Chapter

Functional and Technical Methods of Information and Risk Communication

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Abstract

Risks of natural and anthropogenic disasters can appear at any moment without warning. All levels of government agencies from federal to township, and the systems of the specialized agencies, like weather-specialists, flood control, electricity suppliers, and educational organizations are standardized and the communication has been improving. The systems of the governments and agencies, meteorologists, flood control, electricity suppliers, and educational organizations are standardized and the communication has been improving. In this chapter, government manuals, procedures for agencies and professional responders, and public awareness, perceptions, and capabilities, are reviewed in three international cities: Seoul, Tokyo, and Toronto. Each city is unique with experiences of different disasters. Communication of supports and vital information of risks without understanding the language and culture of the people may lead the public to large-scale panic. Individuals can access government websites and interpret the information, like WebGIS maps, and risks by themselves. In terms of risk communication, all urbanized cities require their own specialized risk management with reasonably effective technologies, which enhance community resilience. Even better is to have a measure of development for the care of the public after the disaster to help the people get back on their feet, such as various public insurances.

Keywords: disaster risk management, risk communication, WebGIS, SNS, Seoul, Tokyo, Toronto

1. Introduction

1.1 Risk on disasters

The United Nations [1] summarized the cities' risk of exposure to natural disasters. Of the 1692 cities with at least 300,000 inhabitants in 2014, 944 (56%) were at high risk of exposure to at least one of six types of natural disaster (cyclones, floods, droughts, earthquakes, landslides, and volcano eruptions), based on the evidence on the occurrence of natural disasters over the late twentieth century. Floods were the most common type of natural disaster affecting cities, followed by droughts and cyclones. Twenty-seven highly developed cities, such as Seoul and Tokyo, have to deal with higher risk of exposures to three or more types of disasters and are more vulnerable to disaster-related economic losses and mortality.

1.2 Risk communication in emergency situation

According to Ortwin Renn [2, 3], the field of risk communication was initially developed as a means of investigating how best expert assessments could be communicated to the public, so that the tension between public perceptions and expert judgment could be bridged. Risk communication links scientists, decision makers, professional performers, communication specialist, and the public. Also, risk communication is to assist stakeholders and the public at large in understanding the rationale of a risk-based decision, and to arrive at a balanced judgment that reflects the factual evidence about the matter at hand in relation to their own interests and values [4].

These days, advanced technologies are applied for better effective communication on answering the "want to know" questions that Michael S. Baram [5] summarized the concept of "genetic right-to-know laws" on hazard communication in manufacturing work environment. Risk communication between governmental agents and individual personnel would be focused in different ways. In most of the cases under the emergency circumstances, any government agents have to focus on their urgent roles rather than to contact with civilian individuals. Conversely, any individual personnel expect that they can receive the information that they want to know or need to know. In terms of the interactive risk communication between groups, such as different government agencies, agents, and individuals are often appearing to lack in interactive communication because of the differences of their own interests. Each level of government agencies including state government, municipality, township, and even specialized agencies such as weather-related groups, flood control, electricity suppliers, and educational organizations can send out the general information with professionally analyzed results.

Today, all types of information are shared via the Internet, with which anyone can freely access details about others' daily lives. The information can contain disasters' natural characteristics and mechanisms with forecasts, damage level and its costs, information acquisition methods, evacuation routes, location of shelters and emergency supplies, school re-openings, hospital capabilities and capacities, information on relocation of patients, road conditions, information-related insurance, and even family member's safety confirmation. Among communication devices, including landline phones and computers, mobile phones are the most effective and primary devices for global communication [6]. In the case of the 2011 Great East Japan Earthquake and subsequent tsunami, some victims, especially isolated victims, had no connection to the outside and experienced great fear and anxiety on obtaining information they want; the transmission towers of mobile phone were broken and they lost electricity and thus lost the ability to even recharge their mobile phones [7]. For risk communication under severe circumstances—for example, flooding, earthquake, wildfires, terror, explosions, and others—information is the most important matter for everyone.

Information is available from multiple sources, from online sources and web-based media, personal conversation, mass media, and official and unofficial reports. However, individuals uniquely internalize this overwhelming information and judgmentally amplify their risks in various ways and degrees [8]. Rumors, or gossip, pass around easily (and thus, fairly quick) which may lead people to wrong directions or decisions, especially under emergency circumstances. Hence, the accurate information and the correct and effective instructions to maintain the safety of people and the society are one of the important roles for the government agencies.

Although every government tries to develop a disaster risk preparedness manual and educate public to enhance the risk perception, disaster risk governance is fairly a new concept [8]. Risk governance requires more one-directional communication rather than interactive communication. Arnold Howitt emphasizes the crisis

management communication, which interprets risk more narrowly with four fundamental rules that apply to the government agencies (as cited in [9]);

- Say What You Know
- Say What You Are Doing
- Say What Others Should Do
- Offer Perspective

The information must contain two different phases at least; phase of preparedness prior to an emergency and phase of the said emergency. The preparedness phase will suggest how to get ready for risks, while the latter phase should give an idea to the public where the safe place is located or how to protect themselves when the disaster occurs.

1.3 Utilize technology for risk communication

During the time of crisis or emergency, the critical issue is whether the people understand what to do. To empower people with knowledge and information before crisis (the "nonemergency time" or "disaster preparedness phase"), government agencies use websites to provide access to this information. Mapping technologies, such as geographic Information System (GIS) associated with Web application environment, are an effective method of disaster-risk communication to amplify the information to broader audience and population. When incidents or disasters occur, governmental agencies implement intensive tasks such as scientific analysis, forecasts, finding safe places and access to get there, dispatch rescue teams and give instructions for safety activities, and so on. Under these circumstances, government staffs frequently appear on the media to try to communicate with the public. In the circumstance under emergency, GIS technology has precisely functioned and clearly proved its effectiveness. 9.11 World Trade Center Attack was one of the significant incidents, and GIS technology was well-exercised. Since this event, GIS and Web technology was combined and developed for the next advanced world technological risk communication.

Social network services (known as SNS) such as Facebook, Twitter, and YouTube are the mostly used web tool for interactive communication in emergency situations. These service users are not only victims, but also supporters and governmental agencies that send the detail of information on how/when/where to get help [7]. The real-time situational information from the victims—for example, victims' conditions, actual detailed help list, health situation of the victims, security problems, and other sorts of information—is actively exchanged through these SNS services.

2. Risk management in three cities

The insurance company Lloyds pointed out at the report of Lloyd's City Risk Index 2015–2025 that mega-cities (such as Seoul, Tokyo, New York, Hong Kong, Shanghai, and London) are exposed to risks of combination of high economic value losses and high exposure to both natural catastrophes and manmade risks. Cities with high asset values are the most financially exposed in absolute terms [10].

The comparison of three large cities, Seoul, Tokyo, and Toronto, is very unique work because of their different profiles of risks they face in their respective countries. Their common characteristics are that all are very urbanized capital towns

with the highest population in each county as shown in **Table 1**, the center of the financial activities, and very globalized. Tokyo, for example, is one of the largest cities in the world with the population and economy, and the capital city of Japan, which is a country well recognized as the disaster kingdom of the world. Toronto, Canada is a metropolitan city that is a popular choice for newcomers including immigrants and refugees, short-term residents, or visitors that are exposed to different categories of potential disasters and risks than Japan. On the other hand, Seoul, Korea is a dense mega-city that is close to Japan, China and also to North Korea. Risks for Seoul are different from the risks of Tokyo or Toronto.

According to the report of the London-based insurance company, Lloyds [10] classifies 18 types of threat risks with 5 categories: finance and trade (market crash, sovereign default, and oil price shock), geopolitics and society (terrorism), natural catastrophe and climate (earthquake, wind storm, tsunami, flood, volcanic eruption, drought, freeze, and heat wave), technology and space (nuclear accident, power outage, cyber-attack, and solar storm), and health and humanity (human pandemic and plant epidemic). They assess the threat of all 18 types and how likely that city can experience a number of representative scenarios of different magnitudes from that threat (3 representative scenarios). Lloyds developed metrics for economic consequences and applied the equation for the 'expected loss (loss × the probability)' which is called gross domestic product (GDP)@risk for each city. This model is implemented for identifying which cities and threats are the most important.

2.1 Seoul, Korea

2.1.1 Background

Seoul is the capital city of the Republic of Korea (South Korea), the place for a habitat of 10,178,395 people [11]. As of the end of 2010, the area of Seoul is 605.25 km^2, which is about 0.6% based on the total land area (100,033 km^2) at the same time [12]. The population density of Seoul has continuously increased with population growth. After the Korean War and temporary population drop, the city of Seoul accepted many people into its area, which followed population boom in the city and forced the architecture of Seoul upward to address the housing problems, building tall apartments in the 1990s to house the increasing population growth. As of the end of 2010, the population density of Seoul is 17.473 people/km^2 [12, 13].

City	Country or area	Statistical concepts	City population (thousands)			Average annual rate of change (percentage)		City population as a proportion of the country or area's total or urban population in 2016 (percentage)	
			2000	2016	2030	2000–2016	2016–2030	Total population	Urban population
Seoul	Republic of Korea	City proper	9878	9779	9960	−0.1	0.1	19.6	23.7
Tokyo	Japan	Metropolitan area	34,450	38,140	37,190	0.6	−0.2	30.1	32.1
Toronto	Canada	Metropolitan area	4607	6083	6957	1.7	1.0	16.8	20.5

Table 1.
Three cities' population (modified, [1]).

Korea is the only divided country in the world that has been in a state of continuing confrontation with North Korea since the end of the Korean War in 1953. Seoul is only 23 km (in the shortest distance) away from North Korea. The confrontation with North Korea for 65 years has kept Seoul citizens in a high level of crisis cognition. Nonetheless, with a remarkable economic growth, foreign residents are increasing since 2014. According to the Brookings Institute, Seoul-Incheon is placed fourth with total GDP with 846 billion US dollars of the world's largest city economies in 2014, which was almost the same as Los Angeles (860) (Tokyo was the first with GDP 1600) (as cited in [14]. In 2015, nominal GDP of Seoul-Incheon (population 25,095 thousands) was 25,095,903 million US dollars and nominal GDP/capita in 2015 was 466 36,002 million US dollars [15]. Seoul is one of the richest cities in the world.

2.1.2 Risks in Seoul

It seems that all these experiences influenced the surveys that are conducted by the Statistics Korea [16] every 2 years for the 10 social indicators system. This data will be available on May 16 for approximately 39,000 household members aged 13 years or older residing in the 25,843 sample households nationwide for the five indicators in family, education, health, safety, and environment. Regarding awareness of social safety, 20.5% of the respondents felt that the society was "safe" overall. The most significant anxieties about the social safety were crime (50.8%), traffic accidents (47.6%), new diseases (42.8%), and information security (42.5%), in relative order. For the question of emergency and emergency situations, most (96.8%) "knew the telephone number (119, etc.)" in the case of an emergency. Seoul residents feel that social indicators are more severe real-life threats than natural disasters. The result of the survey is summarized in **Table 2**.

Lloyds [10] defines that Seoul is facing the risk of windstorm (44.68 billion) economic loss as shown in **Figure 1** the most, and this is 3.5 times more than the oil price stock threat of 12.72, at the second place. Therefore, Seoul is very vulnerable to typhoons. In addition, due to the proximity of oil price shock and market crash, and because Korea has experienced it already in the past, Korea has to react sensitively to the international economic market (1997–1998 Korea financial crisis, which was triggered by 1997 Asian financial crisis). However, earthquake and tsunami were assessed as zero risk in Seoul, while they were the most threatening disaster risk for Tokyo. The total GDP@risk is estimated as103.50 billion US dollars with all 18 threats.

2.1.3 Improvement of crisis management and risk communication

For a long time, the constructed structure of the governance during an emergency is hierarchical. A national crisis incident that occurs within a ward is reported by the staffs of the ward government to the chief of the ward, which is then reported to the municipal council; the municipal council summarizes the issue(s) and, then, reports to the provincial board. The members of the provincial board collect and then report to the federal government, where the chief of that level (usually the president) is the decision-maker for an incident. The decision is then trickled down from the province, to the city, and down to the ward, for the emergency response to take place. This pyramidal communication structure is inherently slow and involves too many individuals in which a report must be filtered through. This introduces complexities such as missing information, distortion of crisis, misunderstanding of issues, and/or severity of the emergency.

		Total	Safe	Very	Relatively	Normal	Not safe	Relatively	Not at all
Overall social safety	2016	100.0	13.2	1.1	12.1	41.2	45.5	36.1	9.4
	2018	**100.0**	**20.5**	**1.3**	**19.2**	**48.2**	**31.3**	**27.6**	**3.7**
National security (war potential, North Korean nuclear issue)		100.0	31.1	3.2	27.9	35.6	33.3	27.3	6.0
Natural disasters (typhoons, floods, and earthquakes		100.0	22.8	1.6	21.1	39.6	37.6	32.2	5.4
Buildings and facilities (collapse and explosion)		100.0	23.9	2.1	21.8	43.3	32.8	28.0	4.7
Traffic accident		100.0	13.1	0.9	12.2	39.2	**47.6**	38.4	9.3
Fire (including forest fire)		100.0	20.9	1.8	19.2	48.0	31.1	26.6	4.5
Food (defective food and food poisoning)		100.0	25.4	2.3	23.2	43.4	31.1	25.5	5.7
Food security (grain flooding and food shortages)		100.0	37.8	5.9	31.9	43.7	18.5	15.4	3.1
Information security (computer virus and hacking)		100.0	17.5	1.6	15.9	40.0	**42.5**	33.4	9.0
New diseases (new virus)		100.0	16.7	1.4	15.3	40.5	**42.8**	34.7	8.1
Crime		100.0	17.2	1.8	15.4	32.0	**50.8**	38.0	12.8

Bold values indicate the most recently surveyed and the highest values in the categories.

Table 2.
Recognition of social safety (unit: %).

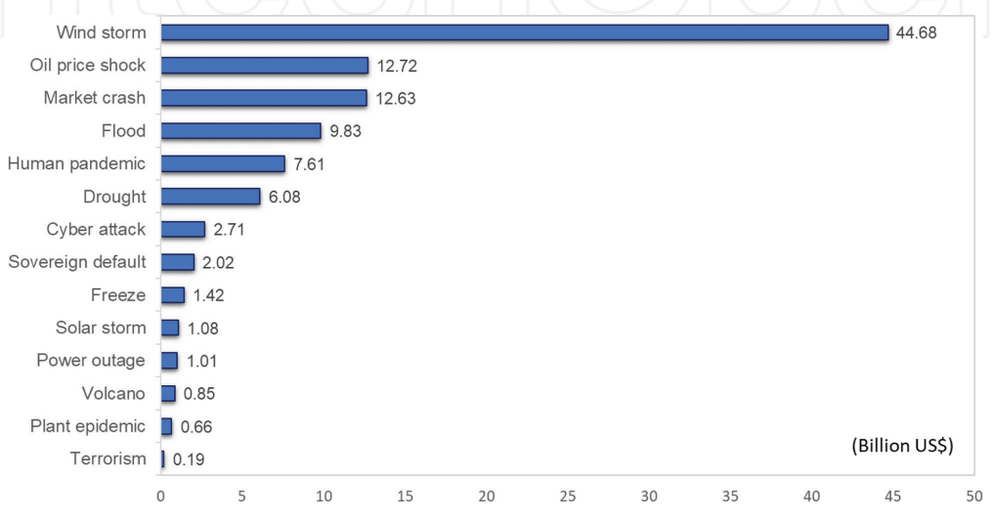

Figure 1.
GDP@risk metrics for Seoul (modified, [17]).

There was a significant incident, which was an important turning point and a trigger, which forced Korea to review and overhaul its crisis management system, as well as replace the government administration with the decision from presidential authority; the significant incident is known as the "Sinking of MV Sewol" in 2014. The South Korean ferry sank while carrying 476 people, mostly secondary school students from Danwon High School (Ansan City). In total, 304 passengers and crew members died in the disaster [18, 19]. Of the approximately 172 survivors, more than half were rescued by fishing boats and other commercial vessels that arrived at the scene approximately 40 minutes after the South Korean coast guard. As the Korean government's attitude toward disaster responses and all the procedures of rescue work were inadequate, regulatory authorities who directed and supervised them were socially criticized, and their attitude of avoiding their responsibility was enough to buy public sympathy [20, 21]. Perhaps, this incident is one of the most suitable examples of Heinrich's law[1].

With these experiences, with sufficient stimulation in the city of Seoul, the city of Seoul authorities made an overall review of the disaster response and initiated the reorganization. The city of Seoul developed the disaster management communication guideline in 2014 [22]. Newly developed "the City of Seoul Crisis Management Communication Guidelines" emphasize four priority values of risk communication capabilities: empathy, transparency, professionalism, and responsibility. **Figure 2** is the diagram that describes the concept of priority value of the risk communication.

In order to prevent the confusion of reporting system, the Seoul Metropolitan Facilities Management Corporation improved its reporting system in case of emergency situation as shown in **Figure 3**. The direction of the arrows indicates the direction of reporting of an incident; one-way arrows represent only reporting and lack of interactive communication (one states "confirm occasionally", which indicates that no actions are taken) and a head group that takes control or responsibility in implementing a plan during an emergency [23]. From this diagram, for example, the hydro-related disaster, the decision makers are far and dislocated from the incident scene, which means that the duration to report to the decision makers takes longer time and the order (decision to act) demands for more time to be communicated back to the scene for an actual work. Thus, there is no clear indication

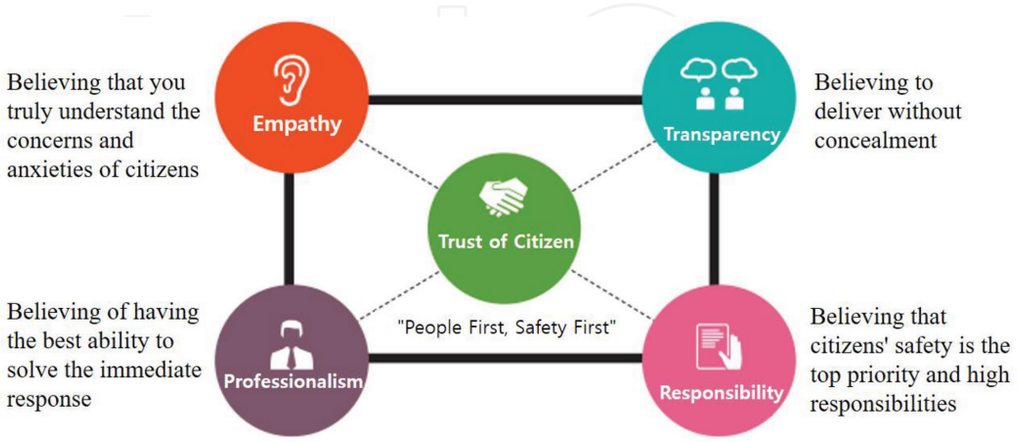

Figure 2.
Four priority values of risk communication capabilities and its expected value criteria (modified, [22]).

[1] Heinrich's Law: Heinrich's work is claimed as the basis for the theory of behavior-based safety by some experts of this field, which holds that as many as 95% of all workplace accidents are caused by unsafe acts. (Source: https://en.wikipedia.org/wiki/Herbert_William_Heinrich).

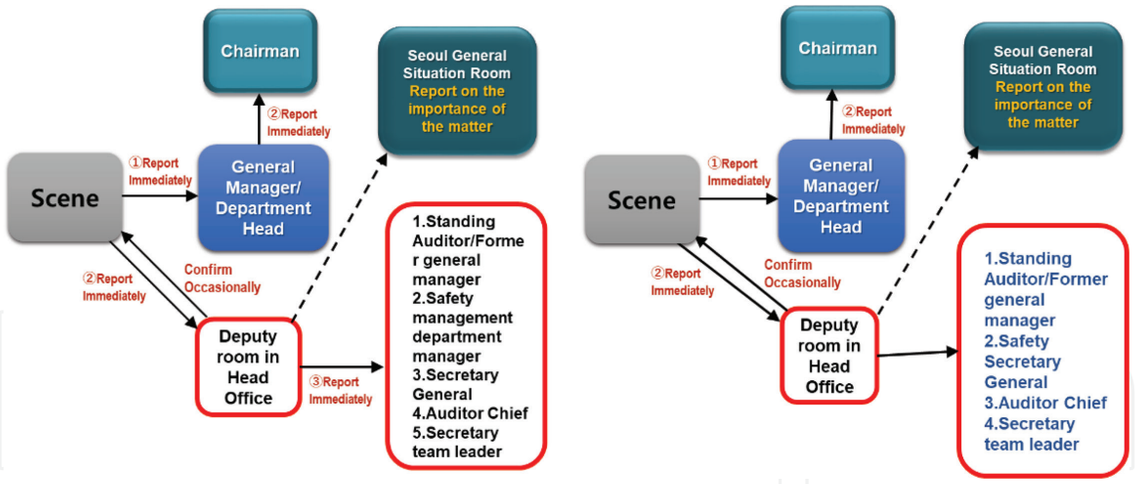

Figure 3.
Diagram of situation report flow between departments in government offices [23].

of how much the decision makers understand the real situation and take actions or responsibility. It is easy to assume that such structure would result in delayed communication and introduce unnecessary complications (especially in between the communicators), and overly long decision-making time. Meanwhile, it does not address who takes charge or takes responsibility to control or direct an emergency; thus, the field works are forced to deal with victims, the crisis, and their own safety on the line without a clear authority, permission, or instruction.

Realizing the shortcomings and inefficiencies of the hierarchical or pyramidal communication system, the national emergency management agency of Korea (normally known as the Department of Fire and Emergency) developed their own drill manual [24] with incorporating with other agencies. Based on convergence of administration, the mutually developed cooperation and integration of the agencies divide the complicated workflow.

Despite the efforts made by the Seoul Metropolitan Government to revise its crisis management guidelines after the 2014 MV Sewol sinking incident, the government's ability to manage crises has been criticized, again, widely and intensely on the way they responded to the 2015 MERS outbreak incident [9]. A joint panel of experts from the World Health Organization and South Korea announced that the South Korean government's failure to share information quickly with the public and establish an efficient disease-control system contributed to worsening the outbreak of Middle East respiratory syndrome (MERS), which has killed 14 people in the country [25] and this event was another significant incident to receive social criticism of the government and its stakeholders and their awareness of crisis management.

2.1.4 The IT country: utilizes advanced IT technology

As an IT powered country, the capital city of Seoul is working on risk communication by operating a well-organized portal-website as shown in **Figure 4** (top image). This website provides breaking news, action procedures, evacuation facilities, related public agencies, weather information, and the information for the press. Also, the website has a linkage option that jump to the new window where anyone can join the discussion with certain subject, leave comments, and apply suggestions. GIS interactive map is generated by clicking of the icon on the right panel with the information icon.

Although technology is shifting to Cloud, WebGIS technology is still used widely, as those who use the technology are divided in the proficiency of available technologies, but the trend of GIS is heading toward cloud-based technology. GIS

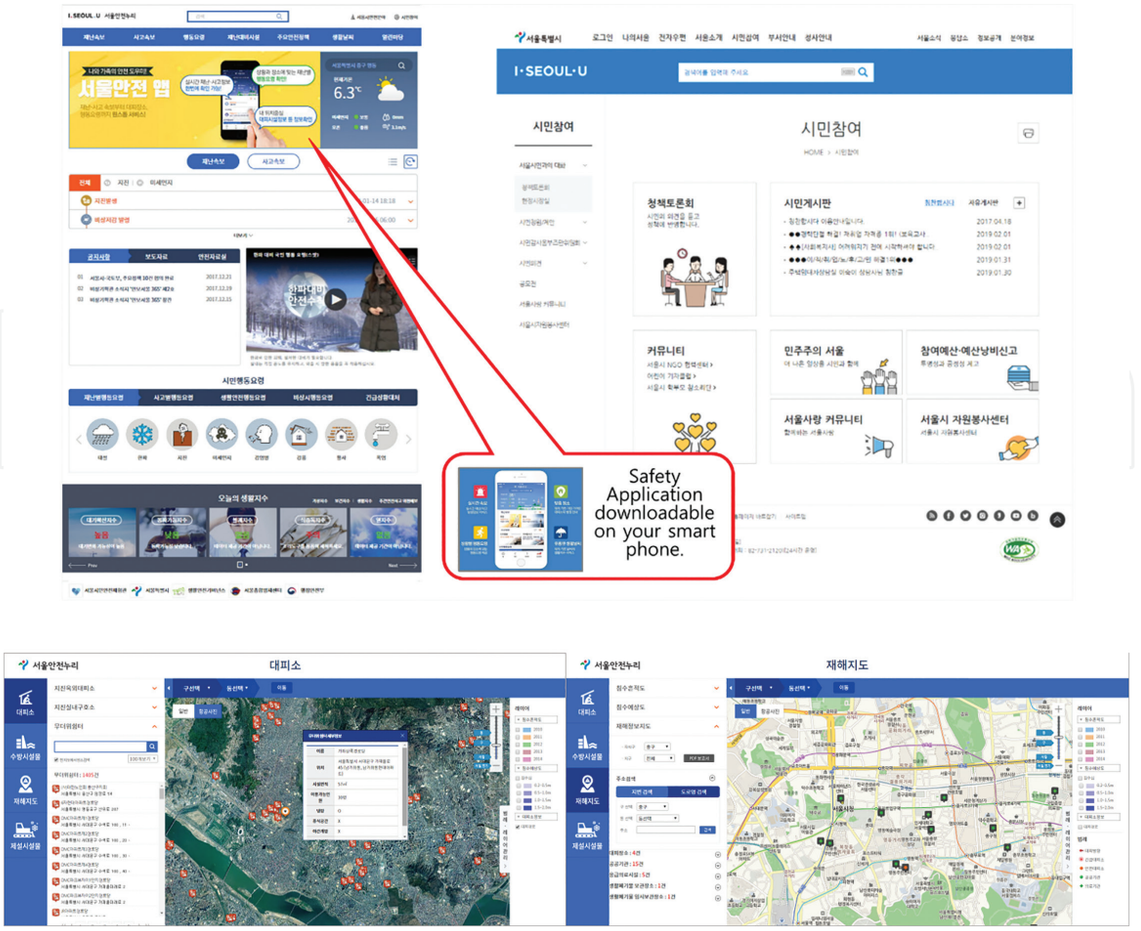

Figure 4.
The city of Seoul safety web portal, which is called "Seoul Safety Nuri" that gives information about current disaster status and suggests a direction where shelters are located and its capability [26].

maps allow users to identify certain facility locations with accurate coordination, query function to call up the associated database information, so end-user can get information by several times of clicking. The disaster maps of Seoul give an option to generate satellite image as background map (**Figure 4**: bottom left) or topography map (**Figure 4**: bottom right); then users can recognize where they are located, where they want to go, what to look for, or identify facilities and its basic information, (such as the name of facility, address, functions, and its capability). For example, the map of evacuation shelters provides information about shelters: earthquake indoor/outdoor shelters, extreme heat weather shelters, water facilities, storage area for snow removal equipment, and general disaster maps. This integrated GIS map has functions associated with the database, which are very limited and still need improvement for the real-time support system. Despite Seoul's copious efforts and technologies, this website has only provided information in Korean, and no other languages are available at this time.

Among the weather-related disasters, it is clear that the typhoon and flooding are big threats when considering the Han River (a large river that passes through the middle of Seoul from east to west). The history of Seoul's modern sewerage dates back to the opening of the late nineteenth century. At that time, the importance of the sewage treatment for the prevention of infectious diseases and the improvement of public sanitation was recognized, and drainage function was moved from the river to the modern sewer model [27].

As of the end of 2015, the city of Seoul is discharging sewage and rainwater to four water reclamation centers through the sewage lines (about 10,000 km), manholes (260,000), and rainwater catchers (470,000). The amount of sewage that

has been treated and flowing into the rivers reaches 4.98 million cubic meters/day. Currently, the city of Seoul has faced a new era of change [27]. As global climate change intensified, Korea is entering change from a sub-tropical climate of four seasons in temperature to a more two seasons of extreme temperature differences. Seoul faces a large risk of natural disasters such as urban flooding and drought. As the phenomenon of heat island occurs more frequently, more powerfully, and for longer periods, it is necessary to cope with thorough water management.

2.2 Tokyo, Japan

2.2.1 Background

As of 2014, the greater Tokyo area was ranked as the most populous metropolitan area in the world (**Table 1**; [1]). The 23 Special Wards of Tokyo were formerly Tokyo City. Tokyo is the one of the largest cities in the world with an estimated population of 13.491 million (as of October 1, 2015); in 2191 km^2, the area of Tokyo is 0.6% of the total area of Japan. Most of the population reside in 23 wards in where 9241 million, the Tama area, 4.223 million, and the Islands, 26,000. With a population density of 6158 persons/km^2, Tokyo is the most densely populated prefecture in Japan. Tokyo has 6.946 million households, with an average of 1.94 persons/household. The number of foreign residents according to the basic resident register is 440,000 as of October 1, 2015 [28].

The general Tokyo budget of the 2016 fiscal year was about 7 trillion yen, and a total amount of about 13 trillion yen will be reached by adding public enterprise accounts as special budget, such as water supply, sewerage, and subway. It is comparable to the national budget of Sweden and Indonesia where it would differ slightly due to the exchange rate [29].

2.2.2 Disaster kingdom of Japan: historical natural disasters leave lessons

Tokyo is the capital city of Japan, the kingdom of disasters. In accordance with the Lloyd's report, Tokyo is ranked second for volcanic eruption risk, third for heat wave, fourth for windstorms, and sixth for earthquakes. Mega city, Tokyo, is highly exposed to man-made and natural threats, which makes it the world's second-riskiest city to live in after Taipei; Tokyo risks a possible economic loss of $153.28 billion of its GDP by the likelihood of events occurring over the next 10 years. Exposure to windstorms may bring Tokyo a loss of $29.06 billion, while exposure to earthquakes and flooding may trigger a loss of $18.83 billion and $17.65 billion, respectively. However, London-based Lloyds said that Tokyo's exposure to potential loss is comparatively low and accounts for only 10.44% of its $1.47 trillion in estimated annual GDP, making it "one of the richest cities." [1, 10].

Lessons learned from disasters often come after catastrophic economic losses [30]. Andrew Coburn [17] summarized the economic loss after Great Hanshin earthquake January 17, 1995, Magnitude 7.3 in a slide at the 2015 seminar in London, UK. As many of the problems posed by this earthquake were highlighted, Japan has renewed many policies, and the citizens' awareness of the natural disaster has increased. After the 2011 Japan earthquake and tsunami, the natural disaster caused secondary disasters such as explosions and radioactive spills of nuclear power plants, and the fear of a direct underground earthquake in the metropolis of Tokyo was heightened.

Japanese society is a well-organized one. Particularly, for Tokyo, rail is extremely important as a means of transportation for people and goods, and is well-organized

and maintained diligently considering that Tokyo has many commuters from suburban area. The national census in 2010 lists the daytime population of Tokyo as 15.576 million people, which is 2.417 million (or 1.2 times) more than the nighttime population figure of 13.159 million. The daytime population index is 118.4 against the nighttime population taken at 100. This difference is caused by the population of commuting workers and students, constituting a daytime influx from mainly the three neighboring prefectures of Saitama, Chiba, and Kanagawa [28].

During the 2011 Japan Earthquake and tsunami, a large population of commuters who has difficulty returning home were stuck in Tokyo until the public transportation reopened, and some of them chose to walk because they could not find the accommodation. According to estimates based on the Internet survey published by the Cabinet Office of Japanese Government on 22 November 2011, due to the 2011 Japan Earthquake and tsunami, approximately 3.52 million people in Tokyo, about 670,000 people in Kanagawa Prefecture, about 520,000 people in Chiba Prefecture, about 330,000 people in Saitama Prefecture, and about 100,000 people in the southern part in Ibaraki Prefecture, total 5.55 million people in the metropolitan area, experienced difficulty returning home or were unable to return home. Hiroi et al. [31, 32] conducted the internet survey 2 weeks after (March 25–28, 2011) the 2011 Japan Earthquake and tsunami that occurred on March 11, 2011. According to this survey, about 28% of the outsiders, when the earthquake occurred, could not return home during the day. Also, as for the question of what was the most troubled matter by this earthquake, 71.1% responded disconnected mobile phone system/reception, followed by decommissioned public transport such as rail (46.4%), inability to contact the family (37.5%), the home telephone not working (35.2%), and short message by the cellular mail not working (32.9%). Wendling et al. [33] pointed out that under certain unusual circumstances, such as natural disasters, victims are desperate to obtain reliable and relevant information from any type of media. Social media can play an important back-up role in dissemination warning and response information if traditional services are overwhelmed by demand.

The idea of risk factor as a perceived magnitude of a disaster does not play a very important role in the risk perception of natural hazards [8]. However, in terms of heuristic rule for Japanese people at least, it is hard to agree with such statement. Japanese are being educated about the natural disaster risks and have been trained on how to protect themselves and the way to follow the evacuation procedures. Most of the populations start from young age of kindergarten. Understanding the risk is critical for Japanese people, and therefore, the Japanese government prepares manuals and evacuation rules efficiently.

2.2.3 Learn together and survive together

The Tokyo utilizes IT technology as well. Tokyo developed a special website, Disaster Prevention Website [34], which provides preparedness information and guidelines to follow on emergency circumstance. Much of the information provided with the text-to-speech functions for those with vision impairment. However, such features must be manually activated via clicking an icon. Thus, the efficiency of the use of such function is not yet verified. The organization tree appears to be strict and usually follows a top-down command structure. The crisis management task team is created to work on establishing a crisis management system to gather and analyze information and prepare strategic measures, while disaster prevention system describes its liaison relationship with the national government, municipalities, and other agencies based on information from the Disaster

Prevention Center as depicted in **Figure 1**. However, this structure only explains the relationship between governmental agencies. This supposed relationship should not only explain the relationship between the provision of information and responsibilities of the intergovernmental departments, but should also explain the sharing of information and communication flow between the government and the residents—which **Figure 5** fails in doing. As the risk communication is a multi-way interactive communication between sectors, this structure can lead to stagnation of communication among the end-users, especially those who are the most vulnerable to disasters.

The Tokyo authorities have compiled a manual called "Disaster Preparedness Tokyo (東京防災)" to help households get fully prepared for an earthquake directly hitting Tokyo and other various disasters (**Figure 6**).

"Disaster Preparedness Tokyo" is tailored to the various local features of Tokyo, its urban structures, and the lifestyles of its residents and contains easy-to-understand information on how to prepare for and respond to a disaster. This information will be useful now and in the event of an emergency. This manual consists of introduction, five chapters, and a manga comic, which provide guidance from the preparedness actions, survival tips, disaster facts and acquisition of information, to evacuation procedures. It is unique in that it uses pictures to explain to the foreigners who do not know Japanese or English. In particular, comics explain how to act without falling into panic by briefly showing how to deal with an earthquake. In this manual, Tokyo authorities have a lot of explanations on how to deal with an earthquake. Also, this means how frequently Tokyo is experiencing earthquakes and trying to reduce earthquake damages and human losses. In the mega city of Tokyo, which has a huge population and economic power, earthquakes are the most threatening risk.

2.2.4 Maps are ready for you

The disaster prevention homepage (**Figure 7**) provides a lot of information as much as they can open to the public. The map utilizes the WebGIS function, and it is well used to upload the prepared disaster-related information such as the location of the facility and road construction information. However, these maps, although

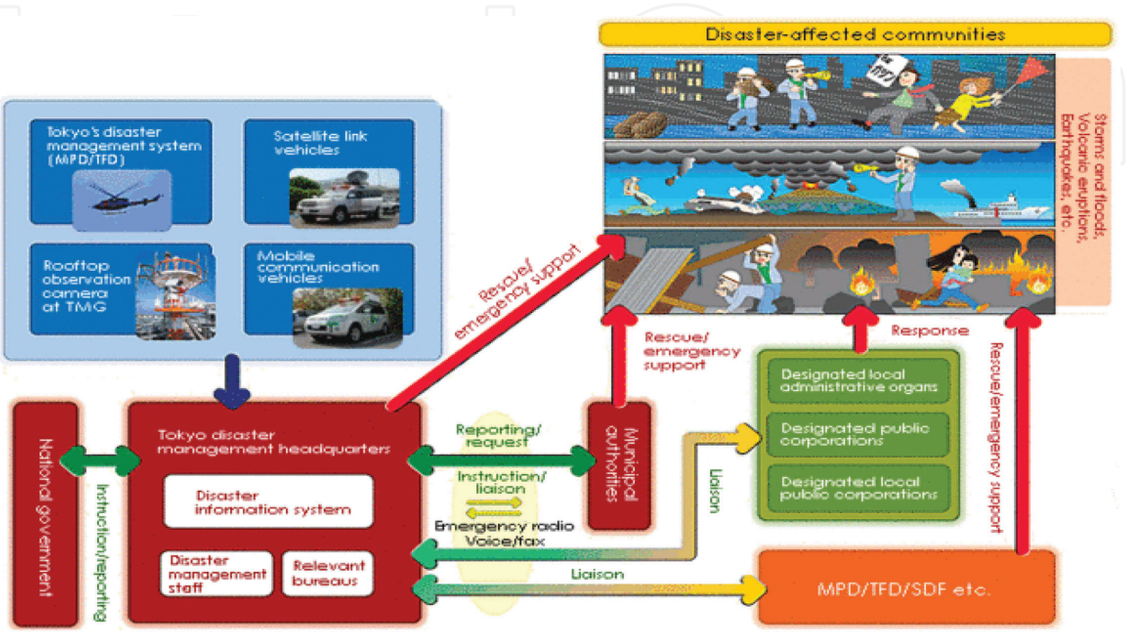

Figure 5.
Workflow of the disaster prevention system.

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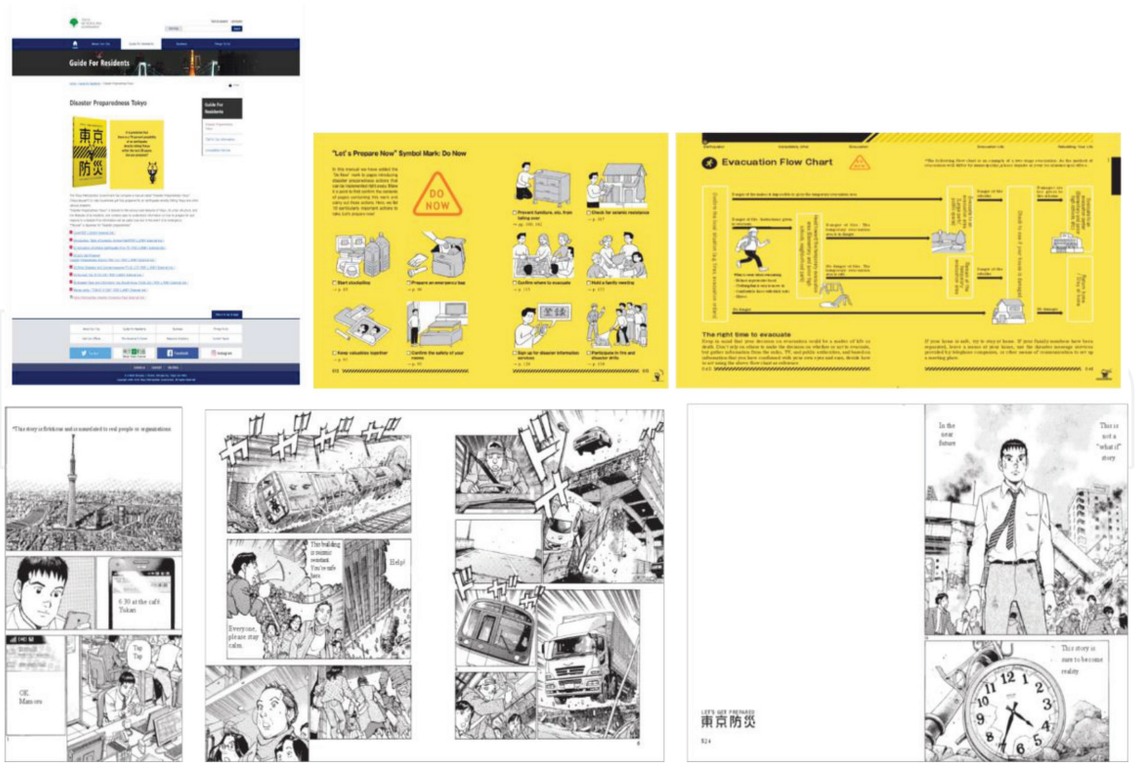

Figure 6.
The English website of "Disaster Preparedness Tokyo" manual; an example of chapters and parts of manga comic.

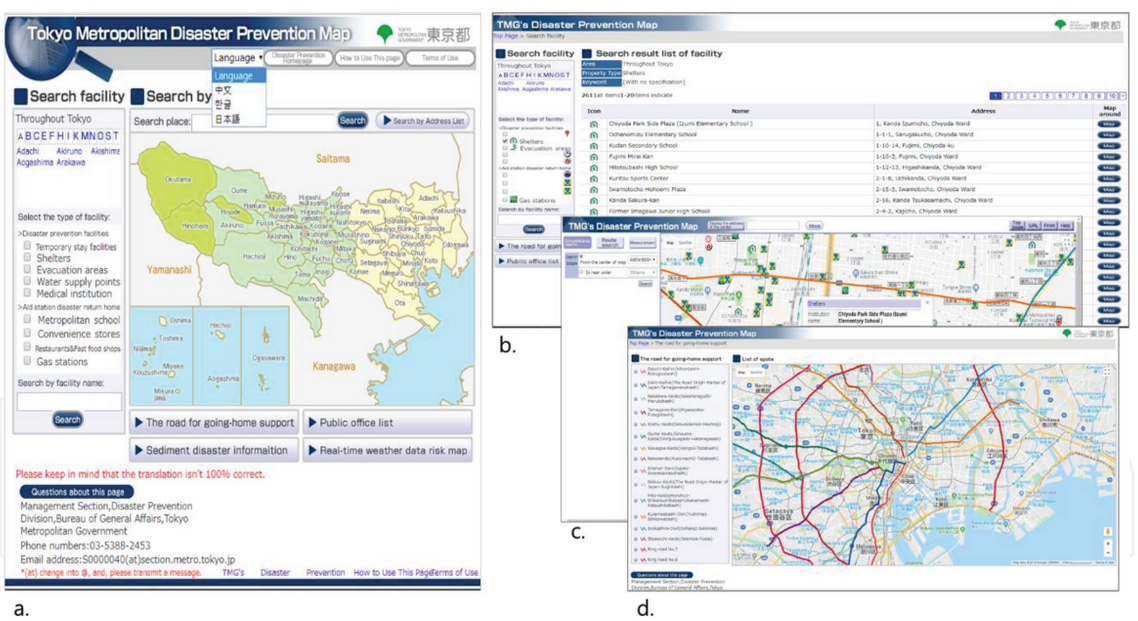

Figure 7.
Tokyo provides disaster prevention map, which shows the list of the facilities and locations by different disaster types. (a) Interface of Tokyo metropolitan Government's disaster prevention map with selection functions, languages, facilities, and related emergency information according to the name of the administrative district. (b) Listed queried information. (c) Google Maps with facility location and its information retrieved by clicking the map icon. (d) The road going-home support function shows where to select a road name and it will display the main crossing points in the road by a list and icons.

used extensively during peacetime, are not guaranteed to be used during the time of disaster crisis to provide real-time updates of the emergencies. The maps focus on the Tokyo metropolitan, which includes 23 wards and neighboring cities under Tokyo metropolitan address. Interface of the map has several functions: languages (Korean, Japanese, English, and Chinese), facilities (temporary stay facilities, shelters, evacuation areas, water supply points, and medical institutions) and facilities

that are run by organizations and private owners that provide current-state disaster status (metropolitan schools, convenience stores, restaurants and fast food shops, and gas stations). It seems that these functions are selected by learning from the 2011 Japan Earthquake and tsunami (**Figure 7a**). There are four additional support options: road information supporting returning home, public office list, landslide disaster-related information, and real-time weather data risk map, which is linked to the Japan Meteorological Agency to obtain the weather data. Users can review the desired facility or function by clicking the check box and the query function used to open a list with basic information about related facilities (**Figure 7b**). Then, by clicking on the map icon, the Google Maps will retrieve Information about the selected facility and display in the form of a memo next to the icon of the facility, so the users can quickly find out relevant information (**Figure 7c** and **d**).

2.3 Toronto, Canada

Toronto is the capital city of the province of Ontario and the home of 2,929,886 residents, 6,346,088 residents within the Greater Toronto Area (GTA)[2] (as of July 2017) [35–37]. A dynamic city, Toronto, is a global city where people of various nationalities and ethnic groups live together. Geographically, Toronto is located on a broad sloping plateau cut by numerous river valleys that cover 641 km^2 and shoreline facing Lake Ontario ,which stretches 43 km (or 138 km when including the bays and islands). As of 2007, GDP of Toronto was 168 US billion dollars and $313.1 US billion dollars in GTA. Toronto is a popular destination to visit; visitors in GTA were recorded as 40 million in 2015 and 93,575 people were counted as nonpermanent residents while 23,065 people aboriginal identity who speak over 60 own languages by report of 2011 statistic Canada [38].

Toronto, with respect to Seoul or Tokyo, experiences much less diversity and scale of natural disasters on average; while Toronto experiences extreme colds or heat alerts [39] during its seasonal extremes; it does not encounter hurricane, earthquake, tsunami, volcano, or flooding on a regular basis. Thus, in comparison, Toronto residents are privileged people in terms of natural disasters.

2.3.1 The emergency plan emphasizes flexibility

The City of Toronto published the Emergency Plan (the Plan, 2017) [40]. In this plan, the city is prepared to deal with any kind of hazards. However, historically, the City of Toronto did not experience natural disasters as much compared with other cities in Canada or similarly scaled cities in the world. Nonetheless, the city of Toronto states that the city is vulnerable to numerous hazards, not only natural disasters such as extreme weather, but also more likely human-caused technological incidents such as those involving hazardous materials, infrastructure disruptions, utility and power failures, or a cyber-attack. It seems that Toronto recognizes that it is more vulnerable to human-caused disasters than to natural disasters from given examples.

The Plan establishes the framework of methodology with necessary documents that the city requires to recover the situation to the normal state by mobilization of resources in case of emergency, and ensure the roles and responsibilities by designing a tool to assist emergency and municipal services. The Plan addresses implementation by flexibly delegating appropriate city agencies roles and authorities in an emergency situation; various supports and services must be provided immediately from other authorities, such as adequate personnel, equipment, and

[2] The Greater Toronto Area (GTA): the central city of Toronto and the four surrounded regional municipalities: Durham, Halton, Peel, and York.

expertise from response agencies. Reviewing and exercising the plan is also required on a regular basis for appropriate implementation. Moreover, most importantly, the Plan emphasizes flexibility to adapt to a broad spectrum of emergencies. Also, the structure of the supporting agencies provides the direction to save lives, protect property and environment, restore essential services and critical infrastructure, and help victims and communities return to normal following an emergency. When Toronto faces an emergency situation, the hazard level will determine its emergency level among four tier emergency level systems as follows:

- Level 0—Normal
- Level 1—Incident
- Level 2—Emergency
- Level 3—Major emergency

When the hazardous situation is determined as a Level 2 Emergency or in the early onset of a Level 3 Major emergency, the operational response team, called the Cluster "B", is called before the Emergency Operations Centre is activated. The Cluster "B" provides strategic management, an operational hub, and a supporting facility for the coordination of emergency response. The Plan clarifies that "once the Emergency Operations Centre is fully activated, the Cluster 'B' operational response team will transition responsibility for operational response to the Emergency Operations Centre to ensure organizational effectiveness and the centralized command is maintained." Also, communication activities such as those outlined in the emergency information and media relations are respected depending on the nature of the emergency.

The Ontario Provincial Emergency Management and Civil Protection Act, Section 2.1 [41] requires that the City of Toronto must develop and implement an emergency management program and adopt it by-law. Training programs and exercises for employees of municipalities, identifying the risk level, and educating the public on risks to public safety and on public preparedness for emergencies are major roles of this act. The Ministry of Community Safety and Correctional Services is committed to ensuring that Ontario's communities are supported and protected by law enforcement and public safety systems that are safe, secure, effective, efficient, and accountable. Their major roles include maintaining the physical and economic security and eliminating hazards to persons or property [42]. The City of Toronto should follow this workflow.

2.3.2 Risks with early warning in Toronto

Environment Canada provides the seasonal weather information to the public with map that illuminates hazard level, warning, watch, statement, or no alert as shown in **Figure 8**. Torontonians can freely access this information to get the climate-related alert. If there is any emergency information with safety issues, both Environment Canada Weather Alert website [43] and Toronto's Alert website provide the latest information to the public, so public can follow the direction to save their life and property. Public health risk and industrial risk are also the City of Toronto's important concerns, and such information is also provided by the city.

The City of Toronto picks up 10 hazards under three categories in 2017, natural hazards, human-caused hazards, and technological hazards; electrical power disruption, explosions/fires, winter weather, pandemic, cyber threats, terrorism,

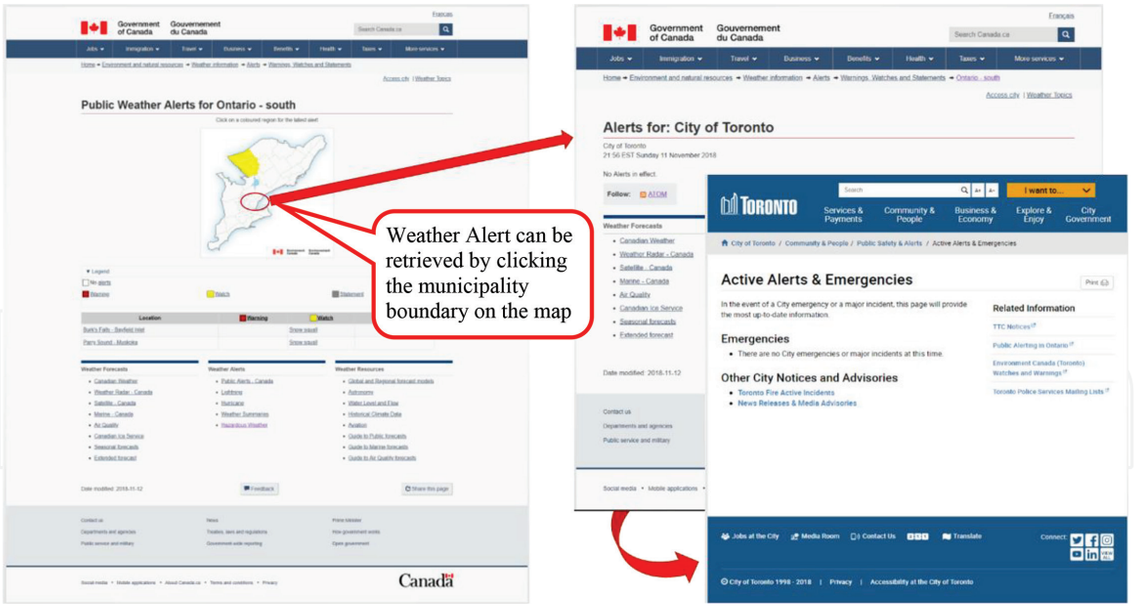

Figure 8.
Public weather alerts for Ontario, which provide real-time watch/awareness, alert, or no alert information to the public directly.

epidemic, flood, fuel/natural gas supply disruption, and extreme heat. Risk assessment is followed by the Ontario's risk assessment matrix (**Table 3**). Risk severity is depicted in different colors (as cited, [44]).

2.3.3 The unique city with diversity

The City of Toronto with diverse races holds 51.5% of visible minority of population, and 51.2% of immigrants were born outside of Canada. Among them, 132,765 people reported that they cannot speak English or French (which are the official language of Canada). This is an important fact to keep in mind, as Toronto is a city that is home to many immigrants and refugees, in addition to many tourists each year. So the City of Toronto must also consider about their vulnerability due to language or cultural barriers. Looking at the data of ethnic demography [45], in 2006, 126 ethnic origins were increased to 278. The different mother tongue (language first learned at birth) users are scattered in Toronto which counted to 89 in 2011, and 85 in 2016; 14 visible minority groups were counted in 2016. Nonvisible minority is indicated as groups from countries in Europe; however, it does not indicate that they use English or French. Some ethnic neighbors are living together in a community that makes Toronto hosts a diverse set of towns such as Koreatown, Little India, Greektown, Corso Italia, Chinatown, and Little Jamaica. The City of Toronto offers to the public its diversity by categories in the 2016 thematic maps where not a visible minority or multiple visible minorities reside as their home, for example

	Probability Rating			
Severity Rating	A. Highly Likely	B. Likely	C. Possible	D. Unlikely
4 – Catastrophic	High	High	Moderate	Low
3 – Critical	High	High	Moderate	Low
2 – Serious	Moderate	Moderate	Moderate	Very Low
1 – Marginal	Low	Low	Very Low	Very Low

Table 3.
Risk assessment matrix of Ontario, which the City of Toronto shall follow as a standard to assess and determine the risk's level.

(**Figure 9**). Understanding the cultural background and language specification is important for both those who give support and evacuation instructions and those who get help in emergency circumstances. Language/cultural risk in emergency situation is another concern for Toronto.

2.3.4 Preparing for a better understanding

The City of Toronto allows the public to access the interactive map, which is called wellbeing index (**Figure 10**) [46]. The city's wellbeing index includes a mapped overlay that shows all community organizations who have agreed to be listed as organizations that have the ability to accept volunteers and provide assistance in the event of an emergency.

2.4 Using mass media for risk communication

The recent trend for urgent information dissemination is using on-line based technology, such as SNS. Government agents are also using SNS such as Facebook (**Figure 11**), Twitter, YouTube, and others [7]. Especially, depending on the people and their culture, specific SNS site is more actively used; for example,

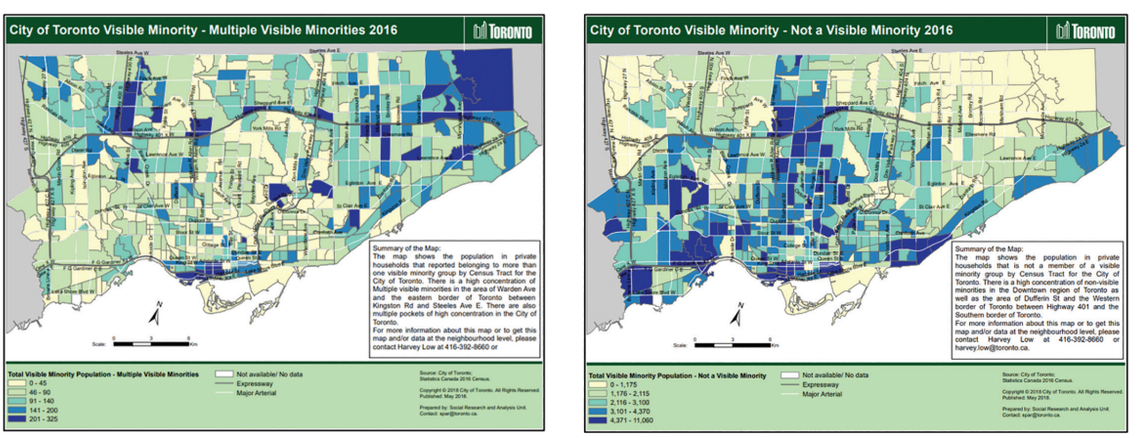

Figure 9.
The 2016 thematic maps where not a visible minority or multiple visible minorities are distributed in Toronto.

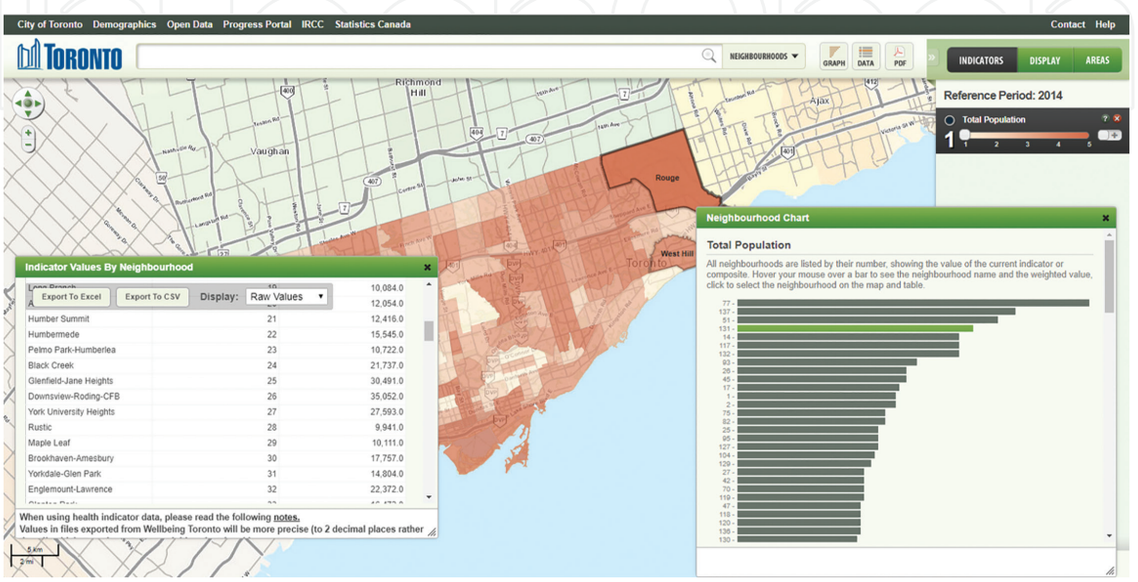

Figure 10.
Wellbeing index (map); information is displayed using query function over spatial map.

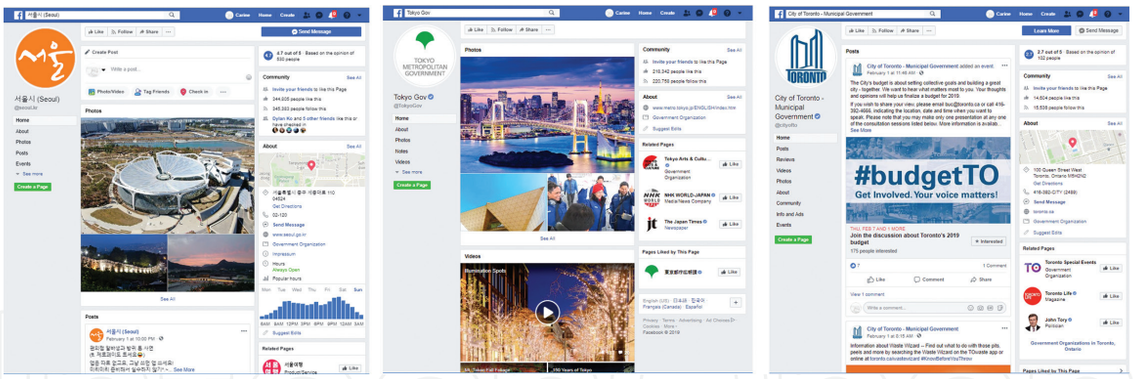

Figure 11.
Each government's official Facebook page: Tokyo (left), Seoul (middle), and Toronto (right). Each city tries to communicate with the public; individuals, agents, volunteers, media, and each other.

Facebook is widely used in the Philippines. As revealed by the 2011 earthquake in Japan and the Philippine Typhoon Haiyan [6, 7], the government, the family and the volunteer groups all used social networking services to communicate information.

Such sophisticated technologies require internet access to use; thus, it would be a fatal weakness for areas with little or no internet, such as remote areas or even urban areas with decommissioned internet. In a highly developed IT city, the disconnection of internet would be a temporary inconvenience, as the public would assume that the service will be recovered quickly because it is considered as one of top priorities. Urban residents, who tend to be more globalized people due to frequent connection to the outside world, use personal IT devices not just to stay connected to the world but also to look for better tools and information to make themselves feel safe and calm.

3. Conclusion

In terms of disaster risk communication, three cities have been developing effective methods and have attempted to provide accurate information to the public. Tokyo, Seoul, and Toronto have different disaster threatening aspects, population characteristics, cultural background, scale, and complexity of the city with physical infrastructures (such as subway system or electricity supply system), so the approach to response to emergencies is differently developed.

In disaster risk management, the disaster cycle has response phase, recovery phase, and preparedness phase. In response phase, there are rescue, supply (materials, equipment, medication, etc.), and support. In recovery phase, there are reopening of the school, repairing of the transportation system, and hard (that is, physical and structural) reconstruction and recovery of infrastructure. In preparedness phase, there are development of manuals, evacuation drills, public education, and so on. Historically, Japanese rely on their government for the entire cycle of a disaster. In the case of Tokyo, despite the many efforts Tokyo makes for the safety of its residents, the information it provides seems to be closer to risk governance than to risk communication. Information that Tokyo provides is mostly preparedness stage information against natural disasters rather than human-related risks, and in general, the government tends to be more prompt with its communication on natural disasters. Therefore, the public most likely depends more critically on broadcasts, media, SNS, and other sources to obtain accurate real-time information on topics about earthquake, tsunami, and typhoon more than risks of terrorism and global political threats.

Won and Kim [47] identified problems by reviewing the disaster and accident scenarios of Seoul and suggested new recommendations for risk communication. By this study, Seoul needs to realize the uncertainties of the disaster incidents and accidents, especially in highly developed complex urban areas. Earthquake and tsunami are not probable natural disasters for Seoul residents, but fine particle dust, such as PM2.5 or yellow sand storm containing heavy metals from China are more realistic risks. Their suggestion emphasizes that initial response is extremely important, and in this early response time stage, every individual should be able to judge the current situation and take their own initiative action. This is a particularly important point in that it can critically affect the life of oneself at an early point in time. On the other hand, the residents in Seoul are dealing with not only high population density, but also complicated transportation system and social services. However, the public is limited in their awareness and knowledge for disaster response in their daily lives—when a crisis occurs, this lack of public awareness/knowledge amplifies the extent of the catastrophe or casualties. Nevertheless, manuals and suggestions are still deployed in governmental agencies and/or organizations, including public and private, and educational sectors.

Considering the hierarchical social work structure in Tokyo and Seoul, top-down control/command, and bottom-up report system, especially, governmental office workers are hired through the employment qualification and hired for a permanent position, but because of the culture of rotating the positions, the work environments hardly accept flexible self-decision-making with one's own responsibility.

Furthermore, there is no manual for residents of Seoul who may not fully understand the government's purpose, intention on disaster drills, or their messages to the public. There may be many well-made drills, policies, and procedures developed by the government, but much of this information do not end up with the public who need these to deal with the emergencies because the channels for the information to reach these end-users are often broken, incomplete, or complex. Thus, these well-developed recommendations and manuals by different government agencies would be "floating in the air", or locked in the storage. This is one of many typical examples of the risk communication being unilateral between decision-makers, field workers, and the victims, which may be a cause of major controversies in bureaucratic administrators.

The unique character of Toronto is the mosaic society with various races and cultures. Still, Canadian government is willing to accept new immigrants from other countries and is open to refugees, as well. The diversity of Toronto society members may characterize the different vulnerability compared to Tokyo and Seoul.

Three cities developed many materials to communicate between governmental agencies and public including manuals and documentary forms, and the clarified relationship between those who command and those who report. According to information on the official websites of the cities, despite the development of IT functions, Toronto seems to have problems communicating with groups with diverse cultural backgrounds and language limitations. Because most information requires a fairly high level of English or French and/or IT knowledge or fluency, it seems that the public experiences difficulty accessing information easily unless particular attention is paid. Moreover, understanding the risks depends on their past experiences, for example, if refugees came from a country in a civil war who will be more aware of the risks of war and terrorism than natural disasters. This can be even more difficult if the amount of information is large. Thus, providing a booklet or pamphlet in different languages is an effective way for public understanding and education depending on the community's ethnic population.

Insurance and financial support allow the victims to return back to their home—their original place—easier and quicker. People returning back to their communities is a very crucial aspect of the society recovering from an event. People return to their communities because of many reasons—memories, assets, land, and other aspects of their lives that are precious to them. This allows the community to rebuild itself, and thus, stand back on its feet and contribute to the society, both economically and culturally. Insurance offered by governmental agencies may potentially give a feeling and sense of safety and hope.

Lessons from 2011 Japan Earthquake and tsunami show that victims were suffering to bring back their original level of quality of life prior to the disaster. Many victims never got their original life back because they did not purchase the earthquake and tsunami combination insurance. The victims could not get the full support from the government up to their expectations. Depending on their original level of quality of life, some victims suffered from the feeling of relative deprivation and decreased financial flexibility. This suggests that mental care of the victims is as important, and having more available options of insurance may reduce or prevent further sufferings of their own people and help them get back on their feet. This highlights an element that is critical in community recovery, resilience, and necessity that were absent in the governance of the three cities.

Depending on the city and their culture, the disaster cycle is often a spiral motion rather than a complete "circle"—as time goes on, as people review and learn from their experiences. As technologies improve, many systems and infrastructures are either repaired or replaced by faster, cleaner, safer, smarter, or better technologies and alternative materials, thus improving the system it replaced with a longer-lasting or more resilient model, leading to a better quality of life for its people and social systems.

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