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A Study on the Countermeasures against Social Disasters in the Itaewon

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Abstract

Purpose: *Research on countermeasures against social disasters by analyzing the Itaewon disaster that shocked Korean society.*

Method: *In order to study how to respond to social disasters considered as the Itaewon disaster, we analyze domestic laws and compare overseas cases.*

Results: *Until the Framework Act on Disaster and Safety Management is revised to resolve legal issues for events without organizers, local governments should be responsible for planning, controlling, and safety. In addition, even if there is no organizer, the contents and risks of the event should be shared among related agencies and systematically responded by sharing roles through the "Regional Safety Management Committee" organized by the head of the local government under the law.*

Conclusion: *The Itaewon disaster has many implications. It should be an opportunity to identify public safety problems such as crowd accidents and check social disaster response systems to move toward a properly established "Safe Korea" through revision of related laws and system and system maintenance.*

Keywords: ***Itaewon, Itaewon Disaster, Social Disasters, Crowd Management, Basic Act on Disaster and Safety Management Super Drugs***

1. Introduction

The streets of Itaewon on Oct. 29, 2022 were filled with 130,000 people trying to enjoy the Halloween festival. At 10:15 p.m., a narrow alleyway from Itaewon Station passing by the Hamilton Hotel to the World Food and Culture Street attracts many people, falls, and causes a crushing accident. This incident, which claimed 58 precious lives, is called the "Itaewon disaster".

2. Basic Act on Disaster and Safety Management

Article 3 of the Framework Act on Disaster and Safety Management divides disasters into two categories[1]. The first is a "natural disaster" caused by typhoons, floods, heavy rains, strong winds, wind waves, tidal waves, heavy snow, cold waves, lightning, drought, heat waves, earthquakes, yellow dust, algae, tides, volcanic occurrences, and other natural phenomena[2].

Second, damage over the scale prescribed by Presidential Decree, paralysis of the national core[3], the spread of infectious diseases or livestock infectious diseases under the Infectious Disease Prevention and Management Act, and "special damage to fine dust reduction and management" are defined[4].

3. Problems in Responding to the Itaewon Disaster and Social Disaster

The Itaewon disaster is a crushing accident and a social disaster caused by a dense crowd. This is not the only time that there has been a crushing accident in South Korean society. Since 67 deaths occurred in 1959 in the Busan Public Stadium crush accident, 31 people were killed in a crush accident on the stairs of Seoul Station ahead of the 1960 Lunar New Year.

In 1980, five people were killed by oppression at Yongho Elementary School in Busan, one was killed during a New Kids on the Block concert at the Olympic Gymnastics Stadium in Jamsil, Seoul, in 1992, two were killed in a public broadcast There were also cases where 11 people were killed in the crush.

The problem is that 17 years after the crushing accident in Sangju, Gyeongsangbuk-do, 158 people died in Yongsan Itaewon, the center of Seoul.

Until now, South Korean society has focused more on natural disasters than social disasters. While the system to respond to natural disasters such as typhoons, heavy rains, floods, and earthquakes was well established, social disasters, including fires, often led to accidents that were so big that the word "disaster" was attached. Recently, the Jecheon Sports Center fire and the Icheon Logistics Warehouse fire are mentioned. In addition, the Itaewon disaster can be seen as an incident that made us realize the seriousness of the damage and scale of social disasters.

The Itaewon disaster was reported by major media in developed countries abroad. Most of the respondents said, "As an advanced country that joined the G20, I can't believe such a disaster occurred in a country called Korea, which has risen to a cultural powerhouse due to K-POP and Hallyu, and in Itaewon, where people and cultures from various countries abroad are harmonized.“

When a disaster that is large enough to be called a disaster occurs, laws and regulations are enacted, systems are reorganized, and regulations and rules are made. In addition, related agencies are trying to widen the gap in disasters by fiercely conducting meetings and discussions through TFs in which the public and private sectors cooperate and developing manuals and guidelines through conclusions drawn here.

Until now, South Korean society has undergone many changes through large and small disaster situations. The Disaster Response Contral Tower was established during the Roh Moo Hyun government after the Daegu subway disaster in 2003, and has fluctuated according to the government.

The Roh Moo Hyun government decided that a comprehensive crisis management control tower was needed, so the Blue House National Security Council (NSC) had to deal with safety and disasters along with pending unification, diplomacy, and security issues. Since then, the Lee Myung Bakn government has abolished the system and entrusted disaster response to the Ministry of Public Administration and Security.

The Park Geun Hyen government changed the existing Ministry of Public Administration and Security to the Ministry of Safety and Security, saying it would put "safety" first, and when the Ferry Sewol disaster broke out in 2014, it took out "safety" separately to create the "Ministry of Public Safety and Security." In addition, the Ministry of Security and Public Administration turned it to the Ministry of Government Administration and Home Affairs, abolished the Coast Guard for failing to respond to the disaster, and instructed local governments to create disaster safety-related departments. However, in the end, the Park Geun Hyen government was criticized for not responding to the disaster, and the Moon Jae Inn government organized the disaster response at the Crisis Management Center in the underground bunker of the Blue House.

Since then, the relocation of the presidential office to Yongsan under the Yoon Suk Yeol administration has led to the "Itaewon disaster" that has forced criticism that the function of the crisis management center has become nominal. In the end, despite much effort and maintenance by previous governments, the fact that problems in responding to disasters continue to occur can be seen as a proof that there are various problems.

In this disaster, the government's "disaster response governance" with citizens, merchants, and experts who are well aware of local risks did not work. In order to prevent accidents at local festivals, the "Regional Safety Management Committee" organized by the head of the local government under the law did not work to share the contents and risks of events among related agencies and systematically respond through role sharing.

The Yongsan-gu Office formally held the regional safety management committee, which had been held every time, and there was no plan on the day of the disaster and no on-site control was carried out because related agencies did not participate. The subway, which had to pass without stopping, was passed without stopping after the disaster, and the emergency medical system, including on-site DMAT(Disaster Medical Assistance Team), was operated belatedly.

The first patient, who was transferred to Soonchunhyang University Hospital, the nearest general hospital, arrived in an hour and a half. There was no traffic control that should have been done at the scene, police forces were not properly deployed, and fire departments were late to raise the response level, and institutions and systems that needed to respond to disasters did not work.

The Local Festival Site Safety Management Manual published by the Ministry of Public Administration and Security in 2021 was prepared in accordance with Article 66-11 of the Framework Act on Disaster and Safety Management. This manual contains information that applies to local festivals held by central administrative agencies, local governments, and the private sector, and local festivals are expected to attract more than 1,000 visitors at the moment.

The problem was that the Itaewon disaster was an event without an organizer. In this regard, both the ruling and opposition parties are attempting to revise the law by supplementing the contents that have been problematic. A total of 18 proposals were proposed to revise the Framework Act on Disaster and Safety Management from November 1 to December 5, 2022, after confirming the legislation of the National Assembly's bill information system. It also includes details on measures by density, disaster safety text messages, the establishment of an integrated disaster safety data system, and the establishment of a reporting system.

Obviously, the disaster will revise the Framework Act on Disaster and Safety Management, and it is expected to compensate for the problems of events without organizers. In addition, the Ministry of the Interior and Safety's "Local Festival Site Safety Management Manual" should be reorganized in line with the revision of the law. However, the fundamental problem is that despite the large crowds, the narrow alley was not controlled and the high concentration of crowds led to the disaster. In the end, South Korean society's safety prediction and control system has not been operated and numerous young people have been sacrificed, the fundamental problem of "how should South Korean society operate the disaster management system, including crowd management?" must be solved.

4. Measures to Cope with Social Disasters

Article 4 of the Disaster Safety Act stipulates the responsibilities of the state and others, saying[5], "The state or local governments should be responsible for protecting the lives[6], bodies, and property of the people from disasters or other accidents[7], make efforts to prevent and

reduce damage[8]." In addition, Article 6 stipulates that “the Minister of Public Administration[9], and Security shall oversee and coordinate disaster and safety management affairs conducted by the State and local governments[10]”.

In order to prevent social disasters such as the Itaewon disaster, the Ministry of Public Administration and Security, the subject of disaster safety management, must reorganize related laws and systems, and ambiguous laws and regulations must be clearly revised in cooperation with the National Assembly. In addition, remember that the organizer of the local event is a "local government" and must fulfill his/her responsibility from the safety plan of the event to on-site control and social response.

Until the Framework Act on Disaster and Safety Management is revised to resolve legal issues for events without organizers, local governments should be responsible for planning, controlling, and safety. In addition, even if there is no organizer, the contents and risks of the event should be shared among related agencies and systematically responded by sharing roles through the "Regional Safety Management Committee" organized by the head of the local government under the law.

Although the local event is hosted by a local government, the police dispatched their experience in crowd management at the request also revealed various problems in the disaster. Of course, the police play a role as a support organization, not as an organizer of local events, but on the other hand, they play a key role in crowd management[11]. As stipulated in Article 5 of the Act on the Execution of Duties of Police Officers, the police may issue warnings, detention, or evacuation measures against "extreme congestion and other dangerous situations." The police, who have been doing their best to prevent various rally protests and safety accidents, have no choice but to say that they were letting go of the disaster. In other words, it can be seen as a failure of prediction. The police should reflect on this disaster and be reborn through great innovation[12].

Through consultation between the government and the National Assembly, clear scope and authority should be established by reflecting specific authorization provisions in the Act on the Execution of Police Officers' Duties, Framework Act on Disaster and Safety Management, Performance Act, Road Traffic Act, Security Act, and Act.

In particular, the police have a principle that discretionary power shrinks to zero when the public is in a dangerous situation. In other words, it is mandatory to intervene immediately in dangerous situations. However, the provisions of the current Police Officer's Duty Execution Act related to crowd management need to be specified in more detail.

Articles 5 (prevention of risk, etc.), 7 (entry to prevent risk), 8 (confirmation of facts, etc.), and 8-2 (collection of information, etc.) should be added to direct force when crowd concentration, and the authority to intervene and control immediately[13].

In addition, when the Framework Act on Disaster and Safety Management is revised, the police should prepare and deliver detailed guidelines, supplement equipment and careers for crowd management, strengthen education and training for crowd management and public safety, operate information reporting and risk prediction systems.

5. Measures and Implications for Responding to Social Disasters from Overseas Cases

In developed countries abroad, system improvement and maintenance were carried out after the crushing accident in which a large number of deaths occurred. Japan changed its security system by revising the National Public Safety Commission rules and the Security Business Act

after the 2005 firework accident in Akashi, Hyogo Prefecture, and establishing “busy expenses” in addition to the existing “residential expenses” and “traffic guidance expenses”.

The United States puts forward three principles when there is a festival or event. First, safety is secured by limiting the number of people, installing protective fences, and securing emergency spaces. It is also noteworthy that the "Special Events Continuity Planning" created in 2005 by the Federal Disaster Management Administration (FEMA), a crisis management control tower, is used as a guideline to “prevent crushing” in the event of a large event.

Regulations on crowd management are also clearly in place. The U.S. stipulates that authorities should take related measures in advance if more than two to three people flock per square meter, and the U.S. Department of Justice's "LSSE" and the U.S. Centers for Disease Control and Prevention (CDC) make recommendations when attending large events for travelers on its website.

In the wake of the 9.11 terror, the U.S. formed a national committee, reviewed the current that U.S. intelligence agencies failed to integrate and dig into dangerous signs, and established a national intelligence integrated system.

The Itaewon disaster has many implications. It should be an opportunity to identify public safety problems such as crowd accidents and check social disaster response systems to move toward a properly established "safe Korea" through revision of related laws and system and system maintenance.

6. References

6.1. Journal articles

[1] Lee BH. A Study on the Legal System for Natural Disaster Response and Recovery. *The Law Research Institute*, 23(4), 87-112 (2022).

[2] Lim HJ. Analysis of Factors Influencing School Safety Culture Applying the Two-level Multilevel Model: Focus on Middle School Safety Education in Gyeonggi-province. *Future Educational Studies*, 33(1), 145-167 (2020).

[3] Kim JI. The Institutionalization of Memory Places for Social Disasters: Comparative Analysis of Sewol Ferry and Daegu Subway Fire. *Economy and Society*, 22(136), 148-198 (2022).

[4] Lee SK. Disaster Management and Response System of the United States and Its Implications. *Journal of Constitutional Justice*, 7(2), 39-75 (2020).

[5] Shin SJ. Legal Protections for Essential Workers. Studies of Social Security law. *Journal of Constitutional Justice*, 21(44), 25-52 (2021).

[6] Jeon GH. Study on Solidarity Experience for Disaster Recovery: Focusing upon South Korean Social Welfare Network(Woori-together)’s Activity*. Locality and Globality: Korean Journal of Social Sciences*, 43(1), 85-115 (2019).

[7] Kim DJ. Relationship between National Crisis Management and Forensic Engineering -Focused on Securing Stability of Nuclear Power Plant*. Myongji Law Review*, 19(2), 39-69 (2021).

[8] Park BW. Polizeiliche Aufgabe und Verantwortung im Lichte des Itaewon Halloween Unglücks -im Hinblick auf Polizeiaufgaben - und vollzugsgesetz und Katastrophen und Sicherheitsmanagemensgesetz. *Police Law Study*, 21(2), 61-108 (2023).

[9] Kim JH. Review of the Disaster Management Laws after the Itaewon Disaster. *Study of National Law*, 19(1), 193-233 (2023).

[10] La HW. The Impact of the Government’s Legal System on Awareness of Disaster Safety Management. *Crisisonomy*, 16(2), 75-89 (2020).

[11] Lee BR. The October 29th Itaewon Disaster and State's Safety Measures Obligation: First Issue in Determining Whether the State Compensation Liability is Established for the Damage Caused by the Disaster. *Democratic Law*, 23(81), 11-46 (2023).
[12] Lee HN. A Study on How to Improve Police Disaster Management Ability: A Focus on a New Police Disaster Response Drill in Jeonnam Provincial Police Agency. *Journal of the Korean Society of Korea*, 31(1), 251-282 (2022).
[13] Kim MJ. Specificity of Determining Loss Compensation Requirements in the Police Enforcement in Disaster Situations. *Journal of Police and Law*, 21(2), 163-188 (2023).

7. Appendix

7.1. Author's contribution

	Initial name	Contribution
Author	GY	-Set of concepts ☑ -Design ☑ -Getting results ☑ -Analysis ☑ -Make a significant contribution to collection ☑ -Final approval of the paper ☑ -Corresponding ☑ -Play a decisive role in modification ☑ -Significant contributions to concepts, designs, practices, analysis and interpretation of data ☑ -Participants in Drafting and Revising Papers ☑ -Someone who can explain all aspects of the paper ☑

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Disaster Response Awareness and Followership Factors of Korean Police Officers

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Abstract

Purpose: *Korean police officers play an important role in disaster situations through initial response, rescue and first aid for the injured, control and maintain order at the scene, traffic control, reporting and conveying information, and using alternative communication methods. They also continue to influence the safety of residents after disasters by guiding citizens to evacuate, protecting vulnerable groups, and supporting recovery at the scene. As such, the police are important to the safety of citizens in disasters, and this study aims to explore the perception of disaster response and followership according to police rank and career path.*

Method: *The data processing of this study was conducted using the statistical package program SPSS 23.0 Program, and statistical verification was performed as follows according to the purpose of data analysis. First, frequency analysis was conducted using the SPSS/PC+23.0 Program to identify general characteristics. Second, One Way ANOVA was conducted to identify differences in police disaster response awareness according to police rank and career path. Fourth, cross-analysis (Chi-Square) was conducted to identify the correlation between police rank and career path. Fifth, exploratory factor analysis was conducted to examine the followership of police organizations.*

Results: *The higher the police rank, the higher the awareness of disaster response, and those who were police officer candidates had the highest awareness of disaster response. Rank and career path were statistically related, and the followership factors of police organizations were structured as 'exemplary followership', 'creative followership', and 'active followership'.*

Conclusion: *Followership of police is very important in disaster situations. The importance of followership in disaster situations is dealt with in various aspects such as rapid and efficient response of the organization, maintaining consistency and integration, conveying information and communication, managing stress and uncertainty, strengthening cooperation and teamwork, maximizing the effectiveness of leadership, and improving resilience after disasters. Through followership, police officers effectively support their superiors in disaster situations and play an important role in helping the entire organization achieve its goals.*

Keywords: ***Disaster Response Awareness, Police Officers, Ranks, Entry Paths, Followership***

1. Introduction

1.1. Background of the study

The Korean police play an important role in disaster situations, both directly and indirectly[1][2][3]. Directly, first, the police are the first to arrive at the scene of a disaster to assess the situation and initiate initial response[4][5]. Second, the police rescue the injured, provide first aid, and request medical assistance when necessary. Third, the police control the crowd

and maintain order to prevent chaos and maintain public order by preventing additional accidents and crimes at the disaster site. Fourth, the police control traffic to ensure smooth movement of emergency vehicles and restrict access to the disaster site[6][7]. Fifth, the police accurately assess the situation at the scene and promptly report it to relevant agencies, and also convey important information to the public. Sixth, the police continue to convey information through alternative means of communication because communication networks may be paralyzed in disaster situations[8][9]. In addition, the police indirectly evacuate residents in the disaster area and nearby areas to safe places. Second, the police give priority to protecting those in need, such as the elderly, children, and the disabled[10][11]. In addition, they support on-site recovery operations after disasters and provide various support to residents who have suffered disasters[12][13].

The importance of Korean police officers in disaster situations is that they are closely related to the safety of citizens not only in national emergencies such as wars, but also in general disasters and emergencies through these various roles.

1.2. Purpose of the study

Depending on the rank and career path of the police officer, the factors of awareness and followership in responding to disasters play a more important role in disasters.

1.2.1. Police ranks

Table 1. Followership characteristics by police rank.

Classification	Ranks	Characteristics
Lower ranks	Police Officer	The lowest rank in the organization, a stage for learning the police organization, performing practical work according to instructions.
	Senior police officer	While following the instructions of the superior, the role of leading subordinates requires followership that gives trust to the superior and encourages the subordinates.
	Assistant Inspector	A person with abundant field experience, and begins to lead the team, and the ability to understand the superior's strategy and implement it is required.
Middle ranks	Inspector	As a mid-level leader in the organization, the role is to effectively convey the superior's instructions and guide subordinates. Smooth communication with the superior is important.
	Senior Inspector	Make important decisions within the organization and act as a mediator between the superior and subordinates. Strategic thinking and reliable feedback to the superior are required.
Higher ranks	Superintendent	Responsible for the operation of the department and the role of concretizing the superior's strategy. The ability to share the superior's vision and goals and encourage subordinates is important.
	Senior Superintendent	As the chief of police in charge of the region, the role is responsible for the security and safety of the local community. The role is to convey the organization's vision to subordinates and strategic thinking is required to meet the superior's expectations.

	Superintendent General Senior Superintendent General Chief Superintendent General Commissioner General	As the highest rank in the organization, the role is to establish and implement national-level security policies. Although leadership is important, loyalty to superiors (such as the Commissioner General of Police) and a deep understanding of policy are also required.

1.2.2. Police entry path (origin)

In Korea, police entry path (origin) is divided into graduating from the police academy, passing the officer candidate exam, and passing the general recruitment (career recruitment and open police officer recruitment) exam[14].

First, graduates of the police academy have high expertise through four years of systematic education at the police academy, have strong ties within the police organization[15], and have well-established networks with colleagues and superiors. In addition, they are appointed as junior officers from the beginning of the police organization, so they have many opportunities to demonstrate leadership from the beginning[16].

Second, graduates who pass the officer candidate exam often have diverse academic backgrounds and job experiences, so they often have innovative and creative thinking, and can quickly adapt to the police organization based on their diverse experiences and present new perspectives[17]. In addition, since they are appointed as junior officers from the beginning, just like graduates of the police academy, they are given the opportunity to demonstrate leadership within the organization through rapid promotion[18]. Lastly, those who passed the general recruitment (career recruitment and police officer recruitment) exam have abundant practical experience and a high level of understanding of the field situation, and since they start from a lower rank and are promoted step by step, they have a solid foundation in the basics of police work[19][20]. In addition, they tend to grow through sincerity and patience within the organization, and followership is required to faithfully follow the instructions of superiors.

2. Methods of the Study

2.1. Study population and sampling methods

In this study, among police officers in the security department as of 2020 who In this study, among police officers in the security department as of recent who had experience in work related North Korean defectors, 100 trainees in the Police Human Resources Development Institute were surveyed via self-administration method. Among the collected survey questionnaires, 91 were selected as valid samples, excluding those whose answers were incomplete or missing.

Table 2. The general characteristic of the research subjects.

	Description	N (%)	Total
Gender	Male	61 (67.0%)	91
	Female	30 (33.0%)	
Age	20s	7 (7.7%)	91
	30s	28 (30.8%)	
	40s	30 (33.0%)	
	50s or older	26 (28.6%)	
Education Level	High school graduate	14 (15.4%)	91

	Junior college graduate	30 (33.0%)	
	College graduate	43 (47.3%)	
	Graduate school or higher	4 (4.4%)	
Rank	Policemen/women	1 (1.1%)	91
	Senior policemen/women	19 (20.9%)	
	Assistant inspector	18 (19.8%)	
	Inspector	29 (31.9%)	
	Senior inspector	14 (15.4%)	
	Superintendent	10 (11.0%)	
Employment path	General recruitment	75 (82.4%)	91
	Special recruitment	5 (5.5%)	
	Police Academy	2 (2.2%)	
	Police cadet	9 (9.9%)	
	Other	0 (0.0%)	
The total period of working as a police officer	5 years and less	13 (14.3%)	91
	6-10 years	32 (35.2%)	
	11-15 years	13 (14.3%)	
	16-20 years	13 (14.3%)	
	Longer than 20 years	20 (22.0%)	
The period of working at the security department	2 years and less	16 (17.6%)	91
	3-5 years	56 (61.5%)	
	6-10 years	17 (18.7%)	
	Longer than 10 years	2 (2.2%)	
The number of police officers in the organization	10 or less	18 (19.8%)	91
	11 to 15 people	42 (46.2%)	
	15 to 20 people	24 (26.4%)	
	21 or more	7 (7.7%)	
Work location	Tier 1 areas (big cities)	80 (87.9%)	91
	Tier 2 areas (small/medium-sized cities)	11 (12.1%)	
	Tier 3 areas (rural areas)	0 (0.0%)	

2.2. Measuring instrument

The appropriate method for each verification method was chosen to increase the content validity and verify the construct validity of the questionnaire. Content validity was validated through consultation with relevant experts to adopt survey questions suitable for the purpose of the study.

Table 3. Disaster response questions.

	Questions
Q-1	I can perform CPR (consciousness check - breathing check - chest compression) correctly in order.
Q-2	I can distinguish between hemostasis (direct compression / indirect compression) and take correct measures depending on the wound.
Q-3	I can distinguish between fracture and sprain emergency treatment (using splints, triangle bandages) and take correct measures depending on the situation.
Q-4	I can distinguish between wound emergency treatment (cuts / burns) and take correct measures depending on the wound.
Q-5	I can accurately operate a fire extinguisher as well as the method of using a fire extinguisher.

Table 4. Followership questions.

	Questions
Q-1	My leader's work helps me achieve social goals or personal dreams.
Q-2	My leader does not wait for instructions from the police organization, but acts by firsthand determining what is most important to achieve the organization's goals.
Q-3	My leader independently creates and actively presents new ideas that can contribute to the goals of the police organization.
Q-4	My leader tries to solve difficult problems on his/her own rather than relying on others.
Q-5	My leader helps superiors and colleagues review their ideas or plans once again, even if they express opposition.
Q-6	My leader actively and frankly acknowledges his/her strengths and weaknesses rather than avoiding the assessment on him/her.
Q-7	My leader has a habit of evaluating himself how wise the judgment was made by superiors such as superintendent or senior superintendent, rather than just taking orders.
Q-8	My leader often refuses when a superior asks him/her to do something that conflicts his/her personal interests.
Q-9	My leader decides and acts according to his/her ethical standards, not by the standards imposed by superiors and others.
Q-10	My leader insists on his/her views on important issues, even if they cause conflicts with superiors or give a bad impression to the organization.
Q-11	I think my leader's personal goal is in good harmony with the police organization's top goal.
Q-12	My leader works very devotedly as well as providing the best ideas and abilities for the organization.
Q-13	My leader enlivens colleagues with enthusiasm for work.
Q-14	My leader actively exerts his/her ability to become a more valuable member in the police organization.
Q-15	My leader tries hard to do better in the work that the police organization considers important.
Q-16	My leader takes the initiative in finding and taking the lead in his/her duties to successfully complete the work that are even outside the scope of a given task.
Q-17	My leader does and contributes more than what is given when he/she is not given the role of accountability.
Q-18	My leader helps colleagues get good reviews even if he/she is not recognized.
Q-19	My leader understands the police organization's needs or goal constraints and tries hard to meet them.

2.3. Data processing and analysis method

The data processing of this study was conducted using the statistical package program SPSS 23.0 Program, and statistical verification was performed as follows according to the purpose of data analysis.

First, frequency analysis was conducted using the SPSS/PC+23.0 program to identify general characteristics.

Second, One Way ANOVA was conducted to identify differences in police disaster response awareness according to police rank and employment path.

Third, cross-analysis (Chi-Square) was conducted to identify the correlation between police rank and employment path.

Fourth, exploratory factor analysis was conducted to identify followership in police organizations.

3. Results

3.1. Differences in disaster response awareness by police rank

Table 5. Analysis of differences in disaster response awareness by police rank.

		N	M	SD	F	sig	post hot
Q-1	Police officer	1	2.0000		3.165	.011	
	Senior police officer	19	2.7368	.56195			
	Assistant inspector	18	2.8333	.38348			
	Inspector	29	2.7931	.49130			
	Senior inspector	14	2.9286	.47463			
	Superintendent	10	3.4000	.69921			
Q-2	Police officer	1	2.0000		5.479	.000	
	Senior police officer	19	2.8947	.65784			
	Assistant inspector	18	2.8333	.51450			
	Inspector	29	2.8966	.40925			
	Senior inspector	14	3.2143	.57893			
	Superintendent	10	3.7000	.48305			
Q-3	Police officer	1	2.0000		3.285	.009	
	Senior police officer	19	2.7895	.63060			
	Assistant inspector	18	3.0000	.68599			
	Inspector	29	2.9310	.65088			
	Senior inspector	14	3.2857	.61125			
	Superintendent	10	3.6000	.51640			
Q-4	Police officer	1	2.0000		5.080	.000	
	Senior police officer	19	3.1053	.73747			
	Assistant inspector	18	3.3333	.48507			
	Inspector	29	2.9655	.56586			
	Senior inspector	14	3.2857	.46881			
	Superintendent	10	3.9000	.56765			
Q-5	Police officer	1	2.0000		3.700	.004	

	Senior police officer	19	3.2105	.71328			
	Assistant inspector	18	3.1111	.67640			
	Inspector	29	3.1034	.55709			
	Senior inspector	14	3.2143	.57893			
	Superintendent	10	3.9000	.31623			

Note: A: Police officer, B: Senior police officer, C: Assistant inspector, D: Inspector, E: Senior inspector, F: Superintendent.

<Table 5> shows that the difference in awareness of police disaster response by rank could not be fully analyzed due to the lack of a sample of police officers due to the nature of the subjects of the survey, but Q-2 and Q-4 were higher at the 0.1% level, Q-3 and Q-5 were higher at the 1% level, and Q-1 was higher at the 5% level.

3.2. Differences in disaster response awareness by police entry path

Table 6. Differences in disaster response awareness by police entry path.

		N	M	SD	F	sig	post hot
Q-1	Police officer open recruitment	75	2.7733	.50866	6.852	.000	D>A
	Special recruitment	5	3.0000	.00000			
	National police university	2	3.0000	.00000			
	Police Officer Candidate	9	3.5556	.52705			
Q-2	Police officer open recruitment	75	2.9200	.53927	7.868	.000	D>A,B,C
	Special recruitment	5	2.8000	.44721			
	National police university	2	3.5000	.70711			
	Police Officer Candidate	9	3.7778	.44096			
Q-3	Police officer open recruitment	75	2.9333	.64375	3.979	.010	D>A
	Special recruitment	5	3.2000	.83666			
	National police university	2	3.5000	.70711			
	Police Officer Candidate	9	3.6667	.50000			
Q-4	Police officer open recruitment	75	3.0800	.58725	7.149	.000	B,D>A
	Special recruitment	5	3.8000	.44721			
	National police university	2	3.5000	.70711			
	Police officer candidate	9	3.8889	.60093			
Q-5	Police officer open recruitment	75	3.1067	.60568	5.913	.001	D>A
	Special recruitment	5	3.4000	.89443			
	National police university	2	4.0000	.00000			
	Police Officer Candidate	9	3.8889	.33333			

Note: A: Police officer open recruitment, B: Special recruitment, C: National police university, D: Police officer candidate.

<Table 6> shows the difference in the awareness of disaster response by the security police according to the recruitment route. The analysis results show that Q-1 officer candidates were higher than the police officer recruitment, Q-2 officer candidates were higher than the police officer recruitment, special recruitment and police academy, and Q-4 special recruitment and officer candidates were higher than the police officer recruitment by 0.1%. Q-5 and Q-3 officer candidates were higher than the police officer recruitment by 1% and 5%, respectively.

3.3. Correlation between police rank and recruitment route

Table 7. Correlation between police rank and recruitment route.

Division	Frequency (%)				Total
	Police officer open recruitment	Special recruitment	National police university	Police officer candidate	
Police officer	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)
Senior police officer	19 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	19 (100.0)
Assistant inspector	18 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	18 (100.0)
Inspector	25 (86.2)	3 (10.3)	1 (3.4)	0 (0.0)	29 (100.0)
Senior inspector	11 (78.6)	2 (14.3)	0 (0.0)	1 (4.1)	14 (100.0)
Superintendent	1 (10.0)	0 (0.0)	1 (10.0)	8 (80.0)	10 (100.0)
x^2(p)	74.265(0.000)***				

<Table 7> The results of analyzing the correlation between police rank and entry route were =74.265, p=0.000, indicating that there is a correlation between rank and entry route at the significance level of <0.001. In particular, the entry route as an officer candidate was high at 8 (80%) in the upper ranks of superintendent and above.

3.4. Factor structure of followership in police organizations

In order to determine the construct validity of the 19 items of the Leader's Followership Scale, exploratory factor analysis (EFA) was conducted to extract latent factors. The MSA was 0.903, indicating that the data is suitable for factor analysis. In addition, the results of Bartlett's sphericity test were =852.883, p=0.000, which means that the correlation between the variables of the 'Leader's Followership Scale' was recognized based on the significance level of 0.05, indicating that factor analysis is possible overall. Accordingly, three subfactors were extracted, and they were named as Factor 1. 'Exemplary Followership' of the 'Leader's Followership Scale', Factor 2. 'Creative Followership', and Factor 3. 'Active Followership', respectively.

Table 8. Test of the sphericity of police organization followership.

KMO's sampling adequacy (MSA) test	0.903	
Bartlett's sphericity test	Approx x^2	852.883
	Degrees of freedom(df)	171
	p	.000***

Note: *p<.05, **p<.01, ***p<.001.

Table 9. Structure of police organization followership.

Item	Commonality	Factor		
		1	2	3
Followership 17	.696	.833	.442	.468
Followership19	.626	.772	.403	.294
Followership15	.606	.724	.520	.469
Followership13	.561	.709	.127	.512
Followership18	.502	.700	.516	.429
Followership16	.530	.699	.405	.471
Followership12	.479	.682	.392	.468
Followership14	.491	.671	.479	.489
Followership3	.647	.438	.818	.426
Followership2	.674	.376	.804	.343
Followership4	.561	.413	.739	.431
Followership1	540	.524	.706	.397
Followership5	.444	.417	.651	.403
Followership6	.533	.376	.332	.826
Followership8	.692	.514	.473	.820
Followership9	.689	.531	.487	.752
Followership7	.602	.555	.455	.695
Followership11	.535	.625	.420	.669
Followership10	.542	.560	.598	.613
Factor name		Exemplary followership	Creative followership	Active followership
Eigenvalue		8.496	1.374	1.084
Variance ratio		44.714	7.231	5.705
Cumulative variance ratio		44.714	51.946	57.651

Note: Extraction method: CFA(common factor analysis).

4. Discussion

Based on the results of this study, first, the higher the police rank, the higher the awareness of disaster response. This is because factors such as greater responsibility and authority, rich experience and knowledge, strategic thinking and planning, leadership, external cooperation and coordination, education and training opportunities, and evaluation and feedback are combined. In this way, higher-ranking officers deeply recognize the importance of responding to situations such as disasters and can seek response measures.

Second, the higher awareness of disaster response among officer candidates appears to be due to a combination of factors such as a rigorous selection process, systematic education and training, diverse backgrounds and experiences, leadership and management skills, high motivation and passion, comprehensive problem-solving skills, recognition of the importance of networks and cooperation, and continuous self-development[21]. These factors contribute to police officer candidates playing an important role in disaster response as well as within the police organization and achieving excellent performance. As a result of analyzing the correlation between police rank and career path, =74.265, p=0.000, indicating that there is a correlation between ‘rank’ and ‘career path’ at the significance level <0.001. The followership of police organizations is divided into ‘exemplary followership’, ‘creative followership’, and ‘active followership’, each of which plays an important role in achieving the organization’s goals and development

through its own characteristics and strengths. Exemplary followership provides stability and reliability, creative followership strengthens innovation and problem-solving capabilities, and active followership increases the vitality of the organization and promotes cooperation with leaders. Each type of followership complements each other and provides the ability to respond to the diverse needs of the organization.

5. Conclusion

In a disaster situation, followership of the police is particularly important[22][23]. Followership is an attitude and behavior that plays an important role in supporting the leader and achieving the organization's goals. First, in a disaster situation, it is necessary to respond quickly and effectively to quickly execute orders and allocate resources efficiently. Second, it is necessary to maintain consistency and integration within the organization and expand consistency and integration. Third, it is necessary to accurately convey and communicate information to clearly understand the instructions of superiors and convey them to other members. Fourth, in a disaster situation, members with strong followership can reduce stress and confusion by systematically acting according to the instructions of the leader, ultimately overcoming uncertainty, strengthening teamwork, and enhancing leadership effectiveness. In this way, followership according to the rank and career path of Korean police officers will serve as important basic data for achieving the organization's goals through cooperation with superiors and command of subordinates within the police organization in a disaster situation. Through this, police officers will be able to maintain the stability and efficiency of the organization and take more solid responsibility for the safety of the people.

6. References

6.1. Journal articles

[1] Oh HS. A Study on the Role of Police in Disaster Management. *Journal of the Korean Society of Private Security*, 22(1), 143-160 (2023).

[2] Lee JM & Shin JH. Measures for Improving Response of Autonomous Police Against Mass Disasters. *Journal of the Korean Society of Disaster Information*, 19(4), 481-489 (2023).

[3] Kim MJ. The Legal Issues of Acting Responsible Person and State Responsible Person in Road-use Local Festivals. *HUFS Law Review*, 48(1), 429 -457 (2024).

[4] Hahm HH. A Study on Operation of PR Organization and the Improvement of Korea Coast Guard Public Relation. *Korean Association of Maritime Police Science*, 7(1), 205-227 (2017).

[5] Kim JK & Kim TY. Private Security Utilization Plan from the Perspective of National Crisis Management: Focusing on Changes in Disaster Patterns. *Korean Security Journal*, 76, 499-525 (2023).

[6] Cho JH. An Exploratory Study on Cooperative Crisis Management in Police Activities. *Crisisonomy*, 19(7), 67-80 (2023).

[7] Ko EJ & Lee JY & Cho JH. A Study on the Operation Plan of the Emergency Vehicle Preemption based on Operation Status and Survey Data. *Journal of Korean Society of Intelligent Transport Systems*, 22(1), 143-160 (2023).

[8] Shin WR & Shin MA. A Study on How to Utilize Disaster Safety Information by the Intelligence Police. *Journal of Korean Public Police and Security Studies*, 20(4), 169-184 (2023).

[9] Kim SW. The Effects of Large Disaster Information Acquisition Level on Police Role Recognition. *Culture and Convergence*, 45(10), 593-601 (2023).

[10] Youn BH & Joo SB. A the Role of the Police in Disaster. *Journal of Public Policy Studies*, 34(2), 115-133 (2018).

[11] Lee H. A Study on How to Improve Police Disaster Management Ability: A Focus on a New Police Disaster Response Drill in Jeonnam Provincial Police Agency, Korea. *Korean Journal of Public Safety and Criminal Justice*, 31(1), 251-282 (2022).
[12] Kim BG & Lim JT. The Impact of Education Training System on Disaster Response Capabilities of Police Officers. *Korean Police Studies Review*, 20(2), 3-24 (2021).
[13] Lee JD. A Study on the Problem of Expanding the Scope of Police Work for Social Safety. *Journal of Community Safety and Security by Environmental Design*, 14(3), 65-90 (2023).
[14] Nam JS & Lee SY & Kim HE & Joo HJ. A Study on Reducing Delayed Promotion of Police Officers based on the Analysis of the Relations between Promotion and Entering the Job. *Korean Police Studies Review*, 22(2), 97-124 (2023).
[15] Bae HW & Kwon KH & Moon M & Moon H. Multidimensional Scaling Analysis on the Images of Special Purpose Academies. *Journal of the Korean Data and Information Science Society*, 21(1), 11-20 (2010).
[16] Choi CG. A Critical Study on the Appointment of the Graduates of the Korea National Police University. *The Police Science Journal*, 12(1), 9-34 (2017).
[17] Ko MS & Jung CY. A Study on the Development System of Coast Guard Officers -Focusing on Recruiting Beginner Officers-. *Korean Journal of Public Safety and Criminal Justice*, 32(1), 1-34 (2023).
[18] Im SJ & Choi ER. Reform and Implications of the Japanese Police Recruitment System. *The Korean Association of Police Science Review*, 23(6), 95-122 (2021).
[19] Kwak YG. The Re-discussion for the Present Employment System of Police Officers -On the System of the Examination of Police Officers-. *The Journal of Police Policies*, 30(3), 39-76 (2016).
[20] Park SJ & Cho YI. A Study on the Recognition Analysis and Suggestion of Police Cadets and Examinee of Adoption Distribution of Marks for Police Officers. *Korean Terrorism Studies Review*, 12(4), 157-178 (2019).
[21] Shin HK. A Study on the Education and Re-education System of Korean Police Training Institute. *Journal of Korean Public Police and Security Studies*, 12(3), 119-142 (2015).
[22] Kang CS & Lee YG. The Impact of Transactional Leadership to Organizational Commitment: The Mediating Effect of Followership. *Journal of Digital Convergence*, 16(11), 81-87 (2018).
[23] Kim SH. A Study on the Followership in Korean Police Officers: Focused on Actual Condition & Its Effectiveness. *Journal of Korean Public Police and Security Studies*, 16(1), 47-72 (2019).

7. Appendix

7.1. Author's contribution

	Initial name	Contribution
Author	SJ	-Set of concepts ☑ -Design ☑ -Getting results ☑ -Analysis ☑ -Make a significant contribution to collection ☑ -Final approval of the paper ☑ -Corresponding ☑ -Play a decisive role in modification ☑ -Significant contributions to concepts, designs, practices, analysis and interpretation of data ☑ -Participants in Drafting and Revising Papers ☑ -Someone who can explain all aspects of the paper ☑

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Development of Topographical Factor Characteristic Correlation Equation for Debris Flow Disaster Prevention

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Abstract

Purpose: *In this study, the relationship between each factor and soil erosion is evaluated in order to simply approximate the amount of soil erosion and sediment runoff in small-scale watersheds or disaster impact assessments.*

Method: *In this study, Linear regression analysis between soil runoff, soil erosion, and topographic factors results in the following criteria: curve number, flow length, bare soil percentage, sand composition ratio, 30-minute maximum rainfall intensity, surface sand, maximum daily probability rainfall, and catchment area between Correlations were analyzed, and the relationship between soil runoff was analyzed and compared.*

Results: *In the correlation analysis of soil erosion and soil runoff for each factor, it was analyzed that the correlation between the basin area and the slope was high. The results of the correlation analysis between the RUSLE equation and the factors did not show a high correlation.*

Conclusion: *The regression equation presented in this study can be applied to the comparative review of the simple estimation and examination of soil runoff in small-scale disaster impact assessment.*

Keywords: ***Disaster Prevention, Debris Flow, Correlation, Soil Erosion, RUSLE***

1. Introduction

As land in its natural state is exposed due to development due to rapid expansion of cities and changes in land use, a lot of soil flows downstream during torrential rain, causing damage. During the longest rainy season in 2020, landslides and soil runoff in many places across the country caused a lot of life damage, and during torrential rain in 2023, a lot of life damage occurred in the Gyeongbuk region. Due to changes in land use and the increase in torrential rain, damages such as an increase in soil runoff, landslides, and collapse of steep slopes are frequent and increasing in scale. Therefore, studies on the evaluation between the methodology and the factors for calculating the soil runoff have been steadily conducted. In general, the soil runoff rate varies depending on the topography, surface, characteristics of soil, and the size of rainfall event in the basin, and when the basin area is small and the slope is steep, the soil runoff rate increases. The soil leaked downstream due to organic material runoff due to soil loss and the loss of a fertile soil layer increases the river level and reduces the cross-sectional area of the waterway. Ji Yong-geun et al. (2017) conducted a study on the calculation of the soil runoff amount in the Erosion control Dam basin and the analysis of basin characteristics[1]. Shin Sang-hoon et al. (2015) studied the characteristics of the soil runoff according to the spatial distribution of rainfall by measuring the temporal variability of the soil runoff according to the spatial distribution of rainfall[2]. Through GIS spatial analysis, Seo Jun-pyo et al. (2018) found that the valley, valley width, and collapse amount of the source had an effect on the cumulative amount of soil leaked downstream, and proposed an estimation equation by finding that it showed a

*This paper summarizes Jonghak Jang's Kyungil University Master's Thesis.

high correlation with the valley length[3]. Mahoseop et al. (2012) analyzed the factors affecting the each stand runoff and soil runoff in the mountainous basin, and the slope, forest floor, soil hardness, basin area, and flow path length showed a significant correlation of 1% and cumulative rainfall of 5%, and the factors affecting the generation of runoff soil were in the order of cover rate, cumulative rainfall, and forest physiognomy order[4]. Kwon Hyuk-jae and Kim Hyung-ki (2020) applied RUSLE, MSDPM, and LADMP to mountain rivers to compare and analyze the soil runoff, and analyzed the effect of vegetation cover factors, conservation management factors, and soil erosion control factors on the soil runoff calculation results[5]. Kim Joo-hoon et al. (2005) induced the relationship between the soil outflow in the basin and the floating amount flowing into the river[6]. Son Kwang-ik and Kim Min-cheol(2010) caused changes in the characteristics of soil runoff due to the rapid urbanization of the basin, delay time, and flood runoff changes such as peak flow, and qualitatively analyzed the land-use distribution change for three years in the pilot basin through changes and actual measurements[7]. Kim Tae-woo et al. (2016) analyzed the amount of soil runoff for rainfall, soil map, geological map, forest physiognomy map, slope, stream network, fountain shape, watershed shape, and the shape of the basin as the biggest cause of the landslide[8]. As in previous studies, studies between soil runoff and occurrence factors have progressed considerably and steadily. Choi et al(2011) is vegetated diversion ditch, runoff and sediment yield could be reduced by 11.8% and 40.4%, respectively[9]. Im et al(2012) is compared to RUSLE, there are limited references for model parameter values of LISEM in Korean practices. Helped by physically-based model structure, LISEM is expected to simulate sediment yield in a more reasonable manner, compared to RUSLE, once the appropriate ranges of model parameters are suggested in the future[10]. Kim et al(2022) is the amount of debris flow was calculated through the empirical equations of RUSLE, NILIM, and Marchi, which are widely used to calculate areas affected by debris flow, and debris flow measured through precise measurements and field surveys was compared[11]. Kwon(2011) is calculation results of sediments yield prediction models were compared with the amount of dredging data for the Inje, Gangwon mountain region of Korea[12]. Ko et al(2013) is soil erosion and sediment yield amount of 2005 using single storm rainfall were estimated high compared with 2000, but for sub-basin 2, the values rather decreased due to changes in land use, and the land coverage of 2005, since there are many classifications of land usage compared with 2000, enabling to reflect more accurate land usage condition, could deduce appropriate results[13]. Kang(2005) is a range of parameters of sediment yield equations considering local characteristics are proposed by analyzing the field data and estimation equations of sediment yields[14]. To estimate the sediment discharge controlled by sediment-filled check-dam and thereby enhancing factor for check-dam design and dredging criteria, we surveyed slope failures and stream-bed fluctuation caused by geomorphic disturbances (i.e., landslides and debris flows) in Inje, Gangwondo[15]. Lee and Kang presents an integrated approach to estimate SY for ungauged coastal basins, using a soil erosion model and a sediment delivery ratio (SDR) model. For applying the SDR model, a basin specific parameter was validated on the basis of field data[16]. In addition, many researchers have conducted studies on the reduction of sediment runoff and proposed various mitigation measures for mountain basins and forest fire areas[17][18][19].

Much research has been done on RUSLE in evaluating and applicating the model in various ways and calculating the amount of debris flow[20][21][22][23][24][25][26][27][28][29].

However, many studies have examined methods for calculating sediment erosion and sediment runoff, but there has been a lack of assessment of the degree of correlation between them. Most of the factors of sediment runoff do not show a high correlation with topographic factors, etc., and are calculated by the influence of each factor.

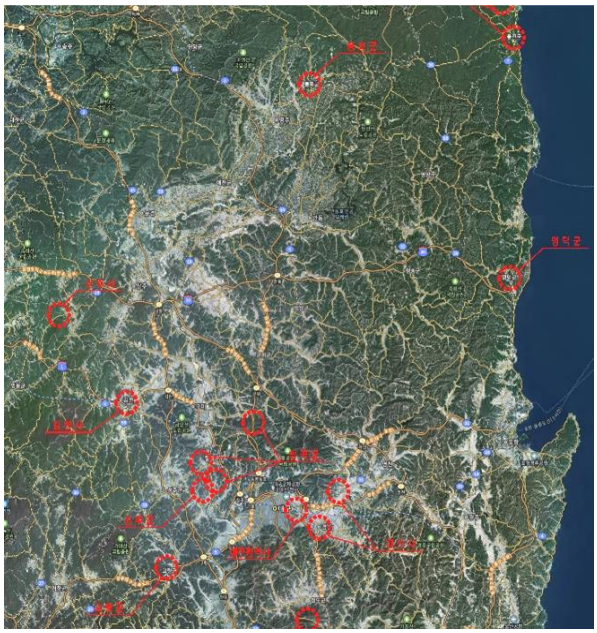
In this study, the correlation between the amount of soil erosion and the amount of soil runoff was examined by using the disaster impact assessment data calculated by applying to the RUSLE formula, a general-purpose formula for calculating the amount of soil runoff[30].

2. Debris Flow Correlation Analysis

2.1. Study area

The watersheds of this study were analyzed using previously conducted disaster impact assessment data. In this study, factors correlated with each RUSLE parameter were selected to analyze the correlation for each fac-tor on soil erosion and soil runoff. The degree of correlation between each factor was analyzed individually, and the regression equation was derived with the correlation between the factors at each stage.

Figure 1. Study area.



3. Development Correlation Equations

3.1. Correlation analysis results

The matrix was constructed by correlating the curve number (CN), watershed area (A), flow path (L), bare land (DE), sand composition ratio (SA), 30-minute maximum rainfall intensity (I30), surface slope (S), and daily maximum probability rainfall (R24), which affect soil erosion (SE).

As a result of the correlation analysis, the amount of soil erosion (SE) is closely related to the watershed area (A), and positive correlation was analyzed in the order of flow path length (L), bare land (DE), sand composition ratio (SA), 30-minute maximum rainfall intensity (I30), surface slope (S), and daily maximum probability rainfall (R24). In the correlation analysis result, the watershed area (A) was 0.847, followed by the flow path extension (L) of 0.718, showing the highest correlation, and the lowest correlation was found to be 0.018 for the daily maximum probability rainfall (R24).

Table 1. Correlation matrix at soil erosion(SE).

	SE	I30	R24	SA	L	S	CN	A(ha)	DE
SE	1.000	0.265	0.018	0.291	0.718	0.163	-0.253	0.847	0.472
I30	0.265	1.000	0.101	-0.179	0.283	-0.221	0.230	0.288	0.345
R24	0.018	0.101	1.000	0.292	-0.063	0.124	-0.183	0.036	0.002

SA	0.291	-0.179	0.292	1.000	0.043	0.183	-0.375	0.313	2.89
L	0.718	0.283	-0.063	0.043	1.000	0.001	-0.071	0.839	0.518
S	0.163	-0.221	0.124	0.183	0.001	1.000	-0.270	0.181	-0.299
CN	-0.253	0.230	-0.183	-0.375	-0.071	-0.270	1.000	-0.171	0.064
A(ha)	0.847	0.288	0.036	0.313	0.839	0.181	-0.171	1.000	0.058
DE	0.472	0.345	0.002	0.289	0.518	-0.299	0.064	0.580	1.000

Table 2. Correlation matrix at unit area(SEU).

	SEU	I30	R24	SA	L	S	CN	DE
SEU	1.000	0.395	0.072	-0.071	0.294	-0.049	-0.053	0.233
I30	0.395	1.000	0.101	-0.179	0.283	-0.221	0.230	0.345
R24	0.072	0.101	1.000	0.292	-0.063	0.124	-0.183	0.002
SA	-0.071	-0.179	0.292	1.000	0.043	0.183	-0.375	0.289
L	0.294	0.283	-0.063	0.043	1.000	0.001	-0.071	0.518
S	-0.049	-0.221	0.124	0.183	0.001	1.000	-0.270	-0.299
CN	-0.053	0.230	-0.183	-0.375	-0.071	-0.270	1.000	0.064
DE	0.233	0.345	0.002	0.289	0.518	-0.299	0.064	1.000

Table 3. Correlation matrix at soil runoff(SY).

	SY	I30	R24	SA	L	S	CN	A(ha	DE
SY	1.000	0.269	-0.067	0.108	0.719	0.146	-0.093	0.769	0.048
I30	0.269	1.000	0.101	-0.179	0.283	-0.221	0.230	0.288	0.345
R24	-0.067	0.101	1.000	0.292	-0.063	0.124	-0.183	0.036	0.002
SA	0.108	-0.179	0.292	1.000	0.043	0.183	-0.375	0.313	0.289
L	0.719	0.283	-0.063	0.043	1.000	0.001	-0.071	0.839	0.518
S	0.146	-0.221	0.124	0.183	0.001	1.000	-0.270	0.181	-0.299
CN	-0.093	0.230	-0.183	-0.375	-0.071	-0.270	1.000	-0.171	0.064
A(ha)	0.769	0.288	0.036	0.313	0.839	0.181	-0.171	1.000	0.580
DE	0.484	0.345	0.002	0.289	0.518	-0.299	0.064	0.580	1.000

In the correlation analysis with soil erosion per unit area (SEU), the correlation was high with the 30-minute maximum rainfall intensity (30), but the soil erosion amount per unit area (SU) was not highly correlated with topographic characteristics factors, so statistically significant results were not derived. In general, it is known that rainfall intensity, duration, and rainfall patterns affect soil erosion (SE), but it was analyzed that the correlation as generally known in the calculation results of soil erosion in 27 districts applied in this study did not appear. Unlike what is theoretically known, these results show that the relationship between the factors applied to the calculation of soil erosion by RUSLE does not necessarily show a high correlation.

In the regression analysis to estimate soil erosion, the correlation coefficient was high at 0.858 in the regression equation consisting of a combination of watershed area (A), curve number (CN), 30-minute maximum rainfall intensity (I30), daily maximum probability rainfall (R24), slope (S), and sand ratio (SA), and even if bare land ratio (DE) and slope (S) were added to this, the correlation coefficient was the same.

In the regression analysis result of the soil outflow per unit area (SEU), it was analyzed that it did not show a high correlation as in the correlation analysis result between factors.

Table 4. Correlation matrix at RUSLE component.

	SE	R	K	LS	VM
SE	1.000	0.180	0.098	0.415	-0.038
R	0.180	1.000	-0.009	-0.002	0.101
L	0.098	-0.009	1.000	-0.125	0.016
LS	0.415	-0.002	-0.125	1.000	-0.600
VM	-0.038	0.101	0.016	-0.600	1.00

Table 5. Estimate of soil erosion(SE) regression equation by step by step.

Step	Estimation equations	R^2
1	SE=-26.135+38.168A	0.847
2	SE=90.397+37.313A-1.301CN	0.854
3	SE=78.893+36.373A+0.339I30-1.510CN	0.856
4	SE=101.611+36.272A+0.379I30-1.626CN-0.060R24	0.857
5	SE=100.337+34.980A+0.372I30+18.158L-1.645CN-0.056R24	0.857
6	SE=87.329+33.844A+0.410I30+27.662L+0.112SA-1.582CN-0.065R24	0.858
7	SE=77.577+34.142A+0.449I30+31.768L+0.150SA-1.519CN-0.068R24-2.381DE	0.858
8	SE=78.163+34.241A+0.446I30+31.236L+0.150SA—1.521CN—0.068R24 -2.797S-2.493DE	0.858

Table 6. Estimate of units soil erosion(SEU) regression equation by step by step.

Step	Estimation equations	R^2
1	SEU=-28.971+0.567I30	0.395
2	SEU=-30.015+0.486I30+27.540L	0.438
3	SEU=0.245+0.536I30+24.937L-0.388CN	0.454
4	SEU=11.377+0.524I30+25.433L-0.462CN-0.069SA	0.459
5	SEU=18.877+0.498I30+20.750L+1.577DE-0.504CN-0.097SA	0.462
6	SEU=14.494+0.478I30+21.432L+1.722DE+0.019R24-0.486CN-0.115SA	0.465
7	SEU=13.336+0.480I30+20.493L+1.986DE+0.019R24+7.531S-0.477CN-0.121SA	0.466

Table 7. Estimate of soil runoff(SY) regression equation by step by step.

Step	Estimation equations	R^2
1	SY=-1.276+12.381A	0.769

2	SY=7.436+13.119A-0.196SA	0.782
3	SY=0.598+10.650A+31.831L-0.142SA	0.786
4	SY=1.192+10.286A+28.671L+1.985DE-0.158A	0.788
5	`SY=-2.147+8.880A+36.011L+3.917DE+41.834S-0.178SA	0.793
6	SY=4.168+8.888A+35.329L+3.859DE+43.038S-0.156SA-0.027R24	0.795
7	SY=-1.081+8.653A+36.603L+3.660DE+45.125S+0.057I30-0.139SA-0.031R24	0.795
8	SY=8.957+8.597A+36.076L+3.816DE+44.355S+0.066I30-0.151SA-0.032R24-0.110CN	0.795

Table 8. Estimate of RUSLE regression equation by step by step.

Step	Estimation equations	R^2
1	SE=45.481+33.286LS	0.415
2	SE=-4.288+49.141LS+99.912VM	0.492
3	SE=-45.148+51.647LS+104.735WM+126.904K	0.521
4	SE=-76.939+50.536LS+97.622WM+126.846K+0.059R	0.541

3.2. Correlation analysis of soil runoff

As a result of conducting a correlation analysis on topographic and rainfall factors affecting the soil runoff (SY), the watershed area (A) was found to have the highest correlation at 0.769, followed by the flow path length (L) showing the highest correlation. The rainfall factor, 30 minutes maximum rainfall intensity and the maximum daily probability rainfall (R24), showed a relatively low correlation. In the case of the target district applied in this study, it was judged that the topographic characteristics, especially the curve number (CN), watershed area (A), and flow path length(L), rather than rainfall, affect the size of the soil runoff. In the calculation of the regression analysis equation for estimating the soil runoff, the correlation coefficient was high at 0.795 when the combination of watershed area (A), sand composition ratio (SA), flow path length(L), bare land ratio (DE), slope (S), and daily maximum probability rainfall (R24), and the 30-minute maximum rainfall intensity (I30) and curve number (CN) were added to calculate the regression equation, and the correlation coefficient was the same as 0.795.

In the correlation analysis between the RUSLE equation and the factors used, the correlation with the topographic factor (LS) was found to be 0.415, and the correlation with the rest of the factors was found to be less than 0.2. In the application of the formula, it was analyzed that each factor had a low correlation, unlike the result expected to have a high correlation, as it was judged that there would be a linear relationship in the form of a product.

As a result of analyzing the regression equation using the RUSLE factor, the correlation coefficient was analyzed to be at most 0.541 even if all factors were applied, which was calculated using the characteristics of the basin and rainfall, but the correlation was not high in relation to the factors directly applied to the 27 districts calculated by the RUSLE equation.

These results are similar to those in many previous studies that the calculation of soil runoff did not show good results in deriving correlations with topographic factors and rainfall characteristics, and it is judged that the unit values applied to calculating factors are complex and do not show high direct correlation.

In fact, the factors that apply to RUSLE are 24-hour probability rainfall in rainfall factors, 30 minutes maximum rainfall intensity, and soil type, structure, and soil particle size in soil factors. The length and slope of the slope in slope factors, and the value of the land cover factor for calculating the value applied as a soil cover factor and soil preservation countermeasure factor are variously nonlinear, so it is judged that there is no direct correlation with the results calculated by topography and rainfall factors and RUSLE. Nevertheless, the regression equation presented in this study shows the result of a correlation coefficient close to 0.8, so it can be considered as a simple way to estimate the amount of soil runoff in a small watershed.

4. Conclusion

In this study, the correlation between topographic factors and rainfall factors applied to the RUSLE formula, which calculates soil erosion and soil runoff, was analyzed and a regression equation was derived and presented. As for the project target districts applied in this study, 27 districts of the disaster impact assessment conducted in the Gyeongbuk area were selected and analyzed. As a result of the analysis, in the correlation analysis between soil erosion and soil runoff for each factor, it was analyzed that the watershed area and slope had a high correlation. The correlation analysis result between the RUSLS equation and the factor did not show high correlation.

In the regression analysis to estimate the amount of soil erosion calculated by sequentially applying each factor in this study, the correlation coefficient was high at 0.858 in the regression equation consisting of a combination of watershed area (A), curve number (CN), 30-minute maximum rainfall intensity(I30), daily maximum probability rainfall (R24), slope (S), and sand ratio (SA). In the calculation of the regression analysis equation for estimating private output, the correlation coefficient was high at 0.795, when the combination of watershed area (A), sand composition ratio (SA), flow path length(L), bare land ratio (DE), slope (S), and daily maximum probability rainfall (R24). Therefore, it is judged that the regression equation presented in this study can be applied for comparative review in simply estimating and reviewing the amount of soil runoff in small-scale disaster impact assessment.

5. References

5.1. Journal articles

[1] Jee YG & Park IC & Kim BS. Sediment Yield Estimation of the Erosion Control Dam Basin and Analysis of Watershed Characterization using RUSLE. *Journal of the Korean Society of Hazard Mitigation*, 17(1), 123-130 (2017).

[2] Shin SH & Kim W & Lee SY & Paik KR. Influence of Spatial Rainfall Distribution on Sediment Yield: An Experimental Study. *Journal of the Korean Society of Civil Engineers*, 35(1), 111-117 (2015).

[3] Seo JP & Woo CS & Lee CW & Kim DY. Characteristics of Sediment Discharge based on GIS Spatial Analysis of Area Damaged by Debris Flow. *Journal of the Korean Society of Hazard Mitigation*, 15(5), 89-96 (2018).

[4] Ma HS & Kang WS & Kang EM. Effect of Forest Land use on Soil Runoff in Small Watershed. *Journal of Korean Society of Forest Science*, 101(2), 220-225 (2012).

[5] Kwon HJ & Kim HG. A Study of Comparison about Estimation Methods of Sediment Yield. *Journal of Korea Water Resources Association*, 53(12), 1109-1117 (2020).

[6] Kim JH & Oh DK & Kim KT. Estimation of Suspended Sediment Runoff for Landuse. *Journal of Korean Wetlands Society*, 7(1), 119-128 (2005).

[7] Son KI & Kim MC & Runoff Characteristics Change of a Basin under Urbanization. *Journal of the Korean Society of Hazard Mitigation*, 10(4), 89-93 (2010).

[8] Kim TW & Kang IJ & Choi H & Lee BG. Causual Analysis on Soil Loss of Safety Class Oryun Tunnel Area in Landslide Hazard Map. *Journal of the Korean Society for Geospatial Information Science*, 24(1), 17-24 (2016).
[9] Choi JW & Shin DS & Kim IJ & Lim KJ. Evaluation of Runoff and Sediment Yield Reduction with Diversion Ditch and Vegetated Swale using WEPP Model. *Journal of Korea Water Resources Association*, 44(11), 863-873 (2011).
[10] Im SS & Kim MS & Kim JH & Paik KR. Comparison of RUSLE and LISEM for the Evaluation of Spatial Distribution of Simulated Sediment Yield. *Journal of the Korean Society of Hazard Mitigation*, 12(5), 199-206 (2012).
[11] Kim GJ & Jun KW & Kang BD. Analysis of Appropriateness of Estimation Methods for Sediment Yields in Damaged Areas by Debris Flow. *Journal of Korean Society of Disaster and Security*, 15(1), 35-46 (2022).
[12] Kwon HJ. Sediments Yield Estimation of Gangwon Mountain Region in Korea. *Journal of Korean Society of Hazard Mitigation*, 11(30), 127-132 (2011).
[13] Ko JW & Yang SK & Yang WS & Jung WY & Park CS. Estimation of Soil Erosion and Sediment Yield in Mountainous Stream. *Journal of the Environmental Sciences International*, 22(5), 559-608 (2013).
[15] Seo JI & Chun WG & Song DG. Estimation of Sediment Discharge Controlled by Sediment-filled Dam Check-dam in a Forest Catchment. *Journal of Korean Forest Society*, 105(3), 321-329 (2016).
[16] Lee SG & Kang SH. Estimating Magnitude of Suspended Sediment Transport in Ungagged East Coastal Zone. *Journal of Korea Water Resources Association*, 51(2), 175-182 (2018).
[17] Son KI & Kim HJ & Lim KJ & Jung YH. Study on Sediment Runoff Reduction using Vegetative Filter Strips in Mountainous Watershed. *Journal of Korean Society on Water Environment*, 31(4), 407-417 (2015).
[18] Jung CG & Joh HK & Yu YS & Park JY & Kim SJ. Study on Damage Reduction by Flood Inundation and the Sediments by SWAT and HEC-RAS Modeling of Flow Dynamics with Watershed Hydrology -For 27 July 2011 Heavy Storm Event at Gonjiam Cheon Watershed-. *Journal of Korean Society of Agricultural Engineers*, 54(2), 87-94 (2012).
[19] Kim KD & Woo CS & Lee CW & Seo JP & Kang MY. Development on Prediction Algorithm of Sediment Discharge by Debris Flow for Decision of Location and Scale of the Check Dam. *Journal of the Society of Disaster Information*, 16(3), 586-593 (2020).
[20] Kim JC & Choi JY & Lee SM & Jung HS. A Comparative Analysis of Annual Surface Soil Erosion before and after the River Improvement Project in the Geumgang Basin using the RUSLE. *Korean Journal of Remote Sensing*, 35(6), 1351-1361 (2019).
[21] Kim JC & Yoon JD & Park JS & Choi JY & Yoon JH. Utilizing the Revised Universal Soil Loss Equation (RUSLE) Technique Comparative Analysis of Soil Erosion Risk in the Geumhogang Riparian Area. *Korean Journal of Remote Sensing*, 34(2), 179-190 (2018).
[22] Jung YG & Lee SW & Lee KH & Park KY & Lee HH. Application of RUSLE and MUSLE for Prediction of Soil Loss in Small Mountainous Basin, *Journal of Korean Society of Forest Science*, 103(1), 98-104 (2014).
[23] Park KH. Soil Erosion Risk Assessment of the Geumho River Watershed using GIS and RUSLE Methods. *The Korean Association of Geographic Information Studies*, 6(4), 24-36 (2003).
[24] Gong HY & Lee KP & Lee JY & Kim BJ & Lee AR & Bae BH & Kim JY. Assessment of Soil Loss at Military Shooting Range by RUSLE Model: Correlation between Soil Loss and Migration of Explosive Compounds. *Journal of Soil and Groundwater Environment*, *17*(6), 119-128(2012).
[25] Lee JS & Jung JH. Characteristics Analysis for RUSLE Factors based on Measured Data of Gangwon Experimental Watershed (I). *Journal of the Korean Society of Hazard Mitigation*, 9(6), 111-117 (2009).
[26] Park JS & Kim GH. Estimation of Soil Loss by Land Use in the Geum River Basin using RUSLE Model. *Korean Society on Water Environment*, 22(4), 619-625 (2006).
[27] Lee JS & Won JY. Suggestion of Cover-management Factor Equation for Mountain Area in RUSLE. *Journal of the Korean Society of Hazard Mitigation*, 12(2), 79-85 (2012).

[28] Lee JS & Jung JH. Characteristics Analysis for RUSLE Factors based on Measured Data of Gangwon Experimental Watershed(II). *Journal of the Korean Society of Hazard Mitigation*, 9(6), 119-124 (2009).
[29] Son KI. Applicability Examination of the RUSLE Sediment Yield Prediction Equation in Korea. *Journal of Korea Water Resources Association*, 34(3), 199-207 (2001).

6.2. Thesis degree

[14] Kang OR. A Study on Parameter Determination of Sediment Yield Estimation Equation in Mountainous Region. Younsei University, Master's Thesis (2004).
[30] Jang JH. Characteristics of Soil Erosion Production in Small-scale Development Project Area. Kyungil University, Master's Thesis (2023).

7. Appendix

7.1. Author's contribution

	Initial name	Contribution
Lead Author	JJ	-Set of concepts ☑ -Design ☑ -Getting results ☑ -Analysis ☑ -Make a significant contribution to collection ☑ -Final approval of the paper ☑ -Corresponding ☑ -Play a decisive role in modification ☑
Corresponding Author*	KP	-Significant contributions to concepts, designs, practices, analysis and interpretation of data ☑ -Participants in Drafting and Revising Papers ☑ -Someone who can explain all aspects of the paper ☑

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A Study on the Activation of Korean Disaster Safety Network (K-SafeNet)

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Abstract

Purpose: *The purpose of this study is to present a plan to respond well to disasters by using the Korean disaster safety communication network. The only well-established Korean disaster safety communication network in the world will be used to minimize damage to people's lives and property by exerting synergy between agencies dispatched to the disaster site by allowing various related agencies to respond to disasters in a linked manner. To ensure this, research should be conducted to make the best use of the Korean disaster safety communication network.*

Method: *In order to suggest a way to make good use of the disaster safety communication network, research methods such as literature research, on-site inspection, and opinion collection were applied. The literature survey studied the actual state of domestic and foreign construction related to the disaster safety communication network, and the research method was applied so that the current state of use of the disaster safety deep-seated network could be confirmed through on-site surveys and opinion collection, and problems could be analyzed to suggest alternative measures. This is a research conducted in the direction of strengthening the field utilization of the disaster safety communication network.*

Results: *As a result of the previous study, it was identified that the Korean disaster safety communication network has a well-established infrastructure and is partially utilized by disaster officials, but some of them are not properly utilized due to a lack of understanding of wireless communication between various organizations through group communication. To overcome this, communication procedures for group wireless communication should be established, disaster management should be performed using the disaster safety communication network, and disaster safety communication network training scenarios should be developed for each type of disaster so that they can be actively implemented.*

Conclusion: *Once established, the disaster safety communication network is not complete in itself. In order for a well-established disaster safety communication network to function properly, it is necessary to develop a group wireless communication procedure for the disaster safety communication network and continue communication training in accordance with the developed communication procedure. To ensure this, continuous communication training should be conducted by actively utilizing the disaster safety communication network communication training scenario developed through this study. Since these efforts are not made in a moment, disaster management activities of disaster management officers should be established as a culture. Continuous and in-depth research should be continuously conducted to this end.*

Keywords: ***Disaster Safety Communication Network, Communication Procedures, Mutual Communication, Communication Training Scenarios, Professional Education***

1. Introduction

The purpose of this study is to present a development plan to effectively respond to disasters by making good use of the already established Korean disaster safety communication network.

No matter how well the disaster safety communication network is established, this study is an important study because disaster response cannot be performed properly if the communication network is not properly utilized.
The only well-established Korean disaster safety communication network in the world will enable various related organizations to respond to disasters in a linked manner through real-time wireless communication at the disaster site, thereby exerting synergy[1]. To this end, it is necessary to make the best use of the Korean disaster safety communication network.
However, the 1:N wireless communication method through the disaster safety communication network in the real world is not easy for disaster officials. In particular, it is difficult for the heads of disaster management agencies or disaster management support organizations that do not usually communicate wirelessly to respond to disasters in connection with related organizations using the disaster safety communication network in the event of a disaster[2]. It is no different from an athlete who has never trained before going out to the competition and winning the prize. Therefore, in this study, the 1:N wireless communication procedure was improved so that the well-established Korean disaster safety communication network could be well utilized, and a communication training scenario was developed so that the communication training could be conducted on a regular basis[3].

2. Construction of Domestic and Foreign Disaster Safety Network

2.1. Types of disaster safety communication network

As shown in <Table 1>, wireless communication technology for the disaster safety net is largely divided into the Trunked Radio System (TRS) method and the mobile communication method. There are TRS methods such as TETRA (Terrestrial Trunked Radio) and iDEN (Integrated Digital Enhanced Network) methods, which are disaster safety communication networks used by most European countries[4]. In the case of the UK, a disaster safety net applied with Tetra technology was initially established and operated, but low wages are planned with an LTE-based disaster safety net. Mobile communication technologies of the disaster safety net include LTE and WiBro, and recently, PS-LTE technology based on 3GPP (3rd Generation Partnership Project) LTE technology is attracting attention, and the US and Korea are using this technology to establish and utilize disaster safety communication networks[4].

Table 1. Types of disaster safety communication network.

Sortation	TRS based		Mobile communication based		
	TETRA	iDEN	LTE	WiBro	
				Cellular	802.16n
International standard organization	ETSI	Corporate Standard	3GPP	IEEE 802.16e/m	IEEE 802.16n
Feature	Open TRS	Nonopen TRS	Broadband Mobile Communication Network	IP-based Broadband wireless network	Special funtion Enhancement Broadban Wireless network

Note: Song MH (2022).

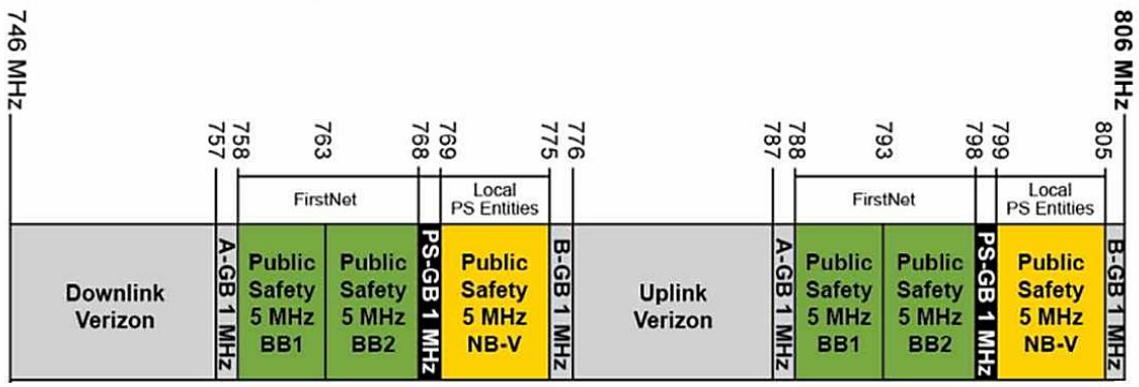
The establishment of overseas disaster safety communication networks is being used by major advanced countries such as the United States and the United Kingdom to quickly respond to terrorism and major disasters.

2.2. Disaster and safety network in the united states.

Following the lesson that the U.S. lacked interoperability between first responder groups during the September 11 terrorist attacks in 2001, the U.S. Congress enacted the "The Middle Class Tax Relief and Job Creation Act of 2012"[5]. Accordingly, since 2012, FirstNET (First Responder Network Authority) has been established and the project has been promoted as an independent agency under the Communications Information Management Agency (NTIA) to establish the National Public Safety Broadband Network (NPSBN)[6].

FirstNet is an LTE-based network-wide broadcast and public safety network to support early responder communication through high-speed connections, and it promoted the establishment of a broadband public safety national network in the 700 MHz band[7]. Through this, the LTE method was adopted to secure a total of 34 MHz width for public safety in the 700 MHz band. See <Figure 1>.

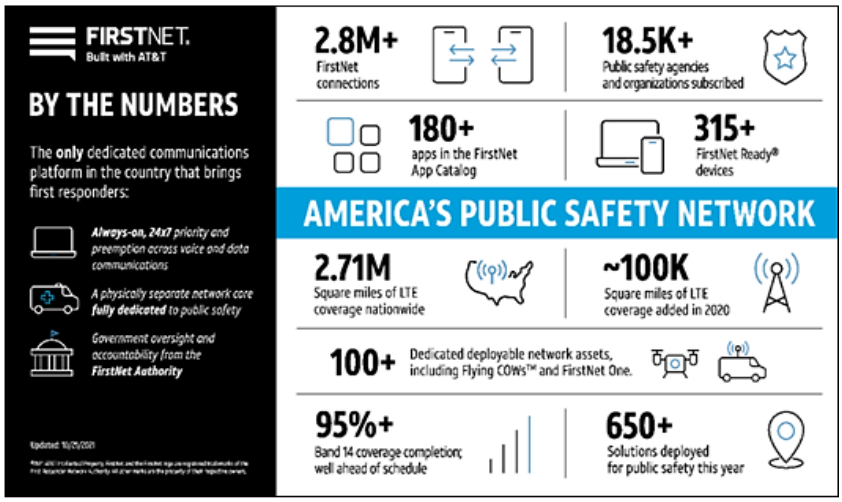
Figure 1. America's 700 MHz band use status.



Note: Kang HJ (2015).

As shown in <Figure 2>, the United States selected AT&T as the operator, completed the core network in March 2018, and currently provides commercial services. As of October 2021, more than 2.8 million terminal subscribers, more than 180 app catalogs, more than 315 terminal approvals, more than 2.71 million square miles of coverage, and more than 95% of FirstNet's dedicated band 14 base stations were completed[8].

Figure 2. America's public safety network.



Note: Kim SH (2022).

2.3. Europe's disaster safety network

Most European countries have established and operated TETRA, the European standard, as their own wireless TRS network for disaster safety communication networks. As interworking between multi-vendors was not supported until the early 2000s, many European countries that selected TETRA as a disaster safety wireless network have established cross-national networks in the form of a single model network. Efforts have been made to increase compatibility as the demand for heterogeneous manganese interworking gradually increases, but smooth heterogeneous manganese interworking is still insufficient[6].

The European Union's foreign countries systematically and manage various types of emergency-related information collection procedures at the domestic and international level, both mutually and in connection with the UN. The central control center is overseen by the central control center, and an interactive system has been established and operated to receive all information in a standardized data collection format from all related organizations, including local governments, police, firefighting, medical institutions, rescue support institutions, national research institutes, and volunteer organizations[6].

Major European countries also judge the 700 MHz broadband band as suitable for PS-LTE disaster safety communication, but they have reservations about the final policy direction[8].

3. Establishment of Korean Disaster Safety Network

3.1. Establishment of Korean disaster safety network

The disaster safety communication network was promoted in 2003 due to the need for quick and accurate communication and close disaster response communication at the disaster site between disaster management agencies, emergency rescue agencies, and emergency rescue support agencies, but the construction was suspended due to criticism of the company's monopoly problem, the economic feasibility of the project, the appropriateness of the project's promotion method, and the lack of standard operation procedures[7].

Since then, the Korean Disaster Safety and Communication Network has confirmed the disaster safety and communication network technology method as PS-LTE (Public Safety-Long Term Evolution) through the National Policy Coordination Meeting on July 231, 2014 as the national attention has been drawn since the sinking of the Ferry Sewol on April 16, 2014[8][9][10]. After a pilot project in Jeongseon and Gangneung, Gangwon-do, the establishment of a PS-LTE-based disaster safety communication network was completed in March 2021[11][12].

Unlike general commercial networks, PS-LTE, a disaster safety communication network, can use services specialized in disaster situations such as MCPTT (Mission Critical Push To Talk) and Evolved Multimedia Broadcast Multicast Service (eMBMS). In addition, to secure a systematic public safety communication network, the introduction of base station sharing technology (RAN-Sharing) and the 700 MHz band used frequency[13], PS-LTE, rail network (LTE-R), and maritime network (LTE-M) were established. In addition, the National Police Agency and its own companies are promoting the creation of a smart city ecosystem by utilizing these disaster safety communication networks using AI and big data, which are technologies of the 4th industrial revolution.

The Korean disaster safety communication network consists of base stations, terminals, command devices, and operation centers, and base stations have fixed base stations based on na-

tional infrastructure (points), major roads (lines), and densely populated areas (myeon) to secure coverage throughout Korea. In addition, communication support is possible through vehicle-type and portable mobile base stations in mountainous and rural areas. In addition, communication shadow areas were minimized by utilizing other integrated public networks (marine networks, rail networks) and RAN-Sharing technology (RAN-Sharing) inside, underground, and coastal buildings[6].

As shown in <Figure 3>, the terminal and command autonomy use dedicated terminals such as smartphone type, radio type, and complex type depending on the type of work. It is manufactured based on Android, so it is convenient to use, and various applications for business expansion can be used. On-site terminals can be integrated and commanded through command devices installed in each reporting center.

The operation center operates the system simultaneously in Seoul, Daegu, and Jeju, and can monitor it 24 hours a day, 365 days a year. The transmission network between centers is established in multiple ways, so if a problem occurs in one center, another regional operation center can manage the area, thereby minimizing the gap in disaster response.

Figure 3. Terminals and command devices according to the type of work.

Note: Kim SG. etc. (2023).

3.2. Utilization of Korean disaster safety network

Standard operating procedures are important to ensure proper use after establishing the Korean disaster safety communication network[14], and the Ministry of Public Administration and Security published and distributed the Disaster Safety Communication Network Standard Operating Procedure (SOP) in a booklet format. Each institution applied the standard operating procedure of the disaster safety communication network to the characteristics of each institution to actively utilize the disaster safety communication network that guarantees interoperability among disaster response agencies[15][16].

The actual state of use of the disaster safety communication network was largely determined in three ways. First, the actual state of use of the disaster safety communication network between 2022 safety training in Korea was identified through the training result report. Second, it

was identified by visiting institutions that actually use the disaster safety communication network (Ministry of National Defense, National Police Agency, National Fire Agency, National Coast Guard Agency, etc.). In order to facilitate on-site visits and interviews with related organizations, the researchers cooperated with related organizations through official documents in cooperation with the research request department of the Ministry of Public Administration and Security, and conducted on-site visits and interviews from July 5, 2023 to July 7, 2023. Finally, it was identified through a phone interview with the person in charge of the disaster safety communication network utilization agency.

As a result of grasping the actual state of use of the disaster safety communication network, first, each institution was using the disaster safety communication network as the main communication network in disaster response, and the call quality was evaluated excellently. In addition, some institutions, such as the National Fire Agency, used the main communication network as a disaster safety communication network, so there were institutions that used the existing communication network as a sub-communication network. Second, it was often used as a means of communication for one-sided situation propagation. Although the disaster safety communication network should be operated to enable rapid spread of disaster situations and organic disaster response through mutual communication in the event of a disaster, it was confirmed that the ability to communicate was insufficient because there was no experience in the 1:N wireless communication method, which is the group radio communication method of the disaster safety communication network. Third, there were many cases of intercommunication in a promised manner based on the order between communications of the disaster safety communication network. In a disaster situation, since disaster information cannot be communicated by a script prepared in advance, mutual radio communication necessary to cope with the disaster situation must be freely, but it was at the level of communication according to the pre-made communication training scenario due to lack of radio communication ability.

In order to make good use of the well-established Korean disaster safety communication network, it was confirmed that special efforts were needed to make good use of the disaster safety communication network.

4. Measures to Revitalize Korean Disaster Safety Network

4.1. Development and utilization of essential procedural terms for mutual communication between disaster safety communication networks

Currently, the standard operating procedure of the disaster safety communication network of the Ministry of Public Administration and Security does not mention any terms of intercommunication procedures. In the military, police, and fire departments that mainly use wireless communication networks, communication procedural terms are used according to the characteristics of each institution. In relation to communicating using a disaster safety communication network, the communication language is slightly different, so it may feel difficult to use the disaster safety communication network, so it is necessary to set the terms of intercommunication procedures of the disaster safety communication network to the essential minimum so that anyone participating in disaster response (situation management, field management) can easily communicate with each other[6].

In general, there are three main reasons why it is difficult for the general public (related officials who have not been trained in radio communication) to communicate with each other without 1:1N network. First, they are not familiar with the terms of communication procedures. It is not easy to communicate without radio in real situations if you have seen radio communication in any form but lack of experience in person. Second, people are afraid of communicating with a large number of invisible people. It is easy to communicate with people who are familiar

even in face-to-face situations, but it is difficult to communicate with people who are new to them, but it is not easy to communicate with invisible people. Finally, in 1;N radio communication, it is often difficult to communicate at all because you do not know when to appear in the radio network and speak and when to withdraw from it. For the above three characteristic reasons, communication procedural terms must be set in advance and communicated with the radio communication must be mastered in real situations in order to be able to communicate without radio in real situations[6].

As the first step in solving the above problems, the essential procedural terms for mutual communication between the disaster safety communication network were proposed as shown in <Table 2>. In order to perform the 1:N wireless mutual communication method well, the minimum essential procedural terms were set so that natural mutual communication could be performed.

Table 2. Results of deriving essential procedural terminology for 1:N intercommunication.

Sortation		Essential procedural terminology
①	Call Name	Name or position of institution within the common currency group
②	Appearance communication	Institution name, appearance complete
③	Short text transmission is over	~ Over
④	Full text received	Institutional name, received
⑤	Send again	Send again
⑥	communication is over	~ Over or communication is over

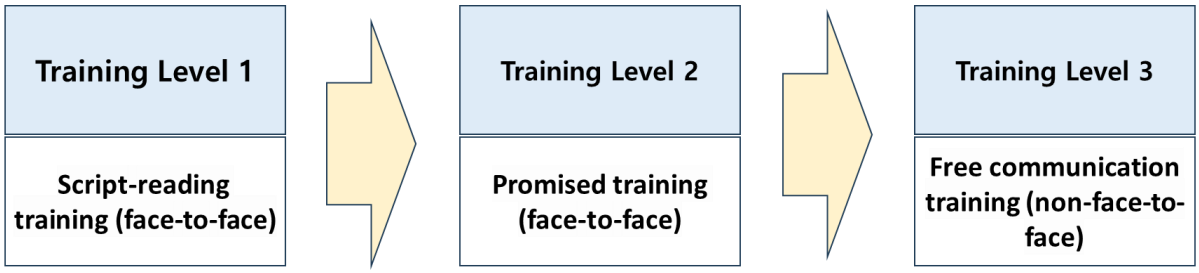
4.2. Development of communication training scenario for disaster safety network

In order to properly utilize the disaster safety and communication network, all disaster-related officials are trained by joining a single network to conduct communication training in order to achieve the pilot purpose by developing a communication training scenario led by the Ministry of Public Administration and Security. However, this communication training scenario needs to be improved because the host and the training headquarters are reflected in the training scenario, but in actual disaster situations, the host cannot lead the communication without radio communication. In addition, by conveniently training the communication training scenario not compatible with the national disaster management system, confusion may occur in actual situations[17][18]. In particular, a communication training scenario is presented in which the integrated support headquarters for the disaster site, which can be called the essential training subject, is omitted and the regional disaster management headquarters is not reflected. In view of this, through this study, an improved disaster safety communication training scenario for each type of disaster was developed and presented by taking into account the problems of the existing communication training scenario. There are a total of 47 newly developed communication training scenarios for 13 types of natural disasters such as earthquakes, 28 types of social disasters such as forest fires, and 6 types of new disasters such as crush accidents due to crowding. If communication training is conducted periodically by creating communication training scenarios tailored to each institution and region by applying these disaster safety communication network communication training scenarios for each type of disaster, the communication capability of the disaster safety communication network can be greatly improved [19][20].

4.3. Step-by-stage training method for Korean disaster safety network

Currently, the Ministry of Public Administration and Security has formed a training headquarters and periodically conducts communication training on the disaster safety communication network on a pilot basis. For the purpose of demonstration, training is conducted in a way that meets in one place and conducts face-to-face communication. Due to the nature of mutual communication of the disaster safety communication network, it is necessary to wirelessly communicate in a 1:1N manner in a situation where they are not visible from each other, but face-to-face training has no choice but to have limitations in achieving the training effect. Even so, there is inevitably a limit to the direct non-face-to-face mutual communication training by related officials who have not even undergone basic communication training. Therefore, the mutual communication training must be completed step by step[18]. To this end, the training plan for each stage of the disaster safety communication network is presented in <Figure 4>.

Figure 4. Korean disaster safety network stage training plan.



Depending on the training level, step-by-step training is conducted, and first, the first stage of training is the stage in which officials with no experience in communication training are trained in a script-reading manner by replacing training officials. Using the communication training scenario script presented in this study, training is conducted at the level of understanding 1:N wireless communication methods. Next, the second stage of training is to conduct face-to-face communication training currently being implemented by the Ministry of Public Administration and Security. This method is a step in which you can improve your understanding of each other and master wireless communication procedures by conducting communication training while face-to-face with each other. Finally, the third stage of training is to form a training control department to secure free communication capabilities through training control by messages. Through the above step-by-step training, disaster-related officials will be able to use the disaster safety communication network without difficulty.

5. Conclusion

No matter how well the Korean disaster safety communication network was established, it would be too bad if it was not used well in actual disaster situations. In fact, when a large number of casualties (159 deaths and 195 injuries) occurred due to crowding at the Itaewon Halloween Festival on October 29, 2022, the disaster safety communication network was used to enable rapid response between related agencies, but the disaster safety communication network was not utilized well. Even though the Gungpyeong 2 Underground Road in Osong, North Chungcheong Province, was flooded by heavy rain on July 15, 2024, the disaster safety communication network could not be used properly[21][22].

In order to deeply reflect on these points and properly utilize the well-established disaster safety communication network, all relevant officials should be familiar with the essential procedural terms for mutual communication between disaster safety communication networks presented through this study, and communication training procedural training should be conducted in accordance with the disaster safety communication network communication training scenarios for each type of disaster. Disaster-related officials, who are skilled in communication with

disaster safety communication networks in peacetime, will be able to respond to disasters by making good use of the disaster safety communication network even in actual disaster situations[23][24].

This study presented communication procedural terminology, communication training scenarios, and training methods for each stage of communication training so that disaster safety communication networks can be used well, and we hope that more practical research on how to utilize disaster safety communication networks will become more active in the future.

6. References

6.1. Journal articles

[2] Kim SG & Lee YJ. A Study on the Factors to Consider for Disaster Site Situation Assessment (MORT-TAC). *Journal of Digital Convergence*, 15(1), 117-127 (2017).

[3] Kim SG & Hwang GT. Study on Effective Field Control at Disaster Sites: Ferry Sewol Lessons of Sinking. *Journal of Digital Convergence*, 11(12), 1-12 (2014).

[8] Kang HJ. A Study on the Public Safety Long Term Evolution Disaster Communication Network. *Journal of Digital Contents Society*, 16(1), 43-51 (2015).

[9] Hong SH & Lee SR. The Present Status and Future of Disaster Safety Communication Network. *Journal of Advanced Navigation Technology*, 24(2), 115-120 (2020).

[11] Ryu JH. Gangwon-do Disaster Safety Comprehensive Plan Policy Direction. *Journal of Disaster Prevention*, 18(6), 22-31 (2016).

[14] Park SG. A Study on Model for Developing SOP with Public Safety Communications. *Journal of the Electrical and Electronic Society*, 23(1), 214-223 (2019).

[15] Lee SH & Kim CB. A Design on the Standard Inter Working Model for Improve Interoperability in Disaster and Safety Radio Network. *Journal of the Korea Communications Association*, 37(3), 259-266 (2011).

[18] Kim SG & Moon SC & Cheung CS & Lee JG. Study on the Establish of Drone Defense System(DDS) against Drone Threat. *International Journal of Military Affairs*, 4(2), 10-17 (2019). [Read More]

[19] Kim S & Cheung C. A Study on the Operation Key of Field Action Manual(FAM) that Works in Disaster Sites. *International Journal of Military Affairs*, 5(2), 34-42 (2020). [Read More]

[20] Kim S & Cheung C & Song E. A Study on the Manual of a Multiple-use Facilities to Work in the Crisis Situation. *International Journal of Human & Disaster*, 6(3), 35-44 (2020). [Read More]

[23] Kim S & Cheung C. A Disaster Situation Management Study using MORT-TAC. *Journal of the Society of Disaster Information,* 7(1), 1-11 (2022).

[24] Kim SG & Cheung CS. A Study on the Disaster Case using MORT-TAC. *International Journal of Human & Disaster*, 7(1), 1-11 (2022). [Read More]

6.2. Thesis degree

[7] Seo YS. A Study on the Optimization of Propagation Path Loss Model for Fire Fighting Wireless Communication Network of Urban Secondary Centers in Seoul. Seoul National University of Science and Technology, Master's Thesis (2018).

[17] Kim SG. A Study on the MORT-TAC of Disaster Site Situation Evaluation. Dongguk University, Doctoral Thesis (2017).

6.3. Books

[1] Ministry of National Defense. Defense Disaster Response White Paper. Armed Forces Printing Factory (2012).

6.4. Additional references

[4] Song MH. Development Trend of PS-LTE-based Disaster Safety Communication Network. Winter Comprehensive Academic Presentation of the Korea Communications Association (2022).
[5] https://www.fema.gov (2024).
[6] Kim SG & Lee YJ & Kim YA. Development of Training Scenarios for Disaster Safety Communication Networks by Type of Disaster. The Ministry of Public Administration and Security's Research Service Result Report (2023).
[10] Kim SH. Presents Materials on Understanding Disaster Safety Communication Networks. Korea Institute for Information and Communication Policy (2022).
[12] Ministry of Public Administration and Security. 1st Basic Plan for Disaster and Safety Communication Network (2021).
[13] Kim HK & Jang CK & Yi OY. Security Requirements for PS-LTE(Public Safety for LTE). Korean Communications Association Winter Comprehensive Academic Presentation Papers (2018).
[16] Ministry of Public Administration and Security, Disaster and Safety Communication Network Standard Operation Procedure (SOP) (2021).
[21] Newsis. Disaster Safety Communication Network to Play Separately… Transmission of Osong Infiltration Situation. Aortic Sclerosis. Dated July 18, (2024).
[22] Ministry of Public Administration and Security. Disaster Safety and Communication Network Playing Separately. The Contents of the Report on the 'Aortic Sclerosis' of the Osong Flood Situation are Different from the Facts. Disaster and Safety and Communication Network of the Safety Policy Office and the Press Correction Release (2024).

7. Appendix

7.1. Author's contribution

	Initial name	Contribution
Author	SK	-Set of concepts ☑ -Design ☑ -Getting results ☑ -Analysis ☑ -Make a significant contribution to collection ☑ -Final approval of the paper ☑ -Corresponding ☑ -Play a decisive role in modification ☑ -Significant contributions to concepts, designs, practices, analysis and interpretation of data ☑ -Participants in Drafting and Revising Papers ☑ -Someone who can explain all aspects of the paper ☑

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