010 Yushu Earthquake**
★ **2013 Yaan Earthquake**
★ **2014 Ludian Earthquake**
★ **2015 Pishan Earthquake**
★ **2017 Jiuzhaigou Earthquake**
★ **2019 Yibin Earthquake**

Figure 3. Earthquake Geographic Location Map

From looking at post numbers and the location of each earthquake, we would suggest that the scale of the NCCP is linked to local population and the cultural significance of each location. Therefore, when discussing Hypothesis 1, the affected population and geographical location need to be considered as the conditions which affect the strength and duration of public engagement in crisis communications. Meanwhile, when combining this information with Table 2, we can see that the proportion of user posts is similar among other earthquakes, although the scale of the NCCP in the Pishan Earthquake (E4) is the smallest. It is also noticeable that VG posts increased and that this increase is not affected by geographic location (or cultural significance), indicating that VG users were actively working to expand their role in NCCP across diverse events, corroborating Hypothesis 2.

Transformation of involved Weibo Actors in Earthquakes

Hypothesis 2 states that the crowding-out effect of VG in the NCCP is multidimensional, including participation numbers, network information sources and first access time. This section will test Hypothesis 2a-2c with a view to these three dimensions in turn.

User Volume Transformation: VG is expanding in numbers

After conducting a deduplication of collected data sources, the number of the four user types involved in each earthquake was counted separately (Figure 4a-d).
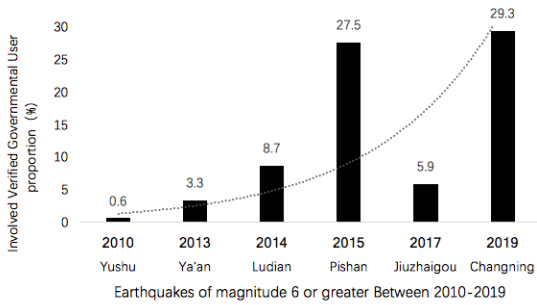
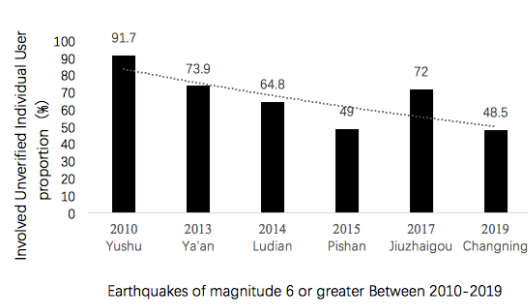**Figure 4a. Involved VG Proportion (%)**

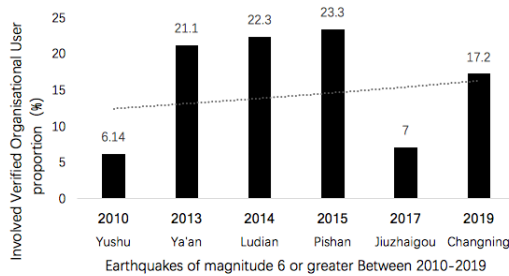**Figure 4b. Involved UI Proportion (%)**
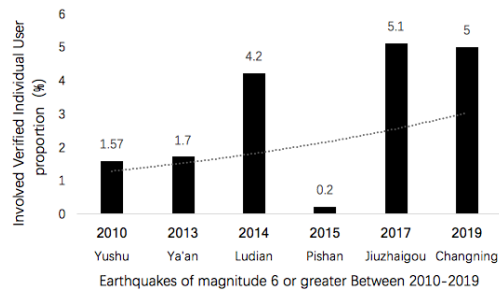

Figure 4c. Involved VO Proportion (%)

Figure 4d. Involved VI Proportion (%)

The figure shows variations in the involvement of the four types of users. UI's participation and posts decreased significantly and increases in the VO and VI groups were negligible. Only VG show significant growth, increasing from 0.6% of overall communications to almost a third, while the participation of UI almost halves over the period in question. This is consistent with Hypothesis 2a. The growth of VG users is also closely related to the overall growth of the VG on Weibo. Why is this happening? We can only speculate that active posting behaviour will provide the public with a more vivid image of the government and positively affect public opinion. However, at the same time, this phenomenon seems to cause other users to *hunker down* in the NCCP, reducing their activity, which can be seen from the decline or slow growth of participation from the other three types of user.

Information source transformation: VG is Synchronising earthquake stories to Weibo

From observing daily post volumes over 30 days, the overall trend for the national park earthquake in Jiuzhaigou (E5) is unusual. Posts drop quite steeply after the initial peak. In contrast, even the remote Pishan earthquake (E4) had an additional peak on day 5 (Table 3d). And posts about E1, E2, E3, and E6 are characterised by multiple peaks across the 30-day time period. To explore the causes of the daily post peaks, a combination of the content, sources of posts and the governmental report were checked and listed (Table 3a-e).

Table 3a. Post Peaks in E1

Post Peak	Date	Disaster Situation	Government Source	Weibo Post Source
Peak 1	Day 3	The death toll from the Yushu earthquake stood at 791 as of 8 am, 31 more than yesterday, with 294 missing and 11,486 injured, including 1,176 seriously	China News Service (CNS)	UI
Peak 2	Day 8	At 10 am, Qinghai provincial party committee and government held a mourning activity in Jiegu Town for the victims of the Yushu earthquake	China.gov	UI
Peak 3	Day 12	As of 17 PM on April 24, the Yushu earthquake has killed 2,203 people and left 73 missing.	China.gov	UI

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Table 3b. Post Peaks in E2

Post Peak	Date	Disaster Situation	Government Source	Weibo Post Source
Peak 1	Day 3	Ya'an earthquake has caused 192 people dead, 23 missing and 11,770 injured according to the emergency command center of the Sichuan provincial people's government.	People's Daily	Verified Organisational Users
Peak 2	Day 10	At 20:43 on April 29, a 3.2 magnitude earthquake occurred in Ya 'an, Sichuan province with a focal depth of 2 km	China Earthquake Networks Center	Verified Governmental Users
Peak 3	Day 13	At present, the production and life order in the quake-stricken areas of Lushan has been gradually restored, among which the industrial recovery rate is 35. 7%	Xinhua	Verified Organisational Users
Peak 4	Day 21	According to the website of the national seismological administration, 8,552 aftershocks were recorded from the 7.0-magnitude earthquake in Lushan.	People's Daily	Verified Governmental Users

Table 3c. Post Peaks in E3

Post Peak	Date	Disaster Situation	Government Source	Weibo Post Source
Peak 1	Day 2	As of 14:00 on August 4, 398 dead, 3 missing and 1,801 injured, affected by the earthquake in Ludian county.	China News Service	VG
Peak 2	Day 6	1,088,400 people has been affected by the earthquake in Ludian county, with 617 people dead, according to the earthquake relief headquarters of Ludian county.	China.gov	VG
Peak 3	Day 8	People mourn for the victims of the magnitude 6.5 earthquake in Ludian, southwest China's Yunnan province, Aug. 10, 2018.	China Wenming Network	VG

Table 3d. Post Peaks in E4

Post Peak	Date	Disaster Situation	Government Source	Weibo Post Source
Peak 1	Day 5	The number of people injured in the earthquake in Pishan, Xinjiang rose to 214, with 891 aftershocks	Xinhua	VG

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Table 3e. Post Peaks in E6

Post Peak	Date	Disaster Situation	Government Source	Weibo Post Source
Peak 1	Day 2	Du fang, an expert with the Sichuan seismological bureau, responded to the online rumours that a larger earthquake was imminent in the region is unlikely.	China News Service	VG
Peak 2	Day 9	173 aftershocks of magnitude 2.0 or above have been recorded in Changning county up to 8 PM on June 25, 2019.	China News Service	VG
Peak 3	Day 14	On June 28, 60 members of the Sichuan forest fire brigade who participated in the earthquake rescue in Changning county, successfully completed various tasks.	China MEM	VG
Peak 4	Day 17	A 4.8 magnitude earthquake struck changning county in Yibin, Sichuan at 12:26 am on July 03.	CCTV	VG
	Day 27	The Gongxian people's court of Sichuan province held a public hearing on the first quake-related and disaster-related case in the Changning earthquake in Sichuan province.	CCTV	VG

The peaks in public attention are comprised of communications about follow on events. They represent high levels of public engagement, indicating that Weibo is increasingly regarded as the main online space for crisis communications, as well as expression of public opinion. This provides further evidence for Hypothesis 1. However, as the actors and sources of information have transformed from primarily VO and UI to now mainly VG, other user types have largely been replaced. We find that VG are crowding out the crowd to the edge of the NCCP by positioning themselves as the authoritative source of information, as Hypothesis 2b suggests (see Figure 5a-f for a visual impression of this process). Moreover, VG communicates official crisis information, and this kind of information crowds out the more diverse voices and topics of VO and UI.

Posting Time Transformation: VG is Shrinking First Participation Time

It is also worth noting that the time it takes users to join the NCCP has shortened between 2010 and 2019. We compiled the first access time of three Weibo user types - VO, VG and VI - during the earthquakes to observe the speed of their first entry (Table 4). In the 2010 Yushu earthquake (E1), VO appeared the fastest, but the interval was 13 hours, and VI accessed after 14 hours. During the 2019 Yibin Earthquake (E6), VG accessed within 1 minute, with VI and VO entering the NCCP within 2 minutes.

Table 4. Access Ranking of Weibo users

E	First access user type		Second access user type		Third access user type	
	User Type	Post Time Interval	User Type	Post Time Interval	User Type	Post Time Interval
E1	VO	13h15min	VI	14h33min		
E2	VO	7min	VI	1h26min	VG	2h24min
E3	VG	15min	VO	24min	VI	1h10min
E4	VG	14min	VO	17min	VI	30min
E5	VG	4min	VI	13min	VO	14min
E6	VG	0min	VO	1min	VI	1min

In addition, according to Table 5 below, VG are rapidly increasing their posting speed and fighting for first access. Hypothesis 2c is validated by this, because the government is transmitting disaster information through VG, and as they become the first official information publisher, they crowd out other users to the edge of the NCCP. This helps spread official crisis information and reduces the dissemination of rumours or unverified information in the NCCP. Such action also helps the government to guide or control public opinion during crisis periods.

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Transformation of Influential Actors in NCCP.

This section introduces how we have analysed data with matrix algebra and visualised the connection relations between users for each earthquake. This was done through Gephi, and it allows observation of how transmission subjects have changed in NCCP to test Hypothesis 2d.

Transformation of transmission subjects in Relationship Matrices

To highlight transmission subjects in the NCCP and the direction of information communication, we apply the partition of modularity class in direction graphs. Relation matrices of six earthquakes are shown in Figure 5a-f[1].

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[1] Higher resolution colour versions are available at:
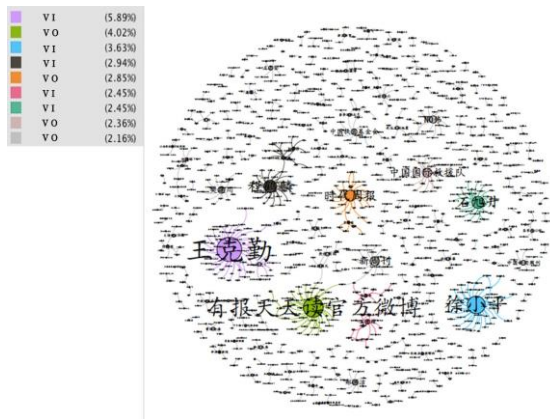https://drive.google.com/open?id=1z9MNc_VSzAX-78VMMT9-q9w_AEcXuABx

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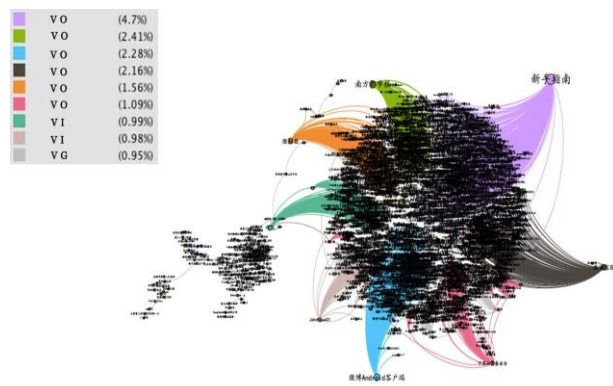
Figure 5a. Relation matrix of E1

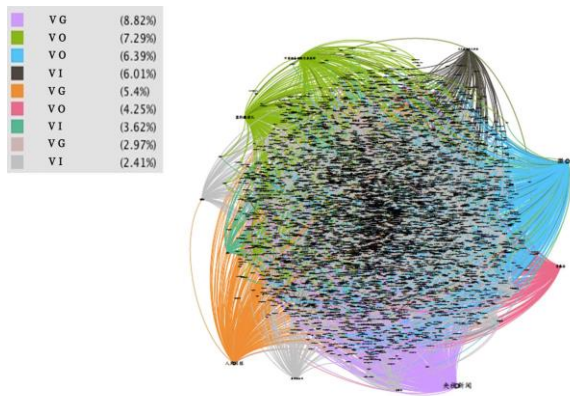**Figure 5b. Relation matrix of E2**

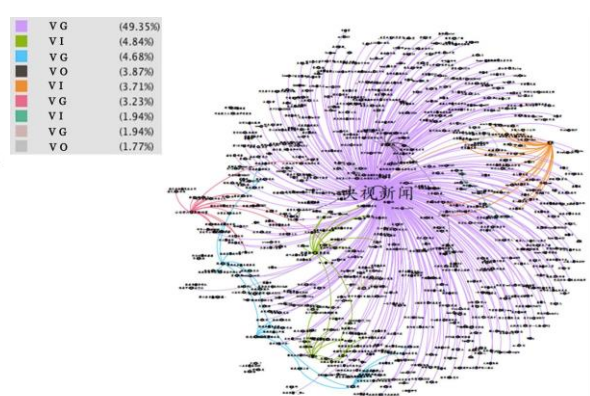**Figure 5c. Relation matrix of E3**
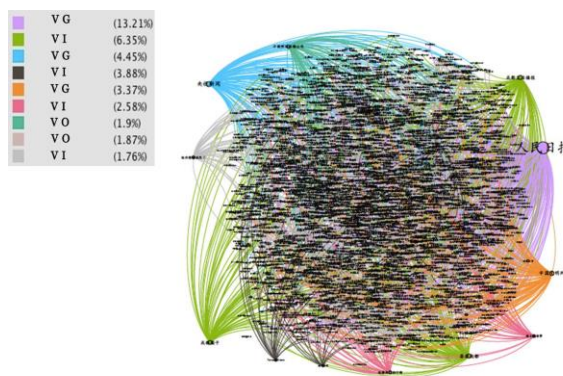

Figure 5d. Relation matrix of E4

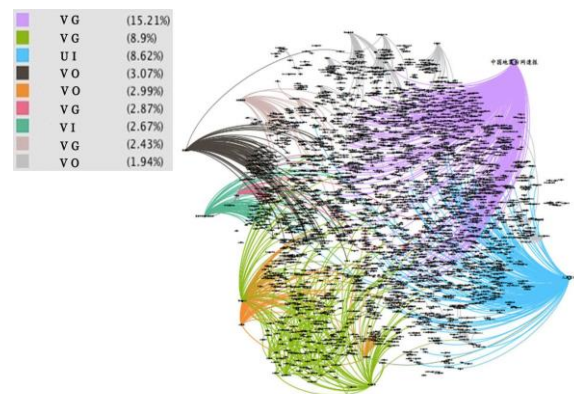**Figure 5e. Relation matrix of E5**

Figure 5f. Relation matrix of E6

Connections between nodes are directional in a social media network, and the concept of vector needs to be added into the calculation of degree centrality: in-degree (the degree of others' attention to the node) and out-degree (the degree of the node's attention to others). When discussing the transformation of the NCCP, the degree centrality and the transformation of user types is important. According to Figures 5a-f, the direction between the node that forms the subject and other nodes is one-way, with information from the primary node spreading to peripheral nodes. The comparison of user types and in-degree of 9 nodes forming dense clusters is shown in Table 5.

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Table 5. Transformation of User Types and In-degree

	E1		E2		E3		E4		E5		E6	
Node	Type	In-degree	Type	In-degree	Type	In-degree	Type	In-degree	Type	In-degree	Type	In-degree
1	VI	49	VO	568	VG	911	VG	456	VG	678	VG	939
2	VO	44	VO	259	VO	765	VI	136	VI	205	VG	483
3	VI	38	VO	258	VO	738	VG	31	VG	196	UI	236
4	VI	36	VO	245	VI	660	VO	24	VI	196	VO	108
5	VO	32	VO	197	VG	436	VI	18	VG	149	VO	100
6	VI	25	VO	184	VO	407	VG	17	VI	110	VG	85
7	VI	24	VI	150	VI	285	VI	11	VO	96	VI	77
8	VO	24	VI	145	VG	203	VG	10	VO	93	VG	69
9	VO	16	VG	135	VI	180	VO	10	VI	89	VO	64

The four types of users who formed transmission subjects have changed over the past decade in number and degree of others' attention. VG transfers from '0' participation in E1 to the largest propagator, obtaining the most attention since E3. Attention to VO from other users is shrinking, while the nature of VO users has changed: Sina's functional VO and charity VO disappeared but media organisations and state-related organisations replaced them. The number of VI has decreased and experienced two qualitative transformations: from political VI to entertainment VI and then to urban culture VI. UI only appears prominently as nodes in E6. However, the post content of the UI there was not related to E6 but added the earthquake related-hashtag to attract the attention of others when searching earthquake-related keywords.

Generally, VG's transition to become the main producer of crisis information is in line with an increase in public trust, indicated by growing numbers of VG information consumers. This proves Hypothesis 2d in that VG are crowding out others by becoming the key transmission subjects on Weibo. State-related VO and city-culture-related VI have replaced individual users in their highly heterogeneous fields. This supports a government motivated by a desire to control public opinion and information about disasters. It is worth considering whether UI can only transmit crisis information if they attempt to spread it through users with high influence. Overall, there seems to be a clear direction of transformation in NCCP, which favours VG and constrains communication opportunities for all other users.

DISCUSSION

Our analysis shows that Weibo is becoming a mobile platform for the public to participate in crisis communication around earthquakes. During the period studied, public posting began to last longer and the number of posts and users significantly increased. The study clarifies the four main types of Weibo users: VG, VO, VI, UI. But the four user types have experienced changes in quantity and nature during the construction of NCCP. We will now discuss some important aspects of transformation and some ethical considerations.

The power of the many

Weibo has provided an important channel for Chinese citizens to share their views and develop better political understandings (Xu, 2012). Our analysis suggests that high public involvement during E1 and the potential power of the many to shape the discourse caught the attention of the Chinese government. This encouraged government departments to operate VG to facilitate, but also to take back control over the communication. The plentiful and diverse VG and highly active interactions on Weibo show an awareness that the Chinese government has built up their own communication to control this virtual community, establishing Weibo as a platform to communicate official information. This is a form of soft power, 'crowding out the crowd' through communicative means.

The Intensive Management of Online Public Opinion

China's Internet censorship system (known as the world's most sophisticated content filtering system) seems to reduce Chinese users' interest in obtaining information (Open Net Initiative, 2005), which could undermine preparedness amongst the population. In light of criticism, the Chinese government has clarified its online censorship officially (Yang, 2011). Based on the cooperation between the Chinese government and Sina, Weibo has set strict controls on posts. Posts containing blacklisted keywords and comments on sensitive topics will be blocked by pre-release censorship software before being published, and can be manually censored or quickly

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deleted after posting. Under the strict management, sharing opinion online is suppressed, as evidenced by the decline in the number of UI in crisis communication. It is a kind of deterrent, making social media users cautious in their speech and activities even in virtual communities. Additionally, VO's transformation in NCCP is a further means of control. Switching the self-operated VO accounts to VG can be seen as Sina transferring some functions to the government and allowing VG to play a more central role.

In light of scandals over extremist and harmful content, as well as political manipulation on the uncensored Internet of the West, censorship and crowding out the crowd might seem interesting strategies. However, what are their effects? Hunkering down and a transformation of participation to entertainment seem most harmful.

Hunkering Down

Our study found that the relationship between different types of users and the degree of participation is reconfigured in NCCP. User relationships enact a new form of 'hunkering down'. In a highly heterogeneous virtual community, VG have moved ahead of other types of users in terms of first entry times, information sources, number, and spread of information coverage, but they do not engage or interact. By crowding out the crowd VG are pushed to hunker down in a central role as information controllers, while other users switch from being information producers to hunkering down as passive consumers who decline interaction.

Transformation of Entertainment Atmosphere

China's management of the Internet is considered extremely strict: private sector companies are subject to censorship and implement self-censorship to maintain their business licenses and avoid penalties (MacKinnon, 2010). To survive in this political context, social media platforms strategically position themselves as information and communication platforms for entertainment and leisure (Wu, 2017). Various research into Chinese social media showed that the most forwarded post content is entertainment and leisure activities rather than current affairs (Yu et al, 2011). We believe that the transformations of VI within NCCP are related to Weibo's shift away from politics towards entertainment and leisure so as to shift public attention from politics to leisure activities.

These phenomena raise several ethical issues. Although government departments have created various VGs, they rarely interact or listen to each other or other users on Weibo, so the hunkering down effect of VG has not developed maturely (Li and Chen, 2018). In terms of the ethics of disaster risk management, it presents a missed opportunity, as in a century of disasters, the participation of many actors, including citizens could actively support more open, 'net-centric' disaster risk management models (Boersma et al, 2010).

As it stands UI posts are not taken seriously unless forwarded by highly followed users (VG), which could delay the discovery and dissemination of urgent information. In the current climate, UI posts are greatly reduced.

This reduces the social capital, cultural competence and communicative capabilities of the population, as well as the trust needed to enact positive change. This is harmful, because rumours can severely damage trust in crisis communication, and they are often generated due to a lack of public responsibility. Burgess et al. (2006) show that public responsibility is not only a normative requirement of the state or society but also a moral quality that citizens should have, and acquire through active communicative engagement. In the current climate, although Weibo has some characteristics of a public sphere and openness, the effects of censorship and crowding out the crowd provide a hotbed for rumours. A more interactive approach could enable users to take more responsibility and place public interests first.

We, therefore, suggest that the participation of a diversity of user types is not a problem that must be eradicated, but could be a resource for better collective crisis communication. Strengthening netizens' awareness of taking public responsibility in virtual communities could reduce potential threats in future crisis communication and lead to better collaboration.

CONCLUSION

Using SNA to explore the transformation of NCCP on Weibo, we have examined six earthquakes in China of a magnitude 6.0 or above between 2010-2019 as examples. We hypothesised that the scale of NCCP is proportional to public interest in disasters, and that over time, government actors have crowded out the crowd of individual and other organisational users in a number of ways, focused on number of posts, claiming the role of authoritative source, timing of posts, and concentrating one-directional information transmission connections. All our hypotheses have been confirmed and elaborated by our analysis. Building on a review of theories on public perceptions and crisis governance, the effects of hunkering down in networked communities, and netizen's public responsibilities, we argue that the overall effect of crowding out the crowd in combination with censorship presents a missed opportunity for more interactive and net-centric, collaborative and collective disaster risk management in a century of disasters.

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