Civic-Tech and Volunteered Geographic Information under the COVID-19 Pandemic: A Japanese Case Study

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Abstract: In the early spring of 2020, a new infectious disease, COVID-19, emerged and spread globally, showing how vulnerable humans are to novel viral threats. Evidently, this crisis has inspired new technological and social innovations. The aim of this paper is to provide a brief overview of the application of civic tech and volunteered geographic information to confront the disease, which spontaneously emerged after the first case was confirmed in Japan in late January 2020. The trend of participatory Geographic Information Systems/PGIS that emerged from the GIS controversy in the 1990s went through crisis mapping and has demonstrated a new way of using GIS via social participation in the 21st century.

1 INTRODUCTION

The year 2020 will be considered as the year in which the world fought the first pandemic to occur in 100 years. This highly infectious disease, COVID-19, has shown how vulnerable human society is to novel viral threats. Taubenberger and Morens (2006) reported the spread of Spanish flu in the UK during the 1918 pandemic, and according to their study, it is likely that the current pandemic will last for at least another year, and we expect at least three waves of infections. This paper was written in December 2020, when the scale of the third wave had already exceeded that of the second wave in Japan, and this persuades us to reflect on the fact that our initial outlook was extremely optimistic.

The work of Pyle (1986) provides fundamental knowledge about the spread of an infection. Pyle compared the processes by which influenza pandemics spread over a period of approximately 100 years and found that the pandemic in 1791 took seven months to reach Spain after invaded Europe from Russia, whereas that of 1889 reached Spain in just three months. One of the major events that had occurred during this latter time was the improvement of railways. The world's first railway line was built in England in 1825, and railways were then built in France in 1832 and in Germany in 1835 (Baxter 1866; Kobayashi and Cotte 1997; Ebeling 2005). Pyle's research shows that the spread of disease has an unquestionable relationship with the changes and developments in transportation modes, via which humans act as virus carriers.

In the case of COVID-19, the peak of infection spreading within China (where the virus is believed to have originated) was in early February 2020, and it is believed that this occurred in relation to people moving around the country during the Chinese New Year holidays from 24 January (Zhou et al. 2020).

In Japan, four Chinese people who visited Japan from Wuhan from 16 to 26 January developed the disease sequentially, and the first Japanese person was infected on 28 January (Shigemura et al. 2020). This occurred just prior to the docking of the Diamond Princess (a luxury cruise ship suspected of carrying many positive patients) in Yokohama Port on 3 February (Gallego et al. 2020). To establish a better understanding of the Japanese situation in the context of this paper, I would like to recall that at this time, Japan considered that the initial spark of the COVID-19 outbreak would have no direct repercussions for Japan. This course of time fulfils the role of understanding the context of this study.

Incidentally, approximately 100 years ago (on 17 November 1910), an advert appeared in the St. Louis Post, a local newspaper in St. Louis, Missouri, in the United States. The advert was placed by the Bell

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Figure 1: Newspaper advertisement placed by Bell Telephone Company approximately 100 years ago (source is indicated in the body text).

Telephone Company, which originated in Boston in 1877, and it was captioned 'When in Quarantine'. The caption was then accompanied by a short description summarising the implications of the caption: 'PEOPLE who are in quarantine are not isolated if they have a Bell Telephone' (**Fig. 1**).

This advert suggests that at the dawn of the last century, the desire played a significant role in the spread of this new technology and its associated demand, because it is targeted at patients in isolation who need to communicate with the outside world.

The theme I of this paper is symbolically depicted in this advertisement; in other words, 'disaster promotes technological innovation'. Social crises such as wars, illnesses, and disasters provide major opportunities for the development of technological innovations. The aim of this paper, therefore, is to review the social peril induced by COVID-19 in Japan 2020 from the perspective of epidemic prevention activities achieved through citizen participation in a 'participatory GIS context'.

2 SOCIAL PARTICIPATION OF CITIZENS

2.1 What Is Volunteered Geographic Information?

The internet is the main infrastructure in today's information society, and its roots lie in a network system of academic institutions by packet communications developed in the late 1960s by funding from the U.S. Department of Defense's Advanced Research Project Agency (Abbate 1994).

Similarly, the development of the geographic positioning system (GPS), the core technology that supports today's car navigation systems and autonomous driving technologies, developed from precision guidance technology introduced to combat during the Gulf War (Daly 1993). Other fundamental technology, such as that of infrared photography, which forms the basis of remote sensing technology, has its roots in film that can visualise the infrared band, which was developed by Kodak during WW2 in 1943. These infrared and ultraviolet night-vision techniques made it possible to identify obscured firearms and military installations from the sky (Monmonier 2002a). Aerial photography, the use of which will be discussed later in this paper as a life-saving entity, is no exception. In 1936, the Agricultural Adjustment Administration began taking aerial photographs of farmland for using in soil surveys and demarcation, and by 1941, more than 90% of farmland in the United States (U.S.) had been photographed (Monmonier 2002b). Shortly afterwards, aerial photographs were used together with latitude and longitude coordinates and topographic maps in Japanese urban air raids at the end of the Pacific War, which showed that they were highly effective for enabling horizontal bombing from the sky (United States Army Air (Forces 1944)).

Based on the bitter lessons learned from the Great Hanshin–Awaji Earthquake (1995), Japan has promoted the digitisation of land information. Today, various statistical data and numerical maps (digitised geographic information, such as prefectural boundaries, railways, roads, rivers, and elevations) can be accessed free of charge on the websites of the National Geographic Institute and the Statistics Bureau of the Ministry of Internal Affairs and Communications, which makes them easy to use on personal computers and mobile devices (Sato and Une 2020).

In 2011, 16 years after the Great Hanshin–Awaji Earthquake, crisis mapping was conducted during the

first restoration stage immediately following the Great East Japan Earthquake. In a situation where it was not possible to determine what was happening in the immediate aftermath of the disaster, the only clues were obtained from the photos taken by satellites in real time and aerial photographs taken by aircraft. It was thus essential to read and digitise these to understand the information relating to roads in coastal areas and to associate it with digital maps on the web, and then to enable its sharing so that Self-Defense Forces and rescue teams could access entrance routes as quickly as possible. A platform was therefore built and used during the Great East Japan Earthquake (Seto 2011), wherein bitter lessons learned following the Great Hanshin–Awaji Earthquake were put into practice.

At this time, the Japanese version of crisis mapping became a copyright-free web map called Open Street Map (OSM), which was created in 2004, and a website (sinsai.info) used map built-in technology called GeoAPI to operate OSM. All these were created by the general public in a collaborative spirit, and not by government officials nor researchers. Although participatory GIS has been rapidly accepted since the beginning of the 21st century, it was the first instance in Japan where social participation by citizens through mapping, namely participatory GIS, achieved concrete and remarkable results for the first time and resulted in the democratisation of mapping (Seki 2011).

In the 2000s, the bi-directionalisation of web communication (Web 2.0) advanced rapidly against the background of faster web communication and higher performance computing devices. Michael Goodchild of the University of California (UCSB) coined the phrase, 'volunteered geographic information (VGI)' in relation to the arrival of an era in which geographic information can be mapped in both directions from anywhere in the world by anybody, provided they have certain skills and the available infrastructure (Goodchild 2007).

2.2 Code for Project

It is welcomed to have knowledge about computer programming when participating in providing VGI. Social participation through mapping can be achieved by people having skills necessary to design a platform, who are willing to play a central role in the VGI project. In other words, VGI is supported by the general public (including engineers and programmers), who write programmes and codes to design the site, and by end-users, who modify and correct the wording on electronic maps and websites. This successful combination enables people to participate in solving social issues. One of the key movements was the Code for Project (CfP), which was founded in the United States in 2004 as a Code for America. The main leader is Jennifer Pahlka, who is also the partner of Web 2.0, advocating Tim O'Reilly. CfP was also introduced in Japan, and the code for Japan was established in 2013 via the achievements made through the Japanese version of the crisis mapping mentioned earlier. It is no coincidence that the founder of the Code for Japan was Hiroyuki Seki, a system engineer who built the website, sinsai.info. Various mobile applications have subsequently been created from Japanese CfP on occasions where it is not possible for local government to focus on providing information. For instance, the Code for Kanazawa developed an application named '5374.jp' by identifying users' residences from information about their GPS location through a mobile phone and linking them with garbage disposal dates provided by the local government. The application then automatically informs you about the type of garbage that can be put out every day (Takeda 2014). Similarly, the Code for Tokushima published an application known as 'Ren-radar' that informed users of the real time locations of Ren, a team of dancers, during the Awa-Odori festival (Code for Tokushima 2015).

In summary, an open data trend was developed in Japan after the Great Hanshin–Awaji Earthquake, and the trend of civic-tech citizens actively participating in society through programmes and data editing was established prior to the emergence of the current social peril, COVID-19.

2.3 Visualising Infectious Diseases with VGI

One of the countermeasures that can be employed in tackling COVID-19 is to use electronic maps and diagrams that can be shared to gain a better understanding of the status and process of transmission of infection, in the same way as we use maps when lost. In fact, this has become the front-line attack for VGI vs. COVID-19.

In this respect, the most famous visualisation site globally as of December 2020 is the website 'Covid-19 Dashboard (DB)' created by The Center for Systems Science and Engineering, Johns Hopkins (JH) University.

A DB is a set of visualisation tools on the web that look like an administration screen. It allows users to adjust values and output results by clicking or pressing buttons relating to data, figures, and charts.

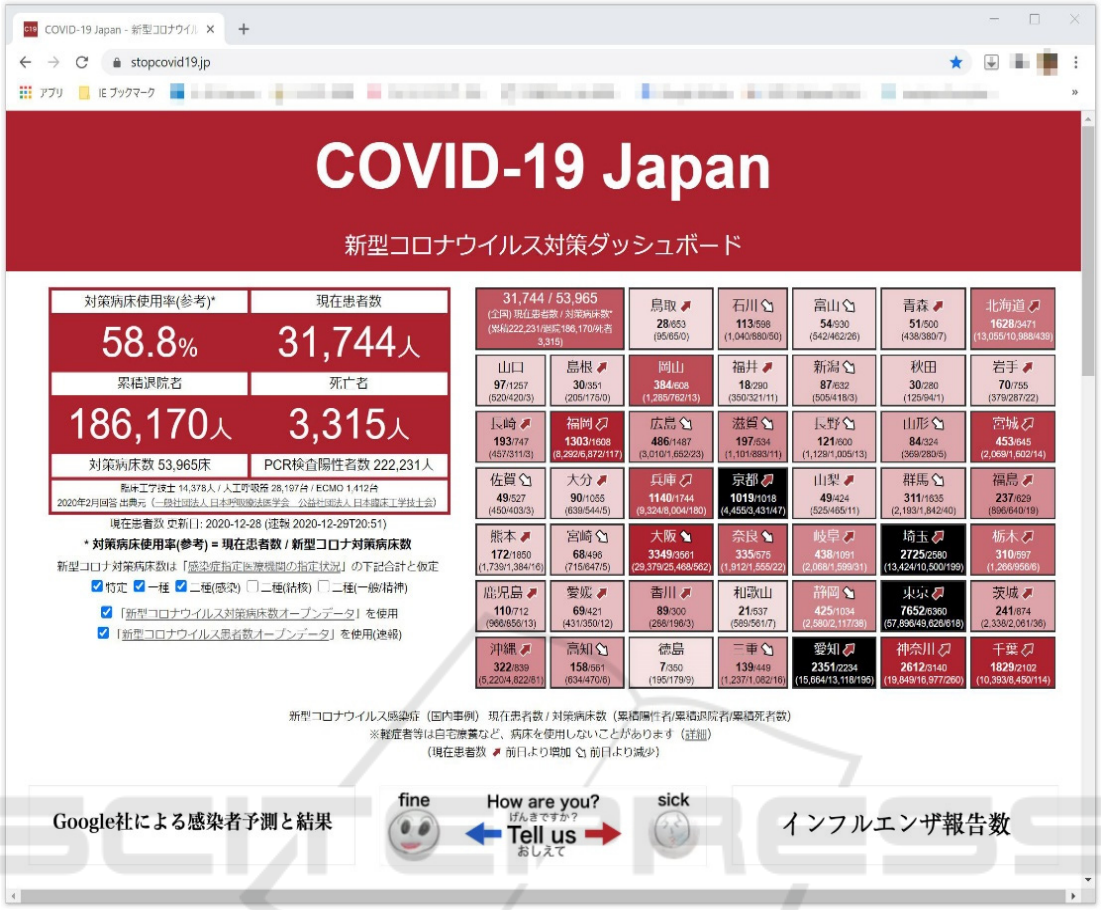

Figure 2: Dashboard screenshot of *COVID-19 Japan.* (Retrieved on 30 December. 2020 from; https://www.stopcovid19.jp/).

A DB does not analyse anything from a professional point of view. It is a public instrument that can be used to effectively visualise and understand the current situation as accurately as possible.

The earliest example of a visualisation website was launched by a Japanese newspaper company, Nihon Keizai Shimbun Co., Ltd., on 7 February, who aimed to visualise the COVID-19 spread using graphic charts. Subsequently, Takuma Ohamazaki, a representative of an election consulting firm, launched the DB entitled 'Map of the Number of Infected People' on 16 February. In this respect, the company aimed to visualise the disease by adding its own expressions, such as a kernel density map, with technical support from the ArcGIS dashboard, while referring to the DB design of JH University.

On 27 February, another newspaper company, Toyo Keizai Shimbun, published a DB that visualises the progress of domestic infection. There are two notable points relating to this DB: the author (Kazuki Ogihara) worked for the company's editorial department individually planned and created the DB, and he used a data vault on the web called GitHub on the visualisation site as far as being found.

GitHub opens the source code of the user's programme so that volunteers can request, point out, and respond to bugs in real time. As a result, sections can contain errors, and their revision statuses and the content of the conversation during the revisions are also visible. This DB subsequently received a good design Award 2020 in October.

This trend became firmly established when the Tokyo metropolitan government, under the technical support of the Code for Japan, released the official 'New Coronavirus Countermeasure Site' on GitHub on 4 March and took further measures to enable perfecting it using collective knowledge by applying an open-source code under a common licence that permits its reproduction and distribution for non-commercial purposes. It was also selected for the Good Design Best 100 award in 2020. In fact, Hokkaido, which was suffering from the spread of infection, employed a Hokkaido version of the Tokyo

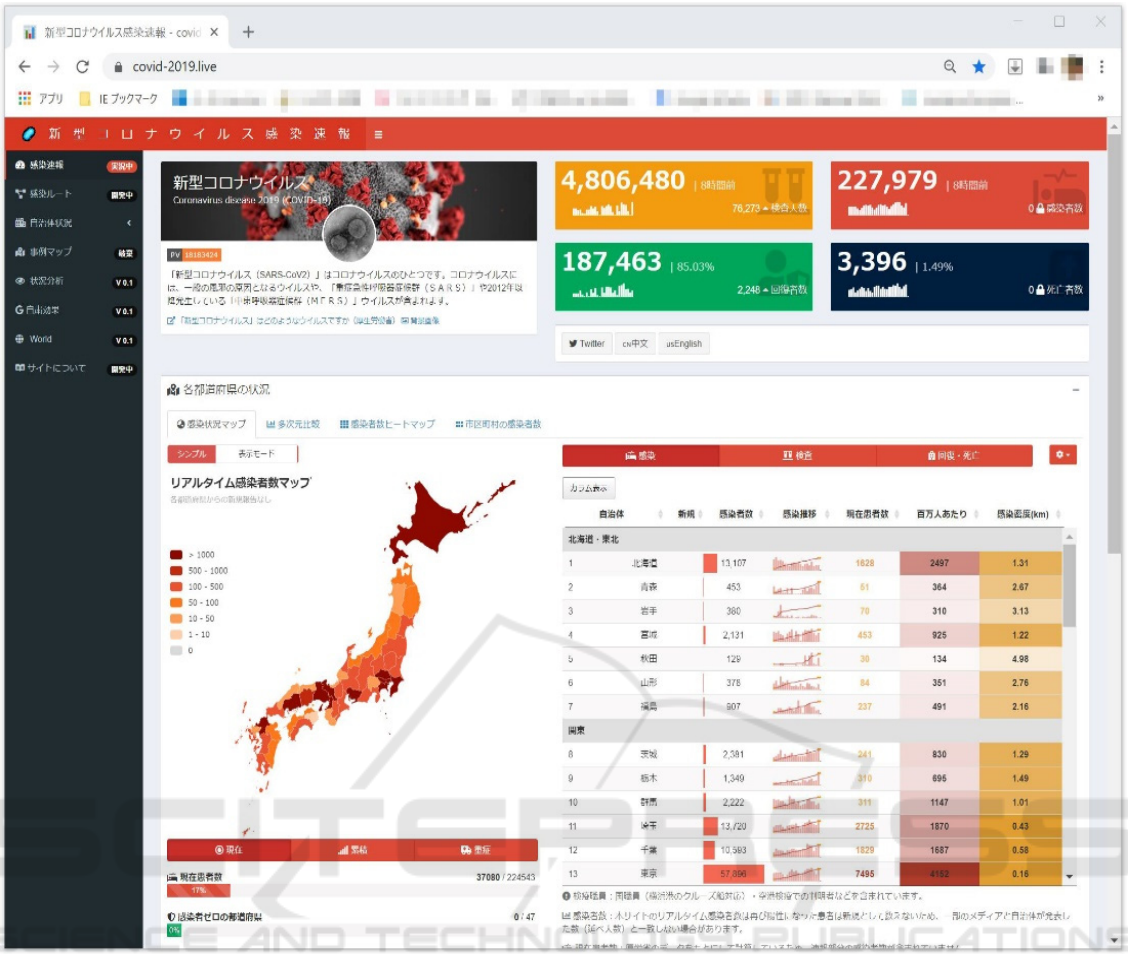

Figure 3: Dashboard screenshot of *COVID-19 live.* (Retrieved on Dec. 30. 2020 from; https://covid-2019.live/).

metropolitan government site created under the name of '#JUSTDoIT', and a similar movement spread to Kanagawa and other prefectures. In addition, large information technology corporations such as ESRI Japan and Yahoo also created the COVID-19 visualisation websites using open data.

A participant in a VGI renders a social contribution based around their time limits and ability and without expecting anything in return. In Japan, during 2020, the VGI movement also occurred on an individual level with based on this conviction.

The first DB relating to COVID-19 was created on 8 March by an anonymous person known as 'Kenmonezumi'. As the data formats and methods of publication for each prefecture were not uniform and the number of PCR tests and the positive test rates were published in PDF format, he manually converted these to CSV via text and published them using Google's data portal. Although it is not a visualisation site using a map, his DB is an example of an individual's first attempt to visualise data related to COVID-19.

Taisuke Fukuno, representative of the Code for Sabae and president of a venture company based in Sabae City, Fukui Prefecture, also charted the occupancy rates of hospital beds by prefecture in late March, and this enabled the visualisation of the risk of the health system collapsing (**Fig. 2**). This website was viewed more than a million times in one month from late March (Mainichi Shimbun, 29 April 2020).

Another noteworthy aspect of VGI that has occurred during the epidemic is that foreigners living in Japan, who tend to be considered socially vulnerable, have made social contributions through VGI. On 23 February, Dong-Yeon Lee, a student from South Korea studying at Kyushu University, created the 'Novel Coronavirus Case Map', which shows infected people in red, people whose migration history is known in blue, and people who have been cured in green, as well as a streamline map of migration history by city, ward, and town (the map has not been updated since 30 October 2020). In addition, covid19.live was launched on 3 March by

Wei_Su, a Chinese international student, and this visualises transitions between the infection density and status by prefecture (**Fig. 3**). Such a movement is in accordance with the Sustainable Development Goals/SDGs philosophy of 'ensure responsive, inclusive, participatory, and representative decision-making at all levels (Goal 16-7)' and 'ensure public access to information and protect fundamental freedom, in accordance with national legislation and international agreements (Goal 16-10)' (United Nations 2020). It is remarkable that active participation of people, who are in a socially vulnerable position during an emergency, occurred via mapping.

3 VGI POSSIBILITIES AND CHALLENGES

As Dekker (2008) noted, 'a prerequisite for partaking in civil society is commitment, the willingness to bind oneself to a common course and to take responsibilities.' In the sense of 'social organisation, such as trust, norms, and networks, that can improve the efficiency of society by facilitating coordinated actions' (Putnam *et al*. 1993: 167), the current VGI movement can be characterised as being a typical social capital. Symbolically, they complained about the lack of usability and inconsistent formats of relevant information released by local and national governments resulting from top-down management. Notably, the COVID-19 disaster has shown how vulnerable the hierarchical (top-down) decision-making system is in the face of a rapidly advancing crisis.

Goodchild (2007), who foreshadowed the promising future of VGI, referred to ethical issues in his article, such as the accuracy of information created and the digital divide. In this respect, ethical issues relating to VGI that have been progressed under the present COVID-19 disaster should be mentioned.

COCOA, the contact verification application released by the Ministry of Health, Labor, and Welfare on 19 June was developed based on COVID-19 Radar, a volunteer open-source project led by Kazumi Hirose, a Microsoft Japan employee. On 8 May, the initiative to develop the application, which had been promoted on a well-intentioned basis, was taken up by the Ministry of Health, Labour, and Welfare and contractors after their decision to use it. However, it was later discovered that when Bluetooth access was disabled, the device would not launch on the iOS. This was severely criticised, and the development was halted. Mr. Hirose, the developer of COCOA, revealed on twitter that he had only three weeks to make changes to the system at the time of the transfer. The COCOA case thus exposed the ethical issue of the extent of qualitative responsibility the donor should take for contributions from volunteers.

Another ethical issue relates to the spread of malice during social crises. Fan *et al.* (2020) extracted 3,457,402 tweets about COVID-19 and China from twitter API using query 'china + and + coronavirus' and showed that 25,467 of these involved hate speech, which was highly related to the users' poverty and unemployment status and feeling of fear. The analysis used the U.S. as a case study and also showed that an upward trend in hate speech occurred when the first COVID-19 cases in the U.S. were reported and then immediately after the spread of the disease was in full swing (which was evidenced by a report from the Asia Pacific Policy Planning Council, which found that 1,497 cases were reported in the U.S. between 19 March and 15 April (Jeung and Nham 2020)).

Since the second wave of COVID-19 hit in October 2020, messages encouraging the exclusion of Asians have spread on social networking sites in France, accelerating the division of society. For example, one tweet said 'Arabs and blacks living in the 91st, 92nd, 93rd, 94th, and 95th arrondissements of Paris, please attack Chinese people if you see them on the street' (**Fig. 4**). When people perceive that they

Figure 4: Tweet calling for Chinese assault. Retrieved on 29 December 2020 from; https://twitter.com/ruiwangfrance/status/1321608375298379777/photo/2.

are protected by anonymity, they are less likely to exercise the same psychological restraint as when they are not anonymous. Suler (2004) called this the 'online disinhibition effect'. The problem, as the tweet suggests, is that threats in virtual space can be projected into real space by virtue of their location (Suzuki 2021).

Velásquez *et al*. (2020) investigated the spread of malicious content on social media using machine learning to identify COVID-19-related hate speech, false information, and misinformation. They revealed that malicious content starting at 4ch spread to other social networking sites (SNSs) (such as Telegram, Gab, and Facebook) while forming network clusters. At present, the right to delete such malicious content is limited to the operating company of each SNS, and it is extremely difficult to prevent it from spreading over SNSs. The EU's ratification of a voluntary code of conduct relating to hate speech in 2016 has not been effective. France is in the midst of developing a new law, the Avia Act (The Cube 2020) that regulates online hate speech, and in the U.S. there is a fierce battle over whether or not Section 230 of the Communications Decency Act (CDA), which has long held the view that social network operators are not legally responsible for the content of their posts, should be upheld (Musil 2020; Sink *et al*. 2020).

Due to the characteristics of social networking tools, cyberspace sometimes becomes a stage for information warfare between nations and ethnic groups. As it was strongly suspected that COVID-19 originated in Wuhan, China, a conflict arose between the U.S., who claimed it should be called the 'Wuhan virus,' and the Chinese, who objected and claimed that it had been imported from the U.S. Wang *et al*. (2020) tracked Chinese #USAVirus propaganda retweets from 1,256 twitter accounts and analysed 3,567 tweets collected before they were banned by twitter on 12 June 2020. As a result, while many were written in English, 74% of them held attached image files of long sentences written in simplified Chinese letters, and the posting time distribution was also confirmed to relate to Chinese working hours. Wang *et al*.'s report is reminiscent of the 'A Study in Empire' made by opportunist scholars being obsequent to Nazi imperialism (Monmonier 1991). It is also possible to look at these logs on SNSs from the viewpoint of historical material criticism.

In the French case I mentioned earlier, the hashtag '#JeNeSuisPasUnVirus' was also spread in response to hate speeches against Chinese people. Social networking is only a tool, and it is people who use it. However, among research fields dealing with geographic information, limited research relating to information ethics on the user side has been conducted. At present, VGI, where engineers build the platform, has only been minimally affected by unethical behaviour that frequently occurs on SNSs. However, it is also true that VGI, which leverages the same collective knowledge as Wikipedia, is constantly exposed to the risk of vandalism, destruction, and data inaccuracy (Viégas *et al*. 2004).

4 REMARKS

In 100 years from now, when people recall the COVID-19 pandemic, it will be apparent that for the first time in human history, ordinary citizens assisted in fighting the spread of disease by visualising geographical information.

In addition, this disease has spread (via SNSs) hate speech, propaganda, and rumours, and exposed the dark side of humanity. In this age of readily available pandemic information and the presence of COVID-19, people are getting more capable of delivering geographic information. In this age of rapid spread of geographic information through citizen participation, we thus need to also focus on the associated ambivalent aspects.

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