



## Review Article

# A mechanism of disaster management in Korea: typhoons accompanied by flooding

Kyoo-Man Ha<sup>\*</sup>

Korea Environmental and Safety Institute, South Korea



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## A B S T R A C T

This article analyzed the improvement of a mechanism in relation to Korean disaster management, particularly of typhoons accompanied by floods. The analysis was done on the basis of own cultural background to ultimately mitigate disaster. By utilizing qualitative content analysis, both triangle- and quadrangle-style approaches have been compared via four factors, namely, national government's policies, business strategies, researchers' efforts, and volunteer activities. The article is valuable as a review of a mechanism of Korean disaster management which has been initially and comprehensively outlined. The key finding is that Korea has to change its current triangle-style approach to a quadrangle-style approach to reduce the impacts of typhoons accompanied by floods. In doing so, both challenges and alternatives or solutions have been identified for Korea.

## 1. Introduction

Typhoons accompanied by floods have annually hit South Korea (hereinafter Korea) and thus caused the huge impacts, as illustrated in Fig. 1. At the level of the central government, the Ministry of the Interior and Safety (MOIS) has currently provided the national guidelines on how to deal with such disasters. Similarly, the section dealing with disaster prevention in each local government has implemented the central government's public policy in the region. Among many professionals, civil engineers have dominated the field in particular by occupying important posts (Ha, 2018). When thinking that the extent of diversity has not been equally embodied in human resources, the Korean structure has been somewhat unbalanced.

Social networks have been formally or informally setup in Korea and then utilized in the field of disaster management. Such networks are based on many things including school affiliation (alumni), family (kinship members), hometown (home boys), or other factions. To illustrate, a people of position are likely to favor those who have some forms of connection with them, such as being graduates from the same school or being from the same town or country. In some ways, networks based largely on such connections may be inefficient or may cause bureaucracy in many fields including in disaster management. In other words, relational association may unnecessarily 'promote' within-network favoritism on disaster management, and as such, cause corruption (Kim and Whitaker, 2013; Clements, 2019).

Many international researchers have discussed their own national mechanisms of disaster management under a unique culture, and diverse stakeholders have tried to deal with disasters by depending on those proposed mechanisms (Bischiniotis et al., 2018). Mechanism means the arrangement of all connected parts of disaster management field to include ethics. However, Korean disaster management has failed to provide an appropriate mechanism for all its stakeholders (Na et al., 2017). Without a related mechanism, it would be more difficult for the field of disaster management to address disasters and their impacts including typhoon and flood. In particular, typhoon accompanied by flood has been an unfortunate annual occurrence in Korea. In this context, it is necessary to study what kinds of mechanism are available around typhoons accompanied by floods in Korea or how to efficiently change the current mechanism of managing such disasters, making it more effective.

The purpose of this article is to study how to replace the current triangle-style approach with a quadrangle-style approach for the ultimate goal of providing an effective mechanism of disaster management in Korea. The former is used as the rule of thumb on the management of typhoon accompanied by flood, whereas the latter reflects the play-by-the-rule method. On the basis of qualitative content analysis, these two approaches will be compared and contrasted using four factors, namely, national government's policies, business strategies, researchers' efforts, and volunteer activities. This paper has initially analyzed a mechanism of Korean disaster management via the case of typhoon accompanied by

<sup>\*</sup> Corresponding author.

E-mail address: [ha1999@hotmail.com](mailto:ha1999@hotmail.com).

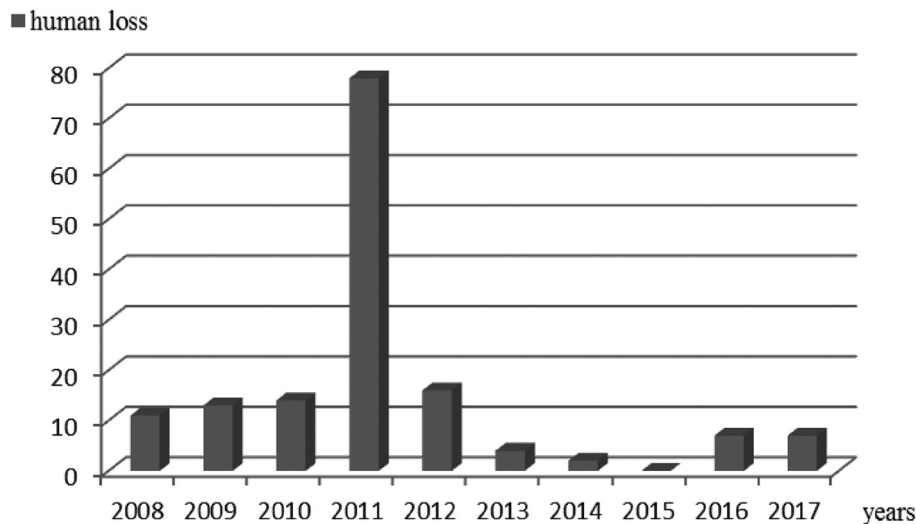


Fig. 1. The number of human loss caused by typhoons accompanied by flooding. Source: KMA, 2019.

flood. Also, this article will maintain the following as its key finding: the triangle-style approach must be changed to a quadrangle-style one.

## 2. Main text

### 2.1. Literature survey

There are many kinds of natural disasters such as typhoons, floods, earthquakes, tsunamis, wildfires, drought, volcano eruption, blizzards, heat waves, avalanches, sinkholes, etc. Among them, typhoons are a type of large tropical storms, which originate from the western Pacific Ocean. They, as a spiral or circular wind system, used to occur during summer. At present, they occur irregularly owing to climate change (Golemo, 2018). The name of hurricanes has been used for tropical storms in the Atlantic Ocean as well as the eastern Pacific Ocean. The people around the Indian Ocean have considered typhoons to be tropical cyclones.

Floods are an overflow of water (or water excess) from rivers, lakes, oceans, or other waterways. Floods have been evaluated as a costly natural disaster and may increase further costs under climate change. During these days, the number of flash floods has been rapidly increasing (Murray, 2017), mainly because the occurrence of typhoons dump a huge amount of downpour within several days, which has often caused mass flooding, regardless of the national boundary. Owing to heavy rains under typhoons, the water level rapidly rises, and thus, it quickly causes flooding. Shortly after the occurrence of typhoons, there are frequent floods.

By and large, a mechanism of disaster management provides the whole picture on a complicated disaster operation (Ash et al., 2014; Labrage et al., 2016). A plethora of mechanisms have been suggested and discussed in the international field of disaster management such as disaster management cycle, three-ball cycle theory, integrated emergency management system, comprehensive emergency management, the concept of redundancy, professionalism, and gene-therapy oriented disaster management, among many others (Alexander, 2002; Momani, 2012; Ha, 2019b; King et al., 2019).

The above mechanisms have been based on a robust foundation of scientific research by examining its related physical and social processes. As an example, the principle of early management is applicable to many situations (Vukadinovic et al., 2018). As another example, when coordination takes place during any kind of decision-making on disaster management, a non-linear dynamic system has been prevalent, resulting from many unexpected factors, such as the composition of stakeholders, the disaster response team's performance, and performance feedback (Guastello, 2010; Radosavljevic et al., 2017). In short, each mechanism

has its own scientific focus.

While identifying, developing, or evaluating the above mechanisms of disaster management, the issue of multi-criteria has been fully addressed. As an example, the Analytical Hierarchy Process, which was introduced by Thomas L. Saaty in 2006, has been considered as one of the most frequently-utilized techniques in the field (Fatemi and Rezaei-Moghaddam, 2019). The Analytical Hierarchy Process is used to analyze unstructured barriers or challenges around disaster management in particular, by referring to multi-criteria, that is, when there are various quantitative or qualitative indicators or alternatives regarding disaster management, the Analytical Hierarchy Process has been appropriately used for the mechanisms of disaster management.

Similarly, the above mechanisms have heavily relied upon the systems thinking approach on the way to sustainable disaster management (Rehman et al., 2019). The systems thinking approach is to identify all active stakeholders (or participants) in the field and then investigates diverse organizational, infrastructural, technical, social, and environmental factors. In doing so, the systems thinking approach may highlight or cover the complete picture of disaster management especially by integrating various tools, components, interrelationships, strategies, alternatives, systems, and others. To the end, the systems thinking approach may achieve long-term sustainability in the field.

Team-oriented management has been actively advocated, while working on those mechanisms of disaster management (Larsen et al., 2018). Since the impact of local emergency or those of national disaster are quite huge, few individuals or participants may not efficiently deal with its related catastrophes. Therefore, teamwork and collaboration among all stakeholders have been absolutely required in the field. When an effective team is operated in the field, the collective product of disaster management can be addressed. As a similar token, goose-style leadership has been further supported in the field than buffalo-style leadership. The former is to emphasize all members' leadership, whereas the latter is to support the role of a single leader.

While proposing mechanisms, many researchers or practitioners have not just approached to their issues in a passive manner but in a proactive manner like tackling down various pre-positioning problems in the field. At the same time, they have utilized not only design strategies but also redesign strategies on their issues to reduce the extent of uncertainty (Hasani and Mokhtari, 2018). When they find out a specific problem on disaster management, they design a related mechanism. After that, they are willing to strategically change or improve the mechanism during a long period, while reflecting on the importance of multiple networks, effective disaster operations, heuristic analysis, and others.

In the meantime, culture plays a huge role in influencing the direction

of disaster management mechanism in the international community. While various disasters have relentlessly caused not only physical impacts but also social impacts in any region, a few individuals, communities, or nations have not placed a lot of significance to those disasters under the governance of their own culture and have thus failed to efficiently deal with them. Risk perceptions or the subjective assessment of disaster consequence have varied largely, depending on local culture (Chionis and Karanikas, 2018). Similarly, there have been various ways of substantially managing those disasters as well. Thus, disaster culture does matter in the field.

As a case on cultural influence, the mechanism of the Incident Command System (ICS) was applied to North America at the beginning of the 1970s. The ICS has been recently used as a management tool for U.S. governments and non-profit organizations, but this has not been always understood by local residents. The ICS has been responsible for cutting down different disaster response units' structural obstacles while dealing with hurricanes accompanied by floods. However, many local residents in Taiwan, who studied the ICS, showed different views on each ICS principle on the basis of their cultural background. Many residents preferred the core principles of the ICS mechanism to include modular organization, integrated communication, and transfer of command. Yet, they were contradictorily ignorant, not only of the incident action plans but also of the span of control. Local residents in Taiwan, in particular, preferred to use non-ICS approaches regarding those two, mainly owing to the fact that they were surrounded by multiple cultural elements in a broad sense, such as a different economic situation, social structures, and a natural environment (Lam et al., 2010; Curtis, 2017; FEMA, 2018).

As another case on cultural influence, the mechanism of national disaster management consisted of three factors in Australia, namely, the basic concepts on disaster management, the importance of disaster planning, and the impact of disasters on the society. The Australian national mechanism strongly depended on disaster plans, roles and responsibilities, and other arrangements among all participants. In doing so, the role of emergency physicians was heavily emphasized, particularly during the process of disaster planning, such that emergency physicians coordinated all disaster planning matters with other participants to include not only environmental health officers but also civil engineers. In addition, emergency physicians took part in disaster management training through disaster medicine courses and disaster management courses (Abrahams, 2001; Shaban et al., 2012).

In Korea, only a small number of mechanisms on disaster management have been suggested in academic areas, as presented in Table 1. To elaborate, studies on disaster management, partially describing the mechanism of disaster management, and focusing on the mechanism of disaster management have not been so widely covered, particularly via the comparative perspective (the United States, New Zealand, and Fiji). Furthermore, those published articles have not been popularly supported, mainly because the history of modern disaster management is not long enough. In fact, considering that the National Emergency Management Agency (NEMA) was set up in June 2004, about 15 years have passed since Korea worked on its modern disaster management. The NEMA was named as the Ministry of Public Safety and Security (MPSS) at the beginning of 2015. The MOIS has replaced the name of MPSS since the middle of 2017. Additionally, the field of disaster management has worked on the micro-perspective aspect that deals with diverse temporary events, such as flood, fires, and typhoon, rather than the macro-perspective aspect (Kim, 2018). Thus, the advent of a distinctive mechanism has been rarely witnessed in Korea.

To elaborate, there is a gap in the literature between literature on mechanisms of international disaster management and literature on the mechanisms of Korean disaster management in the viewpoint of managing typhoons accompanied by flooding (Ha, 2019a). Basically, the international field has developed multiple mechanisms on typhoons and floods, but the Korean field has not equally done so. Many regions in the international community have tried to provide their own mechanisms under a unique environment. However, Korea has not realized the

Table 1

Number of published articles on the mechanism of disaster management.

Countries	Number of articles on disaster management (percentage)	Number of articles that partially describe the mechanism of disaster management (percentage)	Number of articles that focus on the mechanism of disaster management (percentage)
Korea - articles written in Korean on the website of KISS	1,161 (100%)	31 (2.67% = 31/1,161 × 100%)	0 (0% = 0/1,161 × 100%)
U.S. - articles written in English on the website of EBSCOhost (ASC)	28,345 (100%)	12,521 (44.17% = 12,521/28,345 × 100%)	573 (2.02% = 573/28,345 × 100%)
New Zealand - articles written in English on the website of EBSCOhost (ASC)	146,772 (100%)	41,228 (28.09% = 41,228/146,772 × 100%)	3,758 (2.56% = 3,758/146,772 × 100%)
Fiji - articles written in English on the website of EBSCOhost (ASC)	398 (100%)	171 (42.97% = 171/398 × 100%)	15 (3.77% = 15/398 × 100%)

Note: KISS = Koreanstudies Information Service System.

Sources: EBSCO Industries, Inc. 2019; Korean Studies Information Co., Ltd. (2019).

significance of these mechanisms yet. Accordingly, Korea has lacked data collection, research methods, data interpretation, or other conditions regarding the mechanism on typhoons accompanied by flooding.

Depending on a unique cultural background, various requirements may be needed while drawing a mechanism of disaster management. Among them, several pressing requirements are quality, transparency, and trust (O'Malley et al., 2009). When residents are faced with a series of typhoons accompanied by floods, related personnel and resources will be limited within a short period. Also, it will take a lot of time to deliver them to the disaster spot. To this point, the related mechanism of disaster management has to be agreeable and transparent for all stakeholders. In particular, transparent communication plays an important role in managing related disasters, since it allows all stakeholders to maintain a protective behavior, to effectively use disaster resources, and to reduce confusion. Without these requirements, the residents will not trust the mechanism.

Even when one of the best mechanisms is set up in the field of disaster management but still shows its own potential problems, it is necessary for all stakeholders to try to improve it. For example, one decision-making model for a pedestrian evacuation process during a typhoon accompanied by a flood has become a firm mechanism after being modified by so many researchers. Without related modifications, the flow of disaster management would go in the wrong direction. Thus, by incorporating both an individual's behavior and a contextual frame, related modification should be carried out to mitigate human loss, economic damages, and psychological impacts, taking note that each individual is directly faced with a series of disasters and each individual's behavior has its own contingency or context (Smith et al., 2015).

## 2.2. Analytical framework

Diverse ways of making or changing a mechanism of disaster management have been available, depending on an individual's criteria. Generally, after rapidly assessing the formation of an existing disaster management mechanism, it is necessary to elaborately assess its

important means. To put it another way, although an assessment is performed to evaluate the extent of an existing disaster management mechanism, problem identification and efficient response options have to be figured out for the long term. In doing so, all aspects of existing disaster management have to be reflected to a mechanism of disaster management. The proposed mechanism must lead to a future-oriented mechanism by fully utilizing the identified problem and the response options (Wu et al., 2017; Chen and Englund, 2018).

Many Korean newspaper or websites have indicated the necessity of improved national disaster management as well as negative aspects of current management (Shin, 2018). To investigate how a mechanism of Korean disaster management has to be transformed, this article will propose two mechanisms, in particular, the triangle-style approach and the quadrangle-style approach. Following Fig. 2, the former describes how the current mechanism in Korea has evolved by pointing out negative problems, whereas the latter explains where the future mechanism has to head for by suggesting positive alternatives. In short, the paper will maintain that the current triangle-style approach has to be radically changed to a quadrangle-style approach in order for the genuine goal of disaster management to be attained by following a right-sided arrow (→) and a double-sided arrow (↔) subsequently.

Both triangle-style approach and quadrangle-style approach are considered as a major tool to guide the direction of this article. The author developed these two approaches without directly relying on other references, making them unique in their characteristics. In addition, those two approaches play a role in explaining the issue of Korean disaster management well. The rationale of the approaches is also expected to be relatively easy to understand, by simply following the basic geometrical expression (in Fig. 2).

A triangle-style approach, in the case of disaster management, allows each stakeholder to advance to it like the shape of a triangle. Each

stakeholder manages various disasters not following equilateral lines but following a diagonal line, which looks like a sort of shortcut to get to the destination. In reality, many stakeholders in the field of disaster management are willing to respond faster to short-sighted solution, thanks to its simplicity and limited relief, without regard to quality. However, their attempts should be temporary measures, short-term viewpoints, or a rule of thumb. In short, a short-term and nearsighted solution does last for a short frame of time or it is related to a short period. Similarly, the triangle-style approach may be called a diagonal-style approach.

On the other hand, a quadrangle-style approach believes that disaster management must happen like the configuration of quadrangle by following quadrilateral lines (or equilateral lines) instead of a diagonal line. The approach is a sort of fair play by the rule, although it looks farther away to get to the destination, or the approach should be permanent measures, a long-term perspective, and a risk-oriented estimate for the ultimate goal of disaster management. Although taking so long, a long-term and systematic solution is to adjust to new reality in the field of disaster management by addressing patience, sacrifice, coordination, and in-depth analysis. As a similar token, a quadrangle-style approach may also be called a quadrilateral-style approach.

The proposed approach champions the practice of legality, righteousness, and justice, among others, as opposed to favoritism, corruption, and abuse of power. In the field of disaster management, these characteristics and the measures that support them are critical in promoting transparency and solid execution of solutions. Ultimately, the highest level of ethics is manifested within the system, therefore, leading to success and efficiency of related disaster management.

To carefully examine the two approaches, this article considered many subfactors, such as politics-oriented strategy, risk-oriented strategy, the role of local residents, and disaster awareness. However, this article finally selected the following four subfactors: (1) national

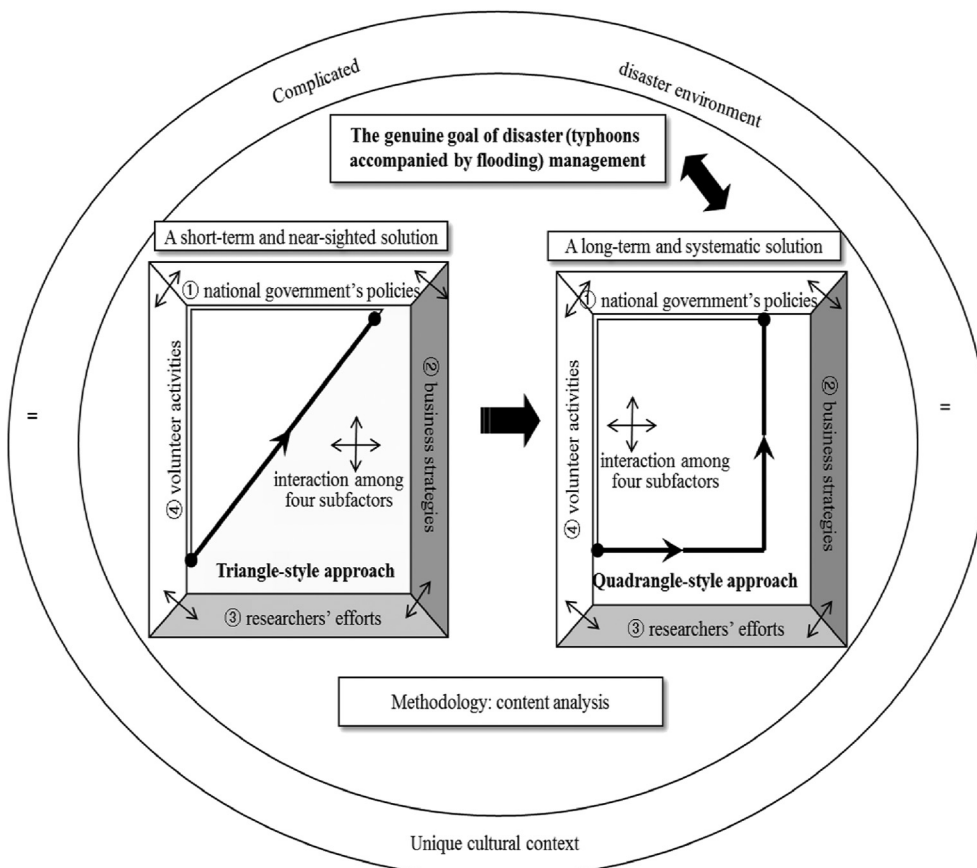


Fig. 2. Analytical frame.

government's policies, (2) business strategies, (3) researchers' efforts, and (4) volunteer activities because they play key roles in reflecting all major negative and positive aspects of a disaster management mechanism in Korea. A variety of literature has partially or fully supported the role of each four stakeholder while studying various national disaster management systems (Sen and Chakrabarti, 2019). Similarly, appropriate literatures from developed world will be considered as guidelines for all four subfactors in this article, as international perspectives. At any rate, these four were preferred by the group of Korean disaster management practitioners ( $68.18\% = 90/132 \times 100\%$ ) via a Korean social network service from July 1, 2017, to August 30, 2017.

To elaborate, the national government and its policies are clearly part of the mechanism of Korean disaster management if we believe that disaster management is basically the government's efforts with the support of closed partners. In addition, business and its strategy, researchers' efforts, and volunteers and their activity are included in the category of close partners when reviewing that the three have played more important roles in managing disasters in Korea than the other partners have. In short, the abovementioned four players are essential subfactors or stakeholders in describing the whole picture of typhoon accompanied by flood management mechanism in Korea.

Through the same four subfactors, this article will compare and contrast both the triangle-style approach and the quadrangle-style approach. In doing so, the goal of systematic comparison will be much more effectively achieved than in the case of using different subfactors between two opposite approaches. In the section of the triangle-style approach, this article will discuss whether the current mechanism of disaster management uses this method. In turn, the article will describe the specific alternatives that are necessary to justify the goal of the quadrangle-style approach in the next section. Also, the best practices in the international community will be cited as exemplary cases to follow in the section.

With all the above in mind, the scope of geographic region in the discussion is Korea in Far-East Asia, though international cases are often cited. A major methodology on the case of Korea is qualitative content analysis. Content analysis is to systematically analyze not the structure but the content of a subject such as written literature to decide the objective of such a subject. In other words, this article has searched, identified, interpreted, and then recorded many qualitative text data into appropriate spaces. Without utilizing any statistical computer package, this article has attempted to qualitatively describe the whole frame of Korean case. In doing so, typed keywords have been "natural disaster mechanism," "Korea and natural disaster," and "typhoon, flood, and Korea," among others.

Besides, when reviewing that qualitative content analysis has been traditionally referred to as conceptual analysis (Selin, 2017), this article has heavily relied on conceptual analysis in viewpoint of qualitative content analysis. To elaborate, two concepts have been chosen for the examination in this article, namely, the triangle-style approach and the quadrangle-style approach. After that, related analysis covered and discussed their presence in the field of disaster management.

### 2.3. Triangle-style approach

A right triangle consists of two straight sides and a diagonal by having a right angle between two straight sides. Table 2 shows some important statistical data on the triangle-style approach in Korea, despite the difficulty.

#### 2.3.1. National government's policies

When the 16th President, Roh Moo-Hyun, set up the NEMA in 2004 by addressing the public demand, he tried to reduce political conflicts between firefighters (against fires) and civil engineers (against typhoon accompanied by flood). Thus, he let two professionals take care of all the hazards in Korea. Since his inauguration, the 17th President, Lee Myung-Bak, more strongly supported the role of civil engineers (in particular

**Table 2**

Some numerical data on the triangle-style approach.

Units	Numerical data
① National government's policies	<ul style="list-style-type: none"> <li>- At the MOIS level, mainly civil engineers (more than 91% of 344 public servants) have been involved in managing typhoons accompanied by floods in 2018.</li> <li>- About 67% of MOIS' civil engineers could not understand the exact meaning of national response system at the end of 2018.</li> </ul>
② Business strategies	<ul style="list-style-type: none"> <li>- Before the development of the four great rivers in 2007, the ratio of flood damages was 3.6%:94.7%:1.7% among four great rivers, small rivers, and others.</li> <li>- A major cause of sink hole in Korean mega cities is not related to the formation of soil to include limestone layers but to business corporations' poor subway construction (almost 92%).</li> </ul>
③ Researchers' efforts	<ul style="list-style-type: none"> <li>- The distribution of public R&amp;D fund on civil engineering was 54.7% among various research areas in 2013–2017.</li> <li>- Less than 5% of proceedings on the Korean Society of Civil Engineers' seminars in 2016–2017 were a sort of interdisciplinary research.</li> </ul>
④ Volunteer activities	<ul style="list-style-type: none"> <li>- Three out of the 10 major NGOs have currently provided disaster management training for volunteers, but it is mostly table-top training.</li> <li>- The majority of NGOs have a limited budget, with an estimate of USD 200,000 per year.</li> </ul>

Sources: KDPA 2019; MOIS 2019.

regarding typhoon accompanied by flood) than that of firefighters, following his political interests (Kim et al., 2018). The 18th President, Park Geun-Hye, added not only those two professionals but also maritime policemen into the human resources of MPSS after the sinking of the ferry Sewol in 2014. The 19th President, Moon Jae-In, has reallocated civil engineers and firefighters into the scope of MOIS activities. In short, because of the four Presidents' political interests, the field of disaster management has been divided into two or three.

Although Korea enacted the Basic Act on Emergency and Safety Management for the national disaster management in 2005 (Park, 2015), the Act has failed to specify which institution shall manage which disaster. Thus, there is still no national response system in the field of disaster management. Fortunately, typhoon accompanied by flood has been approached in terms of disaster management, but mainly civil engineers are allowed to participate in related disaster management without cooperating with other stakeholders. Further, other disasters, such as drought, tsunami, earthquake, nuclear leakage, new disease, and many others, have not been approached in the viewpoint of disaster management but via regular business management. As evidence, no institution has ever claimed related roles and responsibilities just after the H1N1 virus broke out in 2009.

If the four Presidents had transparently reflected the significance of risk-oriented management to government structure more than that of their political interests, it would not have been difficult to see that only firefighters, civil engineers, and maritime police have fought against all kinds of hazards. In short, the four Presidents followed the triangle-style approach, which is a temporary solution for the field of disaster management. Also, when recognizing that Korea has worked on disaster management without establishing a national response system, its management is much similar to finger pointing, which is a triangle-style approach.

#### 2.3.2. Business strategies

Many businesses have recently realized the possibility of a commercialization effect in the field of disaster management (Kim and Song, 2016). Despite their affirmative realization, some businesses have rushed to produce inferior products. Therefore, they have been criticized that they are not sincerely interested in managing disasters, but instead, are more interested in making money.

Similarly, some businesses have kept a strong political relationship

with elected officials. In other words, many businesses in the area of civil engineering have supported the 17th President's development of the four great rivers (i.e., rebuilding Han river, Geum river, Yeongsan river, and Nakdong river by setting up tumbling bays as well as dredging operations), although a majority of experts, including the public, have pointed out much more negative effect than positive effect regarding development. By relying on political relationships, many civil engineering businesses have benefited monetarily with the support of the President, even under the national economic recession.

It is indeed a positive signal to the whole field of disaster management that effective commercialization is feasible. However, some businesses have crossed the diagonal line only to seek money using substandard products (e.g., poor quality products), and this points to the triangle-style approach. In addition, the nepotistic political relationship between civil engineering business and the 17th President has caused the adverse impact of drought and environmental pollution. Therefore, the non-confident relationship between them is a short-term strategy in the triangle-style approach.

### 2.3.3. Researchers' efforts

Diverse researchers have studied disasters or their management in various areas, such as civil engineering, meteorology, nuclear science, public administration, and sociology. Mainly because the history of their research has been only less than 20 years, many researchers, particularly in civil engineering, maintain that their own area or field is sufficient to cover the scope of disaster research to dominate the research community (Cao et al., 2017).

Research on disaster or its management is an interdisciplinary study, which includes all kinds of academic areas. Nevertheless, many researchers have not seriously attempted to interact among them. Under the name of a joint seminar, for example, each researcher has simply presented his or her own article, without having the opportunity to collaborate further. Additionally, many have not tried to systematically analyze the lessons learned on past disasters. Instead, they have just tried to record the history of a series of typhoon accompanied by flood in their research, similar to government documents.

Each researcher is supposed to work on his or her research based on his or her own understanding and often on his or her own field of study. If so, civil engineering researchers must have known the status of interdisciplinary study on disaster research. When they insist on claiming their own field as superior, this is consciously a shortcut for their research. Similarly, research among one's own group is a triangle-style approach, whereas no attempt to draw lessons learned is a non-qualitative attitude, which is again a triangle-style approach.

### 2.3.4. Volunteer activities

In the field of disaster management, voluntary activity was socially recognized at the beginning of the 1990s. Although late, volunteers have recently increased their activities. At the same time, related nongovernment organizations (NGOs), such as the Korea Disaster Safety Network, the Korea Disaster Relief Association, the Community Chest of Korea, and others, have been set up. However, some NGOs have shown stronger interests in making money, rather than helping in disaster management (Yoo and Son, 2018).

Many NGOs have failed to provide systematic exercise and training for volunteers, in general. As evidence, after rushing to several local typhoons accompanied by floods in 2014 and 2015, a majority of volunteers came to experience physical injury, such as vomiting and headache as well as psychological impacts. In another aspect, although those NGOs have high aspiration for disaster management, they do not have professional trainers on disaster management training.

Because some NGOs have made every effort to make money to be financially independent or so, many citizens are not willing to trust these organizations. Furthermore, some nationally known NGOs have been criminally investigated on donation fraud. These images are based on the triangle-style approach. Additionally, NGOs' lack of systematic training

has discouraged many volunteers to initiate their voluntary activity against disasters. Without providing systematic training, the NGOs' standard operating procedure would not be improved.

## 2.4. Quadrangle-style approach

### 2.4.1. National government's policies

Other nations have faced with own experiences and thus indicate lessons learned for Korea. In the U.K., its Civil Contingencies Act of 2004 provides all sources of national protection frameworks against diverse disasters. The Act has been enacted after repealing the Civil Defence Act 1948 and Civil Defence Act 1950. Both roles and responsibilities of local disaster responders are specifically or nationally defined in its part I, whereas special or temporary legislation is set up against catastrophes according to part II (National Archives, 2012). In the United States, the National Response Framework (NRF) against all kinds of hazards has allocated roles and responsibilities to all stakeholders to include federal government, state governments, local governments, private sector, volunteers, and American territory. The NRF is still in the process of revision, after replacing both the Federal Response Plan and the National Response Plan (FEMA, 2019). As a developing nation, Pakistan set up the National Disaster Risk Management Framework by allocating roles and responsibilities to different ministries under the federal government in 2007 (Ahmed, 2013).

Based on the cases of the United Kingdom, the United States and Pakistan, Korea has to pursue the quadrangle-style approach in national government's policies. Because the heads of NEMA, MPSS, or MOIS have been firefighters, civil engineers or maritime policeman, it is quite difficult to expect them to modify their exclusive occupation in MOIS. In short, the heads of NEMA, MPSS, or MOIS willingly or unwillingly have recruited their own professionals. The President, as an individual, has been more powerful over disaster management in Korea than any authority. Thus, the current 19th President (Moon Jae-In) must work toward transparency and inclusion of all relevant professionals into the field of disaster (to include typhoon accompanied by flood) management by relying on risk-oriented management (Shin and Choi, 2018). As a reference, the president of China, Xi Jinping, has been known to utilize not just one or two professionals but various professionals to fight against annual flood or typhoon in the region (CNTV, 2016).

In a similar token, the Korean President has to qualitatively set up the national response system in the field of disaster management by revising the Basic Act on Emergency and Safety Management with the support of the ROK National Assembly. Because the head of MPSS or MOIS is a minister level, he will not be able to allocate roles and responsibilities to other institutions at a minister level. By setting up by way of the national government's policies, the President should facilitate and initiate this for Korea.

### 2.4.2. Business strategies

Various disasters hit India, such as flood, cyclone, earthquake, or other accidents. However, business does not play a noteworthy role in managing related disasters. Thus, the government specified the role of business regarding disaster management in 2004. When a business makes a mistake on disaster management products, it will cause human loss and casualties. Certain business-related acts may kill people during a disaster. Hence, a business has to work on related disaster management professionally and not politically. To elaborate, a business has to provide disaster management resources and set up its own disaster management plans based on its social responsibility. After producing related machinery and equipment, a business has to upload the list of disaster products to the India Disaster Resource Network for the public (Government of India, 2004).

On the basis of Indian government's guideline, businesses in Korea need to commercialize their qualitative products professionally. When a business makes its own products, it also has to consider contributing to disaster management in the long term. In this regard, Japan's

construction corporations have successfully contributed to the goal of natural disaster management in the region, such as Jee. Co., Ltd., Chukyo Juki Co., Ltd., Chubu Ecotec Co., Ltd., and others (JSCE, 2012). As long as businesses are after the monetary benefit, such as the case of waste management business in India, they will collapse, and thus, be unable to make benefits, needless to mention, they may cause human loss during a disaster response (Hazra and Goel, 2009). In short, making biased efforts toward monetary benefit will cause many negative aspects in business. Hence, a business must work on the quadrangle-style approach; although it appears more complicated, it is actually shorter such as short-term plans for financial gains.

To be professional, the civil engineering business has to admit, like many national or international experts, that the development of the four great rivers is harmful to the field of disaster management. After their admission, they have to claim all responsibilities on the aftermath of the development of the four great rivers for social justice. The total expense of the development of the four great rivers has been about US \$21 billion (Ser, 2017), which is huge, but rushing for only monetary gains is very nonprofessional. Thus, nepotism and corruption should be ended or avoided. The civil engineering business should have invested on the development of hundreds of small rivers, which is a quadrangle-style approach. Also, the civil engineering business must upload the list of their activities and contracts to the MOIS' website, for transparency.

#### 2.4.3. Researchers' efforts

After the outbreak of a tsunami in the Indian Ocean in 2004, researchers in Sri Lanka were strongly criticized. Although many foreign researchers examined the impact of the tsunami on Sri Lanka, their own researchers, especially outside its capital, did not study the issue. To overcome it, the participatory research action (PRA) was suggested, and then, diverse researchers could join to study the issue. In particular, to improve the limited research attention on disaster, the PRA responded to ethically responsible research on disaster victims and disaster refugees. Accordingly, many researchers considered the PRA to be the starting point of their study, while the PRA recognized their ability to represent disaster participants (Brun, 2009). Although the PRA was not complete, it played many roles in enlightening researchers.

Regarding development of the four great rivers in Korea, many international researchers from developed nations including Germany were not supportive of the original intention or goal, unlike many researchers in Korea. Further, those international researchers have maintained the removal of tumbling bays in the four great rivers (Markus et al., 2004; Kim and Kim, 2018). According to them, the extent of green alga phenomenon in those rivers would not be successfully reduced without tumbling bays, which is a byproduct of the four rivers' development. In fact, those tumbling bays come to stop the natural flow of water in rivers and thus, cause serious environmental contamination right now.

Following Sri Lanka's PRA or civil engineering researchers in the international community, civil engineering researchers in Korea need to understand that maintaining their area alone will not yield success for the field of disaster management or its management research. Furthermore, individual researchers are encouraged to focus their investigation and exploration on disaster management because it relates to mitigating human loss. Personal or vested interests should have no place in this field, and instead, moral intent and professionalism should prevail. If not, many stakeholders might not trust those researchers and their research results. Without realizing the effect of their selfish behavior under the name of moral intent, the research culture would not be easily improved as illustrated by the case of Sri Lankan industrial researchers (Fernando, 2007).

In the proposed approach, researchers in Korea are encouraged to conduct multidisciplinary studies, collaborate with local and global experts, and learn from lessons of the past. By practicing the latter, resolutions and other policies established previously are expected to address or manage future similar disasters and their impacts more efficiently.

#### 2.4.4. Volunteer activities

According to a survey on volunteer activities in Italy in 2001, many emergency rescue volunteers were nonprofessional individuals, although they were enlisted in the Italian national civil protection program. Most of their educational levels were high, but they did not have the basic skills on disaster management. In particular, some volunteers were very vulnerable to disaster distress, such as anxiety, stress, panic, and others, whereas many volunteers in southern Italy did not have adequate disaster exercise and training in advance. A survey indicated that those volunteers had to get long-term psychological support as well as adequate disaster management training (Dolce and Ricciardi, 2007).

Seeing that the Italian case was not the best practice, Korean volunteers must not repeat similar mistakes in the future by following the quadrangle-style approach. To prevent the greedy image, NGOs in Korea need to focus on helping disaster management. In this context, many voluntary organizations in the United States have implemented the best practice, such as the American Red Cross, the Salvation Army, YMCA, and others (EMI, 2015). However, the American cases are not applicable in Korea, because of their different cultures, such as the lack of monetary donation, unwillingness to recognize voluntary activity, and so on. When NGOs in Korea become more concerned with being profitable, then they have to change their status into private corporations. Furthermore, as NGOs, they need to be transparent by accounting and showing how they allocate and distribute donations to the affected public.

To provide a systematic training for volunteers, NGOs need to have expert trainers, particularly those with advanced training in the international community. To do so, NGOs may encourage trainers to get training and accreditation in international NGOs via an international network. They may set up appropriate training programs with both volunteer selection and organization, which are suitable to the Korean environment, by emphasizing special techniques as well as self-actualization. In particular, such trainers may consider providing team-based training programs, not just within individuals but among diverse individuals and groups for coordination efforts (Mondal et al., 2015; Lee, 2018).

### 3. Conclusions

The threats of typhoons or floods have not been dramatically reduced in Korea like those of many South-Asian nations such as Bangladesh, India, Pakistan, and others (Abbas et al., 2016). Even though Korea has started its modern management for typhoons accompanied by floods at the beginning of the 21<sup>st</sup> century, it has still lacked many measures via a hegemony-oriented policy, monetary greed, non-systematic research, the lack of community participation, and others. In particular, the lack of appropriate mechanism in the field has surely led to poor management for typhoons and floods.

The article aimed to examine how Korea has to improve its current mechanism of typhoons accompanied by flood management. When figuring out an appropriate mechanism such as a quadrangle-style approach, various individuals and institutions in the field will directly or indirectly rely on it and thus contribute to the mitigating critical risks of typhoons accompanied by flooding. To the point, this paper has quite satisfactorily achieved the suggested goal.

The major tenet is that Korea has to reform its current triangle-style approach by adopting a quadrangle-style one in the future. To practically implement it, all four stakeholders (e.g., national government's policies, business strategies, researchers' efforts, and volunteer activities) have to carry out assigned roles and responsibilities (e.g., including various stakeholders into the field, risk-oriented management, professional researches, and systematic training and exercise). By changing individual behavior and related culture, the field of disaster management will be more efficient and transparent.

As for other findings, the article successfully identified diverse challenges and opportunities for the specific goal of related transitions. By aggressively addressing each challenge in a subfactor, Korea may achieve

an appropriate alternative in the same subfactor. Accordingly, such alternatives will reduce not only the physical impact (human loss, injuries, and economic damages) but also the social impact (psychological impact, unequal employment opportunities, unequal resource distribution, etc.) of a flood or a typhoon.

Many international scholars have studied their national mechanisms of disaster management under their own culture. However, scholars in Korea have not attempted to seriously analyze its mechanism. Probably, they have not been able to fully follow the international research trend or have stuck to their own research trend. With these in mind, this article initially analyzed how the mechanism of Korean disaster management needs to be transformed for the whole field. To this point, the analysis on the mechanism of Korean disaster management is considered to be the biggest advantage of this article. In another sense, this research has made a contribution to reduce the literature gaps between the international field and the Korean field.

Based on the proposed analytical frame, Korean scholars need to further study the detailed aspects of the mechanism of Korean disaster management. In particular, through a substantial joint research, it is necessary for stakeholders to provide a better mechanism for the field or modify the proposed one. In addition, international scholars may compare their mechanisms with the Korean one, or based on a similar joint research, international scholars may be able to discern a universal mechanism of disaster management.

## Declarations

### Author contribution statement

Kyoo-Man Ha: Conceived and designed the analysis; Analyzed and interpreted the data; Contributed analysis tools or data; Wrote the paper.

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### Additional information

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## References

- Abbas, A., Amjath-Babu, T.S., Kächele, H., Usman, M., Müller, K., 2016. An overview of flood mitigation strategy and research support in south Asia: implications for sustainable flood risk management. *Int. J. Sustain. Dev. World Ecol.* 23 (1), 98–111.
- Abrahams, J., 2001. Disaster management in Australia: the national emergency management system. *Disaster Med* 13, 165–173.
- Ahmed, Z., 2013. Disaster risks and disaster management policies and practices in Pakistan: a critical analysis of disaster management act 2010 of Pakistan. *Int. J. Disaster Risk Reduct* xxx, 1–6.
- Alexander, D., 2002. *Principles of Emergency Planning and Management*. Oxford University Press, New York.
- Ash, K.D., Schumann III, R.L., Bowser, G.C., 2014. Tornado warning trade-offs: evaluating choices for visually communicating risk. *Weather Clim. Soc.* 6 (1), 104–118.
- Bischiotti, K., Kanning, W., Jonkman, S.N., Kok, M., 2018. Cost-optimal design of river dikes using probabilistic methods. *J. Flood Risk Manage.* 11, S1002–S1014.
- Brun, C., 2009. A geographers' imperative? Research and action in the aftermath of disaster. *Geogr. J.* 175 (3), 196–207.
- Cao, L.-S., Zhang, Z.-F., Xia, T.-T., Kang, T.-H., 2017. A study on accessibility of disaster-prevention green space for earthquake avoidance – focused on jung-gu and nam-gu office, ulsan metropolitan city (in Korean). *J. KILA* 45 (6), 90–97.
- Chen, L., Englund, C., 2018. Every second counts: integrating edge computing and service oriented architecture for automatic emergency management. *J. Adv. Transp.* 7592926, 1–13.
- Chionis, D., Karanikas, N., 2018. Differences in risk perception factors and behaviours amongst and within professional and trainees in the aviation engineering domain. *Aerospace* 5 (62), 1–23.
- Clements, R., 2019. From bureaucracy to management: the international criminal court's internal progress narrative. *Leiden J. Int. Law* 32 (1), 149–167.
- CNTV, 2016. Xi Urges Enhanced Capacity to Fight Disaster [online]. [http://news.xinhuanet.com/english/video/2016-07/29/c\\_135548514.htm](http://news.xinhuanet.com/english/video/2016-07/29/c_135548514.htm). (Accessed 10 September 2018).
- Curtis, S., 2017. Why Police Agencies Need to Embrace the Incident Command System [online]. <https://www.policeone.com/active-shooter/articles/424419006-Why-police-agencies-need-to-embrace-the-Incident-Command-System/>. (Accessed 22 March 2019).
- Dolce, A., Ricciardi, M., 2007. Impact of psychological risk factors on disaster rescue operations: the case of Italian volunteers. *Disasters* 31 (1), 91–103.
- EBSCO Industries, Inc, 2019. Website of EBSCOhost(ASC) [online]. <http://web.b.ebscohost.com.eproxy.pusan.ac.kr/ehost/search/basic?sid=500d8769-b889-46a2-8bff-382a22b63cf8%40sessionmgr101&vid=1&hid=125>. (Accessed 14 March 2019).
- Emergency Management Institute (EMI), 2015. *The Role of Voluntary Organizations in Emergency Management*. Emmitsburg, MD.
- Fatemi, M., Rezaei-Moghaddam, K., 2019. Multi-criteria evaluation in paradigmatic perspectives of agricultural environmental management. *Heliyon*, e01229, 1–39.
- Federal Emergency Management Agency (FEMA), 2018. Incident Command System Resources [online]. <https://www.fema.gov/incident-command-system-resources>. (Accessed 1 May 2019).
- FEMA, 2019. Website of NRF Resource center [online]. <https://www.fema.gov/media-library/assets/documents/32230>. (Accessed 22 March 2019).
- Fernando, M., 2007. Corporate social responsibility in the wake of the asian tsunami: a comparative case study of two Sri Lankan companies. *Eur. Manag. J.* 25 (1), 1–10.
- Golembi, M., 2018. What Is a Typhoon: Everything You Need to Know [online]. ABC News. <https://abcnews.go.com/US/wireStory/dead-missing-midwestern-flooding-61745433>. (Accessed 21 April 2019).
- Government of India, 2004. Disaster Risk Management and the Role of Corporate Sector: the Indian perspective [online]. <http://www.ndmindia.nic.in/WCDRDOC/DRM%20%20The%20role%20of%20Corporate%20Sector.pdf>. (Accessed 19 August 2018).
- Guastello, S.J., 2010. Nonlinear dynamics of team performance and adaptability in emergency response. *Hum. Factors* 52 (2), 162–172.
- Ha, K.-M., 2018. Korean civil engineers: handling of natural disaster management and its implication. *Water Environ. J.* 32, 34–42.
- Ha, K.-M., 2019a. Examining a research boundary within natural disaster management: qualitative case study (forthcoming). *Int. J. Bus. Continuity Risk Manag.*
- Ha, K.-M., 2019b. Suggesting a “Three-Ball cycle” theory on international emergency management and its application in Korea. *Glob. J. Flex. Syst. Manag.* 20 (1), 91–102.
- Hasani, A., Mokhtari, H., 2018. Redesign strategies of a comprehensive robust relief network for disaster management. *Soc. Econ. Plan. Sci.* 64, 92–102.
- Hazra, T., Goel, S., 2009. Solid waste management in Kolkata, India: practices and challenges. *Waste Manag.* 29, 470–478.
- Japan Society of Civil Engineers (JSCE), 2012. JSCE 2011 Great East Japan Earthquake Commemorative Symposiums. The University of Tokyo, Japan.
- Kim, H.-I., Keum, H.-J., Han, K.-Y., 2018. Estimation of inundation area by linking of rainfall-duration-flooding quality relationship curve with self-organizing map (in Korean). *J. Korean Soc. Civ. Eng.* 38 (6), 839–850.
- Kim, M.-S., 2018. Risk assessment and local allocation of aggregate catastrophe loss with copula (in Korean). *J. Insur.* 116, 1–31.
- Kim, S.-E., Kim, S.-H., 2018. A study on the types of seoul citizens' perceptions about the four major river project (in Korean). *J. KSSSS* 43, 97–119.
- Kim, T.-I., Song, J.-Y., 2016. Development of technology and enterprise assessment model for commercialization of public technology (in Korean). *J. Korea Academia-Ind. Cooperation Soc.* 17 (5), 153–163.
- Kim, U., Whitaker, M.D., 2013. Network subversion: the contrasting effects of multiple networks on bribery in South Korea. *Int. J. Law, Crime and Justice* 41, 16–35.
- King, J., Edwards, N., Watling, H., Hair, S., 2019. Barriers to disability-inclusive disaster management in the Solomon Islands: perspectives of people with disability. *Int. J. Disaster Risk Reduct.* 34, 459–466.
- Korea Disaster Prevention Association (KDPA), 2019. The Homepage of KDPA (in Korean) [online]. <http://www.kodipa.or.kr/>. (Accessed 1 April 2019).
- Korea Meteorological Administration (KMA), 2019. KMA's Weather Information (in Korean) [online]. [http://www.weather.go.kr/weather/lifenindustry/disaster\\_02.jsp](http://www.weather.go.kr/weather/lifenindustry/disaster_02.jsp). (Accessed 21 April 2019).
- Korean Studies Information Co., Ltd, 2019. Website of Koreanstudies Information servicesSystem (KISS) (In Korean) [online]. <http://kiss.kstudy.com/index.asp>. (Accessed 14 March 2019).
- Labrague, L.J., Yboa, B.C., McEnroe-Petite, D.M., Lobrin, L.R., Brennan, M.G.B., 2016. Disaster preparedness in philippine nurses. *J. Nurs. Scholarsh.* 48 (1), 98–105.
- Lam, C., Lin, M.-R., Tsai, S.-H., Chiu, W.-T., 2010. A pilot study of citizens' opinions on the incident command system in taiwan. *Disasters* 34 (2), 447–469.
- Larsen, T., Beier-Holgersen, R., Dieckmann, P., Østergaard, D., 2018. Conducting the emergency team: a novel way to train the team-leader for emergencies. *Heliyon*, e00791, 1–27.
- Lee, K.S., 2018. The making of a nation's citizen diplomats: culture-learning in international volunteer training program. *J. Contemp. East. Asia* 17 (1), 95–112.
- Markus, M., Fiedrich, F., Leebmann, J., Schweier, C., Steinle, E., 2004. Concept for an integrated disaster management tool. In: *Proceeding on the 13th World Conference on Earthquake Engineering Vancouver*. B.C., Canada.
- Ministry of the Interior and Safety (MOIS), 2019. The Homepage of MOIS (in Korean) [online]. <http://www.mois.go.kr/irt/a01/irtMain.do>. (Accessed 13 May 2019).
- Momani, N.M., 2012. Integrated framework for earthquake consequences management. *J. Disaster Prev. Manage.* 21 (2), 184–205.
- Mondal, D., Chowdhury, S., Basu, D., 2015. Role of non-governmental organization in disaster management. *Res. J. Agric. For. Sci.* 6, 1485–1489.



- Murray, A., 2017. Natural Flood Management: Adopting Ecosystem Approaches to Managing Flood Risk. Friends of the Earth, Dublin.
- National Archives, 2012. Civil Contingencies Act 2004 [online]. <http://www.legislation.gov.uk/ukpga/2004/36/contents>. (Accessed 7 September 2018).
- Na, W., Lee, J., Moon, H., 2017. Study on calculating class rates with claim amount weighted by risk types in flood and storm insurance (in Korean). *Risk Manage. Stud.* 28 (2), 43–67.
- O'Malley, P., Rainford, J., Thompson, A., 2009. Transparency during public health emergencies: from rhetoric to reality. *Bull. World Health Organ.* 87, 614–618.
- Park, H.-K., 2015. A study on the law-strategic improvement plan of disaster management system on the "disaster & safety management fundamental law" (in Korean). *Policy Stud.* 15 (4), 1483–1512.
- Radosavljevic, V., Belojevic, G., Pavlovic, N., 2017. Tool for decision-making regarding general evacuation during a rapid river flood. *Public Health* 146, 134–139.
- Rehman, J., Sohaib, O., Asif, M., Pradhan, B., 2019. Applying systems thinking to flood disaster management for a sustainable development (online). *Int. J. Disaster Risk Reduct.* (Accessed 28 March 2019).
- Selin, S.W., 2017. Operationalizing sustainable recreation across the national forest system: a qualitative content analysis of six regional strategies. *J. Park Recreat. Adm.* 35 (3), 35–47.
- Sen, R., Chakrabarti, S., 2019. Disaster management dynamics - an analysis of chaos from the flash flood (2013) in the fragile himalayan system. *J. Geol. Soc. India* 93 (3), 321–330.
- Ser, M.-J., 2017. Moon Orders an Inquiry into Lee's Four-Rivers Project (in Korean) [online]. <http://koreajoongangdaily.joins.com/news/article/article.aspx?aid=3033692>. (Accessed 4 May 2019).
- Shaban, R.Z., Holzhauser, K., Gillespie, K., Huckson, S., Bennets, S., 2012. Characteristics of effective interventions supporting quality pain management in Australian emergency departments: an exploratory study. *Australas. Emerg. Nurs. J.* 15, 23–30.
- Shin, H.-S., Choi, J.-M., 2018. Media's negative portrayal of bureaucrats: the relationship of media coverage with presidential bureaucracy-bashing and public perception (in Korean). *Public Administration Stud* 54 (3), 27–51.
- Shin, J.-H., 2018. Preventing Another Jecheon Fire by Replacing Firefighting mobile Phones (in Korean) [online]. (Accessed 16 July 2018).
- Smith, M., Wallace, K., Lewis, L., Wagner, C., 2015. A structured elicitation method to identify key direct risk factors for the management of natural resources. *Heliyon*, e00043, 1–21.
- Vukadinovic, S., Macuzic, I., Djapan, M., Milosevic, M., 2018. Early management of human factors in lean industrial systems (online). *Saf. Sci.* (Accessed 27 June 2019).
- Wu, L., Zhang, J., Lu, Q., Rahman, A.B.M.S., 2017. Tourist adaptation behavior in response to climate disasters in Bangladesh. *J. Sustain. Tour.* 25 (2), 217–233.
- Yoo, S.-R., Son, E.-Y., 2018. Exploring the meaning of citizen education understood by learners: for civic group learners of a city (in Korean). *Educ. Culture Res.* 24 (3), 189–204.