Chapter 2
Development and Operation of Social Media GIS for Disaster Risk Management in Japan

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Abstract Since natural disasters frequently happen all over the world, we must make effective preparations for such disasters. As the implementation of sophisticated computerization expands, the society now benefits from ubiquitous network and cloud computing. Consequently, we can utilize a variety of information systems effectively for disaster reduction measures. Based on the experiences of natural disasters, among a variety of information systems, the roles of GIS (Geographic Information Systems) and social media are considered important for collection and transmission of disaster information. Against the above-mentioned backdrop, the present study aims to classify disaster risk management for natural disasters into three stages—normal times, disaster outbreak times, and times of recovery and reconstruction—to introduce the results of development and operation of social media GIS during each of these three stages. The social media GIS targeted residents who were more than 18 years old in the Tama region of Tokyo metropolis and the neighboring area in Japan for two months. Subsequently, the systems were evaluated based on the results of an online questionnaire survey to users, access surveys using log data during operation of the systems, and an analysis of the submitted information. Based on the results of the evaluation, measures for improvement of the development and operation of social media GIS can be summarized into three areas regarding (a) participation of various users and partnership with local communities, (b) usability, and (c) long-term actual operation.

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1 Introduction

Since natural disasters frequently happen all over the world, we must make effective preparations for such disasters. According to the White Paper on Disaster Management (2012), measures for disaster prevention and reduction of the effects of natural disasters in Japan include "self-help", "mutual help (cooperation)", and "public help (rescue and assistance by public bodies)". "Self-help" refers to local residents, businesses, and other entities protecting themselves from disaster; "mutual help (cooperation)" refers to local communities helping each other; and "public help" refers to measures by government bodies such as national and local governments. Further, the most fundamental form of help was said to be self-help, which involves measures taken by individuals. Nowadays, anybody, anywhere, anytime can use an information system to easily send, receive, and share information, and through the effective use of information systems, disaster information possessed by local residents can be accumulated and shared.

Additionally, the Science Council of Japan (2008) divided "local knowledge" into "expert knowledge" based on scientific knowledge, and "experience-based knowledge" produced by the experiences of local residents, and indicated its importance. Concerning "local knowledge" that is the "experience-based knowledge" of local residents, and exists as "tacit knowledge" that is not visualized if it is not communicated to others, as a measure for disaster prevention and reduction, it is essential for the "experience-based knowledge" to be transformed into "explicit knowledge" which is of a form that can be accumulated, organized, utilized, and made publicly available through the use of information systems, and to have local related entities accumulate the knowledge together. Moreover, Committee for Policy Planning on Disaster Management—Final Report by the Central Disaster Management Council (2012) particularly specified the importance of the roles of GIS (Geographic Information Systems) and social media in the collection and transmission of disaster information, and the role of "public information commons", which provide free information services during disasters, is becoming more important.

Regarding the examples of disaster management in other parts of the world, Greene (2002) proposed five stages of disaster—identification and planning, mitigation, preparedness, response, and recovery—, and shows how GIS processes can be incorporated into each. Vivacqua and Borges (2012) considered the four phases of emergency management which are related in a cyclic fashion: mitigation, preparedness, response, and recovery. They discussed possibilities for the introduction of collective knowledge in emergency response systems. Mansouriana et al. (2006) addressed the role of Spatial Data Infrastructure (SDI) as a framework for the development of a web-based system to facilitate disaster management with emphasis on the response phase in Iran. Neuvel et al. (2012) proposed the network-centric concept of spatial decision support for risk and emergency management in Netherland.

In the present study, firstly, with reference to the White Paper on Disaster Management (2012), Committee for Policy Planning on Disaster Management—Final Report (2012), and Vivacqua and Borges (2012), disaster risk management is divided into three stages—normal times, disaster outbreak times, and times of recovery and reconstruction—. Further, the present study aims to introduce the results of development and operation of social media GIS for risk management in each of the above-mentioned stages, citing results concerning systems developed and operated by the present author and her co-researchers (Okuma and Yamamoto 2013; Murakoshi and Yamamoto 2014; Yamada and Yamamoto 2013).

2 Related Work

Focusing on research methods, existing research related to the present study can be broadly divided into four types: (1) Research involving the staging of workshops; (2) Research related to information system development and proposals; (3) Research related to Web-GIS design and development; and (4) Research related to social media development and use. In (1), studies involving the staging of workshops have been carried out by Matsuda et al. (2005), Miao et al. (2005), and Nagasaka et al. (2009). In these studies, through workshops in which disaster prevention radio dramas were created, and the use of regional disaster prevention capacity diagnostic sheets, local residents' awareness of issues and knowledge were shared. In (2), research related to developing and proposing information systems, Murakami et al. (2009) and Okano et al. (2009) developed disaster prevention activity support systems, and Kato et al. (2010) proposed a disaster management information mashup system. In (3), research related to the design and development of Web-GIS, Sato et al. (2004), Kajiki (2006), and Fujita et al. (2008) developed and published regional safety maps. Takatani et al. (2008) developed hazard maps. Kawasaki and Meguro (2010), and Inoguchi et al. (2011) showed the effectiveness of disaster information web mapping. Additionally, Yanagisawa and Yamamoto (2012) integrated Web-GIS, a Social Networking Service (SNS) and a wiki into a single system which enabled the accumulation of local safety information such as disaster information. In (4), research on social media development and use, Yamamori (2010) developed a bulletin board for use during disasters which utilized a regional SNS, and Korida et al. (2011) developed a community disaster prevention SNS. Wasaki (2012) demonstrated the usefulness of regional SNS in times of disaster. In addition, Yamamoto et al. (2012), and Yoshimura and Inoue (2012) analyzed the situation regarding information transmission and acquisition via Twitter during the Great East Japan Earthquake (2011), and demonstrated the possibility of real-time disaster information transmission via Twitter.

As outlined above, a large amount of existing research utilizes Web-GIS and social media, and the number of services that utilize some kind of information system is increasing. However, while various information systems related to disaster exist, they mainly focus on measures to reduce the effects of natural disasters, and deal separately with each stage of disaster risk management—normal times, disaster outbreak times, and times of recovery and reconstruction. Further, they only collect information and one-sidedly provide information. Excluding the results of research on system developed and operated by the present author and her co-researchers (Okuma and Yamamoto 2013; Murakoshi and Yamamoto 2014; Yamada and Yamamoto 2013), up till now, a series of systems designed for continuous disaster risk management which covers all stages—from normal times to times of recovery and reconstruction—has not been developed. Thus, the main objectives of systems in the series differ according to the stage of disaster risk management. The main objective from normal times to disaster outbreak times is support for accumulation and utilization of disaster information, and the main objective in times of recovery and reconstruction is information exchange; however, the series of systems is set such that by changing the mode for each stage of disaster risk management, the same system can be used continuously in all three stages. Thus, this system is an aggregate of multiple systems, and can be customized to suit the actual situation in a region where it is to be operated. Sections 4–6 describe the development and operation of the three types of social media GIS one by one.

3 Outline of Social Media GIS

3.1 Progress of Transformation to Information-Intensity in Japan

In Japan, the Basic Act on the Formation of an Advanced Information and Telecommunications Network Society (Basic IT Law) came into force in 2000. In "e-Japan" of the year 2000, a plan, strategy, and policies which aimed to realize a Japanese-style IT society were proposed. Further, "u-Japan" of the year 2006 aimed at realizing a society in which "anybody, anywhere, anytime, using any device" could easily connect to a network by the year 2010. In addition, in 2010, "i-Japan 2015", which declared the goal of realizing a "reassuring and vibrant digital society", was proposed. Now, Japan is shifting from being the ubiquitous network society which was aimed for in "u-Japan" to being a cloud computing society in which various information tools can be used to connect to the internet. Therefore, regardless of time and place, as long as there is an information environment which allows internet connection, people can use the internet, using devices such as mobile information terminals (e.g., smartphones and tablet-type terminals), as well as PCs, so anyone can easily send and receive information. Moreover, various social media such as blogs, Twitter, YouTube, Facebook, and Line can be used to transmit information in compound forms combining images, videos, and sounds, not just words.

3.2 Development of Social Media GIS

Information on the situation regarding damage in the Great Hanshin Earthquake that occurred in Japan in 1995 was put into a database utilizing GIS, and information for reconstruction planning was effectively provided. Therefore, the usefulness of GIS came to be acknowledged. Further, as legislation related to GIS, in addition to the Basic IT Law mentioned in Sect. 3.1, the Basic Act on the Advancement of Utilizing Geospatial Information came into force, and presently its application in various areas of our daily lives is highly anticipated.

As shown in Fig. 1, the GIS is based on a digital map, and broadly speaking has four basic functions—a database development function, an information analysis function, an information providing/sharing function, and a decision-making support function. The GIS uses these functions to connect the real world with the virtual world, and it can be said that the GIS is an information system that is intimately connected with people and society. Formerly, research which utilized database development functions and information analysis functions dominated, but together with the development of an information-intensive society, information providing/sharing function have come to be utilized often in research. Therefore, development of GIS which citizens participate in has proceeded, and GIS has come to be used as a tool for providing information to and sharing information with residents. According to Siebel (2006), the term "Public Participation Geographic Information Systems" (PPGIS) was first used in a workshop of the U.S. National Center for Geographic Information and Analysis (NCGIA) in 1996. Moreover, Godchild (2007) termed GIS which enable information provided voluntarily by ordinary people to be accumulated on a digital map, and provided and shared "Volunteered Geographic Information (VGI)", and demonstrated the importance of the role of ordinary people as social sensors.

The present author and her co-researchers took these civic-participation-style GIS a step further, and by integrating social media and Web-GIS, gave GIS a function for interactive communication between users, as shown in Fig. 1. Additionally, aiming for actual operation in local communities, in the series of studies mentioned in the previous section (Okuma and Yamamoto 2013; Murakoshi and Yamamoto 2014; Yamada and Yamamoto 2013), the present author and her co-researchers integrated social media with Web-GIS, and developed a social media GIS which was a disaster information system mainly for earthquake disaster prevention and reduction measures. Because a Web-GIS alone is limited to one-way information transmission utilizing a digital map, an SNS and Twitter were integrated with the Web-GIS to allow interactive information transmission and reception, and that is the greatest distinguishing feature of the system. If long-term operation using the communication feature of the social media GIS developed as outlined above can be achieved, it can be anticipated that information concerning the awareness and behavior of ordinary people as social sensors will be collected and accumulated on the GIS digital map, and using the information analysis

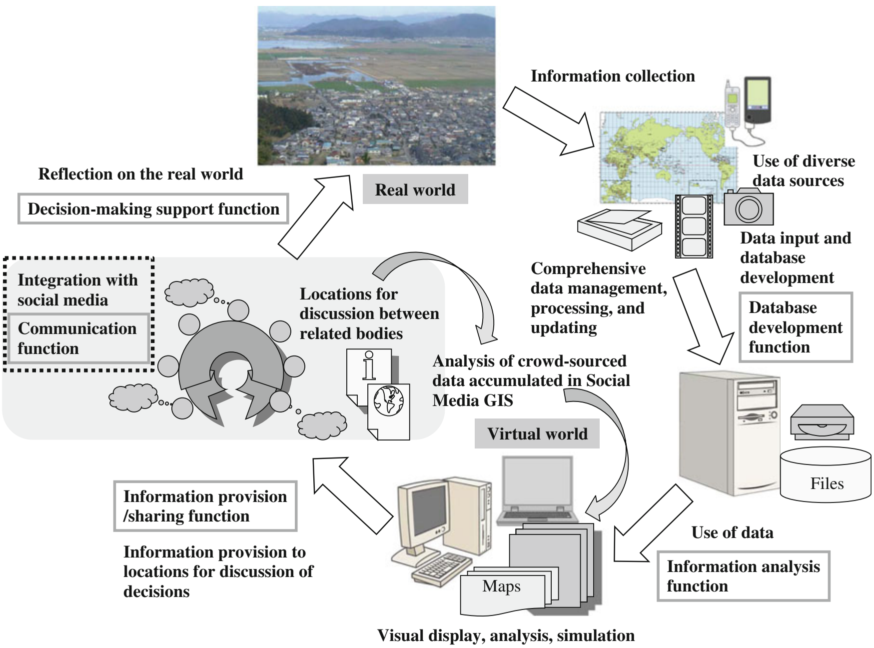


Fig. 1 Various functions of GIS to integrate relevant data by location

function, the information will be analyzed as crowd-sourced data tagged with spatial information.

As social media for integrating with the Web-GIS, firstly, an SNS was selected, and was designed and developed in a unique way in accordance with the primary objectives of systems able to handle each stage of risk management. This is because unlike with other forms of social media, with an SNS a system can be uniquely designed and developed in line with objectives of use, and detailed system configuration can be carried out to suit the actual situation in a region where the system is to be operated. However, considering the penetration rate of mobile information terminals (especially smartphones), for the two types of system developed and operated in 2012 for use in normal times and times of recovery and reconstruction, in addition to an SNS, Twitter was also added to the systems as a form of social media (Okuma and Yamamoto 2013; Yamada and Yamamoto 2013). This is because use from mainly mobile information terminals was anticipated. However, in the system developed and operated in 2013 that focused on normal times through to disaster outbreak times, not only an interface for PC use but also an interface optimized for mobile information terminals was provided (Murakoshi and Yamamoto 2014). Further, as social media for integration with the Web-GIS, only an SNS was used. This is because the results of the systems developed and operated in 2012 revealed that it was necessary to take into account users who did not have Twitter accounts.

3.3 Operation of Social Media GIS

Tables 1 and 2 show the operation of Social Media GIS Series in the present study, and Table 3 describes the outline of users and online questionnaire survey respondents. In accordance with the operation process in Table 1, each of the three types of social media GIS was actually operated after an operation test and an evaluation of the operation test had been conducted. As mentioned in Sect. 3.2,

Table 1 Operation process of Social Media GIS Series (2012, 2013)

Process	Aim	Period	Specific details
1. Survey of present conditions	To understand efforts related to disaster prevention and reduction in the region of operation	January–March	• Survey of government measures and internet services • Interview targeting municipal employees and officials of residents' councils
2. System configuration	Configure the system in detail to suit the region of operation	April–June	• Define system requirements • System configuration • Create operation system
3. Operation test	Conduct the system operation test	July	• Create and distribute pamphlets and operating instructions • System operation test
4. Evaluation of operation test	Reconfigure the system based on results of interviews with operation test participants	August–September	• Evaluation using interviews • System reconfiguration • Amendment of pamphlets and operating instructions
5. Operation	Carry out actual operation of the system	October–November	• Appeal for use of the system • Distribution of pamphlets and operating instructions to local residents • System operation management
6. Evaluation	Evaluate the system based on the results of online questionnaire survey to users, the results of access analysis which used log data during the period of actual operation, and the results of analysis of submitted information	December	• Evaluation using online questionnaire survey to users, access surveys using log data during operation of the systems, and an analysis of the submitted information • Identification of measures for improvement of the development and operation of the system even more effectively

Table 2 Outline of operation of social media GIS series

Relevant section in the present study	Period of stage	Region of operation	Number of users	User characteristics
Section 4	Normal times	Chofu City, Tokyo Metropolis	75	72 % of users were in their 20s, and 10 % were in their 30s and 40s
Section 5	From normal times to disaster outbreak times	Chofu City, Tokyo Metropolis	56	52 % of users were in their 20s, and 20 % were in their 40s. Further, 16 % were in their 50s or above
Section 6	Times of recovery and reconstruction	Tama region of Tokyo Metropolis and eastern Yamanashi Prefecture	45	93 % of users were in their 20s. There were 25 users in the Tama region of Tokyo Metropolis, and 20 users in eastern Yamanashi Prefecture

Table 3 Outline of users and online questionnaire survey respondents

	10–19	20–29	30–39	40–49	50–59	60–	Total
Section 4							
Number of users	4	54	8	7	2	0	75
Number of questionnaire respondents	4	43	2	2	0	0	51
Valid response rate (%)	100.0	79.6	25.0	28.6	0.0	–	68.0
Section 5							
Number of users	1	29	6	11	5	4	56
Number of questionnaire respondents	1	27	4	4	2	3	40
Valid response rate (%)	100.0	93.1	66.7	36.4	40.0	50.0	71.4
Section 6							
Number of users	1	42	2	0	0	0	45
Number of questionnaire respondents	1	30	2	7	2	3	33
Valid response rate (%)	100.0	71.4	100.0	0.0	0.0	0.0	73.3

though the system for use from normal times to disaster outbreak times was operated in 2013, two other types of systems were operated in 2012. As shown in Table 2, each of social media GIS was operated for a period of two months, targeting local residents who were more than 18 years old. The systems for use in normal times and disaster outbreak times were operated in Chofu City, Tokyo Metropolis, while the system for use in times of recovery and reconstruction was operated in two regions—the Tama region of Tokyo Metropolis, and eastern Yamanashi Prefecture. Use of the systems was appealed for the local residents in the regions for operation, using such means as the website of the present authors' laboratory. Further, in the regions of operation, the local governments such as Tokyo Metropolis, Yamanashi Prefecture, and Chofu City helped the present author to distribute system pamphlets and operating instructions to the local residents. Each system was respectively operated according to the main objective mentioned in Sect. 2 in normal time. After the operation of each system for two months, online questionnaire surveys were conducted to users.

It can be seen from Tables 2 and 3 that the majority of users of all three types of system were in their twenties, meaning many users were of a generation proficient in using a variety of information systems in their daily lives. After operation, the systems were evaluated based on the results of an online questionnaire survey to users, access surveys using log data during operation of the systems and an analysis of the submitted information. The questionnaire items were related to the operability especially regarding the functions and the effects of use to evaluate the usability of the three types of social media GIS.

4 System Designed for Accumulating Disaster Information in Normal Times

When a disaster occurs, the helping hand of fire brigades and other rescue groups will not extend to all disaster victims. In order for disaster damage to be kept to a minimum by disaster prevention and reduction measures taken in normal times, it is necessary for each person to have a high level of awareness of disaster information in their daily life. Accordingly, it is important that people always have an accurate understanding of what places are dangerous to pass through during a disaster, where the evacuation sites are in their region of residence, and that this information be collected as geotagged disaster information. Further, in order to link this to "mutual help" and "public help", it is necessary for local governments and residents to accumulate and share disaster information to a sufficient extent during normal times.

In Japan, representative examples of disaster prevention and reduction measures are government efforts such as the "Hazard Map Portal Site" developed and operated by the Ministry of Land, Infrastructure, Transport and Tourism, and the disaster prevention maps and hazard maps of local governments. However, these resources have little detailed information which local residents actually need during a disaster, so they are not very user-friendly, and in the case of resources published in PDF format, the information cannot be viewed all at once. In order to solve the above-mentioned problems, Okuma and Yamamoto (2013) developed a social media GIS specially tailored to accumulate disaster information on digital maps for the purpose of disaster prevention and reduction measures in normal times. To achieve this, two types of social media, an SNS and Twitter, were added to a Web-GIS, and those three applications were integrated into a single system. Due to the integration, this system fundamentally has the information submission and viewing

No.	Description
1	User profile publication
2	The ten most recent items of information submitted from computers and mobile information terminals using Twitter
3	Other users
4	Go to my page
5	Go to the page where information can be submitted from computers
6	Go to the page where information can be submitted from mobile information terminals using Twitter
7	Go to the page where change and registration of personal data can be made
8	Logout
9	Disaster information is displayed on Web-GIS digital map in the region of operation(ChofuCity)
10	Submitted information by residents
11	General degree of risk
12	Explanation of disaster information provided by local governments A: Evacuation assembly area, B: Water station, C: Petrol station, D: Medical institution, E: Homecoming support station

Fig. 2 PC interface of system developed by Okuma and Yamamoto (2013)

functions. Moreover, with reference to disaster prevention maps produced by local governments, information about the support facilities (evacuation sites, stations which provide support for people returning home, water supply bases, etc.) in addition to the general degree of risk was accumulated in the database in advance. Therefore, disaster information provided by local governments and residents was mashed up on a GIS base map. Figure 2 shows the PC interface of the system.

In this system, because the system consists of not just Web-GIS, but rather integrates a Web-GIS with social media, the various functions of social media can be used to collect and transmit disaster information which is the experience-based knowledge of local residents, and this disaster information can be accumulated and shared as explicit knowledge on the Web-GIS digital map. Through this, it can also be anticipated that local residents will be able to appreciate the weaknesses of the area they live in, and their awareness of disaster prevention and reduction will be heightened through the experience of accumulating and sharing disaster information. Accordingly, "self-help" may lead to "mutual help" and "public help". Further, based on the concept of resilience, utilizing the accumulated disaster information, the possibility that this system can be applied to pre-disaster outbreak advance reconstruction efforts involving measures and preparations for recovery and reconstruction can be anticipated.

According to Okuma and Yamamoto (2013), the online questionnaire survey showed the usability of the system in terms of its operability and effects of use. It also showed that the system was effective to heighten local residents' awareness of disaster information, and it will be continuously used as disaster prevention and reduction measures in normal times. Additionally, it was clear that most of users used PCs rather than mobile information terminals (especially smartphones) as a means of information submission, and approximately 30 % of users only viewed the disaster information provided by local governments and residents. The access survey showed that users in their 30s and 40s submitted information only from PCs, while those in their 20s submitted information to approximately the same extent from both PCs and mobile information terminals. Additionally, the 92 pieces of submitted information were classified into five types, among which 73 % of information was provided about evacuation sites and routes. Further, 24 % of information was provided about food and water supply bases in times of disaster, and 3 % of information was related to the Great East Japan Earthquake.

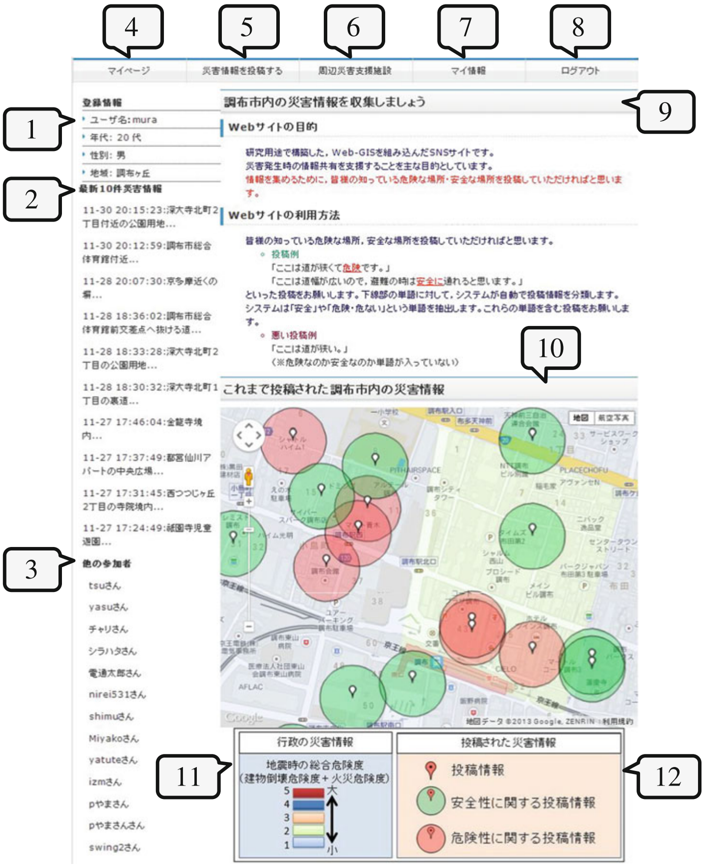
5 System Designed for Supporting Utilization of Disaster Information from Normal Times to Disaster Outbreak Times

In Japan, as a disaster countermeasure, local governments provide information to local residents in the form of disaster prevention maps and hazard maps which show local hazardous places, evacuation sites and so on. However, this information is mainly published as maps that are in paper form or in PDF format on the website. Therefore, it is difficult to update the information on disaster prevention maps and hazard maps in real time, and these forms of information are not very suited to being shared during a disaster outbreak. Further, so that information can be efficiently accumulated and shared during a disaster outbreak, it is desirable that information systems which people are accustomed to using in normal times can be used as is during disasters. However, when a disaster occurs, a situation where the amount of submitted information increases, and there is an excessive amount of information can be expected; therefore, it is necessary for systems to automatically classify submitted information.

Based on awareness of the above-mentioned issues, Murakoshi and Yamamoto (2014) developed a social media GIS which integrated Web-GIS with an SNS, and was specially tailored to mashup the information that local governments and residents provide to support information utilization from normal times to disaster outbreak times. This social media GIS employed the system developed by Okuma and Yamamoto (2013) as a base, and extended the period of use of the system from normal times, during which the system would be used for disaster prevention and reduction measures, to include disaster outbreak times, during which the system would be used for evacuation activity support and support for people facing difficulty in returning home due to disaster. The strongest reason for extending the period of use of the system was that it could be anticipated that through people using the system in normal times and becoming familiar with it, they would also continue to use the system at the stage when a disaster occurred and the situation was very urgent. As mentioned in Sect. 3.2, Twitter was not included in this system. In addition to a PC interface (Fig. 3), an interface optimized for mobile information terminals (Fig. 4) was provided.

In this system, the fundamental functions—the information submission and viewing functions, and the mashup of disaster information provided by local governments and residents—are almost the same as those of the system developed by Okuma and Yamamoto (2013). However, this system also has a function for classifying submitted information, and a function for checking support facilities in times of disaster. Using the former function, based on text information, the system automatically determines whether submitted information is related to either danger or safety. Further, on the Web-GIS digital map, the system indicates danger-related information using semitransparent red, and safety-related information using semitransparent green. Therefore, evacuees can determine with a single glance which areas are dangerous and which areas are safe, even when looking at a small screen on a mobile information terminal when they are evacuating during a disaster. Concerning the latter function, based on the information provided by local governments, users can search for a facility which provides support during a disaster by freely specifying a category of facility and a distance from their present location, and display the search results on the Web-GIS digital map.

According to Murakoshi and Yamamoto (2014), the online questionnaire survey showed the usefulness of the system in terms of its operability, especially regarding the above-mentioned two specific functions, and the possibility to provide disaster information mainly for mobile information terminals in disaster outbreak times. Since it also showed the large extent of the effects of use particularly related to local residents' awareness of disaster information, we expected that this system will be continuously used according to the main objective from normal times to disaster outbreak times. The access survey showed that users continuously accessed the system and 181 pieces of disaster information were distributed throughout the whole region of operation. Additionally, it was clear that 83 % of users accessed the system mainly using PCs, and mobile information terminals were used to assist the use of



No.	Description
1	User profile publication
2	The ten most recent items of information submitted from computers and mobile information terminals
3	Other users
4	Go to my page
5	Go to the page where information can be submitted from computers
6	Go to the page where support facilities in times of disaster can be checked
7	Go to the page where change and registration of personal data can be made
8	Logout
9	Explanation to use this system
10	Disaster information is displayed on Web-GIS digital map using markers
11	General degree of risk
12	Explanation of disaster information submitted by users

Fig. 3 PC interface for system developed by Murakoshi and Yamamoto (2014)

PCs. Among the disaster information, danger-related information occupied 28 %, safety-related information occupied 67 %, and other information occupied 5 %.

What is thought to be a problem at this stage is the internet communication environment (internet connection, electricity, use of information terminals, etc.). However, technological development in related fields is proceeding rapidly, so it is highly likely that this problem will be solved in the near future. For example,

No.	Description
1	User profile publication
2	The ten most recent items of information submitted from computers and mobile information terminals
3	Submitted information is displayed on Web-GIS digital map using markers
4	General degree of risk
5	Support facilities in times of disaster A: User's present location, B: Homecoming support station, C: Evacuation assembly area
6	Logout

Fig. 4 Mobile information terminal interface for system developed by Murakoshi and Yamamoto (2014)

technological development is proceeding rapidly in the area of securement of internet access through such means as mobile internet base stations fitted into cars, wireless communication via solar portable base stations, and satellite communication; in the area of electricity supply which utilizes hybrid cars and the like; and in the area of extension of the length of time which mobile information terminal batteries last.

6 System Designed for Information Exchange Between Regions in Times of Recovery and Reconstruction

Yamada and Yamamoto (2013) developed a social media GIS that enabled information exchange between multiple regions. Figure 5 shows the PC interface of the system. The information submission and viewing functions, and the basic configuration of the system are almost the same as those of the system developed by Okuma and Yamamoto (2013); however, the system also includes a comment function, a button function, and a ranking function. By using the comment function, users in multiple regions or within a particular region can communicate with each

No.	Description
1	User greeting
2	User profile publication
3	The ten most recent items of information submitted from mobile information terminals using Twitter
4	Go to a list of information submitted from mobile information terminals using Twitter and the ranking page
5	The ten most recent items of information submitted from computers
6	Go to my page
7	Go to the page which contains messages from administrators
8	Go to the page where change and registration of personal data can be made
9	Go to the page where information can be submitted from computers
10	Go to the page where information submitted from computers can be viewed
11	Go to the page where information submitted from mobile information terminals using Twitter can be viewed
12	Logout
13	Explanation to use this system
14	Submitted information is displayed on Web-GIS digital map using markers

Fig. 5 PC interface for system developed by Yamada and Yamamoto (2013)

other. By using the button function, users can conduct simple communication with each other, and also evaluate the importance of submitted information. Further, regarding the submitted information list, the ranking function can be used to display submitted information in descending order starting with information which has attracted the highest button function usage frequency, so that important submitted information does not get lost amongst other information.

According to Yamada and Yamamoto (2013), the online questionnaire survey showed the high level of operability, the high frequency of use during the period of operation, and the large extent of the effects of use, and it was clear that the high evaluation of the above-mentioned three unique functions also contributed to the high level of the operability. Additionally, it was also clear that the button function was most highly evaluated by users among the three functions. This is because users were able to easily indicate their intentions in response to information viewed, by using the button to reflect their experiences and thoughts. The access survey results showed that while the access count from mobile information terminals was no more than 12 % of 383 access count, the submission count from mobile information terminals was 41 %, accounting for slightly less than half of 85 submission count. Further, the results revealed that the majority of submitted information was information known only to local residents in the regions of operation. Moreover, of the submitted information, 41 % concerned places to eat and drink, 38 % concerned scenery, and the remaining 11 % concerned various public facilities such as recreation centers, museums, and science centers.

Moreover, the objectives of this system differ between normal times and times of emergency. In normal times the objective is for information relating to the region and tourism to be discovered within each region, for users to send the information to each other, and for the information to be exchanged between multiple regions. Meanwhile, in times of emergency, such as in times of recovery and reconstruction after a disaster, the objective is for information concerning necessary people, things and so on to be exchanged by those inside and outside the disaster-stricken region, and for what is necessary to be rapidly sent from outside the disaster-stricken region to the places where it is needed inside the disaster-stricken region. Therefore, by having local governments which conduct regional exchange such as sister city arrangements with each other use this system to exchange information in normal times, the possibility of achieving effective support for disaster-stricken regions in times of recovery and reconstruction after a disaster can be anticipated.

7 Conclusion

Thus, the present study classified disaster risk management into three stages—normal times, disaster outbreak times, and times of recovery and reconstruction; cited results concerning systems developed and operated by the present author and her co-researchers designed for purposes of mainly earthquake disaster prevention and reduction measures; and presented results concerning the development and operation of social media GIS that can handle each one of the above-mentioned stages. In developing systems for disaster risk management, a particularly essential condition is that the system must actually be usable in the event of a disaster.

Therefore, based on the principles and techniques of inclusive design, it is important to appropriately reflect the opinions of the people who actually use the system, such as local governments and residents, and civic groups, starting from the design stage of the system. It is also important to take into account social change and progression in information communication technology, and continuously improve the system.

An example of an issue that came up based on the results of the evaluations which was common to all three systems was firstly to involve not just local governments and residents, and civic groups, but also to cooperate with fire brigades, police and so on, and operate the system with the participation of a wider user base. In order to achieve this, as well as further strengthening ties with local communities and holding courses on the use of the systems and information tools, it is also necessary to consider having people of a wide range of ages imagine disaster outbreaks and actually use the systems at disaster drills and evacuation drills, and to consider creating systems in which people such as members of the younger generation who are proficient in using information tools support other people, particularly the aged, in using the systems.

A second issue was to further improve the usability of the systems by customizing the interfaces to suit the needs and preferences of each user. A third issue was to achieve long-term actual operation of the systems, as mentioned in Sect. 3.2, and thereby collect submitted information in the form of crowd-sourced data tagged with spatial information; and by analyzing the data using methods such as text mining combined with GIS information analysis functions, to conduct more effective information provision for disaster prevention and reduction measures in local communities.

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