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Disaster management and land administration in South Korea: Earthquakes and the real estate market

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ABSTRACT

In South Korea it was widely accepted that the Korean peninsula was safe from earthquakes. However, powerful earthquakes occurred in Gyeongju in 2016 with a magnitude of 5.8 and in Pohangin 2017 with a magnitude of 5.4. This highlighted the importance of disaster management. Earthquakes in Japan, New Zealand and Haiti have highlighted the fact that land administration seems to be interrelated with disaster management, especially relating to earthquakes. Therefore, this study reviews the relationship between disaster management and land administration conceptually and analyses South Korean disaster management in terms of that relationship, focusing particularly on earthquakes. Conceptually, the four elements of disaster management – mitigation, preparedness, response and recovery – are closely linked to the five elements of land administration, which are country context, land policy framework, land administration functions, land information infrastructure and sustainable development. Land administration contributes to disaster management in South Korea through measures such as the provision of earthquake-proofing information, tax cuts and conducting cadastral surveys. In the process of the study, the real estate market and the danger zone are discussed in terms of land tenure, value, use and development. In addition, the South Korean case is analysed from the perspective of modern history.

1. Introduction

In South Korea it was widely accepted that the Korean peninsula was safe from earthquakes. However, according to statistics by the Korea Meteorological Administration (KMA), around 1688 earthquakes occurred between 1978 and 2017. The average annual number of earthquakes was 19.2 between 1978 and 1998 and 67.6 between 1999 and 2017. In addition, a total of ten earthquakes with a magnitude of 5.0 or more occurred with seven of these having occurred since 2000. The most powerful earthquake occurred in Gyeongju in 2016 with a magnitude of 5.8, and the second most powerful occurred in Pohang in 2017 with a magnitude of 5.4. In 1940, 1964, 1983 and 1993, tsunamis caused by earthquakes in Japan also struck in South Korea (Um, 2008). Given the above, it is obvious that the Korean peninsula can in fact no longer be considered safe from not only earthquakes but also tsunamis caused by earthquakes.

With regard to the devastating 2011 earthquake in Japan, Kaidzu (2014) insists that cadastre played a crucial role in reconstruction and Sekine and Nanjo (2012) also point out the necessities of cadastral measurement because of missing or distorted land boundaries. Murai (2012) refers to RS and GIS for damage assessment. In New Zealand, earthquakes occurred in Darfield (2010) and Canterbury (2011). Grant et al. (2016) highlight the role land administration systems played in the phases of recovery and reconstruction. As for the 2010 earthquake in Haiti, Khouri (2011) argues that the absence of a cadastre and land use regulation made the situation worse in the process of reconstruction.

Aside from the above, Mitchell et al. (2017) analyse the role of land administration after earthquakes based on cases in Haiti, Nepal and New Zealand. Jha et al. (2010) study reconstruction after natural disasters, referring to five principle areas, one of which is the Reconstruction Approach. Land use plays a crucial role in this area. Poser and Dransch (2010) refer to land use planning in terms of mitigation in their study about flood damage estimation. Given the above, this study argues that land administration is interrelated with disaster management, especially in relation to earthquakes.

The purpose of this study is to analyse the relationship between disaster management and land administration, with specific focus on South Korean disaster management in terms of this relationship. In particular, this research focuses on earthquakes in the process of

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Table 1
Key factors of disaster management (adapted from Fajardo and Oppus, 2010: 343; Poser and Dransch, 2010: 3).

Classification	Content
Mitigation	·The attempt to reduce disaster risk by focusing on long-term measures for eliminating disasters · Includes risk identification, analysis and appraisal, as well as risk reduction by means of spatial planning, technical measures, and public awareness and education
Preparedness	·The development of an action plan for an upcoming disaster · Comprises emergency planning and training, as well as the installation and operation of monitoring, forecasting and early warning systems
Response	·The mobilisation of services and relief when disaster strikes · Response measures aim to maintain or re-establish public safety by search and rescue operations, and measures to provide for the basic humanitarian needs of the affected population
Recovery	· The restoration of the affected area to its previous state · Includes rapid damage assessment as well as rehabilitation and reconstruction

analysing South Korean disaster management. The research questions are: (1) *how is disaster management related with land administration conceptually?* and (2) *how has land administration affected disaster management in South Korea*? The first part focuses on reviewing the concepts of disaster management and land administration, and analysing their relationship. The study then moves on to examine earthquakes in South Korea and analyses South Korean disaster management.

2. Literature review

2.1. Disaster management

The concept of disaster management does not seem to be clearly clarified compared with other traditional disciplines. Henstra and McBean (2005, 304) argue that 'disaster management is a term that encompasses a range of policies and practices developed to prevent, manage and reduce the impact of disaster'. Poser and Dransch (2010, 2) define it as 'a process that includes activities before, during and after a hazard event that aim at preventing disasters, reducing their impacts and recovering from their losses'. The general ideas about disaster management tend to be similar, encompassing such concepts as prevention, management, reduction and recovery. However, it seems that Henstra and McBean (2005) is based on activities, while the approach by Poser and Dransch (2010) is based on processes. In addition, Pearce (2003) points out that the academic and practical history of disaster management is somewhat recent. Moe and Pathranarakul (2006, 398) argue that the terms 'disaster management' and 'emergency management' are used interchangeably and there are also similarities between disaster management and public project management. Considering the above, it is argued that disaster management is in the process of conceptual development.

Mitigation, preparedness, response and recovery are of paramount importance in disaster management, as shown in Table 1. The four factors have been reviewed in terms of process (Fajardo and Oppus, 2010; Poser and Dransch, 2010), conceptual elements (Henstra and McBean, 2005), essential activities (Moe and Pathranarakul, 2006) and a cycle (O'Brien et al., 2010). With respect to the four factors, O'Brien et al. (2010) insist that response is the key element in reality, while Pearce (2003) and Henstra and McBean (2005) argue that response and recovery were previously the most focused on but that the importance of mitigation is increasingly being highlighted. It is argued that the degree of the importance of each factor is interpreted differently depending on the type of disaster. For example, for earthquakes response could be seen as being more important than the rest of the factors because it is not easy to predict when earthquakes will strike and their degree of magnitude. On the other hand, floods or heavy rain can be predicted relatively successfully compared with earthquakes, hence preparedness could be more crucial than response in these situations. Aside from the four factors, Moe and Pathranarakul (2006) and Tsai and Chen (2010) refer to other approaches and elements in terms of disaster or risk management, as shown in Figs. 1 and 2 .

Since the late twentieth century, the concept of community-based disaster management (CBDM) has attracted attention (Pearce, 2003; Pandey and Okazaki, 2005; Chen et al., 2006). It was found that a top-down style of disaster management led to a lack of community participation (Pandey and Okazaki, 2005). Hence, disaster management became ineffective, which led to the development and introduction of CBDM as an alternative to top-down style disaster management (Pearce, 2003). Pandey and Okazaki (2005, 3) claim that 'the Community Based Disaster Management (CBDM) approach promoted a bottom-up

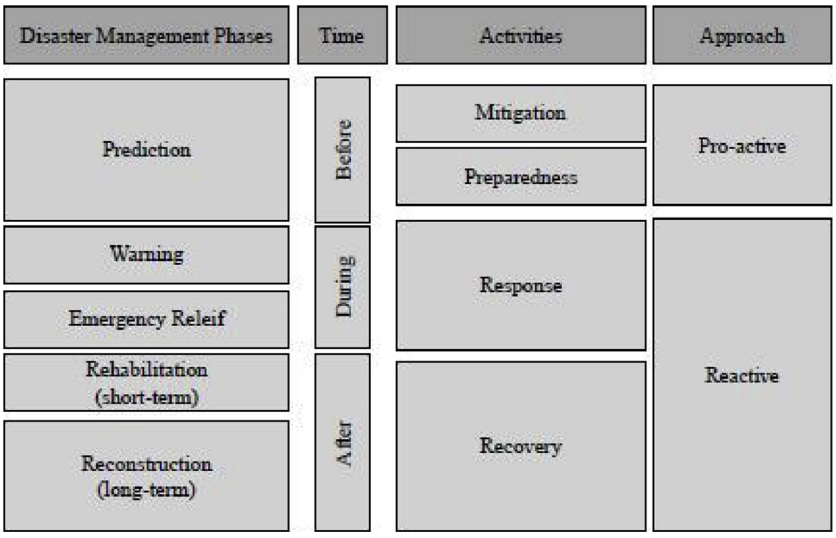


Fig. 1. Disaster management (adapted from Moe and Pathranarakul, 2006: 401).

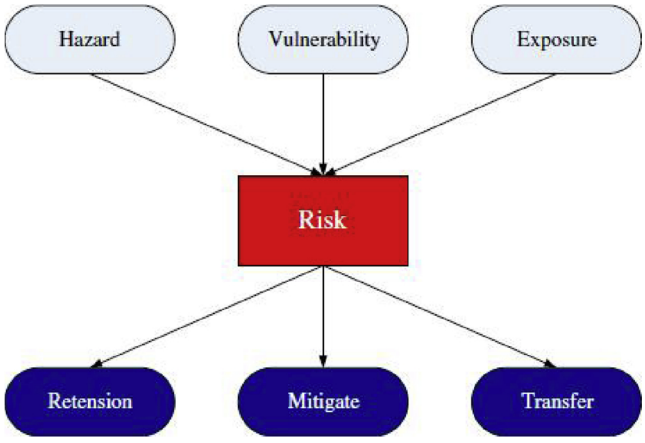


Fig. 2. Formation and management approach to disaster risk (adapted from Tsai and Chen, 2010: 472.

approach working in harmony with the top-down approach, to address the challenge and difficulties'. In light of this, it is argued that the role of not only the public sector but also diverse stakeholders is becoming increasingly crucial in disaster management.

Meanwhile, many researchers refer to the role of land systems in terms of disaster management, including land administration (Mitchell et al., 2017), land use (Poser and Dransch, 2010; Jha et al., 2010), zoning systems (Pearce, 2003; Henstra and McBean, 2005), land records (Khouri, 2011; Bhatta, 2016), movement of boundaries and their readjustment (Sekine and Nanjo, 2012; Kaidzu, 2014; Grant et al., 2016), GIS for damage assessment (Murai, 2012), influence on the real estate market (Grant et al., 2016) and land acquisition (Harris, 2016). This suggests that disaster management is linked to land administration.

2.2. Land administration

Many studies have reviewed and analysed the concept of land administration and management (Dale and McLaughlin, 1988, 1999; Larsson, 1991; Scott, 1998; Ting and Williamson, 2001; Alden Wily, 2003; Steudler, 2004; Enemark et al., 2005; Azad and Faraj, 2009; Lemmen et al., 2015).[1] Multidisciplinary research has been conducted in areas such as land governance (Alden Wily, 2003; Veldkamp et al., 2011), land administration for sustainable development (Williamson et al., 2010), post-conflict land administration (Unruh and Williams, 2013; Todorovski, 2016; Park and Kim, 2017), land management and state (Tilly, 1990; Scott, 1998; Park and Han, 2018) and disaster management and land administration (Mitchell et al., 2017).

Researchers mainly studying the concept or theory of land administration tend to be based in Europe and Oceania. Meanwhile, according to the United Nations, between 1974 and 2003 there were 363 recorded natural disasters in Oceania, 853 in Europe, 918 in Africa, 1667 in America and 2566 in Asia (Moe et al., 2007), demonstrating that in Europe and Oceania the frequency of occurrence of natural disasters is lower than in other continents. In addition, the academic history of disaster management is relatively short, as reviewed above. The academic trend of land administration coupled with the short academic history of disaster management might lead to relatively less attention being paid to the conceptual or theoretical relationship between land administration and disaster management.

Dale and McLaughlin (1988), Larsson (1991) and Enemark et al. (2005) have all designed land administration models, as shown in Figs. 3, 4 and 5 . The paradigm designed by Enemark et al. (2005) appears to be an upgraded version based on the arrangement by Dale and McLaughlin (1988): comparing the models reveals that the main elements overlap. The paradigm tends to approach land administration or management from the macro perspective, while the model by Larsson (1991), on the other hand, seems to be based on the micro perspective. In terms of multidisciplinary research, the paradigm appears to be relatively appropriate. Enemark et al. (2005) went on to describe the paradigm in more detail, as shown in Table 2.

2.3. Relationship between disaster management and land administration

Disaster management seems to be closely interrelated with land administration, while the weight of the components of land administration could be somewhat different depending on the phases of disaster management. In terms of mitigation, all the elements of land administration should be carefully taken into account. Depending on countries and regions, the type of disaster and its degree will differ. For instance, we can say Region A is vulnerable to floods because the region is located in geographically low areas, while Region B is vulnerable to tsunami because the region is located on the coast and earthquakes often occur nearby. The regional characteristics need to be considered and reflected in the organisational structure of land administration as well as in land policy-making. In addition, in danger areas the rights of landowners should be restricted to some extent, or strict regulations for land use and development should put be in place. Pearce (2003, 214) refers to 'zoning bylaws to avoid high-risk areas' and Henstra and McBean (2005, 304) also identify 'land-use management, such as zoning regulations which prohibit or regulate construction in hazardous areas'. Poser and Dransch (2010) also argue that land use planning contributes to disaster management in terms of mitigation and preparedness. Aside from this, an integrated real-time land and disaster information management system (IRTLDIMS) based on land information infrastructure can contribute to efficient land policy as well as disaster management policy. Ultimately, all related activities should be comprehensively considered and performed in terms of sustainability.

Given that preparedness focuses on a potential upcoming disaster, land information infrastructure plays a pivotal role. An upcoming disaster could be monitored and forecasted through IRTLDIMS based on land information infrastructure, which would provide fundamental data for early warning systems, and emergency planning and training. Land administration functions would play a major role in the process. Access to land and property or its use should be rapidly controlled based on the monitored and forecasted information from IRTLDIMS. Kaidzu (2014, 2) argues that 'cadastral records help [in] contacting stake holders on [the] land concerned and speed up preparation'. Kaidzu (2014) goes on to suggest that the promotion of cadastral survey in areas where progress has not been adequate is also vital in preparing earthquake response.

Response tends to be in line with preparedness in terms of land administration. Murai (2012) describes how in the 2011 earthquake and tsunami in Japan, the first tsunami struck at 3.45 pm, with the second following at 4.20 pm and the third at 5.26 pm. However, after the first and second tsunami, some people returned to their houses and died in the third tsunami as a result. This shows that even after a disaster has occurred, it is crucial to continuously monitor and forecast further disaster effects through IRTLDIMS with the support of land administration functions in order to mitigate secondary damage and

[1] UN/ECE (1996) defines land administration as 'the process of determining, recording and disseminating information about tenure, value and use of land when implementing land management polices' (Steudler, 2004, 372). This definition tends to be widely accepted (Molen, 2002; Steudler, 2004; Burns et al., 2006). Dale and McLaughlin (1999) and Alden Wily (2003) also provide definitions of land administration, though their approaches are somewhat different. In particular, Alden Wily (2003) suggests views on land administration and management from the African perspective. Dale and McLaughlin (1999); Steudler (2004) and Enemark et al. (2005) point out some of the key elements of land administration such as land tenure, land value, land use, land development and land planning. Scott (1998) and Azad and Faraj (2009) explore land systems from the economic or fiscal perspective.

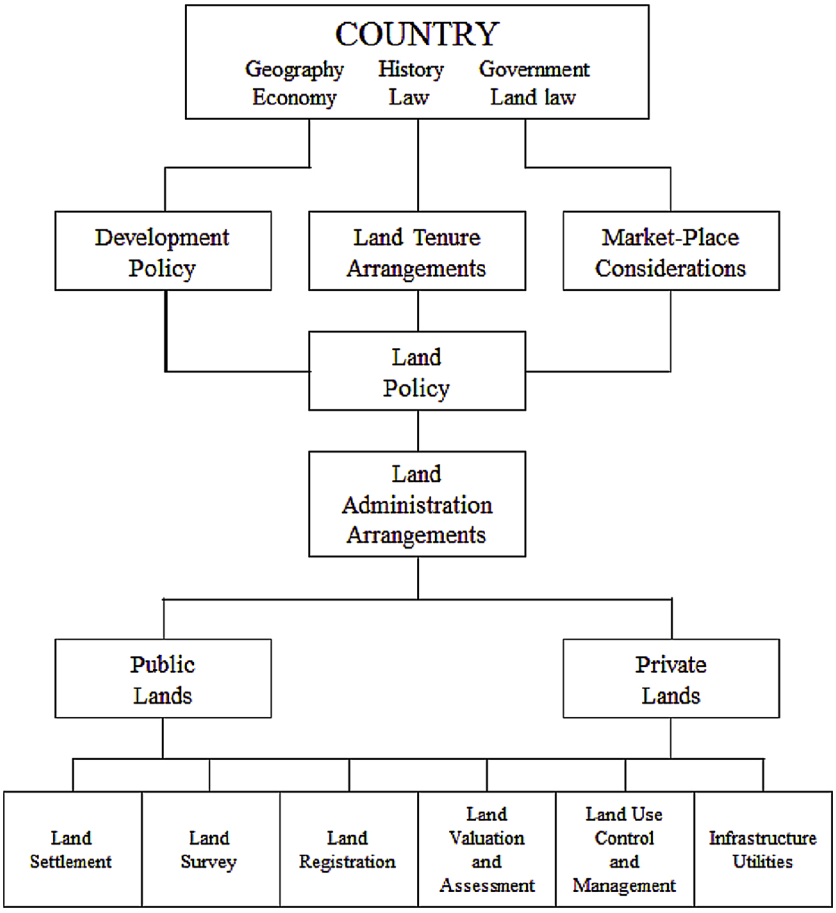


Fig. 3. Land administration arrangements (adapted from Dale and McLaughlin, 1988: 7).

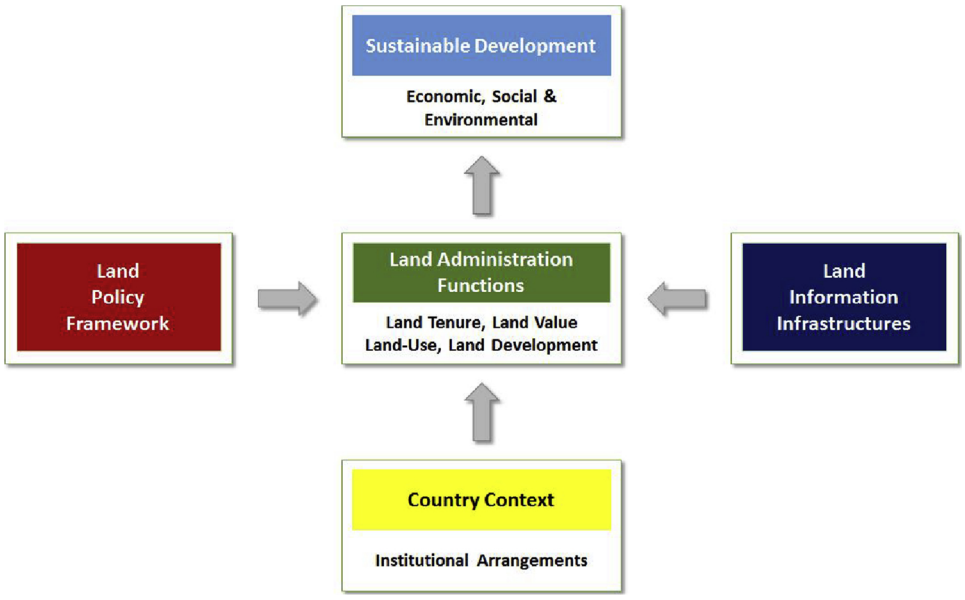


Fig. 4. The land management paradigm (adapted from Enemark et al., 2005: 53).

help people find safe shelter. Murakami (2016) also refers to the role of aerial surveys in terms of response. In the Japanese earthquake and tsunami of 2011, many buildings and concrete walls were swept away by the tsunami, making it difficult to recognise locations (Sekine and Nanjo, 2012). Aerial surveys would support location recognition during the rescue phase through comparison of aerial photographs before and after the disaster.

Many researchers point out the important role of land systems in the phase of recovery. Kaidzu (2014) discusses difficulties around the adjustment of land boundaries, interests and rights following the 2011 earthquake and tsunami in Japan. In particular, missing land owners caused issues regarding succession, acquisition and transaction, and it

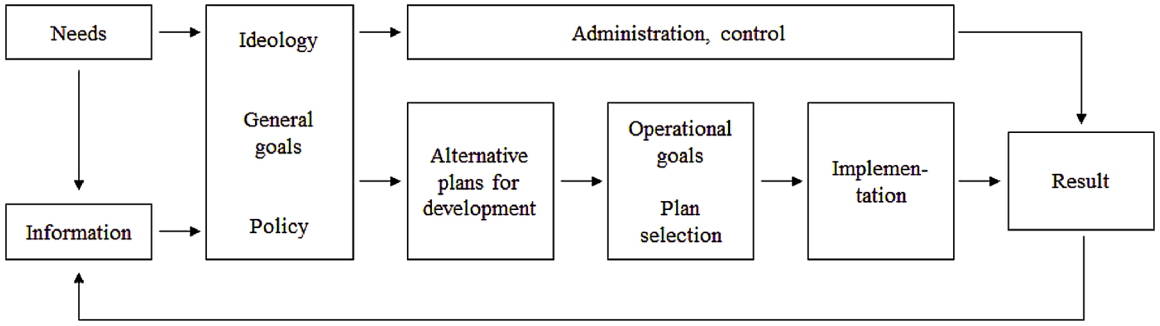


Fig. 5. Land management (adapted from Larsson, 1991: 2).

Table 2
The land management paradigm (adapted from Enemark et al., 2005:52–54)

Classification	Content
Country context	· The organisational structures for land management differ widely between countries and regions throughout the world, and reflect local cultural and judicial settings. · The institutional arrangements may change over time to better support the implementation of land policies and good governance
Land policy framework	· Land policy is part of national policy on promoting objectives including environment sustainability, economic development, social justice and equity, and political stability · Land policies may be associated with: security of tenure; land markets; real property taxation; sustainable management and control of land use, natural resources and the environment; the provision of land for the poor, ethnic minorities and women; and measures to prevent land speculation and to manage land disputes.
Land administration functions	· Land administration functions ensure proper management of rights, restrictions, responsibilities and risks in relation to property, land and natural resources · These functions include the areas of land tenure; land value; land use; and land development
Land information infrastructure	· The land administration functions are based on and are facilitated by appropriate land information infrastructures that include cadastral and topographic datasets and provide access to complete and up-to-date information about the built and natural environment.
Sustainable development	· Sound land management is then the operational process of implementing land policies in comprehensive and sustainable ways

was also difficult to contact land owners who had taken refuge elsewhere. Kaidzu insists that cadastre plays a crucial role in the reconstruction. Sekine and Nanjo (2012) also point out the necessity of cadastral measurement because of missing or distorted land boundaries. Murai (2012) refers to importance of establishment and maintenance of a GIS database. In particular, he underlines the importance of RS and GIS for damage assessment. In New Zealand, earthquakes occurred in Darfield (2010) and Canterbury (2011). Grant et al. (2016) note that earthquakes distort property boundaries and impact the real estate market, highlighting the role of land administration systems in the phases of recovery and reconstruction. Harris (2016) discussed the acquisition programme under which the government purchased properties in the most severely affected areas. As for the 2010 earthquake in Haiti, Khouri (2011) argues that the absence of a cadastre and land use regulation made the situation worse in the process of reconstruction, pointing out that the international community recognised land administration as one of the most important activities. Aside from the above, this study argues that it is necessary to understand recovery from the macro perspective. All activities for recovery should be based on sustainability and regional features should be reflected in the process, as reviewed above. In addition, land policy, administration and infrastructure should be taken into account carefully in the bigger picture.

Jayaraman et al. (1997) argue that the risk of disaster is higher in developing countries (Moe and Pathranarakul, 2006). However, unexpected or large-scale disasters could lead to huge damage even in developed countries. In Japan in 2011, natural disasters were compounded by a technological disaster when an earthquake, tsunami and then radiation leak caused tremendous damage, even though Japan is one of the world's most well-developed countries and the government must have had countermeasures for earthquakes and tsunamis in place due to the frequency with which such events occur there. However, they were not sufficient to prevent the disaster in 2011.

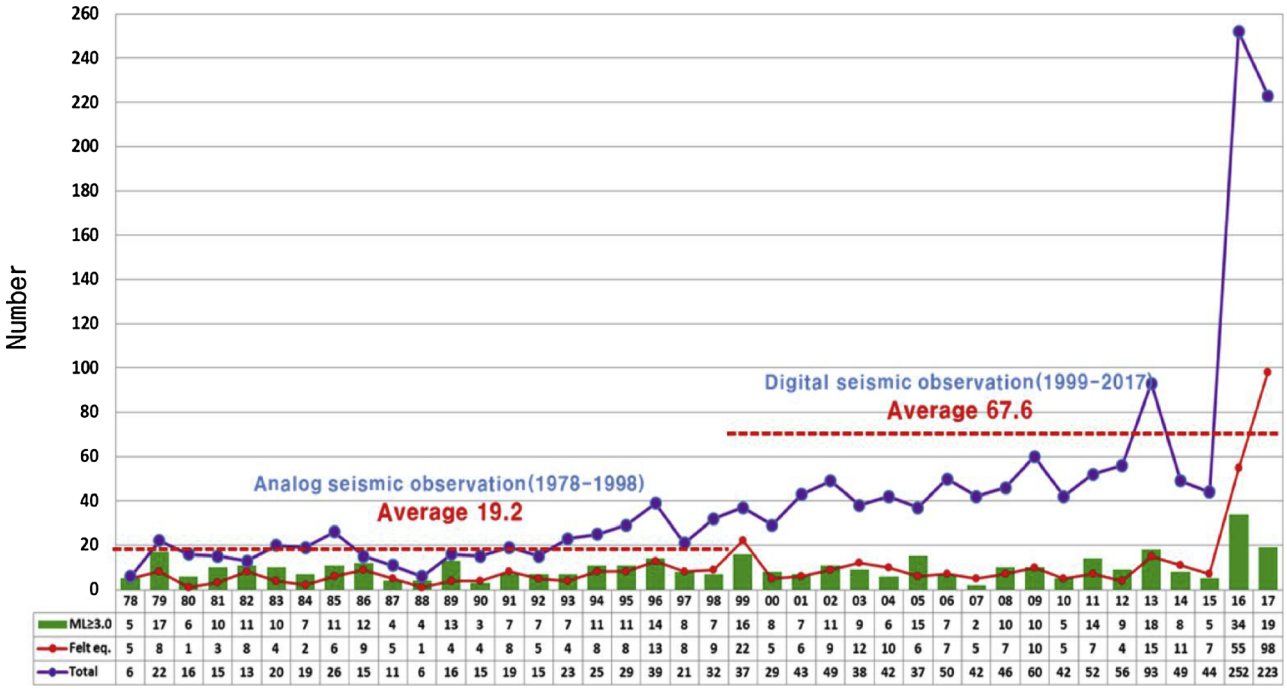
In South Korea it was widely accepted that the Korean peninsula was safe from earthquakes. However, large earthquakes occurred in Pohang in 2017 and Gyeongju in 2016, with magnitudes of 5.4 and 5.8, respectively. These magnitudes were smaller compared with the 2011 earthquake in Japan (9.0 M), but the earthquakes in South Korea in 2016 and 2017 nevertheless caused damage because earthquake countermeasures had not been fully and systematically prepared. In this context, this study intends to review earthquakes in South Korea and analyse South Korean disaster management in terms of the relationship between disaster management and land administration in the following section.

3. Disaster management relating to earthquakes and land administration in South Korea

3.1. Earthquakes in South Korea

Since 1978 the total number of earthquakes has increased, according to statistics by the Korea Meteorological Administration (KMA). Around 1688 earthquakes occurred between 1978 and 2017, with the average annual number of earthquakes being 19.2 from 1978 to 1998 and 67.6 from 1999 to 2017, as shown in Fig. 6. An earthquake with a magnitude of 5.0 in Hongseong in 1978 alerted people's attention to the danger of earthquakes (Hwang, 2012: 10). However, the magnitude of the majority of earthquakes remained lower than 3.0. Hence, people tended to believe that the Korean peninsula was relatively safe from earthquakes. To make matters worse, the importance of safety tended to be undervalued in South Korean society (Lim, 2016; Kim, 2016).

In South Korea a total of ten earthquakes with a magnitude of 5.0 or more occurred in the recorded period, with seven of these occurring after 2000. The most powerful earthquake occurred in Gyeongju in 2016 with a magnitude of 5.8, with the second powerful occurring in Pohang in 2017 with a magnitude of 5.4. Large-scale earthquakes occurred not only in areas close to Japan but also in remote areas, as shown in Fig. 7. In addition, tsunamis caused by earthquakes in Japan



	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ML≥3.0	5	17	6	10	11	10	7	11	12	4	4	13	3	7	7	7	11	11	14	8	7	16	8	7	11	9	6	15	7	2	10	10	5	14	9	18	8	5	34	19
Felt eq.	5	8	1	3	8	4	2	6	9	5	1	4	4	8	5	4	8	8	13	8	9	22	5	6	9	12	10	6	7	5	7	10	5	7	4	15	11	7	55	98
Total	6	22	16	15	13	20	19	26	15	11	6	16	15	19	15	23	25	29	39	21	32	37	29	43	49	38	42	37	50	42	46	60	42	52	56	93	49	44	252	223

Fig. 6. Earthquakes in South Korea (adapted from the Korea Meteorological Administration homepage).

also struck in South Korea in 1940, 1964, 1983 and 1993 (Um, 2008). Considering the above, it is obvious that the Korean peninsula is in fact no longer safe from earthquakes and also tsunamis caused by earthquakes.

3.2. Disaster management relating to earthquakes: government

The government policy and budget relating to earthquakes is summarised in Tables 3 and 4. According to the first earthquake prevention master plan (2015–19) drawn up by the government, around 92% of the total budget is allocated for earthquake-proofing countermeasures. Meanwhile, around 0.2% of the budget is allocated for response, recovery, education, training, research ability, industry promotion and support of infrastructure for earthquake prevention. After the 2016 earthquake in Gyeongju, the South Korean government increased the budget for expanding earthquake-proof objects, strengthening earthquake-proof reinforcement and strengthening the capacity of response to earthquakes (Press Release, 16 December 2016). In terms of disaster management, the government tends to concentrate on earthquake-proofing countermeasures. Considering that mitigation focuses on long-term planning to minimise disaster risk and preparedness focuses on plans for potential upcoming disasters, it seems that government policy relating to earthquakes is mainly designed and performed in terms of mitigation.

With respect to disaster management relating to earthquakes, the initial reaction immediately after earthquakes seems to be of paramount importance because it is relatively difficult to predict earthquakes, compared with other natural disasters such as typhoons and flooding. Therefore, from the perspective of the government, it would be important to strengthen response capacities in the short-term. As for mitigation, it seems desirable that it is reviewed and considered systematically in the long term because some issues are related to laws and systems that can take a relatively long time to implement. In the academic field, many researchers have noted the importance of land administration in the phase of recovery after earthquakes, as reviewed above. Considering those, the government policy and budget relating to earthquakes being so focused on mitigation could be somewhat controversial, depending on perspectives. Some may argue that the government has always been capable of responding to earthquakes. However, following the 2016 Gyeongju earthquake the government's homepage was down and the disaster message was issued late (Lee, 2016); this suggests the government did not have sufficient response capacities at least until the 2016 earthquake. On the other hand, considering that a large-scale earthquake had not occurred for some time before the earthquakes in 2016 and 2017, some may not find it so surprising that the government had difficulty responding to the earthquakes appropriately.

3.3. Disaster management relating to earthquakes: land administration

The government has amended related regulations to include information regarding earthquake-proofing as a new element in land documentation issued by the government (Press Release, 4 September 2017). According to an amendment of the enforcement regulations of the Licensed Real Estate Agency Act in June 2017,[2] earthquake-proofing information about buildings must be added in forms explaining objects of real estate agency. According to an amendment of the Regulations for Record and Management of Building Register in June 2017,[3] earthquake-resistant designs should be added in the building register. In an amendment of the Enforcement Decree of the Building Act in 2017 and 2018,[4] articles about procedures for structural safety and disclosure of seismic capacity were added.

> Mitigation of national taxes, local taxes, health insurance premiums, pension insurance premiums, communication fees, electric charge, etc., or other indirect support, such as delayed payment thereof, as prescribed by related statues. (Article 66, Framework Act on the Management of Disaster and Safety)
>
> The purpose of this ACT is to manage national land efficiently and to contribute to the protection of property rights of people by correcting descriptions registered in official cadastral records, but inconsistent with the actual conditions of land and by converting such

[2] 공인중개사법 시행규칙.
[3] 건축물대장의 기재 및 관리 등에 관한 규칙.
[4] 건축법 시행령.

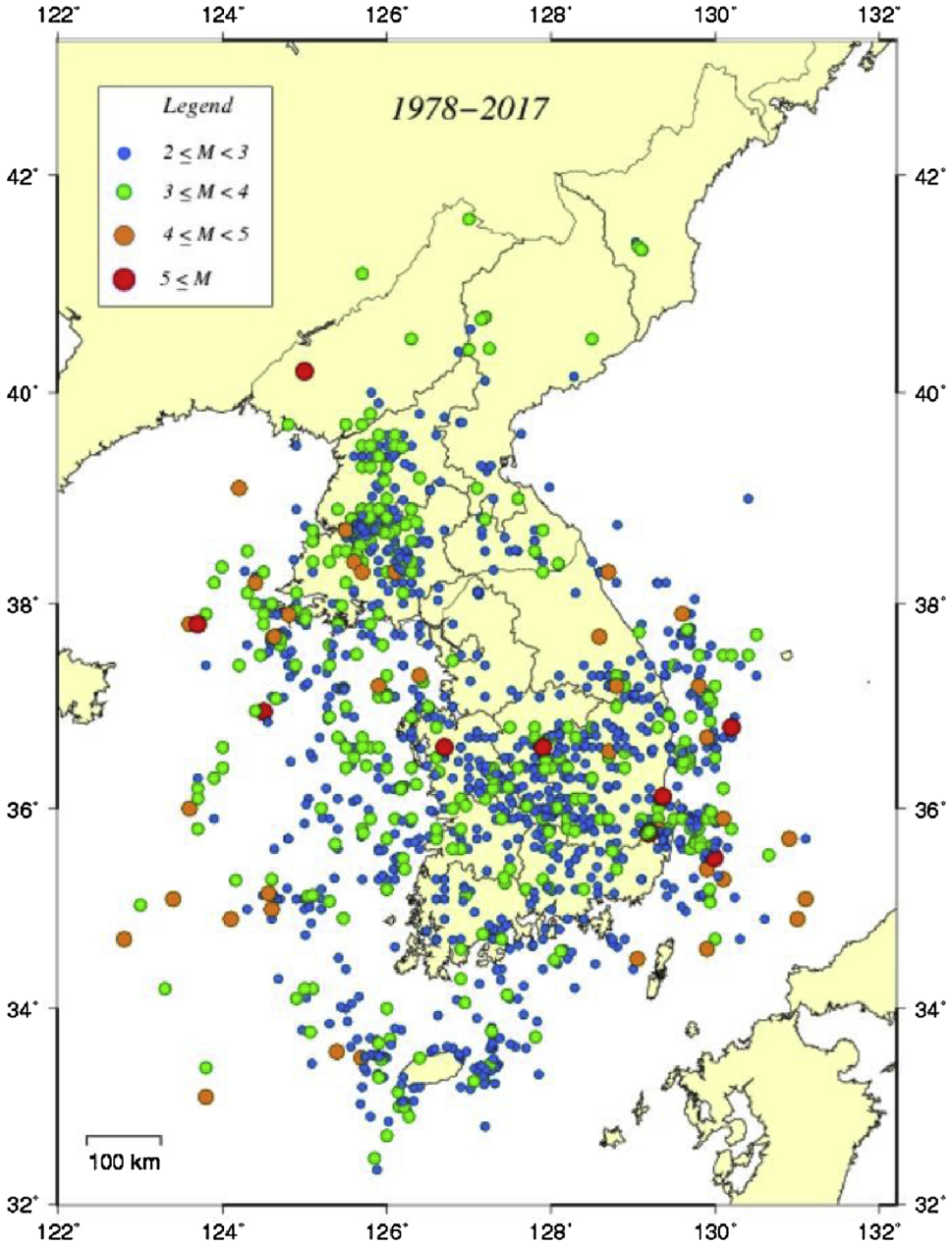


Fig. 7. Earthquakes in South Korea (adapted from the Korea Meteorological Administration homepage).

cadastral records embodied in paper into digital cadastral records. (Article 1, Special Act on Cadastral Resurvey)

Taxation is referred to in Framework Act on the Management of Disaster and Safety.[5] If a special disaster area is declared, people in that area would be eligible to receive support in terms of taxation relief. According to the Special Act on Cadastral Resurvey,[6] cadastral survey has been conducted to secure accurate land information under the Ministry of Land, Infrastructure, and Transport (MOLIT) since 2012.

There are also disaster management information systems relating to earthquakes, such as the national earthquake disaster response system, the liquefaction disaster assessment system, the disaster situation analysis judgement system, the national earthquake comprehensive information system and the national earthquake management monitoring system. These are linked by the Korea Integrated Seismic System (Seok, 2015). In addition, diverse databases from other ministries or local governments are shared for earthquake disaster management such as building registers, detailed soil maps, demographic information and so on (Hwang, 2012).

Research has also been conducted in developing the active fault map and seismic hazard map, funded by the National Emergency Management Agency (NEMA)[7] (Korea institute of geoscience and mineral resources (KIGAM, 2011). However, the results of the research have not been released, resulting in some doubts being raised in sections of the media (Song, 2017). Some suggest that, for instance, pro-nuclear power plant groups may have blocked the release because there are nuclear power plants around active faults. According to press interviews, the active fault map research tends to be passive because real estate price is one of the most important issues in South Korea and the map could influence it. In 2017 the Ministry of the Interior and Safety

[5] 재난 및 안전관리 기본법.
[6] 지적재조사에 관한 특별법.
[7] NEMA was abolished in 2014 and the task is conducted in MOIS.

Table 3
Government policy relating to earthquakes (adapted from Ministry of Public Safety and Security, 2014; Press Release (27.05.2016); Press Release (16.12.2016)).

Year	Key Content	Earthquake Details
2014	The first earthquake prevention master plan (2015–19) 1) Earthquake and tsunami observation systems 2) Setting upper criteria of earthquake-resistant design 3) Earthquake-proofing countermeasures for facilities (buildings/structures) 4) Tsunami countermeasures 5) Response & recovery 6) Education & training 7) Strengthening research ability & industry promotion 8) Support of infrastructure of earthquake prevention	9.0 M in Japan (Mar 2011)
2016 (May)	Key content in improvement plan of earthquake prevention 1) Rapid earthquake information propagation system 2) Earthquake-proofing countermeasures for public and private facilities 3) Strengthening response to earthquakes & expanding education and training 4) Scientific infrastructure for preparedness for earthquakes	5.8 M in Gyeongju (SK) (Sep 2016)
2016 (Dec)	Key content in improvement plan of earthquake prevention 1) Earthquake early warning system & strengthening safety training 2) Expanding earthquake-proof object & strengthening earthquake-proof Reinforcement 3) Expanding earthquake research and public–private cooperation 4) Strengthening capacity of response to earthquakes	5.4 M in Pohang (SK) (Nov 2017)

(M: magnitude/SK: South Korea).

Table 4
Budget of the first earthquake prevention master plan (2015–19) (adapted from The Ministry of Public Safety and Security, 2014:132–133)

The first earthquake prevention master plan (2015-2019)	Budget
1) Earthquake and tsunami observation systems	2.34%
2) Setting upper criteria of earthquake-resistant design	0.14%
3) Earthquake-proofing countermeasures for facilities (buildings/structures)	91.76%
4) Tsunami countermeasures	5.58%
5) Response & recovery	0.05%
6) Education & training	0.01%
7) Strengthening research ability & industry promotion	0.05%
8) Support of infrastructure of earthquake prevention	0.07%
Total	5,182,017,162

(Unit: US Dollar).

(MOIS) started the active fault map project with related ministries for accurate earthquake information (MOIS website).

Given the above, land administration contributes to disaster management. Meanwhile, the split of responsibility for disaster and land management in government could be seen as a potential risk. As noted above, it is necessary to reflect diverse regional features including natural disasters in the process of land policy-making, and close cooperation with stakeholders like CBDM is required. However, MOIS is in charge of disaster management in South Korea, while MOLIT is in charge of land management in the South Korean government ministry. MOLIT would want to invest resources in their own tasks and focus on land policy itself rather than disaster management. On the other hand, MOIS would not want other ministries or organisations to be deeply involved in their tasks because the responsibilities and scale of MOIS could be reduced. This split of responsibility could present an obstacle for cooperation in terms of sustainable land management as well as mitigation of disaster management.

4. Discussion

Land administration in South Korea contributes to disaster management through measures including the provision of earthquake-proof information, tax cuts and the cadastral resurvey project. However, the short academic history of disaster management, the lack of recognition of the importance of safety, the split of responsibility for disaster and land management in the government and (in)directly related industries and stakeholders are inherent as anxiety factors in terms of systematic disaster management as well as sustainable land administration.

In terms of the relationship between disaster management and land administration, real estate issues are worthy of attention. Grant et al. (2016) also point out the relationship between geotechnical classification of soil and property value in New Zealand. Real estate issues have been among the most important affairs in South Korea. Housing prices have been increasing by varying degrees for three decades, as shown Fig. 8, and the mean price of apartments in Seoul is around 622,000 dollars in 2018 (Korea Appraisal Board (KAB, 2018). According to the Financial Services Commission (FSC) and the Bank of Korea (BOK), return on investment in real estate, accounting for over 5%, is higher than stock accounting for 3.32% or savings accounting for 1.67% (FSC website). On the other hand, the total household loans stands at around

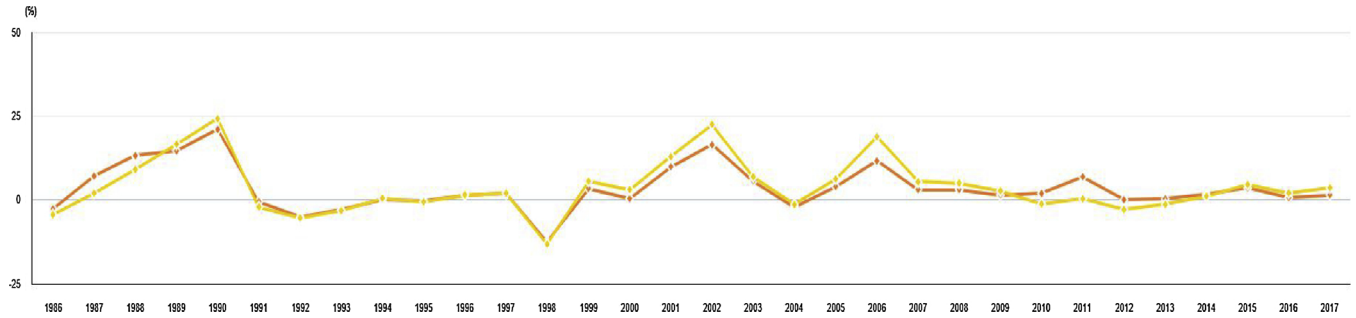


Fig. 8. The trend of rate of increase/decrease of housing sale prices in South Korea (adapted from e-state index homepage).

Table 5
Housing Sale Price Index (adapted from KOSIS website).

	Jan 2018	Jan 2017	Jan 2016	Jan 2015	Jan 2014	Jan 2013	Jan 2012	Jan 2011	Jan 2010	Jan 2009	Jan 2008
S. Korea	1.6	0.7	3.4	1.6	0.8	−1.9	6.0	1.7	2.2	4.8	5.0
Seoul	2.7	1.3	4.3	1.4	−0.4	−4.7	0.5	−1.7	2.1	7.6	8.9
Gyeongbuk	−1.0	−1.7	2.3	3.0	5.6	3.7	6.7	0.3	0.0	−1.8	2.2
Gyeongju	−0.5	−1.3	2.2	4.5	5.8	3.8	–	–	–	–	–
Pohang	−2.7	−2.4	5.5	5.5	7.7	5.7	3.5	0.3	2.1	−2.1	3.1

(Unit: % / Percentage change from the same month of the previous year / *Gyeongju* and *Pohang* belong to *Gyeongbuk*).

1193 billion dollars; 54% of this is accounted for by mortgage loans (FSC website). In line with this, arguments arise that suggest making and releasing the active fault map may be suppressed because if the map is released, it could influence this lucrative real estate market.

According to the Korea Statistical Information Service (KOSIS), since the 2016 earthquake the rate of change of housing sale prices in not only Gyeongju and Pohang but also Gyeongbuk has been lower than the average rate in South Korea, as shown in Table 5. In addition, the rate of change of transactions in the housing sales market in Gyeongbuk tends to be lower than the average rate of change in South Korea, as shown in Table 6. In particular, in 2016 and 2017 the difference between the rate of change in Gyeongbuk and the average rate of change in South Korea was around 20%. Diverse elements affect the real estate market such as economic conditions, government policy relating to real estate, and supply and demand of housing. Therefore, it cannot be argued that the above difference is solely a result of the 2016 Gyeongju and 2017 Pohang earthquakes. However, they must have affected real estate market in the region to some degree.

Meanwhile, this study argues that research about the active fault map and its release would not aggravate the real estate business. In the initial phase of the release, there might be some confusion in the market. However, the market would soon stabilise and the active faults would be considered as one of the elements determining real estate value like the New Zealand case that Grant et al. (2016) describe. If active faults are not investigated and the map is not released, the real estate market could become chaotic should other huge earthquakes occur later. Meanwhile, assuming that 54% of total household loans is accounted for by mortgage loans and property value significantly depreciates, this could be troublesome and alternatives or solutions need to be reviewed. However, regardless of the potential risk, the active fault map should be investigated and released to benefit the real estate market in the long term.

Aside from land value, reviewing land tenure, use and development is also worthwhile. There are diverse land rights such as use, control and transfer rights. In the danger zones, it may be necessary to restrict land rights depending on the degree of risk. For instance, if a landowner uses, leases or transfers private land in the danger zone to build a housing complex, heavy chemical industry complex or power plant, the government needs to place a restriction on such land activities. In the most serious danger zone, the government could expropriate land, as described by Harris (2016). However, the process of land compensation would be controversial. In South Korea, the government announces the official land value annually but their valuations do not reach the market price. If the official land value is adjusted to the market price, tax on land would have to be increased and people would resist. Therefore, not only disaster management and land administration but also other issues need to be taken into account comprehensively in terms of restriction of individual land rights.

Table 6
Housing sales market transactions (adapted from KOSIS website).

	Jan 2018	Jan 2017	Jan 2016	Jan 2015	Jan 2014
S. Korea	1.2	−6.6	7.7	−0.4	16.3
Seoul	13.3	−15.5	14.8	2.1	23.7
Gyeongbuk	−4.8	−25.5	−12.5	−13.6	23.5

(Unit: % / Percentage change from the same month of the previous year).

The lack of recognition of the importance of safety is worthy of attention. Even though big earthquakes have occurred in neighbouring states such as Japan and China, it was widely believed that the Korean peninsula was safe from earthquakes, and therefore disaster management systems for earthquakes did not operate properly in the 2016 Gyeongju and 2017 Pohang earthquakes.

The situation could be interpreted from the perspective of the modern history of South Korea. In 1945 Korea became independent from Japan. However, the southern part of the Korean peninsula was occupied by US forces, while the northern part was occupied by Soviet Union forces until the first South and North Korean governments were established separately in 1948. To make matter worse, the Korean War occurred between 1950 and 1953. Following independence, social stabilisation and post-war reconstruction were the main issues facing South Korean society until the late 1950s. In the situation that even survival was not guaranteed, disaster management would not have been importantly perceived.

From the 1960s and 1970s, economic growth was the key issue in South Korean society. During this period individual rights and safety seem to have been infringed and sacrificed under the purpose of economic growth, but individuals might have been willing to pay for economic growth. Even the sacrifices for economic growth might have been perceived as noble or an indication of self-esteem because South Korea achieved enormous economic growth during the period. Therefore, disaster management might have been considered as the individual's role.

In the 1980s democratisation was one of the main issues. Society tried to achieve democracy and end the military regimes that had lasted more than 20 years. In 1980 the May 18 Democratic Uprising took place in Gwangju. Martial law was declared and numerous casualties occurred. Eventually, with the continuous effort for democracy, a presidential election was held through a direct election system in 1987.[8] In such situations, disaster management would not have been a socially important issue.

From the late 1990s the main issue in society was to overcome the IMF economic crisis that occurred in 1997. In the early 2000s South Korea overcame this crisis, but the middle class collapsed and social polarisation became intensified. Therefore, it seems that not only the economy but also social welfare have been prioritised over safety and disaster management ever since.

There have been natural disasters such as typhoons as well as man-made disasters such as the collapse of the Sungsu Bridge in 1994, Sampoong Department Store collapse in 1995 and Daegu subway fire in 2003. However, it seems that concerns about disaster management did not last long socially. This demonstrates a lack of recognition of the

[8] In 1972 Park Chung-Hee adopted the indirect presidential election system through constitutional amendments designed to ensure a prolonged one-man rule, but he was assassinated in 1979. Chun Doo-Hwan took control of the regime in 1979 following a military coup and was elected as president based on the indirect presidential election system in 1980.

importance of safety.

Another interpretation is that the military tension between South and North Korea have influenced the lack of the concerns about disaster management to some extent. Since the division of Korea into South and North, North Korea has provoked South Korea continuously with major threats. In this situation, disaster management has been naturally perceived in terms of security and protection from the threats issued by the North Korean military. In this context, threats from disasters have been relatively less considered.

5. Conclusion

In this study the relationship between disaster management and land administration has been analysed conceptually and South Korean disaster management relating to earthquakes has been analysed in terms of this relationship. Theoretically, the four factors of disaster management – mitigation, preparedness, response and recovery – are closely interrelated with the five factors of the land management paradigm, which are country context, land policy framework, land administration functions, land information infrastructure and sustainable development. Meanwhile, there are diverse conceptual views on land administration and disaster management; this could lead to different analysis and interpretation of theoretical and practical relationship between disaster management and land administration.

Land administration contributes to disaster management in South Korea through measures such as the provision of earthquake-proofing information, tax cuts and cadastral resurvey. On the other hand, the short academic history of disaster management, the lack of recognition of the importance of safety, the split of responsibility for disaster and land management in the government, and (in)directly related industries and stakeholders could be referred to as anxiety factors.

In the process of this study, the real estate market was discussed. The argument arose that the creation and release the active fault map could influence this lucrative real estate market. However, this study argues that research for the active fault map and its release would in fact not aggravate the real estate business. There might be some confusion in the market in the initial phase of the release but the market would soon stabilise. Aside from land value, restricting land rights depending on the degree of risk in the danger zones in terms of land tenure, value, use and development was also reviewed. In addition, the lack of recognition of the importance of safety was analysed from the perspective of South Korean modern history.

For future study, considering the roles of land and spatial information in terms of resilience would be worthwhile. It is important to return to one's original state after a disaster, and there are diverse perspectives on resilience (Caputo et al., 2015). From this point of view, registration, maintenance and use of land and spatial information are deeply involved in resilience. Especially, given that the government manages land and spatial information through legislation, research on the role from the juridical perspective will be valuable in terms of improving resilience.

Disaster management systems have been re-established and improved by the government and people have paid more attention to disaster management since earthquakes in 2016 and 2017. However, comprehensive disaster management cannot be achieved and awareness of it cannot be changed in the short term. Without continuous effort, investment and attention, disasters will continue to occur as in the past. Eventually, social roles are important for sustainable disaster management as well as land administration. In this respect, it is necessary to build up the administrative structure with central and local government departments and diverse stakeholders. Aside from physical structure, continuous education for stakeholders is also necessary for social awareness. Through these efforts, the role of land administration could be strengthened and expanded in order to improve disaster management.

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